Satellite Symposium for the 2011 Annual Meeting of Cognitive Neuroscience Society

Regstister online at http://www.cnsmeeting.org/index.php?page=hillyard_symposium

COGNITIVE ELECTROPYSIOLOGY: SIGNALS OF THE MIND

A FESTSCHRIFT FOR STEVEN A. HILLYARD

Saturday, April 2, 2011, Grand Ballroom A

Hyatt Regency San Francisco

Schedule of Events

8:15 am Welcome and Overview
George R. Mangun, UC Davis

8:30 am Session 1: Attention in Sensation and Perception
Chair: **George R. Mangun**, UC Davis
Speakers: **David Woods**, UC Davis and Martinez VAMC - *Fishing for Attentional Modulation In a Sea of Stimulus Processing;* **Bernhard Ross and Terry Picton**, Rotman Research Institute, Toronto Neuronal Networks - *Underlying Selective Auditory Attention;* **Max Hopf**, University of Magdeburg, Germany - *Profiling the Spatial Focus of Visual Attention;* **Antigona Martinez**, UC San Diego - *The Role of Spatial Attention in Object-Based Selection;* **Ariel Schoenfeld**, University of Magdeburg, Germany - *Temporal Dynamics of Object-Based Attention;* **Matthias Mueller**, University of Leipzig, Germany - *Basic Mechanisms of Feature Based Attention in the Human Brain*

10:15 am Coffee Break

10:30 am Session 2: Attention and Cognitive Control
Chair: **Wayne Khoe**, UC San Diego
Speakers: **Steven J. Luck**, UC Davis - *Control of Visual Attention by Working Memory;* **John McDonald**, Simon Frazier University - *Control of Involuntary Cross-Modal Spatial Attention*; **Marty Woldorff**, Duke University - *Attentional Control of Visual Processing;* **Jyoti Mishra Ramanathan**, UC San Francisco - *Attentional Control of Multisensory Integration*

11:30 am Break for Lunch

1:00 pm Session 3: Development and Plasticity
Chair: **Wolfgang Teder**, North Dakota State University
Speakers: **Helen Neville**, University of Oregon - *Effects of Experience and Genes on Attention*; **Eric Courchesne**, UC San Diego - *Development and Autism;* **Vince Clark**, University of New Mexico - *Artificial Attention using Brain Stimulation*

2:00 Session 4: Integrative Mechanisms of Mind
Chair: **Michael I. Posner**, University of Oregon
Speakers: **Ken Paller**, Northwestern University - *Attention and Memory*; **Steve Hackley**, University of Missouri, Columbia - *Attention to Reward;* **Ed Awh**, University of Oregon - *Electrophysiological Markers of Individuation During Visual Selection and Storage*; **Robert T. Knight**, UC Berkeley - *Oscillatory Activity and Brain Networks*

3:00 pm Closing Remarks
Michael S. Gazzaniga, UC Santa Barbara

A Supplement of the Journal of Cognitive Neuroscience

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University of California, Davis
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This program was correct at the time of print.

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Saturday, April 2, 2011

7:00 am - 3:00 pm	Steven A. Hillyard Festschrift Onsite Registration & Pre-Registration Check In, Grand Ballroom Foyer
8:30 - 11:30 am	Steve A. Hillyard Festschrift, Grand Ballroom A
11:30 am - 12:30 pm	Festschrift Lunch Break
12:00 - 5:00 pm	Exhibitor Check-In, Pacific Concourse
12:30 - 3:00 pm	Steven A. Hillyard Festschrift continues, Grand Ballroom A
2:30 - 7:30 pm	Onsite & Pre-Paid Registration Check-In, Grand Ballroom Foyer
3:30 - 5:30 pm	Slide Session 1, "Working Memory and Executive Function," Grand Ballroom A Slide Session 2, "Perception and Action," Grand Ballroom B
5:00 - 7:30 pm	Exhibit Hall Open, Pacific Concourse
5:30 - 6:30 pm	Welcome Reception, Pacific Concourse
5:30 - 7:30 pm	Poster Session A, Pacific Concourse

Sunday, April 3, 2011

7:30 am - 7:00 pm	Onsite & Pre-Paid Registration Check-In, Grand Ballroom Foyer
8:00 am - 7:00 pm	Exhibit Hall Open, Pacific Concourse (Exhibit Hall closed from 10:30 am - 1:00 pm and 3:30 - 4:30 pm)
8:00 - 8:30 am	Continental Breakfast, Pacific Concourse
8:00 - 10:00 am	Poster Session B, Pacific Concourse
10:00 am - 12:00 pm	Symposium Session 1, "Ingredients of the Mind: A Psychological Constructionist Approach to Cognitive Neuroscience," Grand Ballroom A Slide Session 3, "Thinking," Grand Ballroom B
12:00 - 1:00 pm	Lunch Break
1:00 - 3:00 pm	Poster Session C, Pacific Concourse
2:30 - 3:00 pm	Coffee Service, Pacific Concourse
3:00 - 4:00 pm	Announcement of the Young Investigator Awards, Grand Ballroom 17th Annual George A. Miller Prize in Cognitive Neuroscience, Grand Ballroom
4:00 - 5:00 pm	GAM Reception, Grand Ballroom Foyer & Market Street Foyer
5:00 - 7:00 pm	Poster Session D, Pacific Concourse

Federal Funding: Training and Research Grant Opportunities

Monday, April 4, 12:00 - 1:00 pm, Grand Ballroom A

We will highlight current federal training, career development, and research funding opportunities available. NIH and NSF Program Directors will present an overview of relevant funding at each agency, the grant application, review and funding processes, and provide hints for successful grant writing along the way. Come learn how to advance your research with federal support!

Speakers: Kathy Mann Koepke, NICHD/NIH, Lynn Bernstein, NSF

Monday, April 4, 2011

8:00 am - 7:00 pm	Onsite & Pre-Paid Registration Check-In, Grand Ballroom Foyer
8:00 am - 7:00 pm	Exhibit Hall Open, Pacific Concourse (Exhibit Hall closed from 10:30 am - 1:00 pm and 3:30 - 4:30 pm)
8:00 - 8:30 am	Continental Breakfast, Pacific Concourse
8:00 - 10:00 am	Poster Session E, Pacific Concourse
9:00 - 9:40 am	YIA Special Lecture 1 - Michael J. Frank, Grand Ballroom A
10:00 am - 12:00 pm	Symposium Session 2, "New Perspectives of the Cognitive Functions of the Angular Gyrus," Grand Ballroom A Slide Session 4, "Emotion and Social Cognition," Grand Ballroom B
12:00 - 1:00 pm	Lunch Break
12:00 - 1:00 pm	Federal Funding Opportunities, Grand Ballroom A Elsevier Reviewers Workshop: A Guide to Best Practices for Journal Reviewers, Grand Ballroom B
1:00 - 3:00 pm	Poster Session F, Pacific Concourse
2:30 - 3:00 pm	Coffee Service, Pacific Concourse
3:00 - 5:00 pm	Symposium Session 3, "The neurobiology of human consumption: Integrating evidence across species and domains," Grand Ballroom A Slide Session 5, "Attention," Grand Ballroom B
5:00 - 7:00 pm	Poster Session G, Pacific Concourse

Tuesday, April 5, 2011

8:00 am - 5:00 pm	Onsite & Pre-Paid Registration Check-In, Grand Ballroom Foyer
8:00 am - 5:00 pm	Exhibit Hall Open, Pacific Concourse (Exhibit Hall closed from 10:30 am - 2:30 pm)
8:00 - 8:30 am	Continental Breakfast, Pacific Concourse
8:00 - 10:00 am	Poster Session H, Pacific Concourse
9:00 - 9:40 am	YIA Special Lecture 2 - Elizabeth Kensinger, Grand Ballroom A
10:00 am - 12:00 pm	Symposium Session 4, "The bilingual brain," Grand Ballroom A Slide Session 6, "Long-Term Memory," Grand Ballroom B
12:00 - 1:00 pm	Lunch Break
1:00 - 3:00 pm	Symposium Session 5, "Cognitive Neuroscience of Multimodal Person Perception," Grand Ballroom A Slide Session 7, "Language," Grand Ballroom B
3:00 - 3:30 pm	Coffee Service, Pacific Concourse
3:00 - 5:00 pm	Poster Session I, Pacific Concourse

Elsevier Reviewers Workshop: A Guide to Best Practices for Journal Reviewers

Monday, April 4, 12:00 - 1:00 pm, Grand Ballroom B

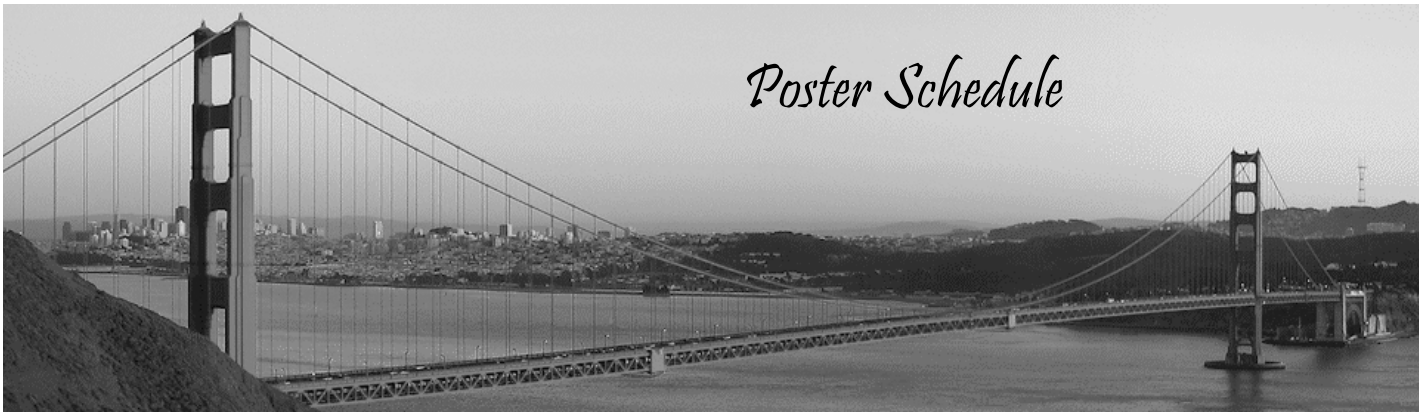
This workshop will cover the importance of the reviewer in the publishing process, the fundamentals of reviewing and an overview of the peer review process. It is aimed at new and junior reviewers for journals, and will address questions such as how to conduct a proper and thorough review, and why reviewers review. There will be some short presentations followed by a Q&A panel session.

Michael Rugg, Editor-in-Chief of Neuropsychologia and Distinguished Chair in Behavioral and Brain Sciences Co-Director, Center for Vital Longevity, Dallas, TX

Mark D'Esposito, Editor-in-Chief of the Journal of Cognitive Neuroscience and Professor of Neuroscience and Psychology & Director of the Henry H. Wheeler Jr. Brain Imaging Center at the University of California, Berkeley

Stephan Hamann, Emotion & Social Neuroscience Editor of Neuropsychologia and Associate Professor of Psychology at Emory University, Atlanta, GE

Toby Charkin, Executive Publisher, Cognitive and Behavioral Neuroscience Journals, Elsevier Ltd.



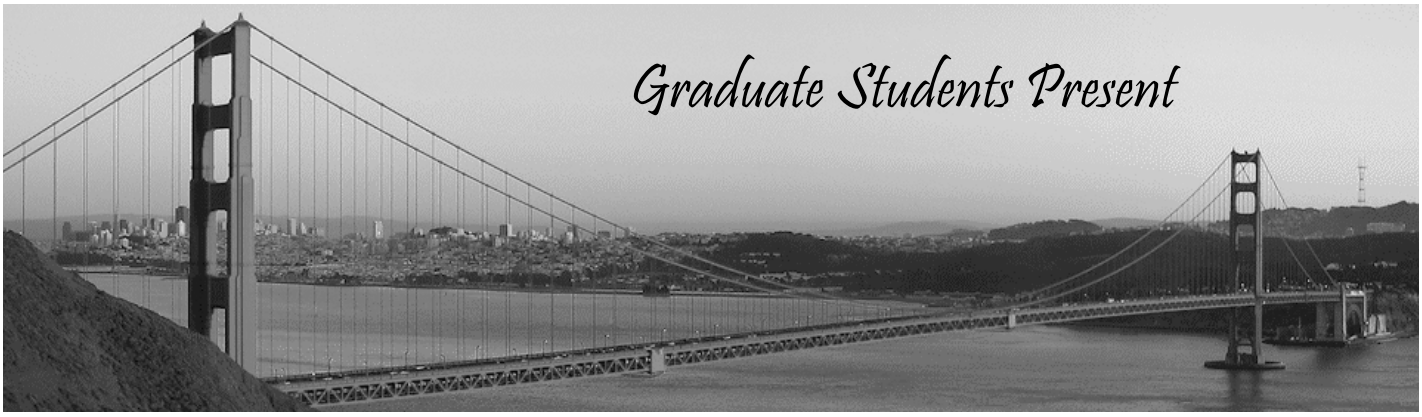
Poster Schedule

Poster sessions are scheduled on Saturday, April 2nd, Sunday, April 3rd, Monday, April 4th, and Tuesday, April 5th. The presenting author should be present at least one full hour during the assigned session and the other authors should be present during the remaining time to be available to answer any questions. The poster sessions are in the Pacific Concourse Exhibit Hall of the San Francisco Hyatt Regency Hotel. Badges are required in the Exhibit Hall at all times. The doors to the poster room will open at 5:00 pm on Saturday and at 7:30 am on Sunday - Tuesday for poster presenters only; you may post your materials on the board assigned to you at the scheduled time. The doors will close and lock for the evening at 7:45 pm on Saturday, 7:30 pm on Sunday and Monday, and 5:15 pm on Tuesday. There is no re-entry after this time. Do not leave personal items in the poster room.

The following times indicate when you are expected to set-up and take-down your poster. You should plan to be at your poster from the start until the end of your formal session. Please note that any posters not removed by "take-down ends" time will be discarded.

Poster Session	Date & Time	Set-up Starts	Session Begins	Session Ends	Take-down Ends	Keywords Included
A	Saturday, April 2	5:00 pm	5:30 pm	7:30 pm	7:45 pm	Perception & Action: Audition Perception & Action: Development & Aging Perception & Action: Motor Control Perception & Action: Multisensory Perception & Action: Other
B	Sunday, April 3	7:30 am	8:00 am	10:00 am	10:30 am	Perception & Action: Vision Thinking: Decision Making Thinking: Devlopment & Aging Thinking: Other Thinking: Problem Solving Thinking: Reasoning
C	Sunday, April 3	12:30 pm	1:00 pm	3:00 pm	3:30 pm	Attention: Auditory Attention: Development & Aging Attention: Multisensory Attention: Nonspatial Attention: Other Attention: Spatial Neuroanatomy
D	Sunday, April 3	4:30 pm	5:00 pm	7:00 pm	7:30 pm	Methods: Electrophysiology Methods: Neuroimaging Methods: Other Other Emotion & Social: Person Perception Emotion & Social: Emotion-Cognition Interactions

Poster Session	Date & Time	Set-up Starts	Session Begins	Session Ends	Take-down Ends	Keywords Included
E	Monday, April 4	7:30 am	8:00 am	10:00 am	10:30 am	Emotion & Social: Emotional Responding Emotion & Social: Development & Aging Emotion & Social: Other Emotion & Social: Self Perception Executive Processes: Development & Aging Executive Processes: Other
F	Monday, April 4	12:30 pm	1:00 pm	3:00 pm	3:30 pm	Executive Processes: Goal Maintenance & Switching Executive Processes: Monitoring & Inhibitory Control Executive Processes: Working Memory
G	Monday, April 4	4:30 pm	5:00 pm	7:00 pm	7:30 pm	Long-Term Memory: Development & Aging Long-Term Memory: Episodic
H	Tuesday, April 5	7:30 am	8:00 am	10:00 am	10:30 am	Long-Term Memory: Other Long-Term Memory: Priming Long-Term Memory: Semantic Long-Term Memory: Skill Learning Language: Syntax Language: Other
I	Tuesday, April 5	2:30 pm	3:00 pm	5:00 pm	5:15 pm	Language: Lexicon Language: Development & Aging Language: Semantic



GSP Awards

Seven to ten abstracts are chosen each year to receive the Graduate Students Present (GSP) award. Winners are awarded a $500 travel award and identified as GSP winners in the meeting program.

GSP presentations are specially-recognized slide presentations that are scheduled and presented with the topically organized slide sessions. As with standard slide presentations, each GSP student first author is given 15 minutes to present and discuss his or her research findings. GSP applications that are not accepted will automatically be considered for a standard slide or poster presentation.

2011 GSP Award Recipients

Congratulations to the following winners of the 2011 GSP Award.

Adam C. Riggall, University of Wisconsin-Madison
Category: Working Memory and Executive Functions

Thorsten Kahnt, Charité Universitätsmedizin Berlin, Humboldt-Universität Berlin
Category: Perception & Action

Sietske Kleibeuker, Leiden University, Netherlands
Category: Thinking and Decision Making

Diana Tamir, Harvard University
Category: Emotion and Social Cognition

Andre Mascioli Cravo, University of São Paulo
Category: Attention

Jared Saletin, University of California, Berkeley
Category: Long-Term Memory

Yuanyuan Chen, University of Cambridge
Category: Language

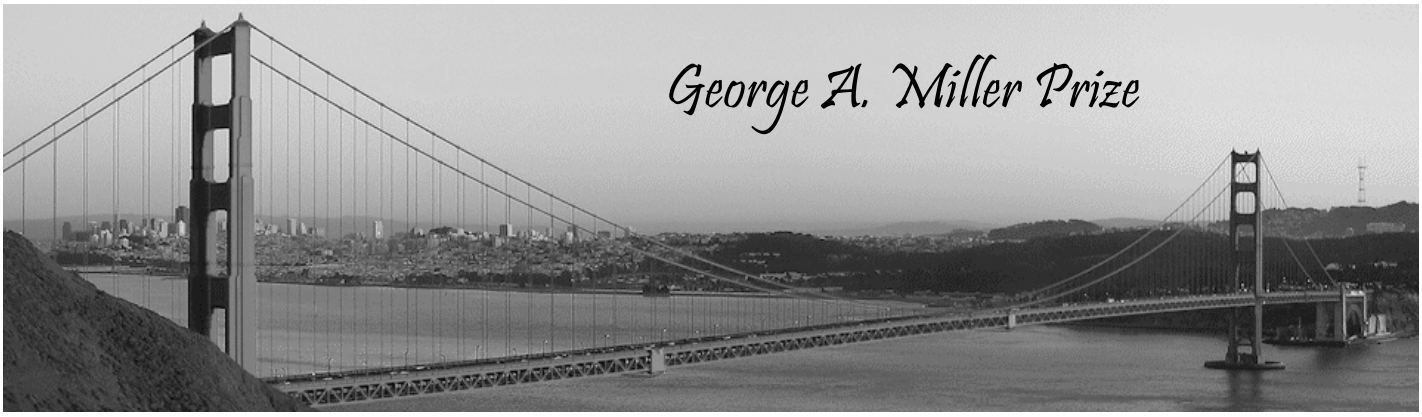
Student Association Social Night

Monday, April 4, 7:00 pm, Hyatt Regency Lounge

All students of the Cognitive Neuroscience Society are welcome. We will introduce everyone to each other and get acquainted before we head out around 7:30 pm to the Americano restaurant and bar (americanorestaurant.com).

There is no cover charge at the bar. Attendees are responsible for purchasing their own food and drinks (sorry, no funding :)) More information can be found on the Cognitive Neuroscience Society Student Association Facebook page (facebook.com/#!/group.php?gid=47806251696).

We look forward to meeting you!



17th Annual George A. Miller Prize in Cognitive Neuroscience

Sunday, April 3, 3:00 - 4:00 pm, Grand Ballroom

Reception to follow, 4:00 - 5:00 pm,
Grand Ballroom Foyer & Market Street Foyer

The Cognitive Neuroscience Society is pleased to announce the recipient of the 2011 George A. Miller Prize in Cognitive Neuroscience:

Dr. Mortimer Mishkin
National Institute of Mental Health

The George A. Miller Prize in Cognitive Neuroscience was established in 1995 by the Cognitive Neuroscience Society and the James S. McDonnell Foundation to honor the career contributions of George A. Miller to cognitive neuroscience. The first 10 years of the prize were funded by generous support from the James S. McDonnell Foundation.

The prize is awarded to the nominee whose career is characterized by distinguished and sustained scholarship and research at the cutting-edge of cognitive neuroscience. Extraordinary innovation and high impact on international scientific thinking should be a hallmark of the recipient's work.

Each year a call for nominations for the George A. Miller Prize is made to the membership of the society. The recipient is selected by a committee with the approval of the society. The prize winner attends the annual meeting of the Cognitive Neuroscience Society and delivers the George A. Miller Lecture.

Speech and auditory memory: How deep are their connections?

That speech and auditory memory may be deeply connected is suggested by two recent findings. The first is the momentous discovery of the FOXP2 gene, essential for oromotor articulation, an ability that appears to have evolved within the hominid line in just the last 300,000 years. The second finding, less momentous but more puzzling, is that monkeys (and dogs!) appear to be unable to store auditory stimuli in long-term memory, even though they are easily able to do so with visual and tactile stimuli, and even though they can retain auditory stimuli for the limited period of working memory. While seemingly unrelated, these two pieces of evidence in combination suggest the following, admittedly radical, proposal. Because natural acoustic stimuli fluctuate rapidly in time, their neural representations, unlike those of stationary sensory stimuli, cannot be packaged for long-term storage in the sensory system alone. Rather, such packaging requires the aid of the motor system, which is uniquely organized to chain-link rapid sequences. Humans have a set of 'recently' evolved or enlarged and enhanced temporo-frontal interconnections – the arcuate fasciculi – that automatically transform the temporally fluctuating acoustic sequence into a subvocal oromotor sequence This integrated acoustic-oromotor sequence serves as the stored representation of the sound. A corollary of this proposal is that a fluctuating sound can be stored in long-term memory only to the extent that it can be reproduced or mimicked by the oromotor system. Evidence will be presented that supports this corollary and, consequently, supports the notion that speech and auditory memory may be so critically dependent upon the other that they could only evolve together.

The Young Investigator Award in Cognitive Neuroscience recognizes outstanding contributions by scientists early in their careers. Two awardees are named each year and are honored at the annual meeting (immediately before the George A. Miller Award). Each winner received a $500 award and gives a 30-minute talk at the meeting.

The Cognitive Neuroscience Society is pleased to present this year's recipients of the Young Investigator Award.

Interactions Between Frontal Cortex and Basal Ganglia in Volitional Control

Michael J. Frank, Ph.D., Brown University

Monday, April 4, 9:00 - 9:40 am, Grand Ballroom A

The frontal cortex and basal ganglia interact intimately to support distinct aspects of motivated behavior, from motor to cognitive control. The dynamics of this circuitry have been explored via a series of inter-related computational models at multiple levels of description (neural to algorithmic). I will discuss recent attempts to combine these levels of modeling to generate and test predictions using a variety of cognitive neuroscience methods.

Michael J. Frank is Assistant Professor of Cognitive, Linguistic & Psychological Sciences in the Brown Institute for Brain Science at Brown University, where he directs the Laboratory for Neural Computation and Cognition. He received his PhD in Neuroscience and Psychology in 2004 at the University of Colorado. His research combines computational models with experiments to examine mechanisms of learning, decision making, working memory and inhibitory control in basal ganglia and frontal cortex. Models are tested and refined with a variety of methods, including patient populations, pharmacological manipulation, deep brain stimulation, electroencephalography, and genetics.

The Influences of Emotional Arousal and Valence on Episodic Memory

Elizabeth Kensinger, Ph.D., Boston College

Tuesday, April 5, 9:00 - 9:40 am, Grand Ballroom A

Dimensional models of emotion typically classify experiences based upon their arousal and valence. A large body of research has confirmed the role that arousal plays in guiding emotional memory, but it has been less clear to what extent valence influences the way in which an emotional experience is remembered. In this talk, I will present evidence that arousal and valence can each influence the types of details remembered about an experience, including neuroimaging evidence to suggest that many of the effects of arousal and valence relate to the processes engaged as an experience is initially encoded into memory.

Elizabeth A. Kensinger is Associate Professor of Psychology at Boston College. She received her Ph.D. in Neuroscience from MIT in 2003 and joined the faculty of Boston College in 2006 after completing a postdoctoral fellowship in the Dept. of Radiology at Massachusetts General Hospital and the Dept. of Psychology at Harvard University. Her research examines how the emotional content of information affects the processes that college-age and older adults use to remember information. She has co-authored over 70 articles and book chapters focusing on emotion and memory processes and how those processes change with aging, and she authored a book, Emotional Memory Across the Adult Lifespan, published with Psychology Press in 2009. Her research has been supported by grants from the National Institute of Mental Health, the National Institute on Aging, the National Science Foundation, the Dana Foundation, the Searle Scholars Program, and the American Federation for Aging Research.

Abstract Book

One copy of the printed program is available to each attendee. If you would like a second copy, please check in at the Registration Counter located in the Grand Ballroom Foyer of the San Francisco Hyatt Regency Hotel.

The program was assembled from a total of 997 submissions. Being presented are 5 symposia, 7 graduate student presentations, 49 slides, and 913 posters.

Every effort has been made to produce an accurate program. If you are presenting at the conference, please confirm your presentation time as listed in this program.

Audiovisual Equipment for Talks

LCD projectors (e.g., for PowerPoint presentations) will be provided in all rooms where spoken sessions are scheduled; however, computers will NOT be provided. Presenters must bring their own computers and set them up BEFORE the start of the session in which they are presenting. Facilities will be provided to allow several computers to be connected to the LCD projector in a room. Presenters are strongly encouraged to arrive in their scheduled symposium room a minimum of 30 minutes before their talks so that they know how to set up their equipment.

Automatic Teller Machines (ATM) & Banks

An ATM is located on the Atrium level of the hotel for your convenience.

Baggage Check

The Bell Desk, located with the Concierge, next to the front desk can assist you with luggage, packages and other carry-on's.

Business Center

The Business Center is located on the Bay Level adjacent to the Drumm Street windows, and is staffed Monday-Friday, 7:00 am - 8:00 pm and Saturday, 9:00 am - 2:00 pm.

The following services are available: Copy Services, Facsimile Services, On-Site Computers, Internet Access, Typing Services, and Shipping Services (UPS and FedEx). After staffed hours, the business center can be accessed with your room key to access computers with Internet and printing capabilities

Catering

Catering will be available during the conference and is included in the registration fee. Please refer to the table below for the catering times.

	Saturday, April 2	Sunday, April 3	Monday, April 4	Tuesday, April 5
Receptions	Welcome Reception *Exhibit Hall* 5:30 pm - 6:30 pm	GAM Reception *Grand Ballroom Foyer* 4:00 pm - 5:00 pm		
Continental Breakfasts		*Pacific Concourse Exhibit Hall* 8:00 am - 8:30 am	*Pacific Concourse Exhibit Hall* 8:00 am - 8:30 am	*Pacific Concourse Exhibit Hall* 8:00 am - 8:30 am
Coffee Breaks		2:30 pm - 3:00 pm	2:30 pm - 3:00 pm	2:30 pm - 3:00 pm

Certificate of Attendance

A Certificate of Attendance is located on the back of your badge. You will receive three receipts via email, two from CNS Meeting for registration and eBadge confirmation, plus one from PayPal for your payment. See also Receipts.

Chair People

Please ensure that you are available in your presentation room at least thirty minutes before the start of the session. Persons chairing sessions are asked to keep the talks on time.

Concierge

The Concierge Desk is located on the Atrium Level, adjacent to the Bellstand, open from 8:00 am to 8:00 pm each day. In addition, the iConcierge touch screen kiosk is located on the Atrium level in front of the Eclipse sculpture. The kiosk provides information on restaurants, shopping, nightlife, activities, tours and more and is available for use 24 hours per day.

Disclaimer

The Program Committee reserves the right to change the meeting program at any time without notice. Please note this program is correct at time of print.

Duplication / Recording

Photography, audiotaping, video recording, digital taping or any other form of duplication is strictly prohibited in the sessions and poster areas.

Exhibit Hall

The conference exhibit is located in Pacific Concourse Exhibit Hall of the San Francisco Hyatt Regency Hotel. Located in this room are the posters, exhibit booths, and catering. The Exhibit Hall is open at the following times:

Saturday, April 2	5:00 - 7:30 pm*
Sunday, April 3	8:00 - 10:30 am 1:00 - 3:30 pm 4:30 - 7:30 pm*
Monday, April 4	8:00 - 10:30 am 1:00 - 3:30 pm 4:30 - 7:30 pm*
Tuesday, April 5	8:00 - 10:30 am 2:30 - 5:00 pm*

*Please note the room will close and lock sharply; there is no admittance until the following day.

Future Meetings

Please join us for the 2012 Annual Meeting in Chicago, March 31-April 3. We welcome ideas for the location of the 2013 meeting and future meetings.

Hotel

The San Francisco Hyatt Regency Hotel is our exclusive Hotel for the CNS 2011 Annual Meeting. All CNS 2011 meeting events will be held at this hotel.

Hyatt Regency San Francisco, 5 Embarcadero Center, San Francisco, CA 94111

Hotel Fitness Center

The center is open to hotel guests 24 hours a day with state-of-the-art fitness equipment. For those who enjoy outdoor physical activity, it is 20 minutes to Baker Beach on the Pacific shoreline in the Presidio National Park, and a walking/jogging trail is located along the Embarcadero waterfront.

Hotel Restaurants

Eclipse Restaurant & Lounge The new Eclipse is the place to begin your San Francisco culinary adventure. Whether you are in the mood for quick refreshment or a full meal, the culinary offerings at Eclipse will satiate you with an unforgettable interpretation of global dining. Open for Breakfast starting at 6:30 am, Lunch, Dinner, and for Cocktails until 12 am.

Internet Access

Wireless Internet Access is available in all guestrooms. The cost for this service is $9.95 for 24-hours. This service is complimentary for guests who have selected our Business Plan package. The service is available in the public areas of the Atrium level only.

Internet Café

An Internet café will be located in the Grand Ballroom Foyer Area near the Registration counter. The Internet Café is available free of charge to attendees, exhibitors, and speakers and will be open during Registration hours on Saturday, 4/2 through Tuesday, 4/5 - when not needed for onsite registration purposes.

Saturday, April 2	2:30 - 7:30 pm
Sunday, April 3	7:30 am - 7:00 pm
Monday, April 4	8:00 am - 7:00 pm
Tuesday, April 5	8:00 am - 5:00 pm

Itinerary Planner

To help you plan your time at this year's meeting, a new online Itinerary Planner is available. The Itinerary Planner lets you construct a personal itinerary of events that you want to attend by selecting sessions from the meeting schedule. You can access the Itinerary Planner by logging into your CNS Meeting Account and clicking Plan My Itinerary.

Lost & Found

The meeting Lost and Found is located at the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel.

Meeting Rooms

The meeting rooms for symposia, slides, and special sessions are on the Ballroom Level of the San Francisco Hyatt Regency Hotel.

Message Center

Messages for meeting registrants can be left and retrieved at the Registration Counter on the Ballroom floor of the hotel. A bulletin board will be available for announcements and job postings.

Mobile Phones

Attendees are asked to silence their mobile phones when in sessions.

Name Badges

The San Francisco Hyatt Regency Hotel and Convention Center is open to public access. For security purposes, attendees, speakers and exhibitors are asked to wear their name badges to all sessions and social functions.

Entrance into sessions is restricted to registered attendees only. Entrance to the Exhibition will be limited to badge holders only. If you misplace your name badge, please go to the Registration Counter on the Ballroom floor of the hotel for a replacement.

Parking

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Poster Sessions

Poster sessions are scheduled on Saturday, April 2, Sunday, April 3, Monday, April 4, and Tuesday, April 5. The presenting author should be present at least one full hour during the assigned session and the other authors should be present during the remaining time to be available to answer any questions. The poster sessions are in the Pacific Concourse Exhibit Hall of the San Francisco Hyatt Regency Hotel. Badges are required in the Exhibit Hall at all times. The doors to the poster room will open at 5:00 pm on Saturday and at 7:30 am on Sunday - Tuesday for poster presenters only; you may post your materials on the board assigned to you at the scheduled time. The doors will close and lock for the evening at 7:45 pm on Saturday, 7:30 pm on Sunday and Monday, and 5:15 pm on Tuesday. There is no re-entry after this time. Do not leave personal items in the poster room.

Please see the Poster Schedule on page 4 for set-up and take-down times.

Receipts

You will receive three receipts via email, two from CNS Meeting for registration and eBadge confirmation, plus one from PayPal for your payment. See also Certificate of Attendance.

Receptions

The Welcome Reception will be held in Pacific Concourse Exhibit Hall, from 5:30-6:30 pm on Saturday, April 2, directly following the first slide sessions. Join us on Sunday, April 3 from 4:00-5:00 pm in the Grand Ballroom Foyer, for a reception honoring Mortimer Mishkin winner of the 17th Annual George A. Miller Prize in Cognitive Neuroscience directly following his talk.

Registration

The Registration Counter is located on the Ballroom floor of the San Francisco Hyatt Regency Hotel. The Registration Counter will be open at the following times:

Saturday, April 2	2:30 - 7:30 pm
Sunday, April 3	7:30 am - 7:00 pm
Monday, April 4	8:00 am - 7:00 pm
Tuesday, April 5	8:00 am - 5:00 pm

Scientific Sessions

Scientific sessions will take place from 3:00 pm on Saturday, April 2 until 5:00 pm on Tuesday, April 5, 2011.

Smoking

Smoking is not permitted in or outside any of the meeting rooms or the exhibition hall.

Speakers

All speakers must register and wear name badge to present. Please ensure that you are available in your presentation room at least thirty minutes before the start of the session. See also Audiovisual Equipment for Talks.

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Visit our exhibitors in the Pacific Concourse. Take the stairs down from the Registration area (Street Level).

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Sunday, April 3	8:00 - 10:30 am 1:00 - 3:30 pm 4:30 - 7:30 pm
Monday, April 4	8:00 - 10:30 am 1:00 - 3:30 pm 4:30 - 7:30 pm
Tuesday, April 5	8:00 - 10:30 am 2:30 - 5:00 pm

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Symposium Session 1

INGREDIENTS OF THE MIND: A PSYCHOLOGICAL CONSTRUCTIONIST APPROACH TO COGNITIVE NEUROSCIENCE

Sunday, April 3, 10:00 am - 12:00 pm, Grand Ballroom A

Chair: Kristen Lindquist, Harvard University; Massachusetts General Hospital; Martinos Center for Biomedical Imaging
Co-Chair: Lisa Feldman Barrett, Northeastern University; Harvard Medical School; Massachusetts General Hospital; Martinos Center for Biomedical Imaging
Speakers: Kristen Lindquist, Tor Wager, William Cunningham, Alexandra Touroutoglou

Cognitive neuroscience has traditionally sought the distinct neural bases of psychological categories like "thought," "attention," "memory" and "emotion." Yet growing evidence suggests that the mechanisms underlying these psychological categories are not as distinct as once thought. According to a psychological constructionist framework, complex mental categories are phenomena constructed from more basic psychological ingredients that correspond to functional networks in the brain. In this symposium, we will explore how a psychological constructionist approach to the mind can inform cognitive neuroscience. The four talks presented will be empirical examples of a psychological construction approach. Kristen Lindquist will present meta-analytic data demonstrating that emotion experiences and perceptions are comprised of activity in functional groupings associated with affect, categorization, language and executive attention. Next, Tor Wager will present findings demonstrating that the same basic brain system is involved in functions central to the "self," pain, and negative emotion. William Cunningham will next demonstrate how amygdala activity is dynamically shaped by the goals of a perceiver. Finally, Alexandra Touroutoglou will next present evidence demonstrating that both attention and emotion experience have a common ingredient in the anterior insula.

ABSTRACTS

PSYCHOLOGICAL INGREDIENTS IN EMOTION: FINDINGS FROM A META-ANALYTIC REVIEW OF THE NEUROIMAGING LITERATURE Kristen Lindquist[1,2], Tor Wager[3], Hedy Kober[4], Eliza Bliss-Moreau[5], Lisa Feldman Barrett[6,2]; [1]Harvard University, [2]Harvard Medical School/Massachusetts General Hospital/Martinos Center for Biomedical Imaging, [3]University of Colorado, Boulder, [4]Yale University School of Medicine, [5]University of California, Davis, [6]Northeastern University — Researchers have wondered how the brain creates mental states like emotions since the early days of psychological science. According to psychological constructionist views of emotion, the experience and perception of discrete emotion categories (anger, sadness, fear, etc.) emerge from the interplay of brain networks corresponding to general psychological ingredients like affect, language, categorization and executive attention. These ingredients are involved in constructing all mental states, not just emotions. This hypothesis stands in contrast to the hypothesis that the experience and perception of discrete emotion categories map consistently and specifically to increased activity in distinct brain regions (e.g., fear in the amygdala). In this talk, I will present findings from a recent meta-analytic summary of the human neuroimaging literature on emotion (summarizing studies published between 1993-2007). Overall, we found that brain regions involved in basic psychological processes like the instantiation of affective states, categorization of sensations, language and executive attention were active across discrete emotion experience and perception. Moreover, increases in activity in certain brain areas (e.g., the amygdala) did not correspond consistently or specifically to any emotion category (e.g., fear). The implications of these findings for a psychological constructionist view of emotion (and of the mind more generally) are discussed.

BRAIN-BODY COMMUNICATION IN STRESS AND PAIN: A VIEW FROM NEUROIMAGING Tor Wager[1]; [1]University of Colorado, Boulder — Whereas some cognitive scientists once thought of emotion as merely a "volume knob," the last 15 years have seen a resurgence in quantitative work on affective processes and their effects on behavior, perception, action, and physical and mental disorders. This research provides new insight into the brain representations of pain, pleasure, and affective/motivational context. These processes, and the brain circuits that underlie them are critical for healthy social and emotional functioning and are likely to play a central role in a variety of mental health disorders. In the first part of the talk, I draw on meta-analytic evidence to describe a vertically integrated, functional system that spans the medial prefrontal cortex, subcortical telencephalon, and brainstem. I will argue that this system is intimately involved in a number of functions central to the "self," including the representation of positive and negative outcomes, autobiographical memory, expectations about the future, and context-driven regulation of the autonomic and endocrine systems. In the second part of the talk, I present examples from recent functional neuroimaging studies that demonstrate a role for this system in the context-based regulation of pain, stress, and negative emotion by abstract contextual information. These studies suggest that medial prefrontal-brainstem pathways mediate placebo effects in pain, mental stress-induced changes in autonomic physiology, and successful self-generated regulation of emotion. These studies demonstrate that healthy function in circuits is likely to be important for a variety of mental health disorders and physical disorders with a neurogenic component.

MOTIVATIONAL SALIENCE: GOALS SHAPE AMYGDALA ACTIVATION William Cunningham[1]; [1]The Ohio State University — Recent research and theory has highlighted the dynamic nature of amygdala activation. Rather than simply being sensitive to a few limited stimulus categories (i.e., fear), amygdala activation appears to be dependent on the goals of the perceiver. Two studies provide evidence that the relation between valence and amygdala activity is dynamically modulated by evaluative goals. In the first, participants evaluated the positive, negative, or overall (positive+negative) aspects of famous people during fMRI scanning. When participants provided overall evaluations, both positive and negative names were associated with amygdala activation. When they evaluated positivity, positive names were associated with amygdala activity,

and when they evaluated negativity, negative names were associated with amygdala activity. In the second, the strategic means by which participants deal with threat were explored. Whereas Neuroticism-Volatility is proposed to be associated with the fight-flight-freeze system and a sensitivity for any cues of negativity, Neuroticism-Withdrawal is proposed to be associated with the behavioral inhibition system and a generalized tendency toward passive avoidance. Participants were presented with positive, negative, and neutral images and were required to approach (move perceptually closer) or avoid (move perceptually farther away) stimuli in different blocks of trials. Participants higher in Neuroticism-Volatility had increased amygdala activation to negative stimuli (whether they were approached or avoided), whereas participants higher in Neuroticism-Withdrawal had increased amygdala activation to all approached stimuli. These data provide support for the motivational salience hypothesis of amygdala function demonstrating that both the ends and means of goal pursuit are important for constructing an amygdala response.

FUNCTIONAL DIFFERENTIATION WITHIN THE ANTERIOR INSULA REVEALED BY INTRINSIC FUNCTIONAL CONNECTIVITY Alexandra Touroutoglou[1], Lisa Feldman Barrett[2,1]; [1]Harvard Medical School/Massachusetts General Hospital/Martinos Center for Biomedical Imaging, [2]Northeastern University — Task-related fMRI studies have suggested that anterior insula is implicated in both executive attention and affective experience. Specifically, the dorsal anterior insula is preferentially involved in cognitive control, whereas the ventral anterior insula is preferentially involved in the subjective experience of emotion. An important question is whether, in the absence of task, spontaneous activity of the anterior insula distinguishes the elementary 'ingredients' involved in cognitive control and emotion. To address this question, we used resting state functional connectivity analysis (18 young adults; mean age 22.09; 6 males) and examined the regions that are intrinsically correlated with the dorsal and ventral subregions of the anterior insula. Results showed that intrinsic blood-oxygen-level-dependent signal fluctuations within the dorsal anterior insula region are significantly correlated with signal fluctuations in frontal, parietal, and dorsal cingulate regions, as well as in dorsal putamen and ventromedial thalamus. The ventral anterior insula network, in contrast, is less extended than the dorsal anterior insula network and comprises regions within the ventral cingulate, medial orbitofrontal cortex, amygdala, ventral striatum and dorsolateral thalamus. Further, our data indicate that the magnitude of intrinsic connectivity within the dorsal and ventral anterior insula networks is differentially predicted by individual differences in cognitive control and affective experience, respectively. These findings suggest that anterior insula is intrinsically connected to functionally dissociated cortical and subcortical regions involved in executive attention and affect. The implications of these findings for our understanding of the psychological 'ingredients' of mental processes are discussed.

Symposium Session 2

NEW PERSPECTIVES OF THE COGNITIVE FUNCTIONS OF THE ANGULAR GYRUS

Monday, April 4, 10:00 am - 12:00 pm, Grand Ballroom A

Chair: Miriam Rosenberg-Lee, Stanford University
Co-Chair: Vinod Menon, Stanford University
Speakers: Vinod Menon, Jeffrey Binder, Roland Grabner, Roberto Cabeza

Functional imaging studies have highlighted the involvement of the angular gyrus (AG) in language, memory, attention and math cognition. Yet each domain ascribes a different function to this region including, speech comprehension, episodic memory retrieval, bottom-up attention, and verbally-mediated retrieval of math facts. Complicating this already busy landscape is the consistent finding that many task-related differences in the AG result from differences in deactivation, rather than activation. Indeed, the AG has been identified as the lateral node of the default mode network, a set of regions with tightly coupled activity at rest, which deactivate during cognitively demanding tasks. This symposium presents current research focused on understanding the cognitive functions of the AG in light of both activation and deactivation, as well as understanding its structural and functional connectivity. In language, the AG deactivates during the processing of nonsense sentences, but activates above resting baseline late in the processing of semantically congruent sentences, suggesting its function in semantic processing. In mathematics, confusion between operations induces above baseline activity in an arithmetic verification task, suggesting the AG is not specifically involved in the verbal storage of math facts, but instead involved in mapping between symbols and referents. In memory, greater AG deactivation during encoding improves performance; whereas, greater activation during retrieval is associated with better memory, consistent with the attention to memory hypothesis. This symposium will foster dialogue between these perspectives and attempt to define important open questions for future research into the cognitive functions of the AG.

ABSTRACTS

STRUCTURAL AND FUNCTIONAL CONNECTIVITY IN THE ANGULAR GYRUS Vinod Menon[1], Miriam Rosenberg-Lee[1]; [1]Stanford University — This presentation will discuss perspectives on the anatomy and connectivity of the angular gyrus (AG). One potential reason why multiple cognitive functions have been attributed to the AG is because its anatomy and connectivity are poorly understood. We present an overview of the anatomy of the human AG, in relation to its boundaries with the supramarginal gyrus, intraparietal sulcus, superior temporal cortex and anterior occipital cortex. We discuss the parcellation and nomenclature of Brodmann's area 39 (1909) and von Economo and Koskinas area PG (1925), and highlight more recent work from the Julich group on cytoarchitectonic mapping of the AG into two distinct areas: a posterior (PGp) and anterior (PGa). We examine functional heterogeneity of the AG during mathematical reasoning tasks and provide evidence for distinct activation and deactivation patterns in the PGp and PGa. We describe our investigations structure-function relations in the AG using multimodal brain imaging by combining resting-state fMRI connectivity with diffusion tensor imaging (DTI). Resting-state functional connectivity reveals that the PGp is strongly coupled with several nodes of the default mode network, including the ventral medial prefrontal cortex, the posterior cingulate and the hippocampus. In contrast, the PGa is tightly coupled with the inferior frontal gyrus and the caudate. Fiber tracking of DTI data provided converging evidence for distinct patterns of PGa and PGa connectivity. Our results point to heterogeneity in the structural and functional connectivity of the AG, and provide a framework for understanding the complex patterns of activation and deactivation reported in the AG.

THE ROLE OF ANGULAR GYRUS IN SEMANTIC PROCESSING Jeffrey Binder[1]; [1]Medical College of Wisconsin, Milwaukee, WI, USA — Many studies have implicated the angular gyrus in aspects of semantic processing. The AG shows stronger activation during semantic decision compared to phonological decision tasks on words. In both reading and lexical decision tasks, the AG shows stronger activation to words than to structurally matched pseudowords, and to concrete words relative to abstract words. In sentence comprehension studies, the AG shows a late increased response for sentences with coherent meaning compared to sentences that cannot be semantically integrated. Retrieval and manipulation of conceptual knowledge are not processes restricted to artificial language tasks, but are also core processes underlying planning, problem solving, and daydreaming, which are mental activities in which humans engage by default when attentional resources are not otherwise occupied. Thus, as with other components of the conceptual network, the AG shows relatively greater activation during conscious "resting" and passive states than during attentionally demanding, non-semantic

tasks. Anatomical characteristics of the AG are consistent with a role in high-level conceptual processing. The AG is located at an intermediate position between visual, somatosensory, and auditory sensory systems, suggesting a role as a high-level convergence zone, and is strongly interconnected with other heteromodal regions in temporal and prefrontal cortex, all of which have greatly expanded in the human relative to the nonhuman primate brain. The AG proper should be distinguished from cortex in the intraparietal sulcus, which forms the medial boundary of the AG but has very different connectivity and is implicated in attention, calculation, and other non-semantic functions.

THE ROLE OF THE AG IN MATHEMATICAL COGNITION Roland Grabner[1], Daniel Ansari[2]; [1]Swiss Federal Institute of Technology (ETH), Zürich, Switzerland, [2]University of Western Ontario, London, Canada — The angular gyrus (AG) has been implicated in mental arithmetic for several decades but its functional significance is still far from being understood. Much evidence has accumulated suggesting that it supports the retrieval of arithmetic facts from memory, and that activation differences between individuals of lower and higher mathematical competence reflect differential reliance on fact retrieval. Since the AG is part of the default mode network (DMN), its specific role in number processing has been questioned. Observations of higher AG activity during fact retrieval compared to more difficult task conditions have been interpreted to be due to the inverse relationship between DMN activity and task difficulty. In this contribution, two functional magnetic resonance imaging studies are presented challenging both accounts. The first study investigated the neural correlates of the associative confusion effect in arithmetic, i.e., the finding of lower performance in addition and multiplication verification tasks when presented solutions are correct responses in the other operation. This study revealed higher AG activity in the more difficult confusion problems (e.g., "4+3=12") compared to non-confusion problems (e.g., "4+3=10"). In the second study, individuals of lower and higher mathematical competence were found to differ in AG activity in a non-arithmetic task requiring the translation among multiple numerical representations. These results suggest that the function of the AG in mental arithmetic goes beyond retrieval of arithmetic facts and cannot be reduced to task difficulty effects. An alternative account of the functional significance of the AG, the symbol-referent mapping hypothesis, is proposed.

THE ROLE OF ANGULAR AND SUPRAMARGINAL GYRI IN MEMORY ENCODING AND RETRIEVAL Roberto Cabeza[1]; [1]Duke University, Durham, NC, USA — The contribution of parietal cortices to episodic memory is a fascinating scientific puzzle. On the one hand, parietal lesions do not normally yield severe episodic-memory deficits; on the other hand, parietal activations are seen frequently in functional neuroimaging studies of episodic memory. To account for this evidence, we have proposed an Attention to Memory (AtoM) model, which states ventral parietal cortex (VPC) mediate bottom-up attention to memories or memory cues, whereas dorsal parietal cortex (DPC) mediates top-down attention to memory task goals. The AtoM model is consistent with available patient and functional neuroimaging data, as well as with further functional subdivisions within VPC and within DPC. Within VPC, there is evidence that the supramarginal gyrus (SMG) and the angular gyrus (AG) have different anatomical connections, belong to different large-scale functional networks, and contribute differently to perception and memory tasks. The AtoM model can account for these dissociations under the assumption that they reflect different aspects of bottom-up attention. This thesis will be supported with evidence from parietal patients and functional neuroimaging studies of encoding and retrieval.

Symposium Session 3

THE NEUROBIOLOGY OF HUMAN CONSUMPTION: INTEGRATING EVIDENCE ACROSS SPECIES AND DOMAINS

Monday, April 4, 3:00 - 5:00 pm, Grand Ballroom A

Chair: Stephanie Preston, University of Michigan

Speakers: Morten L. Kringelbach, Brian Knutson, Stephanie D. Preston, Antonio Rangel

Humans make hundreds of consumption decisions everyday, with significant consequences for themselves (e.g., healthy vs. unhealthy dietary choices), others (e.g., donate to charity vs. consume), and the future (e.g., buy a hybrid vs. an SUV). A sizable body of behavioral evidence from psychology and economics suggests that individuals struggle during these choices to balance short- and long-term desires, often producing suboptimal decisions for the self, society, and the environment. This motivates a basic question in cognitive neuroscience: How does the brain make basic consumption decisions, and why does it often fail to make them optimally? This symposium showcases recent human functional neuroimaging (fMRI) work, informed by animal neuroscience and human clinical work, to address these questions. Morten Kringelbach explains the role of consciousness in decisions about rewards, focusing on differences among species and between fundamental (food and sex) and higher-order (money, material goods) consummatory rewards. Brian Knutson will discuss recent human neuroimaging work using whole brain predictive analyses to understand the distinct roles of the nucleus accumbens and medial prefrontal cortex in human decisions to purchase desired goods. Stephanie Preston will discuss data and theory on the proximate interrelationship between human acquisitiveness, reward processing, animal food storing, and human compulsive hoarding. Finally, Antonio Rangel will discuss recent research investigating differences in the brains of individuals that internalize the consequences of their decisions on the future and on others, and those that do not. Through an integrative view, we can better address widespread problems associated with our consumptive drives.

ABSTRACTS

THE ROLE OF CONSCIOUSNESS AND SATIABILITY ON CONSUMPTION DECISIONS Morten L. Kringelbach[1,2]; [1]University of Oxford, [2]Aarhus University — The advanced human ability to consciously predict the outcome of choices and actions confers our species with an evolutionary advantage. However, human conscious planning is a double-edged sword, as John Steinbeck pointed out as he described "the tragic miracle of consciousness" and how our "species is not set, has not jelled, but is still in a state of becoming." We have previously argued that conscious planning can help the classic problem in animal learning of how to optimize exploration and exploitation; where exploration is the time spent sampling the outcome of different behaviors and exploitation is the time spent using existing behaviors with known reward values. Progress has been made in characterizing the underlying brain networks, and the similarities and differences across rodents, monkeys, and humans. Data show that many regions in a distributed brain network are involved in the processing of reward and pleasure. In particular, we have begun characterizing the necessary and sufficient regions for implementing the underlying mechanisms of wanting, liking, and learning. Some of this processing is non-conscious (especially in sub-cortical areas), but I will describe how the human orbitofrontal cortex is important for interfacing complex, non-conscious and conscious cycles of pleasure (expectation, consumption, satiety and learning) with various sub-regions that code for distinct aspects of the cycle. I will focus on differences between the processing of fundamental (food and sex) and higher-order rewards (money), where the latter's lack of appropriate satiety mechanisms may provide clues to our current troubled state of over-consumption.

DISTINCT ROLES OF MESOLIMBIC DOPAMINE PROJECTION AREAS IN PURCHASING Brian Knutson[1]; [1]Stanford University — Converging comparative and neuroimaging research now suggests that the nucleus accumbens (NAcc) plays a key role in anticipation of diverse gains (e.g., social, edible, monetary), while a region of the medial prefrontal cortex (MPFC) integrates value across diverse dimensions (e.g., valence, probability, and time). These functions appear to inform and even predict choice. For instance, in a shopping task, we found that while NAcc activation covaried with the attractiveness of a product, MPFC activation specifically tracked its perceived monetary worth (Knutson et al., 2007). Activation in both brain areas predicted purchasing. To further explore the differences in their roles, we varied the order of product and price information in a follow-up study. Subjects either saw products first followed by associated prices, or prices first followed by associated products (Karmarkar et al., In Prep.). When price was presented first, NAcc response to the product continued to predict purchasing, but MPFC response to price did not. These anatomically-targeted findings were verified and extended in whole brain prediction analyses. This pattern of results is consistent with the notion that the NAcc plays a critical role in gain anticipation while the MPFC subserves value integration. Together, the findings highlight the distinct contributions of different mesolimbic projection regions to consumer choice.

THE ROLE OF DISTRIBUTED NEURAL SYSTEMS IN NORMAL AND PATHOLOGICAL ACQUISITIVENESS Stephanie D. Preston[1]; [1]University of Michigan — Americans spend much of their free time shopping and organizing their ever-accumulating piles of paper, clothes, and gadgets. Our acquisitive habits have real consequences for the environment, quality of life, and even mortality, but research has yet to directly investigate their neurobiological bases. Research on the neurobiology of normal purchasing, animal food storing, and human compulsive hoarding implicates the mesolimbocortical system in decisions to acquire rewards. However, acquisitiveness per se entails the acquisition and failure to discard a wide variety of even mundane goods. We investigated the neural bases of acquisitiveness using a functional neuroimaging task where participants acquired or discarded everyday items while maximizing personal preference or profit. The orbital frontal cortex (OFC) was involved across frames while the NAcc was not. Instead, the NAcc activity scaled during acquisition with real-world hoarding impairment, suggesting that even common items may acquire an "incentive salience" for acquisitive individuals. Personal decisions recruited midline frontal regions and were biased towards inexpensive, immediate rewards (e.g., candy, coins). Monetary decisions recruited executive regions and biased choice towards valuable, decorative items that were not particularly desired. Acquisition augmented OFC involvement and biased subjects towards shiny, metallic objects while discarding recruited the anterior cingulate and insula, and biased subjects towards utilitarian, "should" items. Across studies, acquisitiveness may reflect future-oriented concerns that directly enhance the perception of mundane but potentially useful items. By examining the human urge to consume, we can understand and abate problems associated with our seemingly bottomless need, in a context of diminishing natural resources.

THE NEUROBIOLOGY OF SELF-VERSUS-OTHER AND NOW-VERSUS-LATER DECISIONS Antonio Rangel[1]; [1]California Institute of Technology — Many important human decisions involve tradeoffs between rewards for the self and for others (e.g., sacrificing consumption to donate to a charity), and between immediate and delayed rewards (e.g., forgoing dessert to improve future health). A sizable body of evidence in psychology and economics has shown that it is difficult to make good decisions in domains involving these types of tradeoffs, and that individuals differ significantly on the extent to which they are able to incorporate the consequences of their actions on others and on the future. This raises two fundamental questions in decision neuroscience. First, what is different about the neural computations that are required for making decisions that involve these types of tradeoffs, as opposed to decisions that do not? Second, what is different about the brains of individuals who make good decisions in these domains? We have investigated these two questions in a series of human fMRI studies involving charitable donations, monetary transfers between individuals, dietary choices, and saving decisions. The findings from these studies suggest that, as is the case in simple choices, the ventromedial prefrontal cortex (vmPFC) encodes value signals to guide decisions. Furthermore, in individuals who are able to internalize future and other's benefits, areas such as the dorsolateral prefrontal cortex (DLPFC) and the temporo-parietal junction (TPJ) modulate the value the value signals in vmPFC so that they reflect these other dimensions. In contrast, this modulation does not take place in selfish and short-sighted individuals.

Symposium Session 4

THE BILINGUAL BRAIN

Tuesday, April 5, 10:00 am - 12:00 pm, Grand Ballroom A

Chair: Arturo Hernandez, University of Houston

Speakers: Mante S. Nieuwland, Katherine J. Midgley, Nicole Y. Wicha, Mairead MacSweeney

A bilingual is not two monolinguals in one head. Whereas bilinguals can for the most part express themselves in two languages, the capacity to do so is not identical in each language. In this symposium, we will present data that show the rich interaction between the learning of two languages and various other cognitive and linguistic processes. The first talk considers how native and non-native speakers of Basque process grammatical functions. Although the behavioral data are identical, the brain systems used are different. This suggests that the bilingual brain may come to achieve the same goal using a different configuration relative to monolinguals. The second talk considers the nature of vocabulary learning and its effect on semantic processing. Second language learning occurs rapidly in adults and leads to almost immediate changes in the word recognition system. Hence, the plasticity that is usually associated with children appears to extend at least into adulthood. The third presentation considers how L2 acquisition interacts with mathematical computations. These results show that mathematics is sensitive to the language in which it was learned. This coding may remain language specific even when that language becomes less proficient. The fourth and final talk considers how deaf bilinguals process their two languages: one spoken and the other signed. Despite gross differences in the articulators used to produce these languages, research suggests that they engage broadly similar neural systems. What emerges from this literature is a complex and interesting set of relationships between language, cognition and the particular brain areas devoted to these functions.

ABSTRACTS

BRAIN REGIONS SUBSERVING GRAMMATICAL PROCESSING: EVIDENCE FROM NATIVE AND PROFICIENT NONNATIVE BASQUE SPEAKERS Mante S. Nieuwland[1], Andrea E. Martin[1], Manuel Carreiras[1]; [1]Basque Center on Cognition, Brain and Language — Quantitative and qualitative differences in native and nonnative sentence processing may surface especially around linguistic parameters that are not shared between L1 and L2. This could mean that even between proficient native Spanish speakers of Basque and native Basque speakers, quantitative and/or qualitative differences exist in processing related to the Basque case system, which is fundamentally different from that of Spanish, but not in processing related to the number agreement, which occurs in both languages. In an event-related FMRI experiment, we tested this hypothesis by examining the cortical networks involved in Basque sentence processing in native Basque speakers and highly proficient native Spanish speakers of Basque. Participants read sentences containing case violations or number violations and correct sentences while performing an acceptability judgment task. Preliminary results (6 nonnative and 18 native speakers) suggest that whereas participants were more accurate for case violations than for number violations or correct sentences, the

two groups did not show any behavioral differences. In native speakers, case violations elicited relative activation increases compared to correct sentences in the inferior parietal lobules, the posterior cingulate and in the precuneus, while number violations elicited additional activation increases in left middle and inferior frontal cortex consistent with reports for morphosyntactic agreement errors. The nonnative speakers showed roughly similar activation patterns but with additional effects in medial prefrontal cortex. While more data for nonnative speakers is needed, the current patterns of results suggest that they achieve the same behavioral outcome via differential neural recruitment.

EARLY VOCABULARY ACQUISITION OF L2 LEADS TO RAPID CHANGES IN ELECTROPHYSIOLOGICAL MEASURES Katherine J. Midgley[1,2], Laura N. Soskey[1], Jonathan Grainger[2], Phillip J. Holcomb[1]; [1]Tufts University, [2]Laboratoire de Psychologie Cognitive — How fast does the brain of second language (L2) learners adapt to the process of learning? And are these processes reliant on the same neural signatures as those used in a first language (L1). In order to explore whether the mechanisms involved in word recognition in beginning L2 learners differ from those of more proficient L2 users and how these mechanisms evolve during beginning learning we conducted three experimental ERP sessions at intervals throughout a semester with participants that were L1 monolingual English-speakers enrolled in an introductory Spanish course. Our results replicated previous studies that show greater negativities in the N400 epoch to L1 items t han to L2 items. Additionally the differences varied significantly across sessions in that amplitudes in the traditional N400 epoch to L2 items became more negative over the course of the semester. We propose that the increasing N400 amplitude to L2 items results from an increase in L2 orthographic and semantic connectivity in the mental lexicon due to L2 learning. Our results suggest that these changes happen quickly and early on in L2 acquisition.

ARITHMETIC REPRESENTATIONS AND THE BILINGUAL BRAIN Nicole Y. Wicha[1], Elena Salillas[2]; [1]University of Texas at San Antonio, [2]Basque Center on Cognition, Brain and Language — The bilingual brain provides a unique test of the debated math-language connection with multiple language mappings for a single arithmetic concept. It has been argued that exact mathematical concepts, like simple multiplications, are represented in a language-specific format and are therefore accessed more efficiently in the language in which they were learned. However, factors like language proficiency play an important role in bilingual language processing, affecting the efficiency of retrieving and using words. By inference, language proficiency could similarly affect accessing and processing language-dependent arithmetic concepts. We measured event related potentials to determine if early learning plays a critical role in the math-language connection in the adult. Adult bilinguals proficient in Spanish and English, who learned arithmetic in only one language during childhood, made correctness judgments on simple multiplication problems; the problems were presented as digits or number words in Spanish or English, and the solutions were either correct (2x3=6), or related (15) or unrelated (13) as factors of the operands. Our results show that arithmetic facts are organized into strong associative memory networks for the language in which arithmetic was learned (LolA), with a weaker network in the other language (Ll2). Although frequency of use changed overall processing efficiency in Ll2, it did not strengthen the spread of activation to related concepts. In addition, Ll2 elicited quantitatively and qualitatively different responses compared to LolA and digit formats. Finally, high proficiency in Ll2 and Ll2 dominance did not change the networks for arithmetic in either language. Thus, we demonstrate that a connection between language and math is established at the time of learning and maintained into adulthood, independent of natural language use. These findings highlight that bilinguals should not be treated as two monolinguals in one brain, and may have important implications for teaching and testing bilingual children and young adults.

THE DEAF BILINGUAL BRAIN Mairead MacSweeney[1]; [1]Institute of Cognitive Neuroscience, University College London — Although many deaf people use a signed language as their preferred language, they all must live in a hearing world and engage with spoken language via speechreading and reading. Therefore, all deaf people may be regarded as bilingual to some degree. Previous studies examining hearing speakers and deaf signers separately have established that broadly similar neural systems are recruited to process speech and sign (see MacSweeney et al., 2008). In this talk, I will present data exploring the neural basis of signed and spoken language processing within the same deaf individuals. I will report findings from studies in which we have compared speechreading (lipreading) with the perception of signs and also reading with fingerspelling (words spelled out using a manual alphabet). In particular, I will focus on results from an explicit sublexical (phonological) awareness task. This consisted of rhyme judgements for words (written or picture stimuli) and 'location' judgements for signs (signs or picture stimuli) – location being one of the sublexical parameters of signs. Using these tasks, we demonstrate that, even at the phonological level, very similar regions are recruited to process speech and sign. Further, we show that sublexical processing of speech and sign is characterised by similar temporal dynamics. Finally, we demonstrate that age of sign language acquisition influences the network recruited. Our findings support the proposal (e.g., Mayberry, 2009) that a robust first language – in this case a signed language – is important to establishing the neural architecture with which to learn another language later in life.

Symposium Session 5

COGNITIVE NEUROSCIENCE OF MULTIMODAL PERSON PERCEPTION

Tuesday, April 5, 1:00 - 3:00 pm, Grand Ballroom A

Chair: Stefan R. Schweinberger, Friedrich Schiller University of Jena
Co-Chair: Holger Wiese, Friedrich Schiller University of Jena
Speakers: Holger Wiese, Nikolaus F. Troje, Pascal Belin, Stefan R. Schweinberger

The efficient analysis and representation of person-related information is one of the most important challenges for human social perception. While faces are known to provide a large variety of socially relevant information, this symposium explicitly adopts a multimodal view of person perception. Specifically, faces, voices, and biological motion signals all contain a number of dimensions including identity, age, gender, or emotional expression that may play different roles depending on context and task. This set of talks illustrates both interactive processing of multiple dimensions within a given domain, and functional and neuronal similarities or differences between domains when processing person-related social information. One presentation (Wiese) focuses on specific mechanisms in face perception, and their neurocognitive correlates, that relate to diminished recognition memory for faces from different age or ethnic groups. The second talk (Troje) presents a current framework to understand person perception from biological motion signals, considering various processing levels and informational dimensions. The third presentation (Belin) summarizes research on voice perception that specifies selectivity, neural correlates and cerebral dynamics, as well as functional similarities to face perception. The final talk (Schweinberger) presents studies that investigate audiovisual face-voice integration in the recognition of familiar people. As a whole, these presentations sketch future directions in person perception research as an integrated enterprise that elucidates how multiple and multimodal social information about others is processed and represented in the brain.

ABSTRACTS

THE ROLE OF RACE AND AGE FOR RECOGNITION MEMORY OF UNFAMILIAR FACES Holger Wiese[1]; [1]Friedrich Schiller University of Jena — Humans are better at remembering faces of their own ethnic and age groups as compared to other-race and other-age faces. Theoretical accounts for these so-called own-race and own-age biases emphasize a critical role of different amounts of contact or expertise with faces of different groups. In this talk, I will present both behavioral and ERP evidence in support of this account. First, long-term expertise with a limited number of other-race faces reduces both the own-race bias and its ERP correlate in the occipito-temporal P2. However, whereas ERP correlates of same- and other-race processing during learning depend on situational factors such as task demands, the behavioral own-race bias does not. Second, an own-age bias has been demonstrated repeatedly in young adult participants. Whether a corresponding bias for elderly participants emerges was found to depend on the amount of contact with younger people. Third, results from a combined own-race and own-age bias experiment demonstrated differences in the neural processes underlying the two effects. Specifically, while an own-age bias independent of face ethnicity was observed in the N250 (probably related to implicit memory) as well as in a 300-500 ms time range at central and parietal scalp sites, an own-race bias independent of age was detected in a 500-800 ms time window, which probably reflects enhanced recollection based processing. Overall, while these findings suggest a lack of expertise with "out-group" faces as one mechanism mediating both the own-age and own-race bias, the exact memory related neural processes for the two phenomena differ.

THE MULTIPLE FACES OF BIOLOGICAL MOTION PERCEPTION Nikolaus F. Troje[1], Daniel R. Saunders[1]; [1]Queen's University, Kingston, Ontario — Since Gunnar Johannson coined the term almost 40 years ago "biological motion" has been used for a variety of different phenomena. Some of them are complementary to each other and probably constitute entirely different processing mechanisms. A clear distinction between them is crucial to design both behavioural and neuroimaging studies, to assess their results, and to compare them among different studies. I will provide a careful analysis of the multiple facets of biological motion perception and I will suggest a framework that helps to safely navigate through concepts and experimental paradigms employed in biological motion research. In particular, I will show experimental data that demonstrate the dissociation between a processing level that uses local motion invariants to detect biological motion and label it as being animate, as compared to mechanisms that use motion to derive the articulated structure of a moving body, and derive information about actor and action. I will then introduce a standardized battery of tests which is able to independently probe performance on these and a number of additional key aspects of biological motion perception, along with normative data and a test-retest reliability analysis. Applications of this test in neuropsychology and cognitive neuroscience are discussed.

PERSON PERCEPTION BY VOICE: COGNITIVE AND CEREBRAL MECHANISMS Pascal Belin[1]; [1]University of Glasgow — The human voice carries speech, but is also an "auditory face" rich in person-related information, which normal listeners are expert at processing for optimal social interactions. We study the cerebral processing of vocal information using behavioural (voice morphing), EEG and fMRI methods. In a series of experiments in normal subjects, we examined the cortical processing of sounds of human voices and found that (i) perceiving sounds of voice involves voice-selective 'temporal voice areas' (TVA) in auditory cortex, located along the middle part of the superior temporal sulcus (STS) bilaterally; (ii) the TVA in the right anterior STS are particularly involved in the paralinguistic aspects of voice perception, including speaker recognition, and gender perception; (iii) the selectivity to voice appears to be largely species-specific, i.e., sounds of animal voices induce a much more restricted activation of STS, but is also observed in the macaque brain; (iv) the dynamics of cerebral voice processing involve a time-course analogous to that evidenced for face processing with voice-selective activity emerging around 170 msec after onset; (v) the TVA interact in a task-selective manner with regions of inferior prefrontal cortex, consistent with a dense pattern of connections between inferior prefrontal cortex and the 'what' stream of auditory processing. Together, these results indicate that the different types of vocal information (identity, affect, …) are processed in interacting but partially dissociated functional pathways, suggesting a neuro-cognitive model of voice perception with principles of organization similar to those put forward for face perception.

AUDIOVISUAL FACE-VOICE INTEGRATION IN THE RECOGNITION OF FAMILIAR PEOPLE Stefan R. Schweinberger[1]; [1]Friedrich Schiller University of Jena — Audiovisual integration (AVI) is a well-known aspect of speech perception, but integration of facial and vocal information is also important for speaker recognition. We demonstrate AVI in the recognition of familiar (but not unfamiliar) speakers. Specifically, systematic behavioural benefits in recognising a familiar voice occur when the voice is combined with an articulating face of corresponding speaker identity, and costs occur for voices combined with precisely time-synchronised noncorresponding faces. AVI is shown (a) to depend on familiarity with a speaker, (b) to show sensitivity to temporal synchronization of facial and vocal articulations, and (c) to occur both for voice and face recognition tasks. Experiments with event-related brain potentials (ERPs) compared unimodal (face only, voice only) conditions with audiovisual conditions (AV corresponding, AV noncorresponding). The results suggest that audiovisual speaker identity correspondence influences later ERPs beyond 250 ms only, with increased right frontotemporal negativity for noncorresponding identities. Remarkably, when compared with the summed responses from both unimodal conditions, both audiovisual conditions elicited a much earlier onset of frontocentral negativity, with maximal differences around 50-80 ms. These findings suggest that the perception of a voice and a time-synchronised articulating face triggers surprisingly early and mandatory mechanisms of audiovisual processing, although the correspondence or discrepancy in audiovisual speaker identity may only be computed about 200 ms later.

Slide Session 1

WORKING MEMORY AND EXECUTIVE FUNCTION

Saturday, April 2, 3:30 - 5:30 pm, Grand Ballroom A

Chair: Silvia Bunge, University of California, Berkeley
Speakers: Adam C. Riggall, Joshua Carp, Jeffrey Johnson, Jessica Green, Elena Patsenko, Robert Hester, Weidong Cai, Matthew L Dixon

ABSTRACTS

WORKING MEMORY STORAGE RELIES ON NEITHER SUSTAINED NOR ELEVATED ACTIVITY (GSP WINNER) Adam C. Riggall[1], Bradley R. Postle[1]; [1]University of Wisconsin-Madison — For at least the past 40 years, the consensus view has been that the short-term retention of information is supported by the sustained, elevated activity that is often observed in electrophysiological and functional magnetic resonance imaging (fMRI) measurements of working memory-task performance. Here, we report results that directly challenge this assumption. Subjects were scanned (fMRI) while performing delayed-recognition of visual motion (directions or speeds; probed unpredictably). Data were analyzed with both a general linear model (GLM) that tested whether delay-period activity was greater than baseline, and pattern classifiers trained to discriminate either directions or speeds of motion. Consistent with prior work, the GLM revealed sustained, elevated delay-period activity in superior frontal cortex and intraparietal sulcus across participants. Strikingly, classifiers restricted to these same regions failed to recover trial-specific stimulus information. In contrast, classifiers restricted to posterior sensory regions that did not show elevated delay-period activity, including V1 and MT, did recover substantial trial-specific stimulus information. Wholebrain timepoint-by-timepoint follow-up classification analyses indicated that trial-specific stimulus information was consistently recoverable throughout the delay-period. These analyses also showed that the importance of many voxels to classification (particularly in superior frontal and parietal areas) waxed and waned over time. Thus, once one "leaves" posterior visual regions, working memory storage is accomplished by broadly distributed, dynamically shifting networks.

AGE DIFFERENCES IN THE NEURAL REPRESENTATION OF WORKING MEMORY REVEALED BY MULTI-VOXEL PATTERN ANALYSIS. Joshua Carp[1], Leon Gmeindl[2], Patricia Reuter-Lorenz[1]; [1]University of Michigan, [2]Johns Hopkins University — Working memory function declines across the lifespan. Computational models of aging attribute such memory impairments to reduced distinctiveness between neural representations of different mental states in old age, a phenomenon termed dedifferentiation. These models predict that neural distinctiveness should be reduced uniformly across experimental conditions in older adults. In contrast, the Compensation-Related Utilization of Neural Circuits Hypothesis (CRUNCH) model predicts that the distinctiveness of neural representations should be increased in older adults (relative to young adults) at low levels of task demand but reduced at high levels of demand. The present study used multi-voxel pattern analysis (MVPA) to measure the effects of age and task demands on the distinctiveness of the neural representations of verbal and visuospatial working memory. Results from sensory cortex during encoding and retrieval supported the dedifferentiation hypothesis: distinctiveness of visual cortical representations during these phases was uniformly reduced in older adults, irrespective of memory load. However, maintenance-related responses in prefrontal and parietal regions yielded a strikingly different pattern of results. At low loads, older adults showed higher distinctiveness than younger adults; at high loads, this pattern reversed, such that distinctiveness was higher in young adults. This interaction between age group and memory load is at odds with the dedifferentiation hypothesis but consistent with CRUNCH. In sum, our results provide partial support for both dedifferentiation- and compensation-based models; we argue that comprehensive theories of cognitive aging must incorporate aspects of both models to fully explain complex patterns of age-related neuro-cognitive change.

RTMS-INDUCED CHANGES IN SUSTAINED DELAY-PERIOD ALPHA-BAND POWER RELIABLY PREDICT PERFORMANCE ON SPATIAL WORKING MEMORY TASKS Jeffrey Johnson[1], Bradley Postle[1]; [1]University of Wisconsin-Madison — Previous work has shown that 10-Hz rTMS of the superior parietal lobule (SPL) influences performance on spatial (but not object) delayed-recognition (Hamidi, et al., 2009). Using simultaneous rTMS/EEG, it was found that for a given subject, the direction and magnitude of the rTMS effect on performance was predicted by individual differences in its effect on sustained delay-period alpha-band power (DPABP): If 10-Hz rTMS increased DPABP, behavioral performance declined, if it decreased DPABP, performance improved. However, the reliability of these effects has not been established, nor has their generality been explored. In the present study, we sought to replicate the earlier findings in a new group of subjects, and to explore their generalization to other stimulus types and to lateralized presentation. While receiving 10-Hz rTMS to the left SPL, subjects performed spatial and color delayed-recognition in two conditions—memory targets presented bilaterally vs. in one (pre-cued) hemifield. Results from the bilateral- and left-visual field conditions replicated the earlier findings: rTMS effects on DPABP and behavior were correlated, but only for location memory. For the right-visual field (RVF) condition, in contrast, 10-Hz rTMS of the left SPL increased DPABP and impaired performance in both color and location delayed-recognition. The "bilateral" results establish the reliability of the earlier findings, and will enable us to begin exploring the effects of varying rTMS parameters. The "RVF" results suggest that color and location memory may have relied preferentially on left-posterior cortical regions, and that rTMS effects, though distributed, may be more potent in the stimulated hemisphere.

ARROW-ELICITED CUEING EFFECTS AT SHORT INTERVALS: RAPID ATTENTIONAL ORIENTING OR CUE-TARGET STIMULUS CONFLICT? Jessica Green[1], Marissa Gamble[1], Michael Rosenthal[1], Marty Woldorff[1]; [1]Duke University — Reaction time (RT) cueing effects (faster responses for cued than uncued targets) have been observed rapidly following centrally presented arrow cues, leading to the suggestion that arrows can trigger rapid, automatic, shifts of attention, in addition to slower, voluntary attentional shifts. However, studies that have reported rapid cueing

effects following arrows typically have had the cue and target remain on the screen until the behavioral response. We hypothesized that the rapid arrow-triggered cueing effects may actually reflect non-attentional processes influenced by stimulus duration. To test this hypothesis we manipulated stimulus duration in attention-cueing experiments using both spatially predictive and non-predictive arrow cues. Target stimuli were presented either simultaneously with the cue or at stimulus onset asynchronies (SOAs) ranging from 100-600 ms. Cueing effects at short SOAs were observed only for long-duration stimuli, and the effects were driven by slowing in the uncued-target responses, rather than the facilitated processing of cued targets that attentional explanations would predict. Moreover, these cueing effects were observed even when the cue and target were presented simultaneously and participants could not possibly have shifted attention in advance of the target. We propose that when the cue and target are presented simultaneously, or nearly so, and remain on the screen together, they are grouped into a single object that contains either congruent (cued) or incongruent (uncued) spatial information. Further support for this explanation comes from event-related potentials (ERPs) at fronto-central scalp sites, which show typical attention effects at long SOAs but conflict-like effects at short SOAs.

THE ACC RESPONDS TO DETECTED ERRORS AND UNEXPECTED NEGATIVE FEEDBACK IN A COMPLEX TASK. Elena Patsenko[1], Erik M. Altmann[1], David C. Zhu[1]; [1]Michigan State University — Several accounts of anterior cingulated cortex (ACC) function currently exist. The results of the present research challenge the idea that the ACC performs conflict monitoring, and they are consistent with the idea that the ACC responds to worse-than-expected outcomes. In the present study, I develop a paradigm in which a memory task and a multiple object tracking tasks are combined. Participants receive feedback on the accuracy of their performance only after both tasks are completed. Negative feedback is ambiguous in terms of what type of error occurred (memory or tracking). After receiving negative feedback, participants are asked to interpret it. Most of the time the interpretations are correct (e.g. when participants make a memory error they indicate that they made a memory error); however, sometimes the interpretations are incorrect (e.g. when participants make a memory error they indicate that they made a tracking error). I assume here that participants interpret feedback correctly if they detect an error and they interpret feedback incorrectly if they miss an error. I found that a region in the left ACC was more active to detected errors than undetected errors during task performance, but during feedback the pattern was reversed, such that the region was more active to undetected errors than to detected errors. The pattern is problematic for the conflict monitoring theory, because there is no conflict during feedback processing. The results are consistent with the reinforcement learning theory, since both error detection and processing of unexpected negative feedback are worse-than-expected outcomes.

IMPROVEMENT OF ERROR AWARENESS AND MODULATION OF ERROR-RELATED BOLD ACTIVITY VIA SINGLE-DOSE OF METHYLPHENIDATE IN HEALTHY ADULTS Robert Hester[1], L. Sanjay Nandam[2], Joe Wagner[2], Pradeep J. Nathan[3], Jason B. Mattingley[2], Mark A. Bellgrove[2]; [1]University of Melbourne, Department of Psychological Sciences, Melbourne, Victoria, Australia, [2]The University of Queensland, Queensland Brain Institute and School of Psychology, Brisbane, Queensland, Australia, [3]University of Cambridge, Department of Psychiatry and GlaxoSmithKline, UK — Poor detection of errors has been linked to clinical symptoms including the loss of insight, delusions and perseverative behaviour, in conditions such as schizophrenia and drug addiction. These conditions share alterations in monoamine signalling that may influence the neural mechanisms underlying error processing, however our understanding of the neurochemical drivers is limited. We conducted a randomized, double-blind, placebo-controlled, cross-over design of the influence of selective dopamine (methylphenidate), noradrenaline (atomoxetine) and serotonin (citalopram) reuptake inhibitors on error awareness in 27 healthy participants. The Error Awareness Task, a Go/No-go response inhibition paradigm, was administered to assess the influence of monoaminergic agents on errors that the participant was either aware or unaware of committing and the associated event-related fMRI changes. Methylphenidate was associated with a significant improvement in error awareness, but not response inhibition accuracy or speed, in comparison to placebo and either atomoxetine or citalopram. Methylphenidate also significantly influenced BOLD activity arising from the anterior cingulate cortex and inferior parietal regions, with moderate increases in aware error activity and large decreases in unaware error activity when compared to the placebo condition. These data suggest dopamine may aid attention to task, thereby setting ideal conditions for promoting awareness of one's errors. Given the relationship between the severity of awareness deficits and clinical symptoms in psychiatric conditions, the current data highlight the potential for such medications to enhance error awareness and in turn improve clinical outcomes.

A PROACTIVE MECHANISM FOR SELECTIVE SUPPRESSION OF RESPONSE TENDENCIES Weidong Cai[1], Caitlin Oldenkamp[1], Adam Aron[1]; [1]University of California, San Diego — How do we control our inappropriate response tendencies? Much research has approached this question using experimental tasks that require one to stop a response when a signal occurs. Neuroscience studies show that stopping is achieved via an influence of prefrontal cortex on the motor system. However, it remains controversial whether this influence is best characterized as active suppression or a withdrawal of facilitation from the response effector. Here we developed a novel behavioral task that requires subjects to prepare to stop a specific response tendency. We used single pulse Transcranial Magnetic Stimulation to probe motor excitability. We found that the motor-evoked potential (MEP) of the hand that might need to be stopped in the future was significantly reduced compared to when that hand was at rest. This MEP difference was visible even before there was any action. Further, this 'neural' index of proactive and selective suppression predicted the subsequent selectivity with which the behavioral response was stopped. These results provide unequivocal behavioral and physiological evidence to support the existence of an active suppression mechanism in the brain. They also clearly show that such a mechanism can be applied in advance (proactively) and also targeted at a particular response channel (selectively). The results have important implications for theories of executive function and for developing ecologically valid behavioral models for impulse control disorders.

FMRI-ADAPTATION REVEALS AN INTEGRATED REPRESENTATION OF TASK-RULES AND REWARDS IN THE LATERAL PREFRONTAL CORTEX Matthew L Dixon[1], Kalina Christoff[1]; [1]University of British Columbia — A prominent view is that the lateral prefrontal cortex (lPFC) supports various complex cognitive functions by representing rules that specify associations between stimuli in the environment and context appropriate responses. However, we presently know little about how the brain represents the reward-value of different rules. The present study examined the hypothesis that the lPFC integrates rules and rewards using a novel fMRI-adaptation paradigm. On each trial, an instruction cue informed participants (N = 15) of the appropriate rule to use (decide if face is male/female or decide if word's meaning is concrete/abstract) and whether or not they could earn money based on their performance. Crucially, in half of the trials, a second instruction cue appeared and systematically varied with respect to the first: the rules repeated, the reward repeated, both rules and reward repeated, or both rules and reward changed. We looked for fMRI-adaptation when rules, reward, or their combination repeated relative to when they were novel. We found that a large expanse of the right lPFC including the rostrolateral prefrontal cortex and inferior frontal sulcus exhibited fMRI-adaptation specifically when both rule and reward information repeated. Additionally, the IFS exhibited a significant increase in correlation with both rule-related and reward-related brain regions during the appearance of an instruction cue signaling a novel rule and reward. Our findings provide strong evidence that lPFC rule processing is not simply modulated by reward processing

in other regions; rather, the lPFC integrates reward information into its representation of rules, thus providing rules with value.

Slide Session 2

PERCEPTION AND ACTION

Saturday, April 2, 3:30 - 5:30 pm, Grand Ballroom B

Chair: Alumit Ishai, University of Zurich

Speakers: Charles Leek, Emily S. Cross, Sabine Grimm, Lauren Emberson, Alex Clarke, Thorsten Kahnt, Golijeh Golarai, Pilar Archila-Suerte

ABSTRACTS

DOMAIN-GENERAL SPATIAL VECTOR TRANSFORMATION IN SUPPLEMENTARY MOTOR AREA (SMA): EVIDENCE FROM FMRI AND VISUO-SPATIAL PROCESSING DEFICITS IN PARKINSON'S DISEASE Charles Leek[1], Julie Kerai[1], John Hindle[1], Martyn Bracewell[1], Stephen Johnston[2]; [1]School of Psychology, Bangor University, Bangor, UK, [2]School of Psychology, Brunel University, Uxbridge, UK — Leek & Johnston (2009, Nature Reviews Neuroscience, 10, 78-79) have suggested that one function of the anterior (pre-) SMA in humans is the computation of abstract visuo-spatial vector transformations. On this account pre-SMA should be involved in any task that requires the transformation or remapping of a spatial location (vector) regardless of whether there is a motor component to the task. Here we test this hypothesis with converging evidence of SMA involvement in spatial and non-spatial tasks using fMRI and studies of Parkinson's disease (PD) – one known consequence of which is SMA dysfunction as a result of dopamine depletion in the nigro-striatal pathway of the basal ganglia. Spatial tasks included abstract grid transformation and mental rotation. Non-spatial tasks included serial subtraction and VSTM for spatial locations which provide controls for sequencing, numerical processing and the encoding of spatial vectors. Functional imaging results showed partially overlapping activation foci in pre-SMA for abstract spatial and non-spatial tasks. PD patients were impaired only in the abstract spatial transformation tasks. These results provide new evidence about functional specialisation in the SMA. In particular, they are consistent with the spatial vector transformation hypothesis, and for the proposed role of pre-SMA in domain-general computations involving the remapping of spatial locations during both motor and non-motor cognitive operations.

ROBOTIC ACTIONS PREFERENTIALLY ENGAGE THE HUMAN MIRROR SYSTEM Emily S. Cross[1,2], Roman Liepelt[2,3], Antonia F. de C. Hamilton[4], Jim Parkinson[2], Richard Ramsey[4], Waltraud Stadler[2], Wolfgang Prinz[2]; [1]Radboud University Nijmegen, [2]Max Planck Institute for Human Cognitive and Brain Sciences, [3]Westfälisches Wilhelms Universität Münster, [4]University of Nottingham — As humans, we gather a wide range of information about other people from watching them move. A network of regions within the human brain termed the 'mirror system' has been implicated in understanding others' actions by means of an automatic matching process that links observed and performed actions. Current views of the human mirror system assume a matching process biased towards actions that are "like me"; specifically, those performed by conspecifics and present in the observer's motor repertoire. In the present study, we test the flexibility of this system when observing natural human motion compared to rigid robot-like motion across two independent functional magnetic resonance imaging (fMRI) experiments. In Experiment 1, 22 participants watched a human dance in a normal, fluid style, or in a rigid, robotic style. Surprisingly, premotor and parietal regions responded more robustly to robotic actions than to natural human actions. With Experiment 2, we aimed to replicate and extend this result with 23 new participants who watched the same human dancer or a Lego action figure moving in the smooth human style or robotic style. Here again, more robust activation emerged within mirror system regions when observing a robotic dance style compared to the smooth, natural human style, independent of whether the agent was a real human or a plastic robotic toy. These findings challenge previous assumptions about mirror system function by demonstrating that parietal and premotor cortices can be flexibly engaged by novel, unfamiliar actions performed by both human and non-human agents.

RAPID DETECTION OF CHANGES IN SOUND SOURCE LOCATION AS REVEALED BY HUMAN AUDITORY EVOKED POTENTIALS Sabine Grimm[1], Heike Althen[1], Marc Recasens[1], Carles Escera[1]; [1]University of Barcelona, Spain — The rapid discrimination of sound source locations is crucial in order to group the auditory input and to selectively attend to specific sound sources. The detection of changes in sound location has been related to the mismatch negativity (MMN), an auditory evoked potential (AEP) occurring at 100-250 ms after change onset. However, animal recordings suggest much faster neural responses to contextually new or deviant stimuli and recent studies have observed early indices of human auditory deviance detection for spectral changes in the middle-latency response (MLR) of the AEP. The present study investigates the processing of sound location changes by measuring the MLR during an oddball paradigm in 20 human subjects. The auditory sequences were comprised of clicks presented via loudspeakers in oddball blocks (80 % standards: 30^(0); 20 % deviants: 60^(0)), reversed oddball blocks (standards: 60^(0); deviants: 30^(0)), and control blocks (randomly from -60^(0), -30^(0), 0^(0), 30^(0), 60^(0)). Oddball blocks were presented both in the left and right hemifield. Clicks presented at deviant locations elicited a larger Na component of the MLR peaking at 17-23 ms compared to clicks presented at the same site when it served as the standard or control location. Whereas the Na component itself was not lateralized, the deviance-related increase in Na amplitude showed a significant dominance over the hemisphere contralateral to the side of stimulation. This indicates that the discrimination of rare spatial changes initiates very quickly, at about 20 ms after sound onset, reflected by an enhanced activity dominantly in contralateral auditory cortex regions.

LEARNING SYSTEMS SUPPORT OBJECT PERCEPTION ACROSS VARIABLE ENVIRONMENTAL EXPOSURE: EVIDENCE FROM A COMBINED FMRI/EYE TRACKING METHODS APPROACH Lauren Emberson[1,2], Jenna Kahn[1], Sara Haas[1], Dima Amso[1]; [1]Brown University, [2]Cornell University — The mechanisms of integration across variable experiences of a novel object are poorly understood. We used an fMRI/eye-tracking methods approach to examine the mechanisms involved in learning to segment a novel object across variable experiences. We eye tracked 10 healthy adult participants (SMI RED system), while acquiring fMRI data using a Siemens 3T TM TRIO. We embedded an 'ambiguous' novel object (seen as a single occluded whole or two broken parts) in a complex visual scene. We generated three less ambiguous views of the same object, in variable orientations and occluded in different locations ('repeats'). Participants viewed the scenes in sequential alternation. Only those who perceived the ambiguous object as broken in a pretest were tested. After exposure, 50% of participants changed their perception to indicate that the object was complete ('perceivers'). Fixation patterns illustrate that non-perceivers had a larger number of fixations for the two parts of the ambiguous object, while perceivers focused their attention on the occluder during learning. A 2 (Ambiguous vs. Repeat) x 2 (Perceivers vs. Non-perceivers) whole brain analysis revealed a reliable interaction in the caudate, hippocampus, inferior parietal, fusiform gyrus, and middle frontal gyrus. Perceivers had higher activations for the unambiguous Repeats relative to the Ambiguous scene, while non-perceivers had higher activations during the Ambiguous scene. This suggests that perceivers are learning to relate the redundant information across scenes to perceptually complete the object in the ambiguous figure. Learning and attentional mechanisms, in concert with visual experience, shape the perception of complex objects.

THE TIME-COURSE OF PERCEPTUAL AND SEMANTIC INFORMATION DURING OBJECT RECOGNITION: CATEGORY-SPECIFIC VS. FEATURE-BASED ACCOUNTS OF SEMANTIC KNOWLEDGE Alex Clarke[1], Kirsten I. Taylor[1,2], Barry Devereux[1], Billi Randall[1], Lorraine K. Tyler[1]; [1]University of Cambridge, [2]University Hospital Basal — Current theories of semantic knowledge disagree about whether the first-order organising principle of the neural representation of semantic information is in terms of categories [animals, tools] or distributed, feature-based representations. A key claim of feature-based accounts is that statistical measures characterising the relationships amongst features provide an explanation of apparent category-specific effects. To test the efficacy of category-specific and feature-based models to account for neural data, and determine the temporal sequence of perceptual and semantic effects, representational similarity analysis (RSA) was applied to magnetoencephalography (MEG) data recorded during a picture naming task. Using an MEG searchlight procedure, we statistically evaluated whether each theoretical model was expressed in the MEG data. MEG signals were found to reflect the perceptual similarity of objects after 100 ms, before effects of visual-semantic features in posterior regions, showing an early transition from purely perceptual effects to visual-semantic effects. Information relating to the degree of shared/distinctive semantic features was available pre-200 ms, before significant effects of both the category-specific models and those relating to shared/distinctive features beginning after 250 ms. Our results highlight the transition from perceptual to semantic encoding of information over time and show that semantic models, based on statistical distributed feature-based accounts, provide a more detailed account of the perception-to-semantic transition than category-specific models which showed isolated effects. The results support feature-based accounts of semantic knowledge, and show that the time sensitive MEG patterns provide critical information about the nature of object representations as revealed using RSA.

PERCEPTUAL LEARNING AND DECISION MAKING IN HUMAN MEDIAL FRONTAL CORTEX (GSP WINNER) Thorsten Kahnt[1,2], Marcus Grueschow[1,3], Oliver Speck[3], John-Dylan Haynes[1,2,3]; [1]Bernstein Center for Computational Neuroscience, Charité–Universitätsmedizin Berlin, [2]Berlin School of Mind and Brain, Humboldt-Universität Berlin, [3]Otto-von-Guericke University, Magdeburg — The dominant view that visual perceptual learning is accompanied by changes in early visual representations has recently been challenged. Current studies suggest that performance improvements are rather related to changes in higher decision-making areas of the cortex. Here we used a model-based neuroimaging approach to test the idea that visual perceptual learning can be accounted for by reinforcement learning involving changes in higher decision-making areas. We trained 20 subjects on an orientation-discrimination task with explicit performance feedback over the course of four days. FMRI data was acquired on the first and last day of training. Behavioral improvements were well explained by a reinforcement learning model for perceptual decision making. Perceptual improvements in this model are accompanied by an enhanced read-out of sensory information, thereby establishing noise-robust representations of decision variables that form the basis for perceptual choices. Using multivariate information mapping techniques (searchlight decoding), we find sensory evidence encoded in early visual cortex as well as in higher-order brain regions. However, only activity patterns in the medial frontal cortex (dorsal anterior cingulate cortex) tracked learning-related changes in the model-derived decision variables. These results provide strong evidence for perceptual learning related changes in higher-order cortical regions. Furthermore, our results suggest that perceptual and reward-based learning are likely to be based on a common neurobiological mechanism. Our findings thus help to narrow the long established gap between perceptual and reward based learning and decision making.

EVIDENCE FOR CHILDHOOD DEVELOPMENT OF FACE- AND PLACE-SELECTIVE REGIONS IN THE HUMAN VENTRAL-TEMPORAL CORTEX Golijeh Golarai[1], Alina Liberman[1], Kalanit Grill-Spector[1]; [1]Stanford University — Functional regions in the human ventral temporal cortex (VTC) preferentially respond to faces, objects or places. Recent studies suggest that face-selective activations in the fusiform gyrus (FFA) and place-selective activations in the parahippocampal gyrus (PPA) undergo a prolonged development after age 7. However, the end-point of these developments or sensitivity to the type of face or scene stimuli is unknown. Here we used functional magnetic resonance imaging (fMRI) to examine the development of face-, object- or place-selective responses in the VTC of adults (18 – 40 years, n = 11), adolescents (12 – 16 years, n = 14) and children (7 – 11 years, n = 10). During fMRI, subjects viewed faces of boys, men, objects, indoor or outdoor scenes and scrambled images in blocks. We defined the FFA and the PPA in each subject. The volume of the right FFA was substantially larger in adults than in adolescents and children, correlating with age, regardless of the age of the face stimuli. This development was associated with higher response amplitudes and selectivity for faces compared to objects, and increased differentiation of the distributed responses to faces versus non-face stimuli in the VTC. Similarly, the volume of the left PPA was significantly larger in adults than in children, along with age related increases in selectivity for scenes in the left VTC. However, left PPA's development was specific to indoor but not outdoor scenes. These results suggest a prolonged development of face- and place- selectivity across the VTC during childhood and adolescence.

DEVELOPMENTAL EFFECTS IN THE SPEECH PERCEPTION OF BILINGUAL CHILDREN Pilar Archila-Suerte[1], Jason Zevin[2], Arturo Hernandez[1]; [1]University of Houston, [2]Sackler Institute for Developmental Psychobiology Weill Medical College of Cornell University — The ability to discriminate non-native phonemes gradually diminishes in the first year of life and early childhood. This change from language-general to language-specific perception is poorly understood in bilingual children. Our goal is to reveal the neural substrates of non-native speech perception in children undergoing linguistic development. In a passive listening fMRI task, 38 Spanish-English bilinguals between the ages of 6 and 10 were asked to watch a silent movie while second language (L2) syllable combinations (saf-saf; saf-sof; saf-suf; sof-sof; sof-suf; suf-suf) played through a pair of headphones. Language assessments were conducted in each language to obtain measures of proficiency. A multiple regression analysis using age, proficiency in English, and proficiency in Spanish as regressors showed that brain activity for non-native speech was negatively related to age and positively related to Spanish proficiency. Younger bilingual children activated subcortical areas (i.e., bilateral caudate nucleus and hippocampus, and right putamen) and areas involved in early auditory processing (bilateral superior temporal gyrus). On the other hand, better Spanish proficiency led to increased activity in the parietal lobe and posterior cingulate gyrus. This reflects the involvement of sensory integration and awareness in linguistically advanced children. The data suggest that behavioral differences in non-native perception are the result of the brain areas developmentally available for the processing of speech.

Slide Session 3

THINKING

Sunday, April 3, 10:00 am - 12:00 pm, Grand Ballroom B

Chair: Kalina Christoff, University of British Columbia

Speakers: Massimo Silvetti, Asaf Gilboa, Roberto Limongi Tirado, Lauren Atlas, Sandrine Duverne, Andrea Stocco, Sietske Kleibeuker, Allyson Mackey

ABSTRACTS

VALUE AND PREDICTION ERROR IN THE HUMAN MEDIAL FRONTAL CORTEX: INTEGRATING THE SINGLE-UNIT AND SYSTEMS LEVELS OF ANALYSIS Massimo Silvetti[1], Ruth Seurinck[1], Tom Verguts[1]; [1]Ghent University — The role of the anterior cingulate cortex (ACC) in cognition has been extensively investigated with several techniques, including single-unit recordings in rodents and monkeys and EEG and fMRI in humans. Based on these studies, various competing theories of ACC function have been proposed, such as reward computation, error detection, conflict monitoring, error likelihood estimation, and estimation of reward volatility. Here we present a unifying theory showing that all the different functions ascribed to the ACC could be grounded on a basic computation consisting of the estimation of value (expected reward) by means of prediction errors. This view is instantiated in the Reward Value and Prediction Model (RVPM). The model contains units coding for the value of cues (stimuli or actions) and units coding for the differences between such values and the actual reward (i.e., prediction errors). We exposed the model to typical experimental paradigms used in single-unit, EEG and fMRI research to compare its overall behaviour with the data from these studies. The model reproduced the ACC behaviour of previous single-unit, EEG and fMRI studies on conditioning, error processing, conflict monitoring, error-likelihood estimation, and volatility estimation. Finally it provided also a computational account for the temporal shifting of brainstem dopaminergic neuron responses from reward onset to conditional stimulus onset, unifying the all the interpretations of the role performed by the ACC in cognition within the theoretical domain of Reinforcement Learning.

VENTROMEDIAL PREFRONTAL CORTEX LESIONS IMPAIR IMPLICIT BUT NOT EXPLICIT ASPECTS OF PROSPECTIVE MEMORY Asaf Gilboa[1,2], Sharon Uretzky[3], Ory Ben-Roi[4], Judith Aharon-Peretz[5]; [1]Rotman Research Institute at Baycrest, Toronto, ON, Canada, [2]University of Toronto, Toronto, ON, Canada, [3]The National Institute for Rehabilitation of the Brain Injured, Haifa, Israel, [4]University of Haifa, Haifa, Israel, [5]Rambam Medical Centre, Haifa, Israel, [6] — Cognitive models of Prospective Memory (PM) propose two types of mechanisms: (1) conscious explicit cue-detection mechanisms; (2) Non-conscious (implicit) mechanisms which provide representations of to-be-performed actions with heightened activation and privileged access to consciousness. We have reported that lesions to the polar prefrontal cortex (Brodman areas 10 and 9) cause a severe impairment on tasks that require detection of PM cues during an ongoing task, regardless of whether the PM cues involve effortful or effortless detection in healthy controls. By contrast, tasks that tap the underlying (implicit) representations of intentions to perform an action are unaffected by lesions to polar PFC. These include normal patterns of Intention Superiority Effects (ISE) for to-be-performed actions and an Inhibition Effect (IE) for prospective actions after they had been performed. In the present set of studies we show that lesions to the ventromedial prefrontal cortex (VMPFC) produce the reverse pattern, with cue detection relatively intact and no ISE or IE. Thus, this is the first report of a neuropsychological double dissociation between explicit detection of cues that support the opportune recovery of prospective memory and implicit privileged representation of prospective intentions. Our data are compatible with the 'gateway hypothesis' which suggests the rostral PFC allows for the flexible alternating of attention between external stimuli and internal representations. The VMPFC, by contrast, appears to support cue-related long-term anticipatory biases in accordance with its known role in reward representation and reversal learning.

HIGHER-ORDER VISUAL CAUSAL REPRESENTATION IN THE PREFRONTAL AND PREMOTOR CORTICES Roberto Limongi Tirado[1], Reza Habib[2], Michael E. Young[2], Karen Reinke[3]; [1]Venezuelan Institute for Scientific Research, [2]Southern Illinois University at Carbondale, [3]University of Illinois at Springfield — The behavioral literature has reported the differentiation between perceived causality and higher-order causal reasoning. The advent of functional magnetic resonance imaging and the theoretical framework of cognitive linguistics and behavioral experimental designs have raised new hypotheses and opened new possibilities to address the perceptual and higher-order distinction in causality. In addition, as the empirical research on the hierarchical functional organization of the frontal rostro-caudal axis evolves, new questions arise on how this organization informs the differential processing of direct causal (e.g., one object striking another object) and indirect causal (e.g., causal chains) events. In this fMRI study, two different types of verbal instructions directed the participants to detect either first or second-order relational complexities in direct or indirect causal events. Direct causal judgment recruited the ventrolateral prefrontal cortex more strongly when the participants were directed to detect first-order relational complexities rather than second-order relational complexities. When they were directed to detect second-order relational complexities, judging indirect causal and non-causal events, as opposed to direct events, strongly activated the rostrolateral prefrontal cortex along with more posterior regions of the rostro-caudal frontal axis. The dorsal premotor cortex was activated during the judgment of both direct and indirect causal events. These data provide new support for the hierarchical functional specialization of the prefrontal cortex and lead to support that two different semantic representations of causality might influence cognitive control mechanisms, memory resources, and preparatory motor responses when observers represent complex visual causal stimuli.

EXPECTATIONS ABOUT STIMULI OPERATE INDEPENDENTLY FROM EXPECTATIONS ABOUT TREATMENTS: THE ROLE OF EXPECTANCY DURING OPIOID ANALGESIA Lauren Atlas[1], Robert Whittington[1], Joe Wielgosz[2], Tor Wager[3]; [1]Columbia University, [2]University of Wisconsin, Madison, [3]University of Colorado, Boulder — Expectations strongly influence how organisms perceive their environments. In humans, placebo-induced expectations about treatments (Outcome Expectancies) and cue-based expectations about stimulus intensity (Stimulus Expectancies) modulate both pain reports and pain-evoked brain responses. Despite overlapping neural correlates, the two are likely to have different underlying mechanisms. The placebo response involves sustained changes, including endogenous opioid release (Levine et al., 1978). When Stimulus Expectancies vary from trial-to-trial, modulation must depend on transient signals, such as expected value and prediction error processing (Schoenbaum et al., 2007). To test whether these types of expectancies operate independently, we manipulated both factors in a single paradigm. We used a balanced placebo design, which crossed Outcome Expectancies (Expect drug vs. Expect no drug) with administration of remifentanil, a potent opioid analgesic (Receive drug vs. Receive no drug). Subjects (n=14) went through a concurrent Stimulus Expectancy task (Atlas et al., 2010), in which cues predicted high or low noxious heat, and each was occasionally followed by a single level of medium stimulation. We found evidence for additive, independent contributions of Stimulus Expectancies, Outcome Expectancies, and Drug treatment, with no interactions. Subjects reported less pain when they believed they were receiving remifentanil than when they believed they were not receiving any drug (M.E. Outcome Expectancy, $p<.05$), and reported more pain when medium stimulation was preceded by high-pain cues, relative to low-pain cues (M.E. Stimulus Expectancy, $p<.001$). Thus, individuals can maintain expectations about treatment and expectations about stimuli independently, supporting the hypothesis that these may reflect separate underlying mechanisms.

INTEGRATION OF REWARD-BASED AND CONTEXT-BASED DECISION MAKING IN HUMAN PREFRONTAL CORTEX Sandrine Duverne[1,2], Etienne Koechlin[1,2]; [1]Laboratory of Cognitive Neurosciences, INSERM, [2]Department of Cognitive Studies, Ecole Normale Supérieure, Paris — Lateral prefrontal cortex (LFC) is widely accepted to guide action selection based on environmental constrains, whilst dorsal medial prefrontal cortex (MFC) has recently been proposed to support motivational demand and reward expectation accompanying action selection. How do these two prefrontal

control systems interact to guide the selection of rewarding options? Using functional magnetic resonance imaging, we recorded brain activations in subjects who were either free or constrained by external cues to choose between a high-rewarded and a low-rewarded discrimination task. We found that MFC supported free task selection based on reward history. In addition, LFC activations classically associated with task selection also increased and were functionally more connected to MFC during reward-based compared to cue-based selection. Crucially, we found dissociation between the integration of reward expectation in MFC and LFC. MFC coded reward expectation during both reward- and cue-based selections. By contrast, LFC integrated reward expectation and was differently connected to MFC according to reward expectation only during reward-based selection, but not during cue-based selection. Our results support the idea that MFC codes reward expectation and, in the absence of external constrain, biases LFC engagement in selection processes toward the most rewarding option

THE BASAL GANGLIA INTERPRET ABSTRACT REPRESENTATIONS OF COGNITIVE ACTIONS Andrea Stocco[1], Christian Lebiere[2], Randall O'Reilly[3], John Anderson[2]; [1]Institute for Learning and Brain Sciences, University of Washington, [2]Department of Psychology, Carnegie Mellon University, [3]Department of Psychology, University of Colorado at Boulder, [4]Department of Psychology, Carnegie Mellon University — A crucial but not well understood aspect of intelligent behavior is the ability of executing actions according to internal representations, such as plans or instructions. In order to investigate the neural mechanisms that allow instruction interpretation, we recruited twenty-one participants to perform the novel experimental task in a 3T fMRI scanner. The task consists in performing arithmetic operations on two input numbers. Crucially, each trial is divided into an Encoding phase, where the operations and their order are revealed; and an Execution phase, where the numbers are presented and participants calculate the result according to the instructions. In addition, half of the trials were practiced beforehand, thus allowing us to distinguish between Instruction and Execution of Novel and Practiced trials. To isolate regions involved in interpreting instructions, we first identified all the voxels that were more active during the Execution of Novel trials than during the Instruction of Novel tasks or the Execution of Practiced ones. Then, in order to eliminate possible confounds due to increased access to instructions during execution, the results were masked by a parametric image of voxels more active in the Instruction phase for Novel than for Practiced tasks ($p < 0.05$, uncorrected). Only two clusters remained, corresponding to the right and left basal ganglia. Thus, our results indicate that the basal ganglia are crucially involved in interpreting and instantiating abstract rules. This function is consistent with existing models of the circuit's computations, and sheds new light on the neural basis of human intelligence.

A DEVELOPMENTAL FMRI STUDY ON CREATIVE PROBLEM SOLVING: HIGH POTENTIALS OF THE ADOLESCENT BRAIN (GSP WINNER) Sietske Kleibeuker[1], Cédric Koolschijn[1], Dietsje Jolles[1], Serge Rombouts[1], Carsten De Dreu[2], Eveline Crone[1,2]; [1]Leiden University, Netherlands, [2]University of Amsterdam, Netherlands — Adolescence is a period in life associated with advancements in reasoning but also high flexibility in the ability to think creatively. Structural and functional imaging studies demonstrated non-linear developmental changes in prefrontal and parietal cortex regions, indicative of slowly maturing cognitive control functions. The goal of the current study was to test the hypothesis that these adolescent specific changes in brain structure and function potentiate creative processes through more widely distributed activation within late developing association areas. Functional imaging data of 24 adolescents (15-17 yrs) and 12 adults (25-30 yrs) were collected during a modified version of Goel & Vartanian's (2005) Match-Problem task. Experimental trials required hypothesis generation and mental set-shifting, important processes in creative problem solving. Control trials required evaluation of hypothetical solutions. Adolescents performed slightly more accurate than adults, specifically on experimental trials (p=.05). These behavioral results were associated with increased activation of frontal areas in the adolescent brain. Relative to control trials (C), experimental trials (E) were associated with activation in left Inferior Frontal Gyrus across all participants, but activation was larger for adolescents compared to adults. Additionally, adolescents showed bilateral dorsolateral prefrontal cortex (DLPFC) activation. ROI analyses for E>C on right DLPFC, previously associated with task-performance on the Match-Problem task, confirmed elevated activation for adolescents relative to adults. A positive correlation between performance and activation for correct>incorrect on experimental trials confirmed the role of this region in creative processing. In all, this study underscores the potential of the developing adolescent brain in creative problem solving.

STRUCTURAL AND FUNCTIONAL PLASTICITY IN A FRONTO-PARIETAL NETWORK WITH REASONING TRAINING Allyson Mackey[1], Kirstie J. Whitaker[1], Alison Miller-Singley[1], Carter Wendelken[1], Silvia A. Bunge[1]; [1]University of California, Berkeley — Neuroimaging studies have consistently demonstrated the involvement of a fronto-parietal network in reasoning ability. We hypothesized that reasoning training would involve repeated use of this network, leading to changes in its structure and function. Rather than designing an artificial training program, we chose to study individuals while they prepared for the Law School Admissions Test (LSAT), a test that places strong demands on reasoning skills. We recruited students who were taking an LSAT course that offers 100 hours of instruction (n=25), as well as age- and IQ-matched pre-law controls (n=12). All subjects participated in two scanning sessions 90 days apart. We collected behavioral and fMRI data for a transitive inference task as well as structural MRI and DTI scans. The LSAT group improved significantly more than controls on the transitive inference task, both in accuracy ($p<.05$) and response times ($p<.05$), and exhibited a significantly greater task-related increase in bilateral superior parietal lobule activation from time 1 to time 2 than did controls ($p<.05$). The LSAT group also showed a decrease in left middle frontal gyrus ($p<.05$), but this change was not significantly different than for controls. Our DTI analyses focused on the superior longitudinal fasciculus (SLF), which connects prefrontal and parietal cortices. Interestingly, the LSAT group, but not controls, exhibited a decrease in fractional anisotropy in left SLF. In summary, we found that preparation for the LSAT improves performance, boosts parietal activation during a transitive inference task, and alters the white matter pathway connecting prefrontal and parietal cortices.

Slide Session 4

EMOTION AND SOCIAL COGNITION

Monday, April 4, 10:00 am - 12:00 pm, Grand Ballroom B

Chair: Kevin Ochsner, Columbia University
Speakers: Oriel FeldmanHall, Robert Spunt, Emile Bruneau, Jamil Zaki, Agnes Jasinska, Diana Tamir, Jennifer Silvers, Joan Chiao

ABSTRACTS

NOT WHAT WE SAY, BUT WHAT WE DO: A NEURAL BASIS FOR REAL MORAL DECISION-MAKING Oriel FeldmanHall[1,2], Tim Dalgleish[1,2], Russell Thompson[1,2], David Evans[1,2], Susanne Schweizer[1,2], Dean Mobbs[1,2]; [1]Cambridge University, [2]Medical Research Council Cognition and Brain Sciences Unit — Some of the most fundamental psychological questions concerning social organisation and human relations centre on morality and altruism. While moral choices in the real world are highly susceptible to pressures of both context and consequence, little research has examined real moral decision-making; instead, research has focused on hypothetical moral reasoning. Consequently, little is known about behavioural responses to real moral challenges and how the brain processes these decisions. Here we show that hypothetical moral decisions do not approximate real moral action and that real moral decisions recruit distinct neural circuitry. Under both real and hypothetical condi-

tions, we measured subjects' responses when deciding between financial self benefit versus preventing physical harm to a confederate. In a behavioural study, we found that subjects dramatically prioritise their own financial benefit at the expense of harming others, keeping over three times as much for themselves in the real task as compared to the hypothetical. In two functional magnetic resonance studies, we showed that decisions made under hypothetical conditions activated neural networks identified in the existing literature, including the posterior cingulate cortex (PCC)—a region also implicated in imagination. However, decisions made during the real condition activated these networks as well as additional regions in the posterior and middle insular cortex (pINS-mINS)—areas essential in integrating affective body states to create a preliminary neural template of subjective feelings. We conclude that the pINS-mINS activity provides a rudimentary marker for real moral decisions.

UNDERSTANDING THE MENTAL AND MECHANICAL ASPECTS OF ACTIONS VISIBLE AND INVISIBLE: EFFECTS OF LEVEL OF CONSTRUAL AND ACTION VISIBILITY ON THE NEURAL CORRELATES OF SOCIAL COGNITION Robert Spunt[1], Matthew Lieberman[1]; [1]University of California, Los Angeles — Actions can be construed as a sequence of mechanical interactions with the physical world (how it is occurring) or as the expression of the motives, beliefs and intentions of the actor (why it is occurring). We have shown that mental and mechanical construals of actions described in text engage dissociable neural systems (Spunt, Falk & Lieberman, 2010), with mechanical construals engaging a left-lateralized set of higher-order visual and premotor areas associated with representing motor actions, and mental construals engaging a diffuse network of regions associated with representing mental states, including medial prefrontal cortex (mPFC), precuneus, and the temporoparietal junction. In the present study, we investigated how action construal and action visibility interactively modulate these neural systems. Twenty-one participants underwent fMRI while being presented with video clips of actions (action visible) and descriptions of action intentions (invisible action; e.g., "She is marking her calendar"). For each presentation, participants identified either why (mental construal) or how (mechanical construal) the action was being performed. Regardless of action visibility, mental construals engaged areas supporting mental state representation, while mechanical construals engaged areas supporting visual/motor representation. Regardless of level of construal, visible actions engaged a primarily right-lateralized set of areas for motor representation. We observed interaction effects in left-lateralized areas for motor representation, and in areas important for social cognition, including the mPFC, medial temporal cortex (including amygdala), and temporal poles. The results demonstrate an imperative to consider effects of both stimulus (bottom-up) and construal (top-down) on the neural systems supporting social cognition.

SEPARATE BRAIN REGIONS RESPOND TO OTHERS' PHYSICAL PAIN AND EMOTIONAL SUFFERING Emile Bruneau[1], Rebecca Saxe[1]; [1]Massachusetts Institute of Technology — Witnessing the aftermath of a disaster, we feel empathic responses towards the physical pain of the victims, and towards the emotional suffering of the survivors mourning the loss of loved ones and livelihoods. While many recent studies have investigated the neural mechanisms of responding to another person's physical pain, how the brain processes another's emotional suffering is less well understood. In the current study we presented participants (n=42) with 144 verbal scenarios, each describing a protagonist's physical or emotional experience, ranging from neutral to extremely negative events. A separate group of participants read these scenarios, and rated them on multiple scales, including "how much physical pain", and "how much emotional suffering" the protagonist experienced. A whole-brain item analysis was used to determine which brain regions' responses were correlated, across items, with these ratings. Although ratings of Pain and Suffering were positively correlated, they revealed activity in distinct brain regions. Stories that described more physical pain elicited neural activity in brain regions associated with feeling physical sensations (e.g. secondary sensory cortices) and in experiencing physical pain (e.g. insula and dorsal cingulate cortices). By contrast, stories that described more emotional suffering elicited activity in a subset of regions associated with thinking about other people's minds: posterior cingulate and medial prefrontal cortex. More broadly, item analyses with continuous predictors provided a high-powered method for identifying brain regions associated with specific aspects of complex stimuli – like verbal descriptions of physical and emotional events.

SOCIAL INFLUENCE MODULATES THE NEURAL COMPUTATION OF VALUE Jamil Zaki[1], Jason Mitchell[1]; [1]Department of Psychology, Harvard University — Social influence—individuals' tendency to conform to the beliefs and attitudes of others—has interested psychologists for decades. However, it has traditionally been difficult to distinguish true modification of one's attitudes from mere public compliance with social norms. That is, individuals may conform publicly to group attitudes in order to avoid ostracism, while maintaining a different opinion in private, or they may actually shift their internal perceptions to match those of a group. Although these are fundamentally different mechanisms through which social influence could operate, it is difficult to distinguish between them using behavioral data alone. The current study addressed this challenge using functional neuroimaging. Participants rated the attractiveness of faces and subsequently learned how their peers rated each face. Participants were then scanned using fMRI while they rated each face a second time. These second ratings were influenced by social norms, such that participants changed their ratings to conform to those of their peers. Importantly, this social influence was accompanied by modulated engagement of two brain regions associated with coding subjective value?the nucleus accumbens and orbitofrontal cortex?suggesting that social norms affected the underlying neural representation of value assigned to stimuli. This converging evidence suggests that social influence is sufficient to cause core modifications of the value assigned to a stimulus. More broadly, these findings document the underlying neural changes associated with social influence on individuals' private evaluations, and elucidate the mechanisms through which the beliefs and attitudes of one person come to shape the mind of another.

NEURAL MEDIATORS OF SEROTONIN TRANSPORTER GENE EFFECTS ON SMOKING CESSATION. Agnes Jasinska[1], Hannah Faye Chua[1], S. Shaun Ho[1], Thad A. Polk[1], Laura Rozek[1], Mike Angstadt[1], Victor J. Strecher[1]; [1]University of Michigan — Growing evidence from imaging genetics suggests that serotonin transporter gene variation modulates activity and connectivity in the amygdala–prefrontal cortex (PFC) circuit during emotion processing and in affective disorders. The goal of the current study was to determine whether serotonin transporter gene variation also modulates the amygdala-PFC circuit response to smoking-cessation messages in smokers, and whether this response serves as a mediator of genetic effects on smoking cessation. We used functional MRI to assess the neural response to smoking-cessation messages compared to neutral messages in 91 smokers who subsequently underwent a message-based smoking-cessation intervention. Participants were genotyped for two common, functional polymorphisms in the serotonin transporter gene: 5-HTTLPR/ rs25531 in the promoter and STin2 in intron 2. The quitting outcome was assessed 4 months after the intervention, yielding 45 Quitters and 39 Non-Quitters. As predicted, the right amygdala response to smoking-cessation messages was modulated by both STin2 and 5-HTTLPR/ rs25531. Furthermore, amygdala activity mediated the effect of STin2 on quitting. In addition, functional connectivity between right amygdala and right ventromedial PFC (VMPFC) during processing of smoking-cessation messages also mediated STin2 effects on quitting. Together, these results demonstrate that the amygdala-PFC circuit response to smoking-cessation messages mediates the impact of serotonin transporter gene variation on smoking cessation.

THE INTRINSIC REWARD VALUE OF COMMUNICATING ABOUT THE SELF (GSP WINNER) Diana Tamir[1], Jason Mitchell[1]; [1]Harvard University — Humans communicate about themselves quite often, and to a wide range of audiences. Why do humans so readily reveal their thoughts and

feelings with others? Using behavioral and functional neuroimaging measures of reward, here we test the prediction that people communicate with others about the self because doing so provides intrinsic rewards. In experiment one, participants made a series of choices to answer questions about the Self, Others, or Facts for money. By comparing participants' choices to answer one question type over another at a variety of monetary values, results showed that participants attribute the greatest monetary value to answering about the Self. In experiments two and three, participants answered questions about the personality or preferences of themselves and another person during fMRI scanning; in experiment three, half of participants' answers were shared with a friend sitting outside the scanner, half were kept private. Using both whole-brain random effects analyses and ROI analyses of independently localized regions implicated in reward processing (NAcc, VTA, OFC) we contrasted Self>Other trials and Share>Private trials to test for the reward of self and the reward of sharing information with others. Results revealed that neural reward activity was significantly greater for answering questions about the self than about others, and that sharing responses—about both self and other—is significantly more rewarding than responding privately. Together, these findings suggest that the human tendency to communicate about their thoughts and feelings may arise, in part, from the intrinsic value of thinking and sharing about the self.

THE DEVELOPMENTAL TRAJECTORY OF THE COGNITIVE CONTROL OF EMOTION Jennifer Silvers[1], Jocelyn Shu[1], Walter Mischel[1], Kevin Ochsner[1]; [1]Columbia University— While adolescence is commonly characterized as a time of social and emotional turmoil, it is unknown whether shifts in socio-emotional behavior in adolescence are due to changes in emotional reactivity or regulation. Study 1 investigated this question by assessing the behavioral correlates of emotional distancing and immersion in individuals ages 10-22. On each trial, participants viewed an aversive or neutral image while either drawing themselves closer to the emotional details of the picture ("close" trials) or mentally distancing themselves from such details ("far" trials). Half of the pictures depicted social and half depicted non-social content. At the conclusion of each trial, participants rated their negative affect. Self-reported affect on baseline "close" trials measuring emotional reactivity did not vary with age. However, whereas all ages reported significantly less negative affect on "far" trials than "close" trials, regulation success (drops in negative affect) increased linearly with age. Importantly, age-related differences in regulation success were largest for trials with social stimuli. In Study 2, this same paradigm was used in an fMRI experiment. Results paralleled those of Study 1 in that age predicted larger decreases in amygdala activity on "far" trials in comparison to "close" trials but did not predict baseline reactivity to aversive images. These age-related differences in amygdala responsivity were greatest for trials containing social content. Differences in amygdala modulation were accompanied by developmental differences in recruitment of prefrontal regions known to support emotion regulation. These results suggest that emotional reactivity does not change during adolescence but that regulatory capacity does.

CULTURAL VALUES OF INDIVIDUALISM-COLLECTIVISM MODULATE AMYGDALA RESPONSE TO EMOTIONAL SCENES Joan Chiao[1], Ahmad Hariri[2], Tokiko Harada[3], Lisa Hechtman[1], Yoko Mano[1], Hidetsugu Komeda[1], Todd Parrish[1], Norihiro Sadato[4], Tetsuya Iidaka[3]; [1]Northwestern University, [2]Duke University, [3]Nagoya University, [4]National Institute for Physiological Sciences— Understanding the aetiology of complex human behaviors, such as emotion and psychopathology, requires accounting for genetic and environmental influences at multiple phenotypic levels, including activity within brain regions associated with emotion processing. Cultural factors, such as individualistic and collectivistic values, affect how people perceive, experience and respond to emotional events, facilitating a diverse array of adaptive behavioral repertoires for navigating the social and physical environment. Yet, how cultural values of individualism-collectivism affect neurobiological mechanisms underlying emotion remains unknown. In two functional magnetic resonance imaging (fMRI) studies, we investigated the effect of cultural values of individualism-collectivism on human amygdala response to emotional scenes. Here we show that people living in a collectivistic culture, such as Japan, demonstrate greater bilateral amygdala response to emotional scenes compared to people living in an individualistic culture, such as the United States, controlling for other known modulators of amygdala response, including ethnicity, personality and serotonin genotype. We also show that bicultural individuals living in the United States primed with collectivistic cultural orientation exhibit greater bilateral amygdala response to emotional scenes compared to biculturals primed with an individualistic cultural orientation, indicating a causal influence of culture on emotional neural circuitry. Finally, we show that degree of cultural priming positively correlates with degree of amygdala response to emotional scenes. Taken together, these findings illustrate culturally-driven variation in amygdala response underlying emotion across macro- and micro-timescales and provide an empirical foundation for incorporating cultural values of individualism-collectivism into gene-by-environment models of emotion and psychopathology and their underlying neural substrates.

Slide Session 5

ATTENTION

Monday, April 4, 3:00 - 5:00 pm, Grand Ballroom B

Chair: Marty Woldorff, Duke University

Speakers: Veronica Mazza, Steven Franconeri, Alejandro Vicente-Grabovetsky, Linda Moya, Kathleen Pirog Revill, Andre Mascioli Cravo, Lawrence Ward, Vicki Chanon

ABSTRACTS

THE FLEXIBILITY OF INDIVIDUATION IN MULTIPLE OBJECT PROCESSING Veronica Mazza[1,2], Alfonso Caramazza[1,3]; [1]Center for Mind/Brain Sciences (CIMeC), University of Trento, Italy, [2]Department of Cognitive Sciences and Education, University of Trento, Italy, [3]Department of Psychology, Harvard University— The ability to process concurrently multiple visual objects is fundamental for a coherent perception of the world. A core component of this ability is the simultaneous individuation of multiple objects. Many studies have addressed the mechanism of object individuation but it remains unknown whether the visual system mandatorily individuates all potentially relevant elements in the visual field, or whether object indexing depends on task demands. We used an Event-Related Potential (ERP) measure of visual selection, the N2pc component, to evaluate the flexibility of multiple object individuation. In three ERP experiments, participants saw a variable number (0, 1, 2, 3) of target elements among homogenous distracters and performed either an enumeration task (Experiment 1) or a detection task, reporting whether at least one (Experiment 2) or a specified number of target elements (Experiment 3) was present. While in the enumeration task the N2pc response increased as a function of the number of targets, no such modulation was found in Experiment 2, indicating that individuation of multiple targets is not mandatory. However, a modulation of the N2pc similar to the enumeration task was visible in Experiment 3, further highlighting that object individuation is a flexible mechanism that binds indexes to object properties and locations as needed for further object processing.

FLEXIBLE VISUAL PROCESSING OF SPATIAL RELATIONSHIPS Steven Franconeri[1], Jason Scimeca[1], Jessica Roth[1], Lauren Kahn[1], Sarah Helseth[1]; [1]Northwestern— Many visual tasks, such as understanding a diagram, require that we process the spatial relationships between objects. There is almost no work exploring how we make these judgments in a flexible way. One hurdle is the binding problem - because our object recognition network codes object features across large regions of the visual field, there is often uncertainty about the location of any given object. Unless individual objects are isolated by selective attention, object identities can

become misbound. We demonstrate examples of this phenomenon for simple displays containing just two colors. When we process a relative spatial relation, the visual system may solve this binding problem by selecting the first object, encoding its location into memory, select the second object, and then compare its relative location. In three studies, we used an electrophysiological correlate of selection (N2pc) to demonstrate that even when dealing with just two simple objects, selection shifts sequentially between them. These shifts (1) occur despite difficult dual tasks that discourage them, (2) occur only for trials where the relation was actually perceived, and (3) do not occur for same-different judgment tasks that do not present a binding problem. Together, these results demonstrate that when seeing one object to the right of another, our impression of simultaneously selecting both objects may be an illusion. We will describe a potential architecture that allows recovery of spatial relations from the pattern of shifts themselves, as show how this flexible processing system could be extended into non-spatial domains (e.g. size judgments).

RETINOTOPIC BUT NOT OBJECTOTOPIC REFERENCE FRAMES DURING ATTENTIONAL MONITORING Alejandro Vicente-Grabovetsky[1], Daniel J. Mitchell[1], Johan D. Carlin[1], Rhodri Cusack[1]; [1]MRC Cognition and Brain Sciences Unit — Spatial coding has been explored in the occipital, parietal and frontal cortex using retinotopic mapping (Wandell et al, 2007), which reveals hemifield maps centred onto an egocentric, eye-centred reference frame. However, little research has been done on other reference frames, which may be non-lateralised and allocentric. Specifically, we are interested in object-centred reference frames, given the body of literature addressing object-based hemispatial neglect (Walker, 1995). We use a novel technique to independently extract Multi-Voxel Pattern (MVP) information related to eye-centred (retinotopic) and object-centred (objectotopic) frames of reference. Implementing this technique, we designed a selective attention experiment requiring participants to detect changes in velocity in specific moving gratings belonging to one of two discs, each located left or right of fixation. Since the targets were defined by colour, the task requirements did not specifically necessitate either a retinotopic or objectotopic reference frame. Our results revealed that while retinotopic spatial information was automatically evoked across the occipital and posterior parietal cortex, objectotopic information was absent. This dissociation confirms that retinotopic reference frames are automatically engaged during attentional monitoring, and suggests several possibilities for objectotopic reference frames. Perhaps objectotopic reference frames are only engaged by specific task requirements. Alternatively, interhemispheric reference frames may not exist, given separate attentional resources for each visual hemifield as shown cognitively (Alvarez and Cavanagh, 2005) and the relative hemispheric independence shown in our univariate results. One final possibility considers how visual stimuli are defined as objects and parts thereof, and the implication of this in objectotopy studies.

THE MICROGENESIS OF OBJECT-BASED VIS-À-VIS SPACE-BASED VISUAL ATTENTION Linda Moya[1], Sarah Shomstein[2], Anto Bagic[3], Marlene Behrmann[1]; [1]Carnegie Mellon University, [2]George Washington University, [3]University of Pittsburgh Medical Center — Visual attention can be understood as the process by which some subset of the input is selected for further cognitive processing. One way of processing input is to attend to a spatial location unbiased by the elements that comprise the input. Another way is to attend to an entire perceptual object and process it preferentially. The former is known as space-based attention (SBA) and the latter as object-based attention (OBA). Recent theories suggest that attention is a basic computational mechanism in which dynamic networks of oscillating neurons are formed to subserve cognition via critical and differential contribution of oscillation frequency. An open question is how the dynamic networks of these two forms of attention differ. The present research utilizes a classic behavioral paradigm for uncovering effects as evidenced by reaction time differences. Simultaneously, MEG, EEG and MRI neuroimaging are used to elucidate how OBA vis-à-vis SBA evolves in time, across the brain, while elucidating the frequency characteristics. Our results suggest that OBA and SBA are processed differentially first in the parietal lobes starting at 50 ms post target onset, then follow a feedback, feedforward then posterior ventral-lateral time course through 300 ms. Left-hemifield targets start and finish differential processing before right-hemifield targets. Finally, differential processing happens within the theta and alpha frequency bands. The present findings lay the groundwork for further research into a comprehensive temporal and spatial understanding of the role of the frontal-parietal areas as the source of OBA vis-à-vis SBA and their modulation of posterior brain regions.

DISTINCT ANATOMY FOR VISUAL SEARCH AND BISECTION: A NEUROIMAGING STUDY Kathleen Pirog Revill[1], Hans-Otto Karnath[1,2], Christopher Rorden[1]; [1]Georgia Institute of Technology, [2]University of Tübingen — Individuals with spatial neglect following brain injury often show biased performance on landmark bisection tasks (judging if a single item is transected at its midpoint) and search tasks (where they seek target(s) from an array of items). Interestingly, it appears that bisection deficits dissociate from other measures of neglect (including search tasks), and neglect patients with bisection deficits typically have more posterior injury than those without these symptoms. While previous studies in healthy adults have examined each of these tasks independently, our aim was to directly contrast brain activity between these two tasks. Our design used displays that were interpreted as landmark bisection stimuli in some blocks of trials and as search arrays on other trials so that low level perceptual and motor responses were identical across tasks. Both tasks generated significant activity in bilateral midfusiform gyrus, largely right lateralized activity in the posterior parietal cortex, left lateralized activity in the left motor cortex (consistent with right handed response) and generally right lateralized insular activation. Several brain areas showed task-selective activations when the two tasks were directly compared. Specifically, the superior parietal cortex was selectively activated during the landmark task. On the other hand, the search task caused stronger bilateral activation in the anterior insula, along with midfusiform gyrus, medial superior frontal areas, thalamus and right putamen. This work demonstrates that healthy adults show an anatomical dissociation for visual search and bisection behavior similar to that reported in neurological patients, and provides coordinates for future brain stimulation studies.

THE ROLE OF LOW FREQUENCY OSCILLATIONS ON MOTOR PROGRAMMING AND UPDATING (GSP WINNER) Andre Mascioli Cravo[1], Gustavo Rohenkohl[2], Valentin Wyart[2], Anna C. Nobre[2]; [1]Department of Physiology and Biophysics, University of São Paulo, [2]Department of Experimental Psychology, University of Oxford — The ability to program and continuously update motor actions for forthcoming events is essential for behaviour. In humans, several studies have associated increasing temporal expectations with synchronization of higher frequency oscillations (i.e. gamma band) and suppression of lower frequencies that are thought to be detrimental to sensory processing. In this experiment, we explore a novel hypothesis that proposes that low-frequency oscillations can provide a central mechanism for temporal expectations. We used a Go/No-go reaction time task where temporal expectations were manipulated by the probability of target presentation after certain intervals. As expected, we found that reactions times decreased with higher temporal expectations. Interestingly, the difference in RT happened in the same time periods where there was an increase of frontal-midline theta. Moreover, we found a transient phase-power coupling between theta phase and beta power in time periods where the temporal expectations were not fulfilled. Taken together, our results support the idea that low-frequency oscillations provide a central mechanism for temporal expectations, and that phase-power coupling between frequencies can work as a temporally specific mechanism to coordinate activity across distributed cortical areas.

SYNCHRONIZATION IN ANTICORRELATED FUNCTIONAL NETWORKS OF THE HUMAN BRAIN Lawrence Ward[1], Aaron Kirschner[1], Julia Kam[1], Todd Handy[1]; [1]University of British Columbia — It is well established that on a regional scale the brain is organized into dynamic functional networks, one of which, the default network, is anticorrelated with other transient, task-specific networks. Putatively the default network manages a variety of cognitive background processes, such as using experience-informed simulations to help predict and plan for the future. One hypothesis about how such always-structurally-connected networks can transiently form and dissolve functionally, is that network formation and dissolution is mediated by increases and decreases in oscillatory synchronization between constituent brain regions. If so, then synchronization within the default network also should be anticorrelated with synchronization within task-specific networks. In order to investigate this hypothesis we conducted two experiments in which participants engaged in a Sustained Attention to Response Task (SART) while having brain activity recorded via high-density electroencephalography (EEG). We found that during periods when attention was focused internally there was significantly more neural phase synchrony between brain regions associated with the default network, whereas during periods when subjects were focused on performing the visual task there was significantly more neural phase synchrony within a complementary task-specific brain network. This anticorrelated network synchrony occurred in each of theta, alpha, and gamma frequency bands. A similar pattern of anticorrelated oscillatory power changes, indicating modulation of local synchronization by attention state, was also found. These results provide additional evidence that the human brain is intrinsically organized into anticorrelated default and task-specific brain networks, and confirm that synchronization is a potential mechanism for functional coupling within these networks.

CHRNA4 GENOTYPE EFFECTS ON THE NEURAL CORRELATES OF ATTENTIONAL BIAS TOWARD CIGARETTE CUES Vicki Chanon[1], Charlotte Boettiger[1]; [1]University of North Carolina-Chapel Hill — Data suggest that craving triggered by drug cue exposure results in part from abnormal allocation of attention to drug cues in substance-dependent individuals (SDIs). In a previous fMRI study measuring attentional bias toward smoking-related images, we found differences between smokers and non-smokers in responses to smoking cues and smoking congruent targets in areas implicated in attention, cognitive control, and episodic memory. Using the same paradigm, here we tested whether predictors of addiction severity predict brain responses to smoking cues. First, regression analysis revealed a positive correlation between attentional bias and cue responses in a network of frontal areas including the orbital frontal cortex, as well as the caudal hippocampus. Second, we compared the neural correlates of attentional bias between participants with differing genetic risk for nicotine dependence severity. We genotyped participants for the C>T exon 5 polymorphism (rs1044396) of the gene encoding the ?4 subunit of the nicotinic acetylcholine receptor (CHRNA4). Participants with the CC genotype, associated with nicotine dependence risk, showed significant attentional bias toward cigarette cues, while T-allele carriers did not. CC's had increased precuneus, precentral gyrus, and middle frontal activity in response to smoking-congruent probes and increased activation in cerebellum, ventromedial prefrontal cortex, and orbitofrontal cortex, previously implicated in executive dysfunction among SDIs, in response to smoking cues. In contrast, TT's showed greater activity in response to smoking-congruent probes in the anterior cingulate cortex, suggesting enhanced cognitive control when distracting smoking cues should be ignored. Results provide novel biomarkers of genetic contribution to addiction-related attentional bias.

Slide Session 6

LONG-TERM MEMORY

Tuesday, April 5, 10:00 am - 12:00 pm, Grand Ballroom B

Chair: Roberto Cabeza, Duke University

Speakers: Laura Skipper, Heather D. Lucas, Richard J Addante, Benjamin J. Levy, Jessica Andrews-Hanna, Sander Daselaar, Jessica Payne, Jared Saletin

ABSTRACTS

SENSORY AND SEMANTIC SUBDIVISIONS WITHIN THE ANTERIOR TEMPORAL LOBES. Laura Skipper[1], Lars Ross[1], Ingrid Olson[1]; [1]Temple University — In the semantic memory literature the anterior temporal lobe (ATL) is frequently discussed as one homogeneous region when in fact, anatomical studies indicate that it is likely that there are discrete subregions within this area. Here we used functional magnetic resonance imaging (fMRI) to investigate whether sensory and stimulus-specific subregions exist within the ATL. Participants were trained to associate social or non-social words with novel auditory, visual, or audiovisual stimuli. Participants then underwent an fMRI scan, during which stimuli was presented and participants were required to recall the associated words. We found that visual stimuli preferentially activated ventral ATL, and that multisensory stimuli preferentially activated polar aspects of the ATL. We also found relatively more sensitivity in the ATL to the retrieval of social knowledge as compared to non-social knowledge, especially in polar regions, and that this factor interacted with sensory modality. These findings indicate that the ATL contains subdivisions based on sensory modality, and that the semantic processing capacities of this region, especially the temporal pole, are strongly biased towards social stimuli.

MANY PROCESSES LEAD TO RECOGNITION: ELECTROPHYSIOLOGICAL CORRELATES OF FAMILIARITY DERIVED FROM SHORT-TERM MASKED REPETITION Heather D. Lucas[1], Ken A. Paller[1]; [1]Northwestern University — Multiple forms of memory can occur simultaneously, including explicit familiarity and implicit priming. Explicit memory and priming are often considered to be independent of each other. However, some evidence suggests that repetition-related increases in processing fluency thought to give rise to priming may also contribute to familiarity. To investigate these issues further, we examined brain potentials during a recognition test for visual words. Fluency was selectively enhanced for half of the test cues via masked repetition. As expected, the proportion of words endorsed as "old" was greater for words immediately preceded by a matching masked word versus a random one. Also, N400 potentials were reduced for words preceded by matching versus random masked words. Most importantly, N400 reductions were larger for unstudied items falsely endorsed as "old" relative to correct rejections. These potentials were distinct from electrophysiological correlates of successful recognition of studied words. These findings suggest that the relationship between familiarity and priming is not immutable. Here, masked-repetition-induced fluency served as a cue to prior experience, in that words made more fluent in this manner engendered more familiarity in the recognition test. The electrophysiological results challenge conventional assumptions that patterns of neural activity that covary with explicit recognition cannot reflect priming. In some cases, the extent to which an item's fluency increases from a prior exposure impacts the likelihood that it will be experienced as familiar. More generally, experiences of familiarity can stem from multiple sources and can have different neural correlates depending on the sources that are operative.

RETRIEVING SOURCE INFORMATION ABOUT ITEMS THAT ARE NOT RECOGNIZED WITH HIGH CONFIDENCE: RECOLLECTION OR FAMILIARITY? Richard J Addante[1,2], Charan Ranganath[1,2,4], Andrew P. Yonelinas[1,2,3,4]; [1]University of California - Davis, [2]Center for Neuroscience, [3]Center for Mind and Brain, [4]Department of Psychology — Recognition memory can be based on recollection of qualitative information about a prior

event, or on the basis of familiarity. Recollection is often operationalized either as the ability to make accurate source memory judgments (i.e., retrieving where or how an item was studied), or with a dual process model in which recollection reflects a threshold process that supports relatively high confidence item recognition responses, but not less confident memories. In general, studies using these approaches have led to convergent results. However, subjects sometimes make accurate source memory judgments even for items that don't receive the highest level of item recognition confidence, and its not clear whether these types of responses are based on recollection or familiarity. To address this, we measured event related potentials (ERPs) during item and source memory confidence judgments. In line with previous studies, recognition was associated with an early fronto-central positivity and a later left parietal positivity, which have been previously associated with familiarity and recollection, respectively. The fronto-central effect increased gradually with item recognition confidence, whereas the left parietal component was only observed for highly confident recognition responses. The left parietal effect was also related to source accuracy, but only for items that had received a high confidence item recognition response; accurate source judgments to items that were less confidently recognized did not exhibit this ERP correlate of recollection. Results indicate that recollection supports high confidence recognition responses and accurate source judgments, but that familiarity may support accurate source judgments when recollection fails.

A COMMON NEURAL SYSTEM MEDIATES ATTENTIONAL CAPTURE BY PERCEPTS AND INTRUSIVE MEMORIES Benjamin J. Levy[1], Ean Huddleston[2], Michael C. Anderson[2]; [1]Stanford University, [2]MRC Cognition and Brain Sciences Unit, Cambridge England — Functional imaging studies of episodic memory reveal the consistent recruitment of lateral parietal cortex (LPC) during retrieval (Wagner et al., 2005). It has been suggested (Cabeza et al., 2008; Ciaremelli et al., 2008) that the specific LPC regions recruited during retrieval may be related to a distinction within spatial attention between the dorsal and ventral attention networks (Corbetta & Shulman, 2002), although this position has been challenged (Hutchinson et al., 2009; Sestieri et al., 2010). Here we provide a novel contribution to this discussion based on evidence from the Think/No-Think paradigm. In this paradigm subjects attempt to intentionally prevent a specific memory from entering conscious awareness, however, in current task we have them report when an unwanted memory intrudes into awareness and reflexively captures mnemonic attention. Across multiple experiments, we find a replicable region of right ventral LPC that is recruited when people experience these mnemonic intrusions, independent of the type of material that intrudes (words, faces, places). We also demonstrate that, within-subject, this cluster overlaps with the regions observed during the reflexive allocation of spatial allocation, as measured by the Posner cueing task, although there also appears to be regions of functional differentiation within LPC between mnemonic and perceptual capture. Lastly, we find a similar activation even when subjects are not asked to report the occurrence of intrusions, suggesting that this finding is not due to the monitoring component of the task. Instead, this suggests common neural responses during reflexive orienting of attention to either percepts or memories.

DEFAULT NETWORK SUBSYSTEMS CONTRIBUTE DIFFERENTIALLY TO EPISODIC MEMORY AND THEORY OF MIND Jessica Andrews-Hanna[1,2,3], Tal Yarkoni[1], Tor Wager[1], Madison Arbuckle[1], Rebecca Saxe[4], Randy Buckner[2,3,5]; [1]University of Colorado Boulder, [2]Harvard University, [3]Athinoula A. Martinos Center for Biomedical Imaging, [4]Massachusetts Institute of Technology, [5]Howard Hughes Medical Institute at Harvard University, [6] — The default network (DN) is a large-scale network that plays a prominent role in spontaneous and goal-directed mentation. Recent research suggests the DN is comprised of a midline core and two subsystems that contribute differently to internal mentation (Andrews-Hanna et al., 2010). Three experiments were conducted to explore the contributions of the DN components to episodic memory (EM) and theory of mind (TOM). In Experiment 1, 36 participants were scanned with fMRI while performing a "remember/know" memory retrieval task and a "false belief" TOM task. The posterior cingulate was similarly engaged during both tasks, while the two subsystems were differentially engaged. EM preferentially recruited a medial temporal lobe (MTL) subsystem that included the hippocampal formation, parahippocampal cortex, retrosplenial cortex, and posterior inferior parietal lobule. In contrast, TOM recruited a dorsal medial prefrontal cortex (dMPC) subsystem that included the dMPFC, temporoparietal junction, and temporal poles. In Experiment 2, resting state functional connectivity was used to examine spontaneous correlations among these regions, replicating the pattern of convergence and divergence observed in Experiment 1. Experiment 3 used a novel "Lexical Brain Decoding" approach (Yarkoni et al., submitted) to identify brain regions that most strongly predicted the presence of EM and TOM in a large-scale meta-analysis of the fMRI literature. Results linked EM to the MTL subsystem and TOM to the dMPFC subsystem. Collectively, these results suggest the DN is comprised of a heterogeneous brain system that involves distinct subsystems with functionally dissociable roles.

EXPLAINING THE ROLE OF DEFAULT MODE NETWORK SUPPRESSION IN SUCCESSFUL COGNITIVE PERFORMANCE: EFFECTS OF RESPIRATION Sander Daselaar[1], Cyriel Pennartz[2], Ewa Beldzik[3], Alexandra Domagalik[4], Martin Vinck[5], Winnie Hofman[6], Willem Huijbers[7]; [1]University of Amsterdam, Netherlands, [2]Jagiellonian University, Krakow, Poland — The default mode network (DMN) regions are deactivated during cognitive tasks as a function of task demands and these deactivations are associated with successful performance. Yet, it is largely unknown why this happens. One intriguing possibility is that the link between DMN deactivation and successful cognitive performance is mediated by changes in respiration, which have been found to track changes in attention and to confound changes in fMRI signal. We investigated this hypothesis within the domain of episodic memory encoding, focusing on the posterior medial component (PMC) of the default network. Several studies found that PMC deactivation during encoding predicts later memory. Thus, in contrast with regions like left ventrolateral prefrontal cortex (VLPFC), which typically show greater activity for subsequently remembered than forgotten items (subsequent memory effect—SME), PMC shows the opposite pattern (reverse SME). To investigate if reverse SME in PMC is related to respiratory artefacts, we measured respiration in the scanner and included a breath-holding condition. We found that respiration predicted subsequent memory performance, and that the reverse SME effect in PMC was substantially reduced during breath-holding. In contrast, left VLPFC did not show this effect. A correlation analysis confirmed these last findings. . These findings suggest that the link between DMN deactivation and successful cognitive performance is partly related to changes in respiration, which in turn may track differences in attention. Further research is required to extend our findings to other DMN components and cognitive domains and to explore the links between respiration and attention.

SLEEP'S ROLE IN THE CONSOLIDATION OF EMOTIONAL EPISODIC MEMORIES Jessica Payne[1], Elizabeth Kensinger[2]; [1]University of Notre Dame, [2]Boston College — After information is encoded into memory, it undergoes an offline period of consolidation that may occur optimally during sleep. Here we show that sleep can have highly selective effects on emotional memory consolidation. Compared to periods of wakefulness, sleep preferentially preserves emotionally salient aspects of complex experiences at the expense of less salient, neutral aspects. We provide evidence that 1) compared to two different wake control conditions (designed to strictly control for circadian and interference confounds), a brief afternoon nap is sufficient to trigger the preferential enhancement of emotional components of complex scenes, and further, this enhancement is correlated with time spent in deep, slow-wave sleep (SWS), 2) this preferential enhancement is further intensified across longer (24hr and 3month) delays, but only when sleep directly follows encoding. Across these longer delays, emotional object memories con-

tinue to be protected (i.e. they do not deteriorate further), but there is additional, perhaps active, suppression of memory for associated backgrounds, suggesting that additional nights of sleep might continue to sculpt the memory trace. Finally, 3) using fMRI, we show that a single night of sleep can provoke changes in the emotional-memory circuitry used at retrieval, leading to increased activity within the amygdala and the ventromedial prefrontal cortex and resulting in strengthened connectivity between the amygdala and the hippocampus and ventromedial prefrontal cortex. These findings strongly suggest that sleep-specific brain physiology plays a specialized role in memory consolidation, going beyond simple stabilization of memories to promote changes in memory representation that may be highly adaptive.

DIRECTING SLEEP TO SELECTIVELY FORGET AND REMEMBER HUMAN MEMORIES (GSP WINNER) Jared Saletin[1], Andrea Goldstein[1], Matthew Walker[1]; [1]University of California, Berkeley — Substantive evidence now implicates sleep in the consolidation and strengthening of human memories. However, numerous circumstances exist where forgetting is as critical as remembering. Here we investigate the impact of explicit cue instruction during learning, prior to sleep, on the subsequent remembering and forgetting, after sleep. At the initial learning phase at 11:00, participants (n=46) were presented with 100 words one at a time. Each word was followed by a cue to either forget or remember that word. Following learning, half of the participants ("Nap-group") were then given a 100-minute sleep opportunity, while the other half ("No-Nap-group") remained awake. At 17:15, all subjects were then given a surprise free-recall memory test. A significant group by cue-type recall interaction was observed (P=0.004), such that those in the nap-group, relative to the no-nap group, showed a preferential recall of words cued to be remembered, yet this benefit occurred in absence of any such enhanced recall of items cued to be forgotten, indicative of specificity. Moreover, the success of this differential remember/forget effect strongly correlated with fast sleep-spindles over the left superior parietal cortex (P=0.0006). Further, EEG source analysis of these spindles revealed a repeating loop of current density between selective memory-related regions of the superior parietal, medial temporal and right prefrontal cortices. These findings move beyond the classical notion of sleep universally strengthening information. Instead, they suggest a model in which sleep may be more ecologically attuned to instructions present during learning, supporting both remembering and targeted forgetting of human memories.

Slide Session 7

LANGUAGE

Tuesday, April 5, 1:00 - 3:00 pm, Grand Ballroom B

Chair: Tamara Swab, University of California, Davis
Speakers: Yuanyuan Chen, Emily Coderre, Itziar Laka, Psyche Loui, Chris Barkley, Michele T. Diaz, Neil Cohn, Kimberly G. Noble

ABSTRACTS

TASK MODULATION OF BRAIN RESPONSES IN VISUAL WORD RECOGNITION REVEALED BY FMRI AND COMBINED EEG/MEG (GSP WINNER) Yuanyuan Chen[1], Matt Davis[1], Friedemann Pulvermüller[1], Olaf Hauk[1]; [1]University of Cambridge — In order to investigate early stimulus-driven from later decision-related brain responses in visual word recognition, we measured word-evoked brain activity using fMRI and combined EEG/MEG for the same set of words in 3 different tasks: silent reading (R), lexical decision (LD) and semantic decision (SD). FMRI results: compared with the corresponding 2 other tasks, SD elicited stronger activation in left IFG and bilateral mid-temporal; R elicited stronger activation in parietal lobe; LD showed greater activation in motor cortex and cerebellum. EEG/MEG results: sensor statistics revealed comparable activation across tasks until about 150ms, when task modulation began to occur. Distributed source analysis showed task differences in left posterior mid-temporal, inferior temporal, superior temporal areas (100ms to 200ms). Task differences in IFG and anterior mid-temporal cortex were seen in a later time window (250ms to 350ms). Multiple regression analysis in fMRI showed task modulation of activity for bi/tri-gram frequency in ventral temporal regions, suggesting that these ventral temporal regions respond to sublexical information due to task-specific influences rather than through purely stimulus-driven processing. However in EEG/MEG source activation in this area was similar across tasks within 500ms after word onset, perhaps indicating that the early effect was task-independent. These results suggest that task-specific processes penetrate word processing before 200 ms (EEG/MEG). Although we observed similarities between activation patterns in fMRI and EEG/MEG source estimation, our results suggest that fMRI is most sensitive to later post-recognition or decision processes, while EEG/MEG is sensitive to early word-specific information retrieval.

AUTOMATICITY AND SPEED OF LEXICAL PROCESSING IN THE FIRST AND SECOND LANGUAGE Emily Coderre[1], Walter van Heuven[1], Kathy Conklin[1]; [1]The University of Nottingham — Being able to process language quickly is a vital skill we rely on for human interactions. Electroencephalography (EEG) research indicates that lexico-semantic information is accessed within 200 ms (e.g. Dell'Acqua et al., 2007). Lower proficiency in a second language (L2) relative to a first (L1) leads to delays in lexical processing speed in L2, as proposed by the temporal delay assumption of the BIA+ model (Dijkstra & van Heuven, 2002; van Heuven & Dijkstra, 2010). The reduced frequency hypothesis (Pyers et al., 2009) proposes that the L1 is also delayed due to lower frequency of use relative to monolinguals The current study investigates these hypotheses in the context of automatic reading by directly comparing English monolinguals and Chinese-English bilinguals' L1 and L2 on a Stroop task. Stimulus onset asynchrony (SOA) was manipulated to provide further information on the automaticity of word reading. Word stimuli elicited an N170 component, which is related to orthographic processing (Bentin et al., 1999), in all SOAs, indicating automatic lexical processing in all groups. At the N170 peak, differences emerged between words and control stimuli in monolinguals and bilinguals' L1, signifying that early lexical processing occurred at the same latency for the native languages despite large orthographic differences. In bilinguals' L2, however, word and control waveforms diverged significantly later, indicating delayed lexical processing. These results provide neurophysiological evidence for the temporal delay assumption but not the reduced frequency hypothesis, and confirm that early lexical processing is automatically activated but significantly delayed in the second language.

COMPLEX SYNTACTIC PROCESSING IN VERY PROFICIENT NON-NATIVES ELICITS N400. Itziar Laka[1], Kepa Erdocia[1], Jon Andoni Duñabeitia[2], Nicola Molinaro[2], Manuel Carreiras[2,3,1]; [1]University of the Basque Country, [2]Basque Center on Cognition, Brain and Language, [3]Ikerbasque Basque Foundation for Science — Despite the classical Subject Relative clauses (SR) processing ease, some languages show the reverse pattern. Carreiras et al. (2010) report that in Basque Object Relatives (ORs) are easier to process than SRs. Here we report a study on Basque relative clause processing by proficient bilinguals whose native language is Spanish (a language showing SR advantage). We explored whether nonnatives transfer from Spanish (L1) and show an advantage for SR, or whether they show the OR advantage of natives. Experiment 1 used a self paced reading task, while ERPs were recorded in Experiment 2. The materials used were those previously tested by Carreiras et al. Experiment 1 revealed longer reading times for SR than OR after the critical disambiguating region. Experiment 2 showed larger amplitudes for SR than OR in the N400 component after reading the critical disambiguating word. These results show that the OR advantage previously reported in Basque does not vary for proficient nonnatives, even if their native language yields the opposite advantage-pattern for RC processing. Hence, proficient L2 speakers do not transfer syntactic structures and processing strategies from L1 into L2. However, a significant difference in the ERP pattern was observed with respect to to the P600 effect found by Carreiras et al.: nonnative profi-

cient bilinguals showed a N400 effect, rather than a P600 effect. In contrast to theories suggesting that at high proficiency levels nonnative processing becomes native-like, our findings suggest that nonnatives rely more on lexical strategies than natives.

RIGHT ARCUATE FASCICULUS PREDICTS ARTIFICIAL GRAMMAR LEARNING IN MUSIC: A BEHAVIORAL AND DTI STUDY Psyche Loui[1], Gottfried Schlaug[1]; [1]Beth Israel Deaconess Medical Center and Harvard Medical School — White matter is important for multiple cognitive domains including language and learning ability. Learning ability is often assessed using Artificial Grammar Learning (AGL) paradigms. Although previous literature has linked AGL to Arcuate Fasciculus (AF) connectivity in the left hemisphere, AGL has been implemented mostly with linguistic syllables, which are predominantly processed by the left hemisphere. We ask whether AGL is left-hemisphere-specific, or whether AGL is linked to the hemisphere that processes materials of the grammar. Since musical pitch is preferentially processed by the right hemisphere, a musical AGL study presents an optimal test case for this question. We acquired diffusion tensor images from participants who were trained on a musical artificial grammar, and then assessed on generalization (a grammar-learning task). Dorsal and ventral branches of left and right AF were identified by probabilistic tractography between inferior frontal gyrus (IFG), superior temporal gyrus (STG), and middle temporal gyrus (MTG). Correlations were used to test for relationships between behavior and volumes of each AF branch. Results showed that right ventral AF was positively correlated to generalization performance. Furthermore, a region in the right ventral AF, in white matter underlying the temporal-parietal junction, showed FA that correlated with generalization at the $p<0.05$ (FWE-corrected) level. Effects were not attributable to age, IQ, or pitch discrimination. Results provide support for AGL being subserved by the hemisphere that processes grammatical stimuli, rather than being a left-hemisphere-specific function. White matter may enable musical AGL by connecting grey matter regions that process pitch to other domain-general cognitive functions.

EVENT-RELATED POTENTIAL (ERP) INDICES OF REFERENTIAL DEPENDENCY FORMATION Chris Barkley[1], Robert Kluender[1], Marta Kutas[1]; [1]University of California, San Diego — Previous research suggests two ERP components relevant to referential processing: referentially-induced frontal negativity (Nref) indexing referential ambiguity, and late positivity indexing referential failure. In this study, we challenge this characterization by focusing on well-formed unambiguous antecedent-pronoun relations, allowing us to investigate brain responses associated with successful formation of a referential dependency rather than responses to referential ill-formedness. We hypothesized that phasic left anterior negativity (LAN) elicited during the processing of these antecedent-pronoun relations indexes retrograde search through working memory for purposes of accessing the non-local elements necessary to establish a long-distance dependency. We recorded the electroencephalogram (EEG) from 26 scalp electrodes while 20 monolingual native English speakers (aged 18-30) read 200 experimental items and 120 filler sentences. Experimental sentences contained either pronominal or proper name main clause subjects that did or did not have coreferents in preceding adverbial adjuncts. In each comparison, critical positions and preceding lexical material were identical. Repeated measures ANOVAs indicated that pronominal subjects with coreferents elicited phasic LAN between 300 and 500 msec. compared to those without coreferents; this effect was followed by sustained negativity spanning subsequent word positions through sentence end. There were no differences between proper name conditions. These results support our hypothesis that phasic LAN indexes the cognitive processes underlying non-local dependency formation, independent of whether the dependency is syntactic or referential in nature. The results also necessitate revision of mappings between observed Nref/late positive effects and underlying cognitive processes, and of frameworks of the ERP indices of referential processing.

THE INFLUENCE OF CONTEXTUAL CONGRUENCE AND FIGURATIVENESS ON HEMISPHERIC RECRUITMENT Michele T. Diaz[1], Larson J. Hogstrom[1]; [1]Brain Imaging & Analysis Center, Duke University — Although the left hemisphere's prominence in language is well established, less emphasis has been placed on possible roles for the right hemisphere. Behavioral, patient, and neuroimaging research suggests that the right hemisphere may be involved in processing figurative language. Additionally, research has demonstrated that context can modify language processing and facilitate comprehension. Here we investigated how figurativeness, context, and their interaction influenced right hemisphere recruitment. Previous work in our lab indicated that novel metaphors, familiar metaphors, and novel literal stimuli engaged right inferior frontal gyrus, and additionally that novel and familiar metaphors engaged right temporal pole. Some theoretical models (i.e., the Graded Salience Hypothesis) have proposed that providing a context may ease integration demands for metaphors, and thereby may reduce right hemisphere recruitment. functional magnetic resonance imaging was used to investigate neural function while participants read literal and metaphoric sentences that were preceded by either a congruent or an incongruent literal sentence. Consistent with prior research, all sentences engaged traditional left hemisphere regions. Although differences between metaphors and literal sentences were observed, effects were restricted to the left hemisphere. In contrast to the main effect of figurativeness, a main effect of congruence was found in right inferior frontal gyrus and right temporal pole. Our results highlight the influence of context on language processing, demonstrate that additional sentential context mitigated right hemisphere recruitment for metaphors, and show that congruent discourse, but not figurative language in context, engaged the right hemisphere.

THIS IS YOUR BRAIN ON COMICS: THE IMPACT OF STRUCTURE AND MEANING ON SEQUENTIAL IMAGE COMPREHENSION Neil Cohn[1], Martin Paczynski[1], Phil Holcomb[1], Ray Jackendoff[1], Gina Kuperberg[1]; [1]Tufts University — Just as syntax differentiates coherent sentences from scrambled word strings, the comprehension of sequential images must also use a cognitive system to distinguish coherent narrative sequences from random strings of images. We conducted experiments analogous to two classic studies of language processing (1, 2) to examine structure and semantics in processing sequential images. Using Cohn's (3) model of visual narrative, we compared four types of comic strips: 1) Normal sequences with both structure and meaning, 2) Semantic Only sequences (semantic relationships but no structure), 3) Structural Only sequences (structure but no semantic relationships), 4) Scrambled sequences of randomly-ordered panels. In Experiment 1, participants monitored for target panels in sequences presented panel-by-panel. Reaction times were slowest to panels in Scrambled sequences, intermediate in both Structural Only and Semantic Only sequences, and fastest in Normal sequences. This suggests that both semantics and structure offer advantages to processing. Experiment 2 measured ERPs to the same target panels. The largest N400 appeared in both Scrambled and Structural Only sequences, intermediate in Semantic Only sequences and smallest in Normal sequences. This implies that a combination of narrative structure and semantic relationships can facilitate semantic processing (as reflected by the N400). However, the effects of structure alone may be independent of semantics. Taken together, these findings suggest that sequential image comprehension uses a grammar that extends beyond semantic associations between individual frames. The comprehension of graphic narrative is guided by an interaction between structure and meaning, akin to that between syntax and semantics in language.

SOCIOECONOMIC STATUS IS ASSOCIATED WITH REGIONAL BRAIN VOLUMETRIC DIFFERENCES IN CHILDREN Kimberly G. Noble[1], Suzanne Houston[2], Eric Kan[2], Susan Y. Bookheimer[2], Elizabeth R. Sowell[2]; [1]Columbia University, [2]University of California - Los Angeles — Childhood socioeconomic status (SES) is strongly associated with important cognitive and academic benchmarks of childhood, such as IQ, grade retention, and school graduation rates. Although these outcomes are the direct manifes-

tations of brain development, traditionally the study of SES disparities in child development operated with scarce input from neuroscience. Recently, a series of studies suggested that socioeconomic disparities result in specific neurocognitive differences, with large effects in language processing, and smaller but consistent effects in memory and self-regulation. Little is known, however, about the degree to which structural brain differences mediate these effects. Here, structural MRI was collected on 44 typically developing children ranging in age from 7 to 17. We used FreeSurfer's automated brain segmentation software (FreeSurfer 4.0.5, http://surfer.nmr.mgh.harvard.edu), to obtain regional cortical volumes, focusing specifically on brain regions known to mediate language, memory, and self-regulation. Hierarchical regressions reveal that SES disparities are associated with regional volumetric brain differences in left inferior temporal cortex, hippocampus, and amygdala, adjusting for age, total cerebral cortical volume, gender, and IQ. Further adjusting for phonological naming eliminates the association between SES and left inferior temporal cortex volume. SES x age interactions were found in left fusiform, left middle temporal, and left inferior frontal regions. Putative mechanistic pathways mediating between SES and specific neurocognitive outcomes are discussed, including linguistic stimulation in the home and chronic stress exposure. Implications for public health are broad: By targeting the specific neurocognitive systems affected by SES, we improve our ability to design programs for educational intervention and remediation.

Saturday, April 2, 5:30 – 7:30 pm, Pacific Concourse

Perception & Action: Audition

A1

ATYPICAL AUDITORY RESPONSES IN INFANTS AT RISK FOR AUTISM Jeanne Guiraud[1], Przemek Tomalski[2], Elena Kushnerenko[2], Tony Charman[3], Kim Davies[1], Helena Ribeiro[1], Leslie Tucker[1], Mark H Johnson[1]; [1]Centre for Brain and Cognitive Development, School of Psychology, Birkbeck, University of London, UK, [2]Institute for Research in Child Development, The University of East London, London, UK, [3]Centre for Research in Autism and Education, Department of Psychology and Human Development, Institute of Education, London, UK — Autism is a developmental disorder characterised by unusual sensory responses (Gillberg and Coleman, 2000) and children with autism are frequently under-reactive and/or hypersensitive to sounds. This variability in behaviour is reflected in electrophysiological responses to pitch differences in tones (Ferri et al., 2003; Dunn et al., 2008). Using electroencephalogaphy, we investigated the neural processing associated with auditory perception in 8-9 month old babies with an older sibling with autism, and hence at risk of a later diagnosis. We analysed the auditory P150 wave in response to infrequent 'deviant', 650 Hz pure tones occasionally placed among repetitive 'standard', 500 Hz pure tones using an oddball paradigm in a group of 20 babies at risk and a matched group of controls (with no relatives with autism). Typically, controls had a larger P150 amplitude in response to the deviants compared to the standards suggesting that they can perceive the pitch difference between the two tones. However, as a group the babies at risk had a reduced difference in P150 amplitude. This finding shows evidence for a neural marker of reduced sound discrimination ability in at least some infants at risk of developing autism. We will follow up the babies to determine if this neural marker relates to outcome of autism and/or auditory dysfunction at 3 years old.

A2

THE BRAIN'S INTERNAL NOISE DETERMINES DISCRIMINATION SENSITIVITY Fosco Bernasconi[1,2], Aurélie Manuel[1,2], Micah M. Murray[1,3,4], Lucas Spierer[1]; [1]Chuv, Lausanne, [2]Lausanne University, [3]Cibm, Lausanne, Switzerland, [4]Vanderbilt University Medical Center, Nashville, TN — Variation in stimulus-related behavior and brain responses is commonplace and typically attributed to the random variability in neural responses ("internal noise"). Computational models indicate that internal noise is sufficient to engender perceptual differences, in turn suggesting that identical stimuli can be (mis)perceived as being different. In the case of signal detection theory (SDT), internal noise is quantified as the ratio between an observer's discrimination threshold and sensitivity (d'). The present study investigated the contribution of internal noise to conscious perception and discrimination abilities. Participants were instructed to indicate which sound of a pair of identical pure tones was of higher pitch, being unaware that sounds were actually physically identical. In order to ensure that participants know what pitch differences referred to, they also underwent an above-threshold frequency discrimination task. With the aim to determine whether and how spontaneous activity can engender different percepts, AEPs to the identical sounds were compared as a function of perceived pitch, yielding a "High perceived pitch" vs. "Low perceived pitch" design. AEPs modulated topographically 92-115ms post-stimulus onset as a function of perceived pitch, indicative of the engagement of distinct intracranial sources; LAURA source estimations indicated that it followed from a modulation within the left temporo-parietal areas. Activity within this cluster negatively correlated with the participant's sensitivity in pitch discrimination measured in the pre-test session. Collectively, our results indicate that the brain's spontaneous internal noise engenders perception and determines sensitivity.

A3

SHARED TUNING TO PITCH AND SPATIAL LOCATION IN THE HUMAN AUDITORY CORTEX Talia Shrem[1], Leon Y. Deouell[1]; [1]The Hebrew University of Jerusalem, Israel — The organization of the auditory system is primarily tonotopic. The representation of acoustic space is less clear. Previously we presented fMRI evidence for auditory spatial tuning in human planum temporale, when neither attention to space nor to sounds was required. Are these spatially tuned neurons also tonotopically tuned? Fifteen subjects were tested in a sparse fMRI experiment, using individually tailored sounds to create a virtual acoustic space. We presented combinations of two sounds differing in pitch, from one or two locations in the right hemispace, creating three types of blocks: Single Location, in which both sounds were presented from one location, Fixed Mapping, in which each sound was consistently mapped to one of the locations, and Mixed Mapping, in which each of the two sounds was equally likely to be presented from either location. We measured BOLD activation to test repetition suppression (fMR adaptation) in the different conditions. We surmised that only neurons tuned to both location and pitch should be differentially adapted by the Mixed and Fixed mappings. Replicating our previous findings, we found higher activation in the auditory cortex for Fixed Mapping than for Single Location blocks, reflecting adaptation to spatial location. Importantly, activation was higher for Mixed Mapping than for Fixed Mapping blocks, even though the two sounds and the two locations appeared equally in both conditions. These results confirm that spatially tuned neurons in human auditory cortex are also tuned to pitch, reflecting overlapping representation of different acoustic features in auditory cortex.

A4

TONALITY PERCEPTION OF BI-MUSICAL LISTENERS: AN MEG STUDY Rie Matsunaga[1], Koichi Yokosawa[1], Daisuke Seki[1], Saya Anbo[1], Jun-ichi Abe[1]; [1]Hokkaido University — Tonal organization is essential for music perception, and it is based on "scale schema" that is acquired through exposure to the music of one's culture. In some musical cultures (e.g., Japan, Korea), listeners develop familiarity with two music traditions (e.g., Japanese traditional music and Western music in Japanese listeners) such that they acquire two different scale schemas. These listeners are called as "bi-musical". This study examined whether bi-musicals have one general (or fused) scale schema or two distinct (or differentiate) scale schemas. We measured magnetoencephalogram (MEG) of Japanese bi-

musical non-musicians while they monitored 480 unfamiliar melodies for the presence of a pitch incongruent (i.e., a pitch deviating from the scale). The unfamiliar melodies conformed to either Japanese traditional scale (n = 240) or Western diatonic scale (n = 240). If bi-musicals have one general scale schema, the MEG responses should not differ between two musical traditions. Results showed that a peak latency evoked from a pitch incongruent of Western music (around 260 ms) started 40 ms earlier than that for Japanese music (around 300 ms). Moreover, iso-field maps at the peak latency revealed a similar dipolar pattern over each hemisphere in two music traditions, but the pattern of Western was clearer than that of Japanese. These differences indicated that Japanese bi-musicals are more sensitive to a pitch incongruent of Western music over that of Japanese music, suggesting that Western scale schema is predominantly internalized over Japanese one. It is likely that bi-musicals handle two distinct scale schemas.

A5

RHYTHM OF PERCEPTION AND ATTENTION: AN OEP STUDY OF TEMPORAL ATTENTION Molly Erickson[1], Benjamin Motz[1], William Hetrick[1]; [1]Indiana University, Bloomington — We investigate how listeners' expectations for sounds in a rhythmic sequence of sounds are affected by the metric structure. In rhythm production tasks, there is a strong tendency for people to place "beats" at simple ratios, or harmonics, (1/2, 1/3, 2/3) of the periodic pattern. The present study was conducted to examine whether these constraints also apply to rhythm perception. In this experiment, the generality of these rhythmic constraints was tested by asking whether participants were able to anticipate the onset of auditory events in rhythmic patterns that were defined by more complex ratios (e.g. 3/7). Rhythmic anticipation was measured using the omission elicited potential (OEP, an endogenous brainwave component triggered by the absence of an anticipated stimulus) as a marker for the moment when a subject had anticipated an auditory event to occur. Results from this experiment revealed that there were significant differences in the onset latency of the OEP to omitted stimuli from these rhythms, indicating that individuals are constrained to expect stimuli at simple ratios of the dominant cycle, even when entrained to sequences with more complex ratios. Furthermore, it was observed that individuals with more variability in OEP onset had poorer performance on tasks related to explicit temporal estimation. These results suggest that the brain actively distorts the timing of complex external rhythms to simple metric patterns, and that less distortion is related to more precise temporal representation.

A6

MAKING A DIFFERENCE: AN EVENT-RELATED POTENTIAL CORRELATE OF ACTION-EFFECT BINDING János Horváth[1]; [1]Institute for Psychology, Hungarian Academy of Sciences — Recognizing the sensory consequences of one's own actions is one of the most important prerequisites of goal-directed behavior. The simplest cue that an action may have a sensory consequence is the contiguity (temporal proximity) of the action and an unpredictable change in the sensory environment. Using a novel protocol, the present study investigated the event-related potential (ERP) correlates of the establishment of action-effect representations. A sequence of sinusoid tones of 1000 Hz frequency with random, 2-6 s onset-to-onset intervals were presented. Participants performed a time interval distribution reproduction task: they pressed a key so that consecutive key-presses were separated by silent intervals of 2-6 s with uniform distribution. In one condition, when key-presses coincided with a sound position (about 3% of the time), a rare (1500 Hz) tone was presented. In the other condition, the frequent (1000 Hz) tone was presented for such coincidences, while the rare tone was presented in random sound positions with the frequency of the coincidences. In comparison to frequent sounds, rare sounds elicited the mismatch negativity, N2 and P3 components. Frequent sounds elicited suppressed N1 and P2 when coinciding with a key-press in comparison to those without coincidence. Importantly, the effects resulting from sound infrequency and key-press-coincidence could not fully explain the ERPs elicited by the coincidence of the key-press and the rare sound: these elicited an additional parietal negativity at 140 ms following onset. This parietal ERP may reflect the first step in establishing an action-effect binding.

A7

MODERATE MUSICAL TRAINING IS ASSOCIATED WITH GENERAL ENHANCEMENT IN COMPLEX SOUND ENCODING AND BETTER INHIBITION OF IRRELEVANT AUDITORY CHANGE: AN ERP STUDY Natalya Kaganovich[1], Caryn Herring[1], Jennifer Schumaker[1], Megan MacPherson[1], Christine Weber-Fox[1]; [1]Purdue University — Previous reports show that musical training may be associated with better linguistic skills, such as prosody processing, speech-in-noise perception, and second language proficiency. Because speech is necessarily carried by voice, we asked whether musicians have an enhanced processing of the human voice. We collected behavioral and ERP data from non-professional musicians and individuals without musical training while they performed a version of the auditory distraction task. Participants identified each sound as either short (300 ms) or long (500 ms). In some blocks, musical sounds (a G4 note played by a cello and a French horn) were presented on 80% of trials while voices (a male and a female saying a neutral "a") were presented on 20% of trials. In other blocks, the reverse was true. A change from one type of sound to another was irrelevant for the duration judgment task. A control condition was also used in which the same vocal and musical sounds were spectrally rotated, which precluded participants from identifying them as belonging to either vocal or musical categories but preserved sounds' complexity. Behaviorally, musicians showed a slightly higher overall accuracy. Their reaction time tended to be less affected by the irrelevant change in sound category compared to non-musicians. Electrophysiologically, musicians exhibited an enhanced negativity to all types of sounds between approximately 100 and 700 ms post-stimulus onset. These results suggest that moderate musical training may be associated with a general enhancement of complex sound encoding as well as better inhibition of irrelevant auditory change.

A8

GAMMA-BAND SYNCHRONIZATION IN THE TEMPORAL LOBE INDEXES METRONOME TIMING AND ITS SUBDIVISION Takako Fujioka[1], Laurel Trainor[2], Edward Large[3], Bernhard Ross[1]; [1]Rotman Research Institute, Baycrest, University of Toronto, [2]McMaster University, [3]Florida Atlantic University — Gamma-band (~40Hz) neural oscillations are considered to reflect neural computation for object feature binding and memory processes. Our previous results indicate that timing of isochronous sound and anticipating its metrical grouping are reflected in the endogenous broad-band response not only in the auditory cortices but also in a wide area of the temporal lobe including parahippocampal gyrus, and sensorimotor related areas such as precentral gyrus and basal-ganglia. Here we examined time courses of changes in the amplitude of gamma-band oscillations when subjects passively listened to the metronome sound and found two prominent gamma responses: the first peaking at 50ms following stimulus onset and the second peaking centered between these responses as if marking subdivisions of the metronome interval. Furthermore, the occasional omission of a stimulus resulted in a significant gamma increase at ~150ms after the omission. Using spatio-temporal principal component analysis (PCA), sources of gamma-band activity were identified: The first component reflected both types of gamma synchronization in the bilateral primary auditory cortices, bilateral caudate nuclei, and the right thalamus, while the second component reflecting only the subdivided interval involved the precentral gyrus, the superior temporal gyrus, and the cerebellum in the right hemisphere, and in the precentral gyrus, the parahippocampal gyrus, the middle temporal gyrus and the frontal gyrus in the left hemisphere. We propose that the network of gamma-band oscillatory activity in the temporal lobe contributes to the automatic maintenance of internally represented rhythm which in turn involves motor and memory systems in the brain.

A9

EFFECTS OF GLOBAL PROBABILITIES ON CORTICAL PROCESSING DURING AN AUDITORY SIMON TASK Carolyn Pauker[1], Edward Golob[1]; [1]Tulane University — The limits of selective attention can be probed by examining the impact of task-irrelevant information on behavior. Dual-process models propose that task-irrelevant information can impair performance by automatically activating response representations that compete with those in task-relevant controlled processing. The interplay between automatic and controlled processes is affected by global stimulus probabilities, but the neural basis has not been well characterized. Here, event-related potentials (ERPs) were recorded while subjects (n=15) listened to monaural amplitude modulated white noise. Subjects pressed a button (left/right hand) according to modulation rate (25/75 Hz) and ignored stimulus location (left/right ear). Stimulus-response locations either matched (compatible, C) or differed (incompatible, IC). The global probability of C:IC varied, with blocks of low (25%), equal (50%), or high (75%) proportions of C trials. Auditory ERPs were examined among trial types (C/IC) and global probabilities, and included early components (N100/P200) and frontal slow-waves (200-800 ms). The Simon effect (reaction time IC>C trials, $p<.001$) increased linearly with greater probability of C trials ($p<.001$), while accuracy on IC trials had corresponding decreases ($p<.001$). Across global probabilities, early slow-wave amplitudes (200-400 ms) were larger for the probable trial type ($p<.001$). Late slow-wave activity (600-800 ms) was prolonged on IC vs. C trials ($p<.05$). Global probability inversely affected slow-wave amplitude on IC trials (600-800 ms, $p<.001$), without affecting C trials or early ERP components. Early neural processing reflected trial probability, while late processing was associated with adjustments on IC trials. These findings may reflect the bias of global probability learning on dual-process interactions.

A10

PERCEPTUAL CAPTURE AND SPEEDED PROCESSING IN AUDITORY STREAMING Kevin Hill[1], Lee Miller[1]; [1]University of California, Davis — One of the brain's greatest perceptual challenges is to segregate mixtures of sounds into distinct "streams". Despite its behavioral importance, the neural mechanisms of streaming remain unclear. While interest in this field has grown, most previous neuroimaging studies could not unambiguously attribute effects to changes in perceptual state because of concomitant changes in stimulus properties, such as frequency disparity. In order to show a clear neural correlate of streaming, analysis must account for perceptual state in the absence of physical stimulus changes. Conversely, in order to interpret these prior experiments, one must account for effects due solely to the differential processing of stimulus features without a corresponding change in percept. To this end we recorded electroencephalographic (EEG) activity while subjects explicitly categorized a mixture of two tone sequences as perceptually segregated or grouped. Using a tightly controlled paradigm to measure the effects of stimulus disparity and perception independently we report two main sets of findings. First, we show that the effects of perceptual state are asymmetric between the two sequences, providing neural evidence of perceptual capture during auditory grouping. Second, we observe a faster EEG response to perceptually grouped tones relative to segregated tones, indicating facilitation of object processing within a grouped stream.

A11

TIME-FREQUENCY ANALYSIS OF NEURAL ACTIVITY DURING AUDIO-MOTOR PROCESSING AFTER TARGETED COGNITIVE TRAINING IN SCHIZOPHRENIA Ethan Brown[1], Alexander Herman[1], Anne Findlay[1], Mary Vertinski[2], Corby Dale[1,2], Sophia Vinogradov[1,2], Srikantan Nagarajan[1]; [1]University of California, San Francisco, [2]San Francisco Veterans' Affairs Medical Center — Both early auditory processing and more complex executive function are impaired in schizophrenia, though the relationship between these deficits has yet to be fully described. Targeted cognitive training (TCT) has been shown to improve these impairments according to neurocognitive metrics as well as non-specific behavioral measures, supporting a new and efficacious form of therapy for this disease. Establishing the neural activity underlying this improvement would help to confirm the efficacy of TCT, highlight the clinically relevant regions affected that contribute to cognitive deficit in schizophrenia, and illustrate the importance of these areas in normal cognitive functioning. To this end, we used magnetoencephalography (MEG) to study cortical activity during both a phoneme identification and a working memory task in 38 schizophrenic patients before and after three months of TCT or a controlled activity and in 14 healthy controls. This study is part of a randomized control trial investigating the behavioral efficacy of TCT. Time frequency analysis using a spatially adaptive filter developed in our lab provided high spatial and temporal resolution of auditory and memory-encoding processing streams. Our results indicate changes in the magnitude and spatial representation of low-frequency activity in auditory regions, representing normalization of sensory processing measures in schizophrenic patients after cognitive training. Training also affected high-gamma oscillations in frontal areas, especially inferior frontal lobe and dorsolateral prefrontal cortex, during the memory encoding tasks. These changes implicate a normalization of cortical activity in specific regions during auditory discrimination and verbal working memory, two functions impaired in schizophrenia.

A12

DIFFERENCES IN NEURAL OSCILLATORY DYNAMICS IN SCHIZOPHRENICS AND CONTROLS IN PHONEME VERBAL REPRODUCTION Alexander Herman[1], Ethan Brown[1], Anne Findlay[1], Mary Vertinsky[2], John Houde[1], Sophia Vinogradov[1,2], Srikantan Nagarajan[1]; [1]University of California, San Francisco, [2]San Francisco VA Medical Center — Speech perceptual and motor dysfunctions are well known features of schizophrenia. We aimed to elucidate how the oscillatory dynamics of the auditory-motor network differ between schizophrenic patients and healthy individuals in phoneme verbal reproduction. 14 healthy controls and 22 schizophrenic patients, matched along demographic measures, performed a phoneme repetition task, while we recorded the corresponding neural activity using magnetoencephalography. Subjects heard either two or four phoneme stimuli, waited for a visual go cue, and then repeated the phonemes. Activity filtered into canonical frequency bands was localized to each subject's structural MRI using a spatially adaptive filter implemented in our in-house open-source software package. NUTMEG. We found significant differences in the spatio-temporal dynamics of the speech motor network between patients and controls. Both theta/alpha and high gamma activity in auditory areas during the encoding phase differed between patients and controls. Patients also exhibited different high-gamma power time courses in speech auditory and motor areas during the pre-production phase. To determine the effect of phoneme cognitive load, contrasts between the four and two phoneme trials were computed for all subjects, and compared between the controls and patients. The load-effect manifested differently in patients and controls in auditory and frontal areas, across the frequency spectrum, indicating that schizophrenic patients utilize neural resources differently from healthy subjects in response to increased task difficulty. The rich spatio-temporal picture that emerges from this study may help to quantify the dysfunction in large-scale neural circuit behavior in speech perception and production in schizophrenia.

A13

EARLY AUTOMATIC DETECTION OF INTENSITY DEVIANTS REFLECTED IN THE MIDDLE-LATENCY RANGE OF THE HUMAN ELECTRICAL BRAIN RESPONSE Heike Althen[1], Sabine Grimm[1], Lavinia Slabu[1], Carles Escera[1]; [1]University of Barcelona — The violation of a regular sound pattern by irregular or novel stimuli is reflected in the mismatch negativity, a component of the human auditory evoked potential (AEP), with a latency of 100-250 ms and main sources in the auditory cortices. Evidence for auditory novelty detection however has also been reported at much shorter latencies (15 – 30 ms after stimulus onset) as revealed by single- and mul-

tiunit recordings in the auditory cortex and midbrain of animals. In this study, we aimed at finding traces of fast auditory novelty detection in the human AEP during a passive intensity oddball paradigm. An oddball condition using click stimuli (standard stimulus = 50 dB SL; deviant stimulus [14%] = 40 dB SL), a reversed oddball condition (standard stimulus = 40 dB SL; deviant stimulus [14%] = 50 dB SL) and a control condition (random presentation of 7 stimuli with different intensities ranging from 10-70 dB SL, 14 % probability each) were applied. The EEG was recorded from 7 scalp electrodes and the data was analyzed in the ranges of the auditory brainstem response, the middle-latency response, and the long-latency response. In the middle-latency range, deviants elicited a significantly more negative response than standards of the same intensity at the descending slope of the Na component (21-27 ms after stimulus onset). This outcome suggests that the human auditory novelty detection system comprises fast processes which are taking place at latencies similar to those found in single- and multiunit recordings in animals.

A14

AN OVERVIEW OF THE ROLES OF FUNCTIONAL AND ANATOMICAL STREAMS OF PROCESSING IN SPEECH PERCEPTION Sophie Scott[1], Carolyn McGettigan[1], Zarinah Agnew[1]; [1]Institute of Cognitive Neuroscience, London — The aim of this poster presentation is to examine the utility of 'streams' of processing in human speech perception. A decade ago, intelligible speech was demonstrated to recruit areas along the rostral 'what' pathway in the left temporal lobe, which has been associated with the processing of the vocalisations of conspecifics in non human primates (Scott et al, 2000). In parallel, studies indicated that auditory fields posterior and medial to primary auditory cortex were associated both with heard speech and the movement of the articulators (Wise et al, 2001; Hickok et al, 2000), and this has been termed a 'how' stream of processing (Scott and Johnsrude, 2003). In this poster I will review the ways that more recent studies have replicated and developed these findings, using both published and unpublished studies. For example, I will show how the anterior 'what' stream has been implicated in the processing of unattended speech (Scott et al, 2004, 2009), and the 'how' stream in speaking aloud under conditions of altered auditory feedback (Takaso, Eisner et al, 2010). I will address the kinds of hemispheric asymmetries seen in the left and right 'what' streams, and how auditory speech processing interacts with the wider language system (Obleser et al, 2007, Eisner et al, 2010). Finally, I will address how the 'what' and 'how' streams interact in the rehearsal of verbal information (Mcgettigan et al, in press).

A15

THE CORTICAL BASIS FOR THE DICHOTIC PITCH DEFICIT IN DEVELOPMENTAL DYSLEXIA Marita Partanen[1], Kevin Fitzpatrick[1], Dorothy Edgell[2], Bruce Bjornson[1], Deborah Giaschi[1]; [1]University of British Columbia, [2]University of Victoria — Children with developmental dyslexia have difficulty learning to read. They may also show deficits in temporal processing, which is the perception and integration of rapidly presented stimuli. Our research group has previously shown that children with dyslexia have deficits in dichotic pitch perception, which is a measure of rapid auditory temporal processing. In the current study, we examined the dichotic pitch deficit using functional MRI in children with average reading ability and children with dyslexia. We presented ascending and descending pitch sequences that were embedded in background noise, using a sparse sampling design. The task was to press a button to indicate whether the tones were ascending or descending in pitch. The conditions included low (1) and high (10) signal-to-background noise ratios (SNR), noise only, and silence. The tones in the low SNR condition can only be perceived by integrating information from both ears (dichotic), while the tones in the high SNR condition can be perceived monaurally. Results demonstrated significant activation in bilateral Heschl's gyrus and superior temporal gyrus for low and high SNR conditions. Children with average reading ability showed activity in the right superior temporal gyrus during both the low and high SNR conditions, while children with dyslexia activated this region only during the high SNR condition. Additionally, cortical activation in the low SNR condition was correlated with reading ability. These results suggest that the cortical regions utilized for dichotic pitch perception are affected in dyslexia, and these regions may be involved in the reading process.

A16

MUSIC AND MU RHYTHMS Matt Schalles[1], Noah Bresler[1], Jaime Pineda[1]; [1]University of California, San Diego — Theories of action-observation matching systems hypothesize that hearing sounds associated with specific motor components may become associated in a Hebbian-like fashion and elicit activity in sensorimotor cortex. Activities such as playing music engage precisely coordinated muscle patterns that are tightly coupled in time to the sounds they produce, and EEG could provide the temporal specificity necessary to study these functional associations. Specifically, the mu rhythm (8-13 Hz) desynchronizes during sensorimotor activity as well as during periods of visual action observation. Hence, we predicted that audio-motor associations that rely on sequential patterns could elicit mu desynchronization despite alterations to pitch information. Over the course of 5 days subjects learned to play a simple piano melody by ear over synthesized backing instruments. After successful completion of training, subjects listened to clips from that song and two similarly constructed songs (transposed and scrambled) while their brain waves were recorded. Initial results suggest a trend towards significant differences between hearing the learned song and an unlearned song. Blind source separation analyses showed that mu and theta activity varied significantly by song in central/temporal and frontal mu clusters compared to a more occipital cluster. Significant effects of song occurred in these anterior clusters 1.5-2 seconds after the onset of the second beat of the song clip perhaps reflective of time to discriminate between songs. Finally, desynchrony in upper beta appeared while listening to the transposed version of the song, while rebound synchrony occurred across all frequency bands around the 5th second of the learned song.

A17

ACTIVATION IN MOTOR SPEECH REGIONS TRACKS WITH EXPERIMENTALLY INDUCED BIAS Jonathan Venezia[1], Kourosh Saberi[1], Gregory Hickok[1]; [1]University of California, Irvine — Recent evidence suggests that the speech motor system may play a significant role in speech perception. Repetitive transcranial magnetic stimulation (TMS) applied to a speech region of premotor cortex impaired syllable identification but not color discrimination, while TMS stimulation of motor areas for different articulators selectively facilitated identification of phonemes relying on those articulators. However, in these experiments the speech stimuli were embedded in noise and performance was not corrected for response bias. It may be that higher-level decision networks are preferentially taxed under conditions of stimulus degradation. Thus, the present functional magnetic resonance imaging experiment is designed to systematically manipulate response bias in speech perception using degraded speech input. Minimal consonant-vowel stimulus pairs were presented between volume acquisitions for same-different discrimination. Speech stimuli were embedded in Gaussian noise at the psychophysically determined threshold level. We manipulated bias by changing the ratio of same-to-different trials: 1:3, 1:2, 1:1, 2:1, 3:1. Ratios were blocked by run and subjects were cued to the upcoming ratio at the beginning of each run. We predicted that activation in speech motor regions would vary systematically with bias. Indeed, we found that the pattern of response bias – as measured using the criterion measure, "c," from signal detection analysis – was predictive of activation patterns in left frontal brain regions typically associated with speech production. Examination of discriminability (d') indicated that performance was constant across bias conditions. These results suggest a role for motor speech regions in decision components of speech perception under adverse listening conditions.

A18

NEURAL RESPONSE TO AUDITORY INFORMATION IN EXPERT AND NON-EXPERT ATHLETES Elizabeth A. Woods[1], Sian L. Beilock[2], Arturo E. Hernandez[1]; [1]University of Houston, [2]University of Chicago — Evidence is emerging that expertise in a sport can modulate behavioral and neural responses and that expert athletes process information related to their own sport and other sports differently. However, despite the high relevance of auditory information in athletics, previous research in the area has primarily focused on visual processing. The goal of the present study was to examine the effect of athletic expertise on neural response to auditory information. Participants played basketball or tennis at the collegiate (Expert) or recreational (Non-Expert) level. During the functional magnetic resonance imaging (fMRI) experiment, athletes passively listened to familiar and unfamiliar sport and non-sport environmental sounds. Overall the task recruited large swatches of bilateral activation in superior temporal gyrus (STG) extending into middle temporal gyrus (MTG), inferior frontal gyrus (IFG), insula, and precentral and postcentral gyri. Between group analyses revealed significant differences in neural activation between Expert and Non-Expert athletes, suggesting an effect of expertise in processing auditory information. Specifically, Experts showed greater activation in motor regions such as the postcentral gyrus and insula when listening to familiar sport sounds, while Non-Experts showed greater activation in sensory regions such as the STG, MTG, and precuneus when listening to unfamiliar non-sport sounds. This suggests that Expert athletes' brains were more specialized to attend to and use familiar, relevant sounds while tuning out unfamiliar, irrelevant sounds. Non-expert athletes on the other hand more broadly attended to all possible relevant sounds. Taken together, implications for theories of athletic training, auditory processing, learning, and brain plasticity abound.

A19

BRAIN ACTIVITY DURING EFFORTFUL AUDITORY RETRIEVAL DIFFERENTIATES EXPERT AND NON-EXPERT ATHLETES Victoria Wagner[1], Elizabeth A. Woods[1], Sian Beilock[2], Arturo E. Hernandez[1]; [1]University of Houston, [2]University of Chicago — Previous functional magnetic resonance imaging (fMRI) studies have shown that expertise in a sport can modulate neural response (Beilock et al, 2008). However, these studies have only examined differences in the visual modality. The present study investigated the impact of athletic expertise on the processing of auditory information. Participants were members of collegiate basketball and tennis teams (Experts) and college-aged recreational players (Non-Experts). During the fMRI task, participants heard basketball and tennis sounds as well as familiar and unfamiliar environmental sounds. Following each sound participants were asked to explicitly retrieve the sound or the action associated with the sound. Significant differences were found between the two groups of athletes, suggesting an expertise effect. Experts showed greater activation than Non-Experts in superior temporal regions when processing familiar environmental sounds, but no regions of greater activation when processing unfamiliar environmental sounds. Non-Experts recruited bilateral hippocampus, left inferior temporal gyrus, right fusiform gyrus and left Brodmann Area 6 to a greater extent than Experts when processing familiar sport sounds, and intraparietal cortex and Broadmann Area 3 when processing unfamiliar environmental sounds. Taken together these results suggest that Experts are better at processing familiar sounds and better at tuning out unfamiliar sounds, while retrieval of familiar sport information is more effortful for Non-Experts.

A20

ATTENUATION OF MISMATCH NEGATIVITY TO FULLY PREDICTABLE DEVIANTS REFLECTS PREDICTIVE MODELING IN AUDITION Alessandro Tavano[1], Andreas Widmann[1], Alexandra Bendixen[1], Erich Schröger[1]; [1]Institute of Psychology, University of Leipzig, Germany — Neurons in primary auditory cortex show stimulus- and probability-specific adaptation: the same neurons in the cat A1 respond less strongly to a frequently presented sound than to the same sound when it is rare (Ulanovsky et al. 2003, 2004). In humans, the Mismatch Negativity (MMN) event-related component is elicited by infrequent violations of acoustic regularities, and it could represent a correlate of stimulus specific adaptation (Nelken & Ulanovsky 2007). Recently, the regularity extraction mechanism of MMN has been shown to index predictability of tone sequence continuation (Bendixen et al. 2009). We investigated whether contextually dependent predictability inferences modulate adaptation by repetition of the same deviant sound. The Electroencephalogram (EEG) of 16 participants was recorded using a passive oddball isochronous stimulation paradigm with pseudorandomized sine-tones of 500 Hz (Standard) and 560 Hz (Deviant). In a 100% predictive condition a Deviant was always immediately repeated. In a 75% predictive condition a Deviant was occasionally followed by a Standard. In a 50% condition a Deviant was followed either by a Deviant or by a Standard with equal probability. Global probabilities (80% Standard, 20% Deviant) were kept constant throughout conditions. MMN was significantly attenuated to the repeated Deviant in the 100% predictive condition, suggesting that the occurrence of a second Deviant was anticipated. Adaptation in the 75% predictive condition approached significance, while no adaptation effect was evidenced in the 50% predictive condition. These findings suggest that the auditory system exploits contingencies between infrequent sounds to (partly) overrule expectations for a frequent sound.

A21

OBLIGATORY AUDITORY RESPONSES IN CHILDREN: NO N1 BUT BIG N1 EFFECT? Philipp Ruhnau[1], Björn Herrmann[2], Burkhard Maess[2], Erich Schröger[1]; [1]University of Leipzig, [2]Max Planck Institute for Human Cognitive and Brain Sciences — It is well known that obligatory auditory responses measured with EEG/MEG differ substantially between school-aged children and adults. Usually, when presenting sinusoidal tones at fast rates, the P1(m) and N2(m) components of the event related potentials/fields (ERPs/ERFs) are prominent in children, whereas the P1-N1-P2 complex is found in adults. It has been suggested that the auditory N1 emerges in children at around 12-13 years of age. In the present experiment, we measured ERPs and ERFs to a 500 Hz tone in 9-10 year old children and an adult control group. This tone was either frequently repeated or presented randomly amongst tones of different pitches. A distributed source model (sLORETA) was used with MEG to localize the sources of the P1m, N1m and N2m components. In adults, the tone in the repeated condition elicited only a P1m that was localized to the primary auditory cortex (PAC). In the random condition, however, an additional N1m component was elicited that was localized to the PAC and the superior temporal gyrus (STG). In children, tones in both conditions elicited a P1m and N2m which were both localized to PAC. Furthermore, the EEG analysis revealed an N1 component in children that was highly similar to adults when the repeated condition was subtracted from the random condition. The current results strongly suggest that, contrary to previous assumptions, the auditory N1 is already mature at around 9-10 years of age, but is often obscured by strong P1-N2 components.

A22

HIPPOCAMPUS ACTIVATION CORRELATED WITH COMPLEXITY OF RECENT AUDITORY STIMULATION Michael Tobia[1], Vittorio Iacovella[1], Uri Hasson[1,2]; [1]Center for Mind/Brain Sciences, Trento, Italy, [2]University of Trento, Italy — The uncertainty or complexity of an environment can be quantified via information theoretic measures including those reflecting the relative frequency of tokens and their transition constraints (Shannon, Markov entropy). Given the purported role of the hippocampus in representing environmental uncertainty, we examined if it represents the complexity of the recent past in a non-stationary context where input complexity shifts with time. In an fMRI study, participants listened to a series of four unique, repeating tones presented at 3.3 Hz for ten minutes, while performing a simple incidental visual task. Our analysis used a sliding window approach where for each time point in the study we quantified both 1st order Markov entropy and Shannon entropy of the tone sequence presented in the recent 5 seconds. In addition to these

entropy regressors, two regressors coded for points in the sequence where a trend towards greater/lesser entropy reversed towards the other direction. Using a region-of-interest analysis, for each participant we quantified the percentage of hippocampal voxels that reliably correlated with the regressors (single voxel threshold set at $p < .05$). We then evaluated whether these percentages departed from chance (5%) at the group level. The hippocampus was sensitive to Shannon's entropy bilaterally (18.75%/12.2%, left/right), and Markov transition entropy bilaterally (22.9%/15.5%, left/right), but not for reversals in either type of entropy progression. Our findings indicate that the BOLD time course for a significant volume of the hippocampus is correlated with features of non-stationary entropy, and suggests it represents the complexity of the recent past.

A23

THE EFFECT OF MUSICAL TRAINING ON PERCEPTION AND REPRESENTATION OF SPEECH McNeel Jantzen[1], Dane Aamodt[1], Zachary Stratton[1], Lauren Shands[1], Heather DeVries[1], Melissa Devries[1], KJ Jantzen[1]; [1]Western Washington University — Musicians are more sensitive to acoustic features such as onset timing and frequency (Levitin, 2006). Musical training may enhance the processing of acoustic information for speech sounds. Phillips (2006) proposed that there are three levels of speech representation, acoustic, phonetic, and phonological. Further, Zeftawi (2005) found that the encoding of acoustic information occurs earlier than the encoding of both the phonetic and phonological information of the speech signal. We addressed the following questions to determine if and how musical training enhanced the ability to perceive and represent a single speech sound in the presence of multiple speech sounds: 1)Does musical training improve performance on a dichotic listening test. 2)Does musical training affect the ability to attend to one auditory stream in the presence of another. 3)How does the neural representation of the speech signal compare to behavioral results for musicians and non-musicians. 4)Do musicians show more bilateral and/or right hemispheric activity when perceiving speech sounds. Thirty subjects, fifteen musicians and fifteen non-musicians, were presented with a voiced unaspirated stop consonant in one ear and a voiceless unaspirated consonant in the other ear such that all combinations were presented. Through five tasks, subjects identified a dominant speech sound, indicated location for a specified speech sound, and indicated speech sound for a specified location. Behavioral results indicate that musical training improved subjects' ability to perceive specified speech sounds. Musical training effects and organization of acoustic features were reflected in the EEG as observed by location and amplitude of the ERP's.

A24

INVESTIGATION OF MELODIC CONTOUR PROCESSING IN THE BRAIN USING MULTIVARIATE PATTERN-BASED FMRI Yune-Sang Lee[1,2], Petr Janata[3], Carlton Frost[1], Michael Hanke[1,2], Richard Granger[1,2]; [1]Psychological & Brain Sciences, Dartmouth College, Hanover, [2]Center for Cognitive Neuroscience, Dartmouth College, [3]Center for Mind and Brain, U.C. Davis — Music perception generally involves processing the frequency relationships between successive pitches and extraction of the melodic contour. Previous evidence has suggested that the 'ups' and 'downs' of melodic contour are categorically and automatically processed, but knowledge of the brain regions that discriminate different types of contours is limited. Here, we examined melodic contour discrimination using multivariate pattern analysis (MVPA) of fMRI data. Twelve non-musicians were presented with various ascending and descending melodic sequences while being scanned. Whole-brain MVPA was used to identify regions in which the local pattern of activity accurately discriminated between contour categories. We identified three distinct cortical loci: right superior temporal sulcus (rSTS), left inferior parietal lobule (lIPL), and the anterior cingulate cortex (ACC). These results complement previous findings of melodic processing within the rSTS, and extend our understanding of the way in which abstract auditory sequences are categorized by the human brain.

A25

PERCEPTION OF TONE CONTRASTS IN CHINESE CHILDREN WITH DYSLEXIA Yajing Zhang[1,2], Hua Shu[1]; [1]State Key Laboratory of Cognitive Neurosciences and Learning, Beijing Normal Universtiy, [2]School of Education, Hebei Normal University, Shijiazhuang, China — Background: Previous research has shown a relationship between speech perception and dyslexia in alphabetic writing. In these studies speech perception was measured using phonemes, a prominent processing of alphabetic languages. Given the primary importance of lexical tone in Chinse language processing, we tested the neuro physiological correlates of categorical perception of Chinese lexical tone in chidren with phonological dyslexia. Methods: Dyslexic children and age-matched controls were tested on their categorical perception of tone contrasts by behavioral and ERP technology. Results: Experiment 1 used identification task to examine the categorical perception of lexical tones between age-matched children and dyslexic children. The results demonstrated that dyslexic children perceived tonal contrasts less categorically and accurately than age-matched controls. Experiment 2 further investigated the neural correlates of the categorical perception of lexical tones at a pre-attentive stage between dyslexic children and age-matched children. We tested the perception of either a across-category or a within-category speech stimulus shift. MMN amplitudes in response to the across-category deviant were significantly greater than those for the within-deviant by age-matched children. But there was no discrepancy between the two kinds of deviant stimuli by dyslexic. The results also showed that categorical perception of tone contrasts by behavioral and ERP technology are able to predict different level of reading and phonological abilities.

A26

LEFT AND RIGHT AUDITORY CORTICES CONTRIBUTE DIFFERENTLY TO PERCEPTION OF SLOW AND FAST BINAURAL BEATS Takahiro Miyazaki[1], Jessica Thompson[2], Bernhard Ross[1]; [1]Rotman Research Institute, Baycrest Centre, Toronto, Canada, [2]McGill University — Interaural time difference (ITD) is an important cue for sound localization. Periodic changes in the ITD occur when two pure tones with slightly different frequencies are presented to both ears separately, which evokes the sensation of a beat. To reveal the relationship between cortical activities and beat perception, auditory evoked steady-state responses to binaural beats were recorded with magnetoencephalograpy. The beat frequency of the binaural beat stimulus was dynamically changed between 3 and 60 Hz. A two alternatives forced choice behavioral test showed that the strength of the beat sensation consistently decreased as the beat frequency increased over this frequency range. Neuromagnetic activity was localized in bilateral auditory cortices and source activity was analyzed in the time-frequency domain using short-time Fourier transform. The contour of the time-frequency representation of cortical activities followed the rhythm of the stimulus beat with different time-locking in left and right hemispheres. Three distinct peaks of brain activity were observed at beat frequencies around 6, 15, and 40 Hz. The 6 Hz activity, corresponding to perception of a moving sound, was stronger in the left hemisphere, whereas the 15 Hz activity, corresponding to a warbling sound, was stronger in the right hemisphere. 40-Hz activity occurred bilaterally. The different lateralizations according to slow and faster beat rhythms is consistent with the concept of left hemispheric specialization for the temporal structure of sound and right hemispheric involvement in processing complex sounds and may reflect the distinct change in the subjective experience of the binaural beat at various frequencies.

A27

EARLY AND LATE STAGES OF NEURAL SPEECH PROCESSING IN NATIVE-ENGLISH AND NATIVE-POLISH LISTENERS: A BEHAVIORAL AND ERP STUDY Monica Wagner[1,2], Valerie Shafer[2], Brett Martin[2], Mitchell Steinschneider[3]; [1]St. John's University, NY, [2]The Graduate Center, CUNY, [3]Albert Einstein College of Medicine, NY — The effect of exposure to contextual features of the cluster /pt/ on speech perception was investigated in native-English and native-Polish listeners using behavioral and ERP

methodology. English and Polish listeners experience the cluster /pt/ in their languages, but only the Polish group experiences the cluster in the context examined in the current experiment (i.e., word onset). Acoustic features of phonemes change with context and, therefore, only the Polish listeners are exposed to the acoustic features of the word onset /pt/ cluster. Two and three-syllable nonsense words beginning with /pt/, /p´t/, /st/ and /s´t/ were presented within same and different word pairs. A syllable identification task revealed that Polish listeners were able to distinguish /pt/ and /p´t/ nonsense words but English listeners were not, suggesting that contextual features of phonemes are intrinsic to perceptual speech processing. ERP responses to the second word in the pair revealed native-language speech perception to be reflected late in latency within the late positive component and P400. The ERP response to the first word in the pairs revealed the P1N1P2 complex to the 2 and 3-syllable pt words to be highly similar for the English and Polish listeners. In contrast, English and Polish groups showed different responses from lateral-temporal sites (T-Complex) to the 2-syllable pt word forms reflecting native-language speech perception and these differences began early in cortical processing at 40 ms. Together, these findings suggest that both acoustic and linguistic distinctions are reflected at early stages of cortical speech processing but from different brain sources.

A28

ALPHA BRAIN WAVE ENTRAINMENT THROUGH ACOUSTIC BEATS Henk Haarmann[1], Tim George[1], Alexei Smaliy[1], Joseph Dien[1]; [1]University of Maryland College Park — Various types of brain wave entrainment (BWE) have been used in attempts to induce increases in neural oscillatory states associated with improved cognition. Most studies using auditory BWE have addressed the impact of binaural and monaural beats, which involve the presentation of two sustained tones of different pitch. We conducted an experiment that used a different form of auditory BWE involving acoustic beats that consisted of short same-pitch tones cycling on and off at the to-be-induced frequency. The aim of our study was to test whether brief exposure to acoustic beats at the center alpha frequency of 10 Hz would transiently increase EEG power in the alpha frequency range and not in other frequency ranges, such as, theta and beta. Each of sixty healthy adult participants had their full scalp EEG recorded while listening to pink noise for 10 minutes. Two groups of participants also heard an overlay of acoustic beats, presented at 10 Hz (alpha condition) in one group and 22 Hz (beta condition) in the other group. A third group only listened to the pink noise (no beats). Results indicate the presence of a frequency-specific increase in alpha power in the alpha condition as a function of scalp topography, relative to a baseline condition without BWE. These findings motivate the use of acoustic beats as a BWE method for testing theories about the causal influence of alpha power on cognition (e.g., semantic memory).

A29

GLUTAMATE NEUROMETABOLITE CONCENTRATION PREDICTS AUDITORY P50M LATENCY IN ALCOHOL USE DISORDERS Jason Long[1], Bobby Sena[1], Chuck Gasparovic[3], Paul Mullins[3], David Ruhl[3], Mollie Monnig[1,3], Per Lysne[1,3], Ronald Yeo[1,3], Robert Thoma[1,2,3]; [1]University of New Mexico, Albuquerque, NM, [2]University of New Mexico School of Medicine, Albuquerque, NM, [3]MIND Research Network (MRN), Albuquerque, NM — Abnormal glutamate levels are characteristic of an alcohol use disorders (AUD) group, where as normal controls have shown an otherwise healthy human population. Glutamate (Glu) is a critical excitatory neurotransmitter in the brain and is distributed throughout neural tissue. Magnetic resonance spectroscopy (MRS) was used to assess glutamate metabolite levels in bi-lateral anterior cingulate cortices. Magnetoencephalography (MEG) assessed P50m latency was used as a measure of processing in auditory cortex. MRS and MEG data were available on 4 healthy control subjects (HC), 6 subjects with current alcohol dependence (AUD-C; no alcohol on board at the time of neuroimaging), and 5 subjects with alcohol dependence and at least one year of remission (AUD-R). No significant relationships between Glu and P50m latency were evident in HC. However, significant negative correlations were evident between Glu and left hemisphere P50m latency (r = -.96, p= .001) and right hemisphere P50m latency (r = -.88, p = .01) in AUD-C; and significant positive correlations were evident between Glu and left hemisphere P50m latency (r = .90, p= .02) and right hemisphere P50m latency (r = .87, p = .03) in AUD-R. No relationships were evident between latency and any other neurometabolite. Hence, the relationship between Glu level and neural function is mediated by alcohol status.

A30

HUMAN GAMMA BAND OSCILLATIONS AT THE INTERFACE BETWEEN SENSATION AND CONSCIOUS COGNITION Bernhard Ross[1], Takahiro Miyazaki[1], Takako Fujioka[1]; [1]Rotman Research Institute, Toronto, Canada — Continuous sensory input results in a central representation of the elementary features of our environment. However, we perceive an object in the world around us as an integrated entity. Neural oscillations at frequencies around 40Hz (gamma band) have been discussed as mechanism for binding of sensory information for conscious perception. Our model is that reciprocal thalamocortical connections form oscillatory loops, in which the stimulus entrains synchronous oscillations. Binding is than established by interaction between specific and non-specific thalamocortical circuits. To test this hypothesis, we recorded the human magnetoencephalogram (MEG) while participants listened to 40-Hz amplitude modulated sound in a series of experiments. The 40-Hz rhythm of stimulation synchronized oscillations in thalamocortical networks. We introduced subtle changes in the auditoy stimulus, which were short temporal gaps, brief clicks to the opposite ear, changes in sound location, and informational contralateral masking, respectively. Consistently such stimulus modifications resulted in a reset of entrained 40-Hz oscillations, which was characterized by a 200ms time interval with delayed response phase and increasing amplitude. Based on the temporal dynamics we separated two partial 40-Hz oscillations; the first was entirely stimulus locked and likely indicates sensory representation and the second showed systematic temporal phase and amplitude deviations and likely indicates the emergence of an early object representation, which than becomes accessible for conscious perception. We interpret the gamma band reset as process of resolving an existing binding when a new stimulus had been detected and establishing dynamically a synchronous network representing the new stimulus configuration.

A31

MONAURAL AND BINAURAL CONTRIBUTIONS TO SPATIAL CUE TUNING IN HUMAN AUDITORY CORTEX G Christopher Stecker[1], Susan A McLaughlin[1]; [1]University of Washington — Functional magnetic resonance imaging (fMRI) studies have consistently demonstrated blood-oxygenation-level-dependent (BOLD) responses to be stronger in auditory cortex (AC) contralateral to the stimulated ear, a preference that might reflect tuning to auditory spatial cues such as interaural level differences (ILD), or alternately might originate in contralaterally biased monaural pathways. The current study compared AC BOLD responses to monaural and binaural sounds varying in intensity (55-85 dB SPL) and binaural configuration across imaging blocks. "Sparse" fMRI (TR=12s) at 3 Tesla measured responses to 4000-Hz narrowband, temporally modulated sounds. Stimuli were delivered monaurally or binaurally with intensities matching (diotic condition) or opposing (ILD condition) across the two ears. ILD values ranged -30 to +30 dB. Rate of presentation was either 5/s ("slow") or 40/s ("fast"). The overall stimulus set allowed measurement of parametric response-intensity and response-ILD functions, along with indices of contralateral preference (contralateral vs ipsilateral), binaural interaction (binaural vs monaural), and response adaptation (slow vs fast). Monaural and binaural responses were contralaterally biased (more strongly so in left than right cerebral hemispheres). Binaural responses indicated significant binaural suppression, with minimum responses to ipsilateral ILD of 10-20 dB; larger ILD values produced responses similar to monaural stimulation of the contralateral ear (i.e., no binaural suppression). Adaptation effects were similarly

greater for moderate (10-20 dB) ILD values than for 0 or 30 dB. The results are consistent with separate contributions of monaural and binaural, as well as left and right hemispatial, processing channels within AC. Supported by NSF IOB-0630338, NIH R03-DC009482-02S1.

Perception & Action: Development & Aging

A32

NEURAL CORRELATES OF COGNITIVE AGING IN FACE MEMORY: AN ERP STUDY ON THE OWN-AGE BIAS IN FOUR CONSECUTIVE AGE GROUPS Nicole Wolff[1], Stefan R. Schweinberger[1], Holger Wiese[1]; [1]DFG Research Unit Person Perception, Friedrich Schiller University of Jena, Germany — Young adult participants are more accurate at remembering young as compared to old faces, a phenomenon known as the own age bias. However, whereas most former studies examined clearly separate age groups, the present study investigated behavioural and ERP correlates of recognition memory for faces in four consecutive age categories (ranging from 19-29, 30-44, 45-59, 60-79 years), both with respect to stimulus and participant age. Young and younger middle-aged participants demonstrated similarly enhanced recognition memory for young and younger middle-aged as compared to older middle-aged and old faces. No memory bias was observed in the older middle-aged and elderly participants. Both N170 and the directly following occipito-temporal P2 exhibited. In addition, a decrease in the ERP old/new effect (400-700 ms) was detected, with clearly more positive amplitudes for hits compared to correct rejections in the youngest participant group, followed by a reduced effect in the younger middle-aged group, and no significant difference between hits and correct rejections in the two older groups. These findings show similarly enhanced recognition memory in young and younger middle-aged participants for corresponding face age categories, and thus no own-age bias exclusively directed towards 'in-group' faces. Whereas group differences in N170 and P2 reflect effects of cognitive aging on the perceptual processing of faces, the reduced ERP old/new effect with increasing age suggests declining contributions of recollection during memory retrieval.

A33

DEFICIENT CENTRAL COHERENCE IN PEOPLE WITH WILLIAMS SYNDROME: EVIDENCE FROM AN EVENT-RELATED POTENTIAL STUDY OF FACE PROCESSING Ching-Fen Hsu[1], Jenn-Yeu Chen[2], Ovid J.L. Tzeng[3]; [1]Huafan University, Taiwan, [2]National Cheng Kung University, Taiwan, [3]Academia Sinica, Taiwan — Unlike healthy controls processing faces with global configurational information, it has been debated whether people with Williams syndrome (WS) process faces with deviant strategy based on local facial features. More behavioral studies found different results between WS group and healthy controls, pointing to distinct face processing strategies of two groups. This study was aimed at finding neurological correlates of face processing to features or configurations in people with WS with 128-channel event-related potentials. The participants were required to make same-different judgments to target faces which followed the same face model (same-different task). Further interests on component sensitivity to explicit instructions to feature-changed or configuration-changed faces were employed (feature-task, configure-task). In the same-different task, while the people with WS reflected sensitivity to feature-changed faces in the N170 component, the healthy controls did not have this reflection. With respect to the P2 component showed larger neural activities to configuration-changed faces than feature-changed ones on healthy controls, the people with WS failed to show this pattern with instruction attending to features or second-order configurations of faces. Behavioral results found that the people with WS were significantly less accurate than the healthy controls in detecting the configurational changes in the configure-task. These findings are consistent with the local preference in this clinical group found in previous visual construction studies. Together, the evidence suggests deficient central coherence in integrating parts into whole in face processing of people with WS.

A34

NEURAL CORRELATES OF GESTURE PROCESSING ACROSS DEVELOPMENT Elizabeth Wakefield[1], Karin H. James[1]; [1]Indiana University — The use of gesture in a learning paradigm has been shown to benefit learning (e.g., Church & Goldin-Meadow, 1986; Ping & Goldin-Meadow, 2008), and is more beneficial for children than adults (Hostetter, in press); however, the neural mechanisms underlying this facilitatory effect are unknown. The current study was conducted as a first step in determining how learning with gesture affects the brain. Specifically, we used functional Magnetic Resonance Imaging (fMRI) to identify how the brain processes gesture across development as a way to localize regions of interest for further studies. Three groups of children (5-11 year-olds) and adults watched movies in which an actor spoke a sentence and (1) performed a congruent gesture, (2) performed an unrelated movement, (3) performed no gesture, or (4) a gesture was produced without speech. Sentences were either iconic (e.g., "Bugs ran up his arm") or metaphoric (e.g., "Chills ran up his spine) in content, such that the same gesture could be used in both contexts, as well as in the gesture-alone movies. Results reveal a developmental change in gesture processing, as well as a difference in how all age groups process gestures produced in metaphoric versus iconic contexts. Although all groups show activation in the middle temporal gyrus (MTG) and visual processing regions, only adults recruit the premotor cortex bilaterally, and the fusiform gyrus. The differences in how gestures are processed across development may underlie the differential facilitatory effects of gesture use in learning paradigms for children and adults.

A35

MATURATION OF AUDITORY EVENT-RELATED POTENTIALS IN ADOLESCENCE Yatin Mahajan[1], Genevieve McArthur[1]; [1]Macquarie University — Adolescence is a time of great change in the brain in terms of structure and function. It is possible to track the development of auditory function across adolescence using auditory event-related potentials (ERPs). We measured passive auditory ERPs to pure tones and consonant-vowel (CV) syllables in 90 children and adolescents aged 10-18 years, as well as 10 adults. The results revealed that the latency of the P1 and N1 peaks decreased with age, the latency of the P2 peak increased with age, and the latency of the N2 peak remained stable across age. The amplitude of the P1, P2 and N2 peaks decreased with age, while the amplitude of the N1 peak increased across age. These patterns in maturation, which were seen for both the tone and CV stimuli, occurred earlier for tones than the CVs. Interestingly, step-like changes were observed for N1, P2 and N2 peaks between 13 to 16 year olds, which could be due to pubertal changes influencing underlying neural processes of generators. These results provide much needed insight into the development of auditory ERPs in typically developing adolescents, and will form norms for identifying atypical auditory processing in clinical populations.

A36

REPRESENTING OTHERS' ACTIONS: THE ROLE OF EXPERTISE IN THE AGING MIND Nadine Diersch[1], Emily S. Cross[2], Waltraud Stadler[1], Martina Rieger[3], Simone Schütz-Bosbach[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, [2]Donders Institute for Brain, Cognition & Behaviour, Radboud University Nijmegen, [3]Goethe University Frankfurt am Main — A large body of evidence suggests that action execution and action perception share a common representational domain. Thus, observed actions are mapped onto one's own motor representations, which enables observers to anticipate and predict actions they are watching. To date only little is known on age-related changes in the representations of actions and how motoric experiences might compensate for these changes. The present study investigated how precisely older and younger adults are able to predict the time course of actions for which they have motor expertise or not. Videos of figure skating actions as well

as everyday movements were shown to novices and figure skating experts from two age groups (young/old). The actions were transiently occluded at critical time points and the continuation afterwards was temporally manipulated. Participants were asked to judge the temporal coherence of the observed action continuation. Older adults predicted the time course of observed everyday actions less accurately compared to younger adults, demonstrating that action representations become more imprecise with advancing age. However, figure skating experts showed better performance when they observed figure skating actions compared to novices of the same age group suggesting that in domain-specific tasks expertise might indeed attenuate age-related declines in action prediction. As a next step, fMRI will be used to disentangle the underlying brain activation patterns within the age groups as a function of expertise. We predict that both age and expertise will modulate activity in the action perception network, including inferior parietal lobule, premotor cortex, and superior temporal sulcus.

A37

SIMULATING COGNITIVE DEFICITS IN PARKINSON'S DISEASE USING A COMPUTATIONAL IMPLEMENTATION OF COVIS Erick J. Paul[1], Sebastien Hélie[1], F. Gregory Ashby[1]; [1]University of California, Santa Barbara — Ample evidence suggests that human category learning is mediated by distinct systems depending on the nature of the category structures. COVIS (Ashby et al., 1998) proposes an explicit system that mediates learning in rule-based tasks and a procedural system that learns information-integration categories incrementally through trial and error. COVIS posits a critical role of dopamine (DA) in both systems and was developed with careful consideration of known neurobiological constraints. Given these two features, a computational implementation of COVIS was designed to simulate the myriad deficits observed in Parkinson's disease patients in a variety of benchmark psychological tasks. In Parkinson's disease, dopamine-producing cells in the substantia nigra pars compacta (SNpc) degenerate at an accelerated rate (Albin, Young, & Penney, 1988); the death of DA cells causes reduced DA availability to the SNpc's efferent brain areas such as the striatum and the prefrontal cortex. This loss of DA affects both the explicit and procedural systems of COVIS: DA in the explicit system affects hypothesis selection while DA in the procedural system serves as the reward prediction error signal necessary for learning in the striatum. Manipulating the DA parameters in COVIS allows for the model to reproduce several behavioral results typical of PD patients under different learning conditions, such as the differential deficits in rule-based and information-integration categorization, increased perseveration in the WCST and modified WCST, and poor performance relative to age-matched controls in those tasks (for reviews, see, e.g., Ashby et al., 2003; Price et al., 2009).

A38

AGE-RELATED DEDIFFERENTIATION IN THE FACE NETWORK Joonkoo Park[1], Joshua Carp[1], Gerard Bischof[2], Chih-Mao Huang[2], Kristen Kennedy[2], Jenny Rieck[2], Karen Rodrigue[2], Thad Polk[1], Denise Park[2]; [1]University of Michigan, [2]University of Texas at Dallas — Previous studies have found that cortical responses to different stimuli become less distinctive as people get older. This age-related dedifferentiation may reflect the broadening of the tuning curves of category selective neurons ("broadening hypothesis"), or it may be due to decreased activation of the category selective neurons ("reduction hypothesis"). In this study, we tested these two hypotheses in the context of the face-selective neural network. Nearly 300 participants ranging in age from 20 to 90 viewed images of faces, houses, and control stimuli in an fMRI session. The face-selective bilateral fusiform face area (FFA), occipital face area (OFA), superior temporal sulcus (STS), and amygdala activations were identified individually by contrasting neural responses to faces to neural responses to houses, and the magnitude of such neural activations was examined across the lifespan. Activation in the left FFA and the bilateral amygdala decreased significantly as a function of age, confirming previous findings of age-related dedifferentiation. Consistent with the broadening hypothesis, this dedifferentiation in the left FFA was driven by increased activation to houses. In contrast, dedifferentiation in the amygdala was driven by decreased activation to faces, consistent with the reduction hypothesis. These results suggest that age-related dedifferentiation reflects different mechanisms in different brain areas. More specifically, dedifferentiation in FFA activity may be due to broadening of the tuning curves for face-selective neurons, while dedifferentiation in the amygdala reflects reduced activation of face- or emotion-selective neurons.

A39

MOTHER AND STRANGER: AN ELECTROPHYSIOLOGICAL STUDY OF VOICE PROCESSING IN NEWBORNS Maude Beauchemin[1,2], Berta Gonzales-Frankenberger[1,2], Julie Tremblay[1], Phetsamone Vannasing[1], Eduardo Martinez-Montes[3], Pascal Belin[2,4], Renée Béland[1,2], Diane Francoeur[1], Ana-Maria Carceller[1], Fabrice Wallois[5], Maryse Lassonde[1,2]; [1]Centre de recherche, CHU Sainte-Justine, Montréal, Canada, [2]Centre de recherche en neuropsychologie et cognition (CERNEC), Département de psychologie, Université de Montréal, Canada, [3]Cuban Neuroscience Center, Neurostatistics Department, Havana, Cuba, [4]Voice Neurocognition Laboratory, Institute of Neuroscience and Psychology, University of Glasgow, Scotland, United Kingdom, [5]Groupe de Recherche sur l'Analyse Multimodale de la Fonction Cérébrale (GRAMFC, EA4293), Université of Picardie Jules Verne, CHU Nord, Amiens, France — In the mature adult brain, there are voice-selective regions that are especially tuned to familiar voices. Yet, little is known about how the infant's brain treats such information. Here, we investigated, using electrophysiology and source analyses, how newborns process their mother's voice compared to that of a stranger. Results suggest that, shortly after birth, newborns distinctly process their mother's voice at an early, pre-attentional, level, and at a later, presumably cognitive level. Activation sources revealed that exposure to the maternal voice elicited early language-relevant processing whereas the stranger's voice elicited more voice-specific responses. A central, probably motor response was also observed at a later time, which may reflect an innate auditory-articulatory loop. The singularity of left-dominant brain activation pattern together with its ensuing sustained, greater central activation in response to the mother's voice, may provide the first neurophysiologic index of the preferential mother's role in language acquisition.

A40

COMPLEXITY OF SEMANTIC PROCESSING DIFFERENTIATES INHIBITORY BRAIN RESPONSE IN ADOLESCENTS WITH ADHD Neena Rao[1], Tiffani Jantz[1], Monique Salinas[1], Matthew Brier[2], Mandy Maguire[1], John Hart[1,3], Sandra Chapman[1], Jacquelyn Gamino[1], Michael Motes[1,3]; [1]University of Texas at Dallas, Center for BrainHealth, [2]Washington University, [3]University of Texas Southwestern Medical Center — The present study explored the neural underpinnings of response inhibition among adolescents with ADHD who were medically managed. One well-documented characteristic of ADHD is impaired control of inhibitory processing. Sixteen male adolescents diagnosed with ADHD and 16 male neurotypical controls (Mean age = 13.3) completed three versions of a response inhibition task while EEG data were recorded. The required depth of semantic processing was varied across the three versions to explore the role of complexity in semantic processing. The lowest level version required relatively simple feature-based discrimination (i.e., responding to a picture of a single repeated car [80% of stimuli] and not responding to a single repeated dog [20% of stimuli]); the next level required more complex feature-based discrimination (i.e., responding to multiple types of cars but not multiple types of dogs); and the highest level required more conceptual-based discrimination (i.e., responding to objects but not animals). Mean reaction time and accuracy did not significantly differ across the two groups. However, for the ADHD group, the difference in mean evoked potential amplitudes for NoGo compared to Go responses at 300 ms (P3) in frontal regions (Fz) decreased as each task increased in semantic complexity. The control group only showed a difference in mean evoked potential amplitudes at 300 ms in frontal electrodes for the most semantically complex condition. The pattern of frontal-mediated inhibition effects for the ADHD group compared to the control group suggests that

successful inhibition for adolescents with ADHD requires greater involvement of frontal-mediated semantic resources.

A41

PERCEPTUAL PROCESSING IMPAIRMENTS IN MCI PATIENTS ARE RELATED TO PERCEPTUAL INTERFERENCE Rachel Newsome[1], Audrey Duarte[2], Morgan D. Barense[1]; [1]University of Toronto, [2]Georgia Institute of Technology — Recent evidence suggests that memory in mild cognitive impairment (MCI) patients may be improved by reducing interference from competing, but irrelevant, stimuli (Della Sala, et al., 2005). In the present study, we sought to investigate whether these findings would extend to a perceptual task in which the degree of interference could be carefully controlled. MCI patients performed a visual discrimination task (a same-different judgment) with varying levels of interference. In the high interference condition, many perceptually similar, semantically negligible objects (blob-like objects) were presented sequentially. In contrast, in the low interference condition, these perceptually similar objects were interspersed with dissimilar semantically meaningful objects (e.g. a shoe and a bagel). MCI patients [n = 8] were impaired on the high interference condition compared to healthy controls [n = 11; $t(17) = 2.22$, $p = 0.04$]. Critically, performance was intact in the low interference conditions [$t(17) < 1$]. We suggest that the critical factor in modulating perceptual processing deficits in MCI patients is the degree of interference from competing similar stimuli.

A42

ELECTROMYOGRAPHYCAL CORRELATES OF OBSERVED ACTIONS IN 6-MONTH-OLD INFANTS Elena Natale[1], Marta Picozzi[1], Veronica Ferrara[1], Irene Senna[1], Nadia Bolognini[1], Viola Macchi Cassia[1], Chiara Turati[1]; [1]University of Milano-Bicocca, Department of Psychology — Neuroimaging evidence suggests that a parieto-frontal cortical circuit with action observation-action execution mirror properties exists in the human brain, enabling adult individuals to understand the intentions of others. Recently, a desynchronization in the mu-frequency band of infants has been found during action observation, which seems to be modulated by the goal of the action. This has been taken as evidence that the human motor system might be involved in making predictions about the end of an observed action from early in life. Here, we aimed at directly testing the latter possibility by using the surface electromyography (sEMG) technique with infants. We recorded sEMG from healthy, full-term six-month-olds while watching two video-clips displaying an agent either reaching a pacifier and bringing it into the mouth (pacifier action) or reaching a piece of lego and placing it on the head (lego action). The mouth-opening suprahyoid muscles were selected as recording site. We found a reduction in the EMG activation for the bringing as compared to the reaching phase of the lego action (whole group). Moreover, a greater activation was observed for the bringing phase of the pacifier action as compared to the bringing phase of the lego action (half the subjects). Present findings show a specific modulation of infants' muscular activation with the type of action goal and strongly argue for an involvement of the human motor system in action understanding early in development.

A43

LONG-LASTING EFFECTS OF GABA ADMINISTRATION ON VISION IN CHILDREN C. van den Boomen[1,2], J.C. de Graaff[3], T.P.V.M. de Jong[4], C. Kemner[1,2]; [1]Department of Developmental Psychology, Utrecht University, [2]Department of Child and Adolescent Psychiatry, UMC Utrecht, [3]Department of Pediatric Anesthesiology, Division Perioperative & Emergency Care, UMC Utrecht, [4]Department of Pediatric Urology, Pediatric Renal Center WKZ/UMC Utrecht and EKZ/AMC Amsterdam — Background: Visual processing is modulated by Gamma-Aminobutyric Acid- (GABA-)ergic inhibition between neurons in the brain. Psychopharmacological studies revealed that small changes in GABA levels affect specific visual processes in adults. General anesthesia, applied to induce a reversible unconscious state during surgery, produces larger changes in GABA levels. As is suggested by post-hoc cognitive studies in children, GABA administration through anesthesia could have longer-lasting effects on brain functioning than previously assumed. Aim: In the present study, we directly investigated whether GABAergic modulation through general inhalation anesthesia has long-lasting effects on visual processing in children. If present, these effects would be expected for contrast sensitivity, texture segregation, and contour integration, but not visual acuity. Methods: Visual processing was investigated at home in thirteen typically developed children (age 5-12 years). In a texture segregation task, the difference in Event-Related Potential (ERP) response to homogeneous and checkered stimuli was investigated. In addition, behavioral performance on acuity, contrast sensitivity, and contour integration were measured. Results were compared between before and the day after GABAergic modulation through general anesthesia. Children were anesthetized with sevoflurane for urologic procedures under general anesthesia (>30 min) with locoregional analgesia in day care treatment. Results: No changes on either ERP measures or behavioral performance were found after surgery. These results show that GABAergic modulation through anesthesia has no long-lasting effects on texture segregation, acuity, contrast sensitivity, and contour integration. This suggests that children do not suffer from abnormal neural or behavioral visual processing due to anesthesia at one day after surgery.

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A44

SEPARATION OF GLOBAL AND LOCAL HAPTIC PROCESSING IN THE BRAIN Nick Davis[1], Simon Tomlinson[1], Helen Morgan[1], Martyn Bracewell[1]; [1]Bangor University — Lifting an object with efficient grasp requires knowledge of the surface texture of the object and of the distribution of its mass. Without the former the object could slip through the fingers, and without the latter the object could rotate in the grasp. Differences in processing global and local features of objects and scenes are well known in the visual modality. However it is not known how well these differences extend to other modalities. This work aimed to discover if the haptic system showed a separation of global and local processing. People lifted with the right hand small wooden objects while lying in a 3T MRI scanner. They were asked to judge either the surface texture of the object (rough, medium or smooth) or the position of the grasp point within the object (centred or off-centre). The task activated a wide network of brain areas. We were especially interested in areas whose activity differed between the global and local judgement conditions. We found that local judgements preferentially activated the left primary sensory cortex (S1), the bilateral insula and right inferior parietal cortex. Conversely global judgements activated S1 bilaterally, left dorsolateral prefrontal cortex, and bilateral cingulate cortex. We conclude that the processing of global and local information is separated in the haptic system. Of particular interest are the right S1 and the right parietal areas, which relate to the two different conditions. Future work will use these areas as targets for brain stimulation to dissociably affect global or local haptic judgements.

A45

FUNCTIONAL ACTIVATION CHANGES IN COMPLEX MOTOR CONTROL TRAINING: INFLUENCE OF STRATEGY AND GENDER Hyunkyu Lee[1], Ruchika Shaurya Prakash[2], Michelle W. Voss[1], Arthur F. Kramer[1]; [1]University of Illinois, Beckman Institute, [2]The Ohio State University, Department of Psychology — In this study, we examined strategy- and gender-related changes in cortical activity following training with the Space Fortress videogame (Donchin et al., 1989), using one of two strategies: Hybrid Variable-Priority Training (HVT) or Fixed Emphasis Training (FET). A control group received minimal game experience. Functional magnetic resonance imaging (fMRI) data were acquired before and after 30 hours of training. We examined Time × Strategy and Time × Gender interactions to isolate strategy- and gender-dependent changes in activation. We found that most regions involved in complex motor control processing before training showed reductions in activation after training, in the

two experimental groups, relative to the control group. We also found that the HVT group showed larger activation decreases in these areas than the FET and control groups, coupled with better performance improvement in HVT compared to FET and control groups. Relative to females, at pre-training males showed greater activation in the right dorsal striatum and anterior cingulate cortex, coupled with better performance. However, gender differences in brain activation and performance diminished after training. These results suggest that strategy and gender affect individual differences in videogame training-induced plasticity.

A46

"MOTOR PLANNING MODULATES AVAILABILITY OF VISUALLY PRESENTED ITEMS IN WORKING MEMORY." Marnie Ann Spiegel[1], Thomas Schack[1], Matthias Weigelt[2]; [1]CITEC Center of Excellence Cognitive Interaction Technology, Bielefeld University, [2]Sport Psychology / Movement Science, Institute of Sport Science, Saarland University — The ability to flexibly adapt movements to changing environments is vital. Previous research has shown that actions are measurable and planned in considerable detail prior to motor execution. Action planning seems not to be an isolated operation but rather an active cognitive mechanism that interacts with other cognitive domains like e.g., language or memory. The goal of the present study was to investigate whether simultaneous motor and memory tasks draw on common cognitive resources, and to characterize the nature of this interaction. Participants were asked to perform a grasp-to-place task which required in some trials an update of the current action plan, while actively maintaining letters of a visually presented 3x3 matrix in working memory (phonological loop). In a second step, precision demands on the motor task were manipulated. The results suggest that a correction of a motor plan is a resources-demanding process, interacting with a concurrent memory task. Motor re-planning led to reduced availability of items in verbal working memory resulting in a worse memory task performance. Dual-task costs were greater for the re-planning of a high complexity motor task compared to a motor task of low complexity. Interestingly, although the speed of action was not influenced by the motor update, placing movements more often resulted in movement errors. These data are consistent with prior findings and support the notion that changing movement plans requires cognitive resources withdrawn from other cognitive domains, e.g. working memory. This processing effort leads to both, modulated memory and decreased motor performance.

A47

ARE INCREASES IN 20 HZ CORTICOMUSCLUAR MEG-EMG COHERENCE ASSOCIATED WITH PLACEBO RESPONSES TO A SHAM TREATMENT FOLLOWING THE INDUCTION OF FATIGUE? Catherine Kerr[1], Erik Tobiason[1], Jane Adkins[2], Matthew Sacchet[1]; [1]Osher Research Center, Harvard Medical School, [2]Wellesley College — Background: The 20 Hz beta rhythm is the dominant oscillator in the supraspinal motor system. As part of this larger system, 20 Hz corticomuscular coherence is thought to provide a descending drive that synchronizes local muscles during isometric holding tasks. 20 Hz corticomuscular coherence (CMC) disappears during movement and is enhanced during visuomotor tasks requiring high-precision holds. In this study, we hypothesized there would be a positive relationship between beta CMC and centrally-generated fatigue, based on the fact that beta CMC is thought to originate in cortex. Methods: We examined the role of centrally-driven fatigue by inducing perceived muscular fatigue using a 10-min sustained low-force (~6% MVC) hold task that required high precision and mental concentration. Before and after the sustained task, we used MEG to compare beta rhythm CMC between the motor cortex and the first dorsal interosseous muscle associated with low force holds (~3% MVC). We extracted a signal from motor cortex using MRI to anatomically to localize the anterior bank of the central sulcus. Building on previous reports of placebo effects in clinical and experimental fatigue, we also evaluated whether a placebo-sham therapy applied after the fatigue condition affected the Beta CMC in a small sub-group of subjects (n=3). Results: Nearly all participants reported moderate perceived muscle fatigue (~4.5/10 on Numerical Analog Scale) coinciding with the loss of the prominent 20 Hz beta rhythm CMC spike. The results of a small sub-group (n=3) who received a sham treatment are considered in light of this preliminary fatigue finding.

A48

IMPAIRED VOLITIONAL ACTION INITIATION AS A CANDIDATE ENDOPHENOTYPE FOR OBSESSIVE-COMPULSIVE DISORDER? Lisa Kloft[1], Benedikt Reuter[1], Riesel Anja[1], Kathmann Norbert[1]; [1]Humboldt Universität zu Berlin — Patients with obsessive-compulsive disorder (OCD) show repetitive behaviours which might result from impaired response selection or response initiation. By using simple volitional saccade tasks we recently found impaired response initiation and intact response selection in OCD patients. The present study had two aims: to replicate this finding and to investigate whether dysfunctional saccade initiation reflects a genetic disposition for OCD. Therefore, the same volitional saccade task was used in 27 unaffected first-degree relatives of OCD patients, 27 task-naïve patients and 27 healthy controls. We found that unaffected first-degree relatives and OCD patients were slowed in conditions of volitional saccade initiation when compared to healthy controls. Reaction times between patients and unaffected first-degree relatives did not differ significantly. To conclude, we confirmed the assumption of slowed volitional response initiation in OCD patients which is in accordance with findings from manual tasks. These deficits might relate to known dysfunctions of basal ganglia circuitries in OCD patients. Results from unaffected first degree relatives suggest that dysfunctional initiation of volitional responses might be a candidate endophenoytpe for OCD.

A49

CHARACTERIZATION OF SENSORIMOTOR RHYTHM (SMR) ON HEALTHY AND PREMATURE INFANTS WITH PVL Minerva Moguel-Gonzalez[1], Ana Milene Roca-Stappung[1], Thalía Fernández H[1], Thalía Harmony B[1], Salvador Ruiz-Correa[2]; [1]Instituto de Neurobiología, UNAM Campus Juriquilla, México., [2]Centro de Investigación en Matemáticas CIMAT. Guanajuato, México — A prevalent form of brain injury in preterm infants due to white matter lesions is Periventricular Leucomalacia (PVL); it is accompanied by neuronal and axonal deficits affecting many cerebral structures. Infants with PVL are vulnerable to develop motor and cognitive impairments because of the many risk factors in which are involved. It has been described that premature infants with PVL show significant impairment in sensory, motor and/or cognitive areas. The main purpose of this work was to characterize the sensorimotor rhythm (SMR) on healthy and premature infants with PVL. The SMR is an electroencephalographic rhythm localized over the central regions during wakefulness; is reactive to generalized movement and also presents a contralateral reactivity to one hemibody movement. The SMR has been related to motor and cognitive development. At this work we show that SMR is established in different frequencies depending on age and presence of PVL. Healthy infants of 4 -month old show an SMR between 3.90Hz-7Hz, specifically at 5.46Hz and 6.25Hz, healthy infants of 8-month old show an SMR at 7 Hz and 7.8Hz. The 8-month old premature infants with PVL show an SMR at the same frequency of its homologue control group, 7Hz, but 4-month old premature infants with PVL don't show the necessary electroencephalographic characteristics to establish SMR or show them at a low frequency, 3.9 y 4.6Hz; which can be an evidence of an immature brain for their age. Our results contribute with important information to the knowledge of infant brain development. SALUD-2009-01-112217 and PAPIIT IN220110

A50

DOPAMINERGIC CORRELATES OF THE GAP EFFECT IN REFLEXIVE SACCADES Jutta Billino[1], Jürgen Hennig[2], Karl Gegenfurtner[1]; [1]Experimental Psychology, Justus-Liebig-Universität Giessen, [2]Personality Psychology and Individual Differences, Justus-Liebig-Universität Giessen — Saccades allow for moving the eyes rapidly to targets of interest and thus represent a basic prerequisite for precise visual perception in changing environments. Latency of saccades is influenced by target characteristics as well as cognitive factors. The gap effect refers to a substantial reduction of saccadic latency by fixation stimulus offsets and has been attributed to a preparatory process consisting of a general alerting component and an ocular orienting effect. We were interested in the gap effect in healthy adults with supposed differences in dopaminergic activation. Catechol-O-methyltransferase (COMT) plays a major role in regulation of prefrontal dopamine levels. The COMT val158met polymorphism modulates enzyme activity in that met alleles lead to less active dopamine degradation and accordingly to higher dopamine levels. We investigated the gap effect in reflexive saccades in 62 subjects and determined the individual genotypes. Subjects had to make horizontal saccades to targets presented either in an overlap or a gap condition. In the overlap condition, the fixation stimulus remained present during target presentation, in the gap condition, the fixation stimulus disappeared 200ms before target onset. Analysis of saccade latencies yielded a significant main effect of gap condition ($F(1, 59)=120.1$, $p<0.01$) and a significant interaction between the genotype and gap condition ($F(2, 59)=3.8$, $p=0.02$). There was no main effect of genotype ($F(2, 59)=0.6$, $p=0.57$). Met158 homozygotes showed a more pronounced gap effect than both other genotype groups. We suppose that higher prefrontal dopaminergic activation contributes to enhanced ability to prepare saccades.

A51

THE HUMAN MOTOR SYSTEM IS SENSITIVE TO TEMPORAL FEEDBACK DISTORTIONS OF ONE'S OWN ACTIONS Carmen Weiss[1], Manos Tsakiris[2], Patrick Haggard[3], Simone Schütz-Bosbach[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, [2]Royal Holloway University of London, [3]University College London — A large body of evidence has shown that the experience of self-agency is influenced by the congruency of sensorimotor cues during action execution. For example, an action (effect) is more likely to be self-attributed when there is temporal congruency between its execution and the actual sensory feedback. Moreover, recent studies showed a specific suppression in the human motor system for one's own actions, which suggests that a sense of self-agency is embedded on the level of primary sensorimotor representations. The present study sought to further specify the involvement of the human motor system in self-agency. More specifically, we investigated whether the human motor system is sensitive to temporal discrepancies between executed and observed movements and whether and how this relates to the explicit detection of those discrepancies. Participants performed simple finger movements that were displayed on a screen in front of them either in real-time or with a temporal delay. Furthermore, they were required to judge explicitly whether the observed movement temporally corresponded to their actual movement execution or not. Using transcranial magnetic stimulation, we compared motor-evoked potentials after the observation of real-time and delayed movements. The results revealed an increase of corticomotor excitability with larger temporal discrepancies between movement execution and observation. This modulation of corticomotor excitability varied in close correspondence to individual differences in the explicit delay detection performance. We conclude that sensorimotor cues can influence lower-level, sensorimotor and higher-level, explicit representations of one's own actions in similar ways.

A52

WHEN SOUNDS BECOME ACTIONS: DEVELOPING GOAL-DIRECTED REPRESENTATIONS IN THE HUMAN MOTOR SYSTEM Luca F. Ticini[1], Simone Schuetz-Bosbach[1], Carmen Weiss[1], Antonino Casile[2], Florian Waszak[3]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]Harvard Medical School, Boston, Massachusetts, [3]University Paris Descartes & CNRS, France — We offer the first neurophysiological demonstration that the audio-motor representation of actions (also known as 'auditory mirror mechanism') can quickly develop ex novo in the adult human brain, and we show that the motor system dissociates the goals of newly acquired actions from the movements to achieve them. The results of two TMS experiments shed light on the mechanism of early automatic recognition of action-related sounds. They demonstrate that matching of sounds and actions in the mirror system is largely dependent on audio-motor experience: it gets established rapidly when self-produced actions are associated with their perceivable outcomes. In addition, the results show that the activity of the motor and premotor cortices is modulated by the action's goal, suggesting that a high-order audio-motor representation of action sounds emerges through experience. Current theories assume that the mirror mechanism develops through stimulus-response associations and through imitation of others' actions. Our work challenges this view by suggesting that the brain, in the first place, learns to understand others' actions by associating self-produced ones with their perceivable consequences. The results also corroborate theories claiming that, through the motor resonance mechanism, actions are not purely coded in terms of motor output, but rather in terms of action goals. We believe that this work represents an important step in the growing scientific understanding of action recognition and action representation.

A53

MERGING ACTS TO EPISODES: WHAT IS MORE IMPORTANT, CONSISTENCY OF THE ACTOR OR THE PRESENCE OF OVERARCHING GOALS? Mari Hrkac'[1,2], Moritz Wurm[1], Yuka Morikawa[1], Ricarda Schubotz[1,2]; [1]Max Planck Institute for Neurological Research, Cologne, Germany, [2]Westfälische Wilhelms-Universität Münster, Münster, Germany — The actions we perceive during everyday life can be conceived as sequentially and hierarchically structured events. Even when observation is discontinuous, for instance when following the interlaced plot of a movie, we are able to recognize well the coherence of single acts building a common action directed towards an overarching goal. The present functional imaging study was aimed at identifying the neural signatures of processing coherent acts. In particular, we set out to disentangle two coherence-building factors in actions that normally covary: the actor and the presence of an overarching goal. Subjects watched short video clips of single acts that were either steps of a common action with an overarching goal or not. Acts were performed by either one and the same or by varying actors. This 2 x 2 design resulted in four experimental conditions that were presented in a randomized trial design. Conjunctions were calculated for the effect of overarching goals and actor. Observing acts with an overarching goal yielded activation in intraparietal sulcus bilaterally and precuneus and the right superior frontal sulcus reflecting internal monitoring of action and mental imagery of the previously seen acts belonging to the same goal. Observing acts performed by several as compared to a single actor increased activity in the ventromedial prefrontal cortex possibly due to stronger demands in tracking the actors. Results emphasize an overarching goal rather than consistency of the actor to be crucial for understanding acts as belonging to a coherent episode.

A54

THE EFFECTS OF EXPERTISE ON REVISING EVENT MEMORY - AN FMRI-STUDY Anne-Marike von Anshelm-Schiffer[1], Ricarda I. Schubotz[1]; [1]Max-Planck-Institute for Neurological Research — Establishing forward models encompassing predictions on the likelihood of specific events has been recognized as a pivotal capacity. Hence, revising these predictions in response to change should be of equal importance to successfully adapt to dynamic environments. The current fMRI study investigated the effect of forward model solidity on re-learning predictions. Before entering the scanner, subjects were presented movies showing daily routines such as preparing food. Expectation solidity was manipulated by varying the

number of times each movie was presented. In the fMRI session, some actions took an unexpected but valid turn. We hypothesized that adaptation to the modified model should vary as a function of pre-experimental presentations of the corresponding original model. As a result, a parietal-premotor network showed activation attenuation over iterations. The interaction between original model solidity and repeated presentation of the modified model activated anterior cingulate cortex, mesial BA 10 and cuneus, showing these brain areas to be involved in integration of new information into an established model. This was regardless the model being either the solid original or a modified model that had reached considerable solidity by having been presented multiple times of what the original had been. This network of mesial frontal and occipital components was comparatively less activated when the relation between original and modified model presentation was on a par, meaning it was less active during the process of evidence accumulation in volatile environments. Results show that there is a circumscribed network activated when receiving expectation-modifying information on a well-known event.

A55

STIMULUS SPECIFIC LEARNING IN PERCEPTUAL CATEGORIZATION Jessica Roeder[1], Michael B. Casale[2], F. Gregory Ashby[1]; [1]University of California, Santa Barbara, [2]University of California, San Diego — Rule-based (RB) categorization tasks are those where the optimal strategy is easy to verbalize and the categories can be learned via a logical reasoning process. In contrast, information-integration (II) tasks require participants to integrate perceptual information from different stimulus components at a pre-decisional level. There is abundant evidence implicating the striatum in II categorization. One popular account of II category learning is that stimuli become associated with a response goal via dopamine-mediated reinforcement learning at cortical-striatal synapses. This hypothesis makes the strong prediction that knowledge gained during II learning should be stimulus specific, and therefore should not transfer to novel stimuli that obey the same rules for category membership. This is in sharp contrast to RB tasks, where the ability of participants to generalize their knowledge to novel stimuli is well known. Three experiments tested these predictions. As expected, in all three experiments participants were unable to transfer knowledge gained during II learning to novel stimuli. Instead, when novel stimuli were introduced participants had to relearn category membership, even though the novel stimuli obeyed the same rules for category membership that the training stimuli did. In contrast, with RB categories, participants were just as accurate at classifying novel stimuli as they were training stimuli.

A56

SEPARATE SYSTEMS FOR INITIAL CATEGORY LEARNING, BUT A COMMON SYSTEM FOR AUTOMATIC CATEGORIZATION Jennifer G. Waldschmidt[1], Sebastien Hélie[1], Jessica L. Roeder[1], F. Gregory Ashby[1]; [1]University of California, Santa Barbara — There is now abundant evidence that human categorization is mediated by a number of functionally and neurally distinct category-learning systems that are each best suited for learning about different types of category structures. For example, initial rule-based (RB) category learning is susceptible to dual-task interference but not to button-switch interference, whereas initial information-integration (II) category learning shows the opposite pattern (button-switch, but not dual-task interference). This study investigated whether RB and II categorization are also mediated by separate systems after automaticity develops. To address this question, 36 participants were each trained for over 11,000 trials in one of two RB tasks (simple or complex) or in an II task. Each participant completed four training sessions in an fMRI scanner. Results showed that later in learning, there were no significant behavioral differences between participants who learned RB versus II categories. After 11,000 trials of practice, in all three conditions, switching the locations of the response keys caused a similar highly significant interference, and a simultaneous dual-task that engaged executive functions caused no interference. The fMRI analysis yielded similar conclusions. After automaticity had developed, activation in similar motor regions was correlated with accuracy, and in all conditions activation in the striatum was not correlated with performance after automaticity had developed. Whole brain analysis also revealed several similar peaks after extensive training. Overall, the results are consistent with a theory assuming separate processing pathways for initial RB and II category learning, but a common pathway after automaticity develops.

A57

NEURAL CORRELATES OF AUDITORY PERTURBATIONS OF SPEAKING AND LISTENING Naomi Kort[1], John F Houde[1], Srikantan Nagarajan[1]; [1]University of California, San Francisco — Understanding the role of auditory processing during speech offers insight into the mechanisms of speech production and perception. Functional neuroimaging allows for study of the neural correlates of speech production and the effects of speech production on auditory perception. The role of sensory feedback in speech is complex and remains poorly understood. Alteration of auditory feedback causes systematic changes in speech production. Thus, experimental manipulation of auditory feedback during speaking offers a unique window to understand the neural substrates of speech motor control. In this study we explored the dynamics of speech production and auditory perception during single vowel utterances using magnetoencephalography (MEG). Data was collected using a 275-channel biomagnetometer and analyzed with synthetic aperture magnetometry (SAM) virtual sensor analysis. Subjects produced single vowel utterances and heard their voice through headphones. During the phonation the subjects will hear a 100 cent pitch perturbation lasting 400ms pseudo-randomly alternating between a positive and negative pitch shift. In a separate run, subjects passively listened to the recording of their voice. MEG responses in temporal sensors averaged around the perturbation onset show a greater response in the speaking condition than the listen condition. Virtual sensor analysis shows a sequence of activations first in right auditory cortex followed by bilateral superior parietal temporal/parietal temporal area (spt/pt) and then in left pre-motor cortex, then continues with a later component in bilateral spt/pt and finally in left auditory cortex. The State Feedback Control model of speech motor control can explain this sequence of cortical responses.

A58

T'AIN'T WHAT YOU SAY, IT'S THE WAY THAT YOU SAY IT – NEURAL CORRELATES OF VOCAL IMPERSONATION IN NON-EXPERT PARTICIPANTS Carolyn McGettigan[1], Frank Eisner[1,2], Zarinah K Agnew[1], Sophie K Scott[1]; [1]University College London, [2]Max Planck Institute for Psycholinguistics — The investigation of expert behaviors in fMRI is of considerable interest to cognitive neuroscientists. However, for some skilled motor behaviors, the physical constraints of the MRI scanner often mean that the expertise can only be measured indirectly (e.g. visual observation of dance; Calvo-Merino et al., 2005), or using restrictive simulations (e.g. simple keypads for pianists; Baumann et al., 2007). An additional problem is how to select control groups and tasks for some of these highly specialized outputs. In contrast, speech production can be performed naturally in fMRI and is an expert skill for normal adults. Professional voice artists are additionally skilled in this capacity and work in a variety of settings that require expert manipulation of the voice, for example performing impressions of famous individuals, or providing voices for cartoon characters. As part of a larger study of vocal expertise, we collected fMRI data from a group of non-expert participants while they performed vocal impersonations of familiar individuals and accents of English. Changing the voice during impersonations gave increased activation in left-lateralized areas for speech motor planning and production, and in left temporal cortex. Comparing the two impersonation conditions showed increased activation of visual and somatosensory cortex when participants attempted to impersonate a specific individual, as opposed to a generic accent. These results suggest that impersonating a familiar individual's speech involves stronger visual imagery (Ishai et al., 2002) and monitoring of somatosensory feedback from the articulators (Dhanjal et al., 2008) in the attempt to generate a specific non-self target voice.

A59

THE PERCEPTUAL DEMANDS OF DELAYED ACTION ARE REFLECTED BY INCREASED MU SUPPRESSION DURING MOVEMENT Leanna Cruikshank[1], Anthony Singhal[1], Mark Hueppelsheuser[1], Jeremy Caplan[1]; [1]University of Alberta — The mu rhythm (8-12 Hz activity) is the chief EEG rhythm implicated in sensorimotor behavior. It is present over the motor cortex during periods of stillness and decreases during movement. Recently, it has been suggested that while mu desychronization reflects motor processes, it may also be sensitive to additional requirements of a task, implicating a greater functional significance than was once assumed (Pineda, 2005). We tested the hypothesis that mu suppression is a sensorimotor phenomenon and not just a motor phenomenon. We reasoned that levels of mu suppression should index the sensory-perceptual demands of a task. We examined mu activity during visually guided and delayed actions, which rely on different amounts of sensory-perceptual based neural activity. Delayed actions recruit sensory-perceptual mechanisms in the ventral stream whereas visually guided actions do not (Goodale & Humphrey, 1998). Using a goal-directed reaching paradigm, participants were auditorily cued to reach towards target dots appearing on a touchscreen while EEG activity was recorded. Mu activity was present prior to movement and desynchronized during the movement, replicating the classic behavioral dependence of mu (Niedermeyer & Lopes da Silva, 2005). Confirming our hypothesis, mu activity was more desynchronized during delayed reaching. Our results suggest that mu desychronization is a mechanism of sensorimotor integration and not just motor control. These results are also consistent with the theory of mu as an analogue of the mirror neuron system (Altschuler et al., 1997), which is a proposed mechanism for perception-action coupling.

A60

SENSITIVITY OF REPETITION SUPPRESSION TO CHANGES IN FUNCTIONAL NETWORK STRUCTURE Shivakumar Viswanathan[1], Pierre-Michel Bernier[1], Nicholas Wymbs[1], Scott T. Grafton[1]; [1]University of California Santa Barbara — Depending on task demands, the same neurons can be flexibly recruited as processing nodes in different functional networks. However, the extent to which the neural responses are invariant within different networks remains poorly understood. In the current study, we examined the network invariance of the stimulus-repetition induced adaptation response or Repetition Suppression (RS). The Repetition Suppression response of the BOLD signal has been widely used to localize function in tasks that typically satisfy the assumption that a stimulus and its repetition engage the same functional network. Here we instead used a Stimulus-Response choice task where (i) a behavioral response and its subsequent repetition could each be the product of different response selection networks; (ii) a stimulus feature and its subsequent repetition could engage different input networks. The overlap in the different stimulus-processing networks was manipulated by varying subjects' task-sets. In one task-set, every stimulus had to be held in memory till the next trial; while the other task-set had no such memory demand. We found that the BOLD response in motor execution regions (M1) was invariant to whether a repeated response was an outcome of the same or different network as the previous response. In contrast, the task-set governed which regions adapted to the stimulus repetitions coming from different input networks. Our results suggest that network differences may have a limited influence on RS at the motor output level due to the convergent input from association and executive region networks used for response selection.

A61

RELATIONSHIP BETWEEN CREATIVITY PERFORMANCE AND FINE MOTOR CONTROL: POTENTIAL RELATIONSHIP WITH DOPAMINERGIC ACTIVITY Bradley Ferguson[1], Kristi Stringer[3], Ana Hartman[1], David Beversdorf[1], Paul Foster[2]; [1]University of Missouri-Columbia, [2]Middle Tennessee State University, [3]University of Alabama-Birmingham — The neurotransmitter dopamine is involved in the regulation of motor movements. On a finger tapping test, decreases in finger oscillations have been shown to be associated with reductions in dopamine. Further, spreading activation in the brain, a critical aspect of creative thought, also decreases as a result of increases in dopamine. Thus, a relationship may exist between finger tapping, spreading activation, and creativity. This investigation sought to examine the relationship between finger tapping scores and indices of creativity. We hypothesized that lower rates of finger tapping would be associated with increases in scores on behavioral (Abbreviated Torrance Test for Adults; ATTA) and self-reported attributes and behaviors (Scale of Creative Attributes and Behaviors; SCAB) of creativity. A total of 36 participants completed a finger tapping test, ATTA, SCAB, and surveys assessing current mood and handedness. High and low finger tapping groups were created by taking a median split of finger tapping scores. The groups did not differ on handedness or current mood, and so subsequent analyses did not include these variables. Scores on the SCAB and ATTA did not differ significantly for high versus low finger tapping groups. We then conducted exploratory, non-linear analyses on the data, as previous research indicates that an inverted U-shaped relationship exists between dopamine and creativity. The relationship between SCAB score and finger tapping was found to follow an inverted U-shaped function. These findings suggest that a relationship between some measures of creativity and dopaminergic functioning, as measured by rates of finger tapping, may exist.

A62

THE NOVELTY P3 AND THE P2A: ELECTROPHYSIOLOGICAL CORRELATES OF ACQUIRING ACTION-EFFECT ASSOCIATIONS Jeffery Bednark[1], John Reynold[1], Tom Stafford[2], Pete Redgrave[2], Elizabeth Franz[1]; [1]University of Otago, [2]University of Sheffield — Performance of goal-directed behavior is contingent on associations between actions and their effects. We aimed to identify the electrophysiological correlates of acquiring these action-effect associations. In two experiments we measured the amplitude of the novelty P3 and the P2a event-related potentials (ERPs) during a motor learning task where participants moved a mouse cursor on a computer monitor to elicit a particular sensory effect, but without being instructed how. We hypothesized: (1) The novelty P3 will initially have a large amplitude which will then decrease with acquisition of action-effect associations, and (2) P2a will occur when the sensory effect is relevant to task performance. In Experiment 1, the ERPs from the motor learning task were compared to those from two control tasks with already-defined action-effect associations. Only the motor learning task elicited a novelty P3 that reduced in amplitude as participants acquired an action-effect association. A robust P2a also occurred when the sensory effect provided feedback related to task performance. In Experiment 2, the ERPs from the motor learning task were compared to those from a control task in which the participants' actions did not elicit the sensory effect. Both the novelty P3 and P2a elicited in the motor learning task were significantly larger than in the control task. These findings suggest that the neural formation of an action-effect representation can be indexed by the novelty P3. Moreover, the P2a indexes mechanisms for detecting effects which are caused by a person's own actions.

A63

ALERTING IN ELITE ATHLETES: BEHAVIORAL AND EEG STUDY Olga Sysoeva[1,2], Irina Polikanova[1], Alexander Tonevitsky[1]; [1]Moscow State University, Moscow, Russia, [2]Washington University School of Medicine, St Louis, MO — The study examines the attentional networks in the group of elite athletes and controls. The Attention Network Test (ANT) (Fan et al., 2002) was used to differentiate the executive control, orienting and alerting systems. Alerting scores is obtained by subtraction the reaction time (RT) in the condition with central cue (precede the target by 500 ms) from that in the no cue condition. Orienting score is the subtraction of RT in the spatial cue condition from that in central cue condition. Executive score is the subtraction of RT for congruent stimuli from that for incongruent ones. Thirty-six cross country skiers and biathletes (9 females, Olympic team level) and 26 controls (5 females) participated in Exp. 1, which employs only behavioural task. In the Exp. 2 the high-density 256-channels EEG was measured during the performance of ANT both for

elite athletes (5 elite male skiers) and controls (10 aged-matched man). Exp. 1 showed that the elite athletes had smaller alerting-attention scores compared to control group and higher executive-attention scores. Exp. 2 confirmed the smaller alerting scores for elite athletes group and showed that athletes also have prominent contingent negative variation (CNV) after the response preceding no cue condition while controls have not. The amplitude of CNV significantly correlates with alerting scores. The CNV component represents the degree of preparation to the upcoming target stimuli. Therefore, the elite athletes' smaller scores in alerting might be explained by their ability to mobilize the alerting system even without the cue stimuli.

A64

RELIABILITY OF FMRI/TMS MOTOR MAPS ACROSS AGE GROUPS Keith McGregor[1,2], Erin Kleim[1,2], Haley Carpenter[2], Atchar Sudhyadhom[2], Kim Horn[2], Jeffrey Kleim[1,2], Bruce Crosson[1,2]; [1]Malcom Randall VA Medical Center, [2]University of Florida — The current study compared the reliability of cortical motor maps generated using TMS and fMRI across younger and older right-handed adults. Seven younger adults (ages 19-31) and seven older adults (ages 64-76) underwent three cortical mapping sessions at one week intervals. All participants were caffeine-free, reportedly healthy and did not engage in regular skilled motor practice of the upper extremity. In each session, TMS motor mapping of the first dorsal interosseous (FDI) muscle immediately preceded block-design fMRI mapping of FDI using a 3N pinch squeeze task. Center of gravity (CoG) shift and volume of activity were the dependent measures for both modalities. As compared to older adults, CoG was significantly more stable in younger adults on both TMS ($U = 2.88$, $p<.01$) and fMRI ($U = 3.75$, $p<.01$) motor maps. In older adults, fMRI and TMS maps showed low intrasession correspondence in terms of map volume ($? = .11$, ns). In younger adults, TMS and fMRI map volume was significantly correlated in sessions 2 ($? = .76$, $p<.05$) and 3 ($? = .75$, $p<.05$). These findings indicate that motor map stability decreases with advancing age. Caution should be used when interpreting motor maps, particularly with older adults.

Perception & Action: Multisensory

A65

AUDIOVISUAL SPEECH PERCEPTION IN NOISE IN CHILDREN WITH AUTISM SPECTRUM DISORDER (ASD) Lars Ross[1], Sophie Molholm[1,2], Daniella Blanco[1,2], Natalie Russo[1], Hans-Peter Frey[1], Dave Saint-Amour[3], John Foxe[1,2]; [1]Albert Einstein College of Medicine, [2]City College and the Graduate Center of the City University New York, [3]University of Montreal — It has been proposed that one of the root causes of autism is the failure to appropriately develop the ability to integrate multisensory inputs to benefit perception. However direct empirical support of such deficits is still scarce. Impairment in communication is one of the hallmark symptoms in autism and the ability to perceive speech is a fundamental prerequisite for communication. In this study we assessed whether the integration of auditory and visual speech signals is impaired in high functioning children with ASD by presenting them with monosyllabic words in auditory alone, audiovisual and visual alone conditions under varying signal-to-noise ratios. We uncovered a severe deficit in the ability of the ASD children to benefit from visual inputs relative to age matched, typically developing (TD) children, a deficit that became more severe as background noise levels increased. Eye fixations were similar in ASD and TD children making it unlikely that the avoidance of fixating the face accounts for this deficit. In contrast to profound differences in the ability to benefit from multisensory speech cues, performance in the auditory alone condition was relatively intact.

A66

SUCHAN CROSSMODAL WORKING MEMORY PERFORMANCE IN PROFESSIONAL AND NON-PROFESSIONAL MUSICIANS Boris Suchan[1], Christine Friedmann[1], Gordian Scholz[1], Elke Giezewski[2], Michael Forsting[2], Irene Daum[1]; [1]Institute of Cognitive Neuroscience, Ruhr-University Bochum, [2]Institute of Neurology and Neuroradiological Intervention, Essen — In a former study we investigated whether auditory and visual working memory is organized in an amodal way, we investigated crossmodal processing (visual and auditory) in working memory. We could demonstrate in this former study that the transformation of visual into auditory modality activates the primary auditory cortex suggesting a re-coding of visual stimuli when matched with their auditory probe. To study crossmodal processing in both directions, professional musicians reflect a perfect population as they are trained to read musical notes and to transcribe auditory music into its written form. A special designed crossmodal two back task with rhythmical musical stimuli was used in this study. 12 professional and 12 non-professional musicians were investigated using fMRI. Results of the three way interaction Group x Modality x Transformation of the imaging data resulted in a right dorsolateral prefrontal activation related to auditory stimulus processing in professional musicians suggesting a top-down control. Group x Modality interaction yielded evidence for activation in the rolandic operculum related to activation of the Larynx which might reflect auditory perception – execution matching. The interaction Transformation x Modality suggest a re-coding related activity reflected by activation in the visual and auditory cortex. Using rhythmically musical stimuli we could demonstrate recoding processes of both modalities when matched to the different, probe modality reflected by activation in the visual and auditory cortices. Results suggest amodal processing in working memory. Additional results give insight in specific and non-specific working memory processing in musicians and non-musicians.

A67

EXPERIMENTAL INDUCTION OF A PERCEIVED "TELESCOPED" LIMB USING A FULL-BODY ILLUSION Laura Schmalzl[1], H. Henrik Ehrsson[1]; [1]Department of Neuroscience, Karolinska Institute, Stockholm, Sweden — Phantom limbs refer to the sensation that an amputated or missing limb is still attached to the body. Phantom limbs may be perceived as continuous with the stump, or as "telescoped" with the more distal portion of the phantom being perceived as withdrawn within the stump. Telescoping tends to be related to increased levels of phantom pain, however the causal relationship between the two remains unclear. In the current study we induced the sensation of a telescoped limb in healthy individuals by using a full-body illusion. Participants saw the body of a mannequin, which was missing a hand, from a first person perspective while being subjected to synchronized visuo-tactile stimulation through stroking. Differential stroking of the mannequin's stump with respect to the participants' hand clearly influenced the perceived location of the hand: a) Simultaneous stroking of the participants' hand and the empty space below the mannequin's stump evoked the sensation of the hand being located below the stump; b) Simultaneous stroking of the participants' hand and the end of the mannequin's stump evoked the sensation of the hand being located "inside" the stump. In three experiments, we obtained subjective data from questionnaires and objective measurements of differential proprioceptive drift in the two experimental conditions. The fact that telescoping sensations can be induced in healthy individuals provides an intriguing platform for future studies investigating the cognitive and neural mechanisms underpinning the phenomenon. In addition, it has the potential of shedding light on the relationship between telescoping and phantom pain in amputees.

A68

BEING BARBIE: THE SIZE OF ONE'S OWN BODY DETERMINES THE PERCEIVED SIZE OF THE WORLD H.Henrik Ehrsson[1], Arvid Guterstam[1], Björn van der Hoort[1]; [1]Dept. Neuroscience, Karolinska Institutet, Stockholm, Sweden — A classical question in philosophy is if the sense of the body influences how one visually perceives the world. By contrast, in vision science, perception of object size and distance is traditionally explained by the combination of information of different visual cues. Here, we describe new illusions in which participants experience the ownership of

a doll's body (80cm or 30cm) and a giant's body (400cm) and use these as tools to demonstrate that experienced size of one's body has a causal effect on perception of object size and distance. When participants experienced the tiny body as their own, they perceived objects to be larger and farther away, and when they experienced the large-body illusion, they perceived objects to be smaller and nearer. These effects were quantified in ten separate experiments with complementary verbal, manual, walking, and physiological measures. Our results are fundamentally important because they show that there exists a causal link between the size of one's body and visual spatial perception. This shows that the representation of one's own body size serves as a basic reference for scaling allocentirc and ego-centric representations of external space. These results resolve a centuries-old debate in philosophy and psychology and demonstrate that the sense of one's own body determines how we experience the world.

A69

EVIDENCE OF TOP-DOWN PROCESSING IN RECALIBRATION OF TIME PERCEPTION USING VIRTUAL DEPTH Kyung-Ae Cha[1], Sung-Bin Hong[2], Sung-Ho Woo[3], Hyun Taek Kim[4]; [1]Korea University, [2]Korea University, [3]Korea University, [4]Korea University — It has been demonstrated that recalibrations of audio-visual asynchrony are likely to occur in sensory processing rather than in the higher domains of cognition in the brain. In the present study, we investigated a feasible top-down modulation of time recalibration for judging auditory and visual input simultaneity using virtual depths. A virtual corridor built for this experiment has depth of field, and includes six light sources (light-emitting diodes: LEDs) affixed on a computer monitor, which appear to be situated at different distances. Subjects in the virtual environment (VE) were presented with both the flashes of LED lights and associated bursts of white noise with random stimulus onset asynchrony (SOA). Even though the auditory and visual stimuli were presented from the same distance on the display device, the subjects showed different time recalibration effects (TREs) depending on subjects' tendencies of immersion in VE. The results suggest that the differences in the TREs can be explained by subject-specific tendencies such as absorption to stimuli, which can construct subjective reality in the realm of top-down processing. Future research on neural substrates of top-down processing in recalibration of time perception could contribute toward understanding of how the brain creates the representation of spatiotemporal coherence.

A70

PROMPTING VIEWERS' ADHESION TO FICTION IN LIVE THEATRE, AN FMRI STUDY Marie-Noëlle Metz-Lutz[1], Hélène Otzenberger[1], Yannick Bressan[2]; [1]FRE 3289 CNRS, Université de Strasbourg, [2]Université Paris Ouest Nanterre La Défense — Unlike motion picture, which displays a fac-simile of the real world on a fixed physically constrained space, i.e. the screen, live theatre exhibits simultaneously two realities, one actual, related to the performance itself, the other "fictional" conjured by it. Adhesion to the fictional reality entails both a cultural posture, the agreement of the viewers to provisionally suspend their judgement, and mental processes enabling them to go beyond what perceptual inputs tell them about the actual reality, i.e. to perceive the fiction as reality. This phenomenon raises the issue of the cognitive processes shaping adhesion to fictional reality during live theatre, and of their neural underpinnings. The physiological correlates of adhesion to fiction were investigated in an original fMRI/ECG experiment recreating, within the laboratory, the unique relationship between spectator and actor, peculiar to live theatre. Instants when, for each spectator, fiction acted as reality were identified using a first-person methodology, and used as a basis to work out individual fMRI time-series for statistical computations. Random-effect group analysis allowed to define in response to 'theatrical events' a brain activation pattern, within which changes related to subjects' adhesion to fiction, were investigated using a region of interest analysis. Besides a robust decrease in dynamic heart rate variability resembling that associated with an altered conscious state, adhesion to fictional reality correlated with increased activity in the left BA47 and pSTS. The hypothesis that aesthetic experience enables to dissociate physical and mental (drama-viewing) experiences through subtle changes in state of awareness is discussed.

A71

THE NEURAL TIMECOURSE OF AUDIOVISUAL INTERACTIONS AFFECTING PERCEPTION OF DISTORTED SPEECH Ediz Sohoglu[1,2], Jonathan Peelle[1], Robert Carlyon[1], Matthew Davis[1]; [1]MRC Cognition and Brain Sciences Unit, [2]University of Cambridge — Cortical integration across sensory modalities is fundamental to successful identification of objects or words. For example, distorted speech sounds dramatically clearer if listeners are provided with prior information on speech content (e.g. a matching written word; Frost et al., 1988). In the current study, we investigated the timecourse of these audiovisual interactions using magnetoencephalography (MEG). Monosyllabic spoken words were spectrally degraded using a noise-vocoding procedure (Shannon et al., 1995). Three levels of distortion were applied by varying the number of vocoder channels: 2 channels (high distortion), 4 channels (medium distortion) and 8 channels (low distortion). A matching or mismatching written word was presented 1 second prior to each spoken word while an 8-point intelligibility rating procedure was used to measure perceived speech clarity. A 306-channel Elekta Neuromag MEG system was used to derive speech evoked event-related fields from 15 right-handed participants. Our behavioural results show that speech clarity is similarly enhanced by increasing spectral detail and the presence of matching written input. To assess neural correlates of these audiovisual interactions, a statistical parametric mapping procedure was used to test for differences across sensor space and time (Kiebel and Friston, 2004). The earliest effect of matching/mismatching written words appeared ~300 milliseconds after word-onset over right frontal sites followed by a more widespread left posterior-temporal and bilateral frontal distribution 100 milliseconds later. These effects become larger with increased speech clarity suggesting that neural effects of written feedback are contingent on there being sufficient phonetic cues in the speech signal.

A72

IMPLICIT CROSSMODAL ASSOCIATIONS MODULATE PERCEPTION: AUDITORY AND TACTILE INFLUENCES ON VISUAL GRATING PERCEPTION Marcia Grabowecky[1], Emmanuel Guzman-Martinez[1], Laura Ortega[1], Julia Mossbridge[1], Satoru Suzuki[1]; [1]Northwestern University — Our recent investigations of crossmodal visual perception suggest pervasive interactions, including sounds influencing perception of face gender (Smith et al., Current Biology 2007), attention to body sensations affecting perception of self-faces (Smith et al., Current Biology 2008), and characteristic sounds of objects speeding target detection for both frequent (Iordanescu et al., PB&R, 2007) and rare targets (Iordanescu et al., Acta Psychologica, 2010). We have speculated that these crossmodal interactions stem from regular experiential associations. Some observed associations (e.g., gender and sounds) are implicit, whereas others may be partially explicit (e.g., characteristic sounds in visual search). In the experiments reported here, we demonstrated that visual gratings of specific spatial frequencies are reliably matched by specific sinusoidally amplitude modulated sounds (sAM). The sAM matches were unaffected by changes in viewing distance, suggesting that the matches were to physical grating size rather than retinal spatial frequency. In a second experiment, new observers matched the visual gratings with tactile (vibration) frequencies that were very similar to the sAM matches. These results suggest that tactile and auditory matches to visual spatial frequency might be mediated by the trimodal experience of tactile exploration of visual textures, with a resulting auditory experience. In the final experiment, we investigated whether presentation of sounds matched to a specific visual grating would influence dominance durations during binocular rivalry. Consistent sAM sounds increased the proportion of dominance for the matched grating, whereas inconsistent sAM sounds were ineffective. These robust effects further support a role of experiential associations in crossmodal perception.

A73

AUDIO-VISUAL FACILITATION OF THE MU WAVE Lucille McGarry[1,2], Frank Russo[2], Jaime Pineda[1]; [1]University of California, San Diego, [2]Ryerson University — Recent research supports the presence of audio-visual neurons in the mirror neuron system (MNS) that generate supra-additive responding during perception of audio-visual (AV) versus unimodal action. Measured using single-cell recordings in monkeys, as well as fMRI studies in humans, AV facilitation occurs only when stimuli represent spatially and temporally congruent goal-directed action, suggesting that mirror neurons not only respond selectively to sets of actions serving a single intention, but that they single out matching goal-directed actions from multiple modalities (Kohler et al., 2002). In humans, AV action facilitation has been demonstrated in the ventral premotor cortex as well as the superior temporal sulcus (Kaplan & Iacoboni, 2007). EEG recorded desynchronization of the mu wave, a frequency band with peaks at 8-12 and 20 Hz, is thought to reflect activation in the MNS, but AV facilitation of mu desynchronization has not yet been measured. In the current study, subjects viewed audio, visual, or AV stimuli consisting of biological action or no action, while EEG was measured. An additional condition required subjects to participate in the action themselves. EEG data was analyzed using independent components analysis. Preliminary analyses suggest that desynchronization of the mu wave is greater in central, parietal and occipital areas during AV perception of congruent action as opposed to unimodal perception. Conversely, the mu wave is more synchronized during execution of action than during perception conditions. These results suggest that AV facilitation does occur in the MNS and can be captured through mu oscillations.

A74

LET'S GO ROUND AGAIN: THE EFFECT OF VISUAL INTENTION ON NEURAL RESPONSES TO MULTI-STABLE PERCEPTS Ben Dyson[1]; [1]Ryerson University — Observing neural activity during the presentation of ambiguous sensory information is a useful tool in understanding how certain internal processes such as perceptual intention are represented in the brain independently of environment input. An experiment is described in which two squares alternated with one another, in terms of simultaneously opposing vertical and horizontal locations relative to fixation (i.e., stroboscopic alternating motion; von Schiller, 1933). Participants were asked to impose two traditional forms of intended motion upon the stimuli (vertical, horizontal) alongside three new forms of visual intention: clockwise rotation, counter-clockwise rotation, and, a free-view condition in which participants were encouraged to make the percept as unstable as possible. Subjective report of perceptual stability varied significantly across condition, with the rotational conditions showing intermediate levels of stability compared to relatively stable vertical and horizontal motion, and, relatively unstable free-view motion. Visual ERP showed significant group modulation in early evoked responses as a function of intended motion. This was also reflected at an individual level, with increased perceptual instability correlating with increased negativity at parietal-occipital sites. Larger neural responses as a function of increased perceptual instability may reflect a 'resetting' of the visual system, with instable motions less likely to lead to neural habituation. Evoked responses to ignored auditory stimuli were also collected on half the trials but did not vary systematically as a function of visual intention. The study underscores the utility of combining ERP recording with the presentation of multi-stable percepts in revealing brain activity associated with purely internal processes.

A75

IS THE EEG MU RHYTHM SENSITIVE TO THE PREDICTED OUTCOMES OF OBSERVED ACTIONS? Lorna C. Quandt[1], Peter J. Marshall[1], Thomas F. Shipley[1]; [1]Temple University — There is increasing interest in how the mu rhythm in the electroencephalogram (EEG) relates to links between action perception and production. The mu rhythm originates in the somatosensory cortex and desynchronizes in response to observed and executed movement. A recent suggestion from Csibra and colleagues is that the mu response during action observation is predictive, such that desynchronization begins as an action unfolds. We were interested in linking this suggestion with the somatosensory origins of the mu rhythm. Specifically, we examined whether mu amplitude during the observation of reaching varies with differing proprioceptive outcomes of otherwise identical reaching actions. Two pairs of objects were created, with objects in each pair being the same size and shape but different weights (80g vs 1200g) and colors (yellow/blue). Participants (N=31) were initially given experience grasping and lifting the objects from one pair. EEG was recorded while participants viewed videos showing a right hand reaching for the yellow and blue objects. The kinematics of the reaches were equated across conditions. Overall, desynchronization during reaching observation was maximal at mid-central and mid-parietal sites for the lower mu band and at more posterior sites for the upper mu and beta bands. Mu desynchronization was significantly larger in the left hemisphere, contralateral to the observed action. However, mu desynchronization did not differ for viewing reaching towards heavy or light objects. The mu rhythm response during action observation may represent a general gating of sensorimotor cortex rather than specifically relating to the predicted consequences of the actions.

A76

ROLE OF THE MOTOR SYSTEM IN AUDIO-VISUAL SPEECH INTEGRATION: EVIDENCE FROM THE MCGURK EFFECT IN BROCA'S APHASIA William Matchin[1], Tracy Love[2,3], Michelle Ferrill[2,3], Gregory Hickok[1]; [1]University of California, Irvine, [2]University of California, San Diego, [3]San Diego State University — A mismatch between auditory and visual speech information can result in a fused percept that corresponds neither to the auditory nor visual signal but rather to an intermediate form (McGurk effect). For example, an auditory /pa/ overlaid onto a video of a speaker's face articulating /ka/ often leads to a percept of /ta/. Because visual speech provides information about the articulation of a speech sound, many speech scientists attribute McGurk effects to the involvement of the motor system in speech perception, Broca's area in particular. An alternative is that audiovisual fusion is driven by cross-sensory integration in the STS. We assess the role of the motor speech system in two experiments both designed to minimize motor input to AV integration. The strength of the McGurk effect was assessed (i) during articulatory suppression in healthy adults and (ii) in patients with compromised motor speech systems (Broca's aphasia). The McGurk effect was not reduced during articulatory suppression in experiment one and a majority of Broca's aphasics were found to exhibit a robust McGurk fusion effect; subjects who did not show a fusion effect exhibited visual capture. This finding argues for a minimal role of the motor speech system in audiovisual integration.

A77

NEURAL ADAPTATION TO THE EFFECTS OF DELAYED AUDITORY FEEDBACK ON SPEECH PRODUCTION Zarinah Agnew[1], Carolyn McGettigan[1], Sophie Scott[1]; [1]University College London — Speaking under delayed auditory feedback (DAF) results in dysfluent speech, which manifests itself in a range of speech errors. The longer the delay, the more severe the dysfluencies become, up to around 200ms. Neuroimaging studies have demonstrated that speaking under DAF conditions elicits activity in bilateral dorsolateral temporal cortices, and motor regions. Individual vary in how severely they are affected by DAF, and over time, performance of speech production under DAF conditions improves. However, the neural basis of this adaptation and individual variability is unclear. This is the first fMRI study to investigate length of delay and individual variability in performance under DAF. This study used functional MRI to investigate the neural networks underlying individual variability in ability to cope with, and adapt to speech production under delayed auditory feedback. The results show bilateral posterior auditory areas are more strongly activated under DAF conditions than during normal speech production. A longer delay in auditory feedback was associated with activity in right superior temporal and inferior pari-

etal cortices. Ongoing analyses are investigating the neural networks underlying individual variability in producing speech under DAF .

A78

SYNESTHETIC COLORS ARE PERCEIVED BEFORE CONSCIOUS RECOGNITION OF GRAPHEMES Elizabeth Seckel[1], V.S. Ramachandran[1]; [1]University of California, San Diego — Two projector grapheme-color synesthetes were shown two different examples of graphemes that are visible only after prolonged viewing. The first stimuli was the famous "No Sex Causes Bad Eyes" hidden message, which takes viewers approximately 30 seconds to see. The second stimuli was a Z composed of illusory contours and shadow which normals see as random shapes for approximately 30 seconds. Intriguingly in both cases the subjects saw the colors accurately long before the letters and were surprised by this until the letters became visible. Subject 1 was also shown Bregmans B's which people see as fragments until an opaque black splotch is superposed to allow amodal completion of B's. She did not see color (blue) in the fragments until the splotch was added. But when we retested her a year later she had no recollection of the display, yet saw blue fragments - as if an unconscious memory of the "completed" B's remained in her brain. Results clearly demonstrate that graphemes can cross-activate colors long before they reach consciousness ("blindsight"). This is consistent with the cross-activation occurring in the fusiform gyrus between graphemes (or even PORTIONS of them!) and colors, before being relayed to higher areas for consciousness. Lastly, if borders are drawn on the illusory Z, neon color spreading of the synesthetic color was reported, demonstrating that synesthetic colors behave like "real" non-synesthetic sensory colors.

A79

SOUNDS EXAGGERATE VISUAL SHAPE Timothy Sweeny[1], Marcia Grabowecky[2], Satoru Suzuki[2]; [1]University of California - Berkeley, [2]Northwestern University — While perceiving speech, we experience mouth shapes that are systematically associated with specific sounds. One familiar association is between /woo/ and /wee/ sounds and visual aspect ratio (vertical and horizontal elongation) of the mouth. A /woo/ sound is generated when the mouth is vertically stretched, whereas a /wee/ sound is generated when the mouth is horizontally stretched. Aspect ratio is a fundamental mid-level visual feature that is population coded in the ventral visual pathway, contributing to perception of 3D space, objects and faces. We demonstrate that hearing a /woo/ sound increases the apparent elongation of a vertical (but not horizontal) ellipse, whereas hearing a /wee/ sound increases the apparent elongation of a horizontal (but not vertical) ellipse. The shape selectivity of the crossmodal effect as well as a control experiment ruled out response bias. Furthermore, because we intermixed other environmental sounds across trials, our observers were unaware of the auditory-visual associations that altered their visual shape perception. These results imply that audiovisual experience of speech develops selective neural connections from auditory spectral processing to visual shape coding, and demonstrates that the impact of these crossmodal associations is not limited to metaphorical symbolism, but can actually change the appearance of a basic geometric feature such as aspect ratio.

A80

FINE SPATIAL GRAIN OF HUMAN ECHOLOCATION RIVALS PERIPHERAL VISION Santani Teng[1], Amrita Puri[2], David Whitney[1]; [1]University of California, Berkeley, [2]Hendrix College — Echolocating organisms utilize auditory information reflected from emitted vocalizations to represent their external environment. This ability, long known in various non-human species, is also used by some blind humans as an aid to navigation and object perception. Using self-generated echoes, human practitioners of echolocation have demonstrated detection and localization of a range of stimuli. Still, many fundamental characteristics of this skill in humans are poorly understood, a dearth exacerbated in part by a lack of standardized testing methods. The basic spatial acuity attainable by practitioners — critical to object recognition and all spatial tasks — remains unknown. Here we show that the spatial resolution achieved by trained echolocators in an echoic vernier discrimination task is remarkably precise. We found that experts were able to discriminate horizontal offsets of stimuli smaller than 1.5 deg. auditory angle, a resolution approaching the maximum measured precision of human spatial hearing and comparable to that of bats performing similar tasks. We then tested sighted volunteers on the same discrimination task and found that visual performance equated to echolocation thresholds at approximately 35 deg. visual eccentricity. Our results represent the first measure of functional spatial resolution in a group of expert echolocators and provide a potential benchmark for comparison to near-field sighted performance.

A81

EYE-HAND COORDINATION AND EEG MICROSTATES ASSOCIATED WITH RAPID POINTING UNDER RISK AND UNCERTAINTY Markus Plank[1], Steven A. Hillyard[1], He C. Huang[1], Diosalyn Alonzo[1], Sergei Gepshtein[2], Howard Poizner[1]; [1]University of California San Diego [2]Salk Institute for Biological Studies, La Jolla, CA — During rapid reaching to spatial targets, subjects minimize error by taking into account the shapes of their endpoint error distributions (Gepshtein et al., 2007). To establish representations of pertinent error distributions (Trommershäuser et al., 2003), multimodal sensory inputs must be integrated and adapted to current task requirements. We investigated how eye and limb movements under risk and uncertainty are coordinated, as well as how this coordination is reflected in electroencephalographic (EEG) activity. Our focus was on spatio-temporal EEG characteristics during movement planning, initiation, and execution of hand and eye movements. We recorded unconstrained 3-D kinematics of arm/hand/finger movements, eye movements, and EEG scalp surface activity during visually-guided rapid reaching. Healthy participants sat in front of a touch screen and performed time-constrained reaching movements with their dominant hand from the screen center to a lateral stimulus configuration that consisted of either a single reward region (day 1), or overlapping reward and penalty regions (day 2). Reward-penalty configurations were either aligned or non-aligned with the movement direction. Hitting reward or penalty regions yielded monetary gains or losses. Subjects were allowed to move hand and eyes, or only their hand. We found that gaze points and reach points were decoupled, the amount of decoupling modulated both by stimulus position on the screen and by the relative position of reward and penalty regions. Furthermore, restriction in eye-hand coordination modulated distinctive EEG patterns that were associated with different phases of task performance.

A82

VISUAL INFLUENCES ON ECHO SUPPRESSION Christopher W. Bishop[1,2], Sam London[1,2], Lee M. Miller[1,2,3]; [1]University of California, Davis, [2]Center for Mind and Brain, [3]Department of Neurobiology, Physiology, and Behavior — Listeners can localize sounds better in reverberant environments by perceptually suppressing short latency (1-10 msec) echoes. This process is known as the precedence effect and is putatively an early, unimodal phenomenon. However no study has addressed whether visual information, which profoundly affects auditory perception in noisy environments, also contributes to echo suppression. We conducted two within-subject experiments to test directly for a visual contribution to echo suppression and to characterize the temporal dependence of this interaction. In Experiment 1 (N=15), we presented human subjects with temporally leading (precedent) and lagging (echo) auditory noise-bursts spatially separated by 36 degrees. Sounds were presented unimodally or combined with a coincident visual flash at the leading- or lagging-location. Subjects pressed one of two buttons to indicate whether they heard a sound at one- or two-locations (i.e. suppressed or failed to suppress the echo, respectively). A repeated measure ANOVA revealed that, compared to the unimodal condition, echo suppression was enhanced by 14.15+/-3.28% ($p=0.006$) when a visual flash coincided with the leading-location and decreased by 9.88+/-5.08% ($p<0.05$) when the flash coin-

cided with the lagging-location. In other words, vision was able to enhance or inhibit echo suppression. In Experiment 2 (N=18), we demonstrated that vision's contribution to echo suppression persists with audiovisual offsets (audio leading) up to 100 msec and is eliminated with a 400 msec offset. Together, these data demonstrate that echo suppression is fundamentally a multisensory process in everyday reverberant environments.

A83

VISUAL-TACTILE INTEGRATION DEFICIT IN ANOREXIA NERVOSA Laura Case[1], Vilayanur Ramachandran[1]; [1]University of California, San Diego — Individuals with Anorexia Nervosa (AN) experience pronounced body image distortion. While much is known about the social and cultural factors that elevate risk for eating disorders, relatively little is known about the biological basis of body image distortion in AN. Despite having normal visual perception, individuals with AN both feel and see themselves as large-bodied. Recent work points to a possible right parietal dysfunction in AN underlying multimodal sensory body representation. In the current study we tested tactile-visual integration in individuals with AN and healthy control participants through a Size-Weight Illusion (SWI) battery. The SWI task involves comparing the weights of two disks of different sizes. Although the larger disk is heavier than the smaller one, typical individuals experience a strong and robust illusion that the smaller object feels much heavier because of an expectation that weight scales with size. Individuals with AN exhibited a markedly reduced SWI, suggesting disproportionate reliance on tactile and proprioceptive information in judgments of size and weight. If proprioceptive input from the patient's own body is distorted to begin with, helping patients with AN to accurately integrate visual information with proprioceptive input may help rehabilitate their judgments of size and weight regarding their own bodies as well as external objects.

A84

SOUND-SHAPE CONGRUENCY AFFECTS THE MULTISENSORY RESPONSE ENHANCEMENT Elena Makovac[1], Walter Gerbino[2]; [1]University of Edinburgh, [2]Department of Psychology "Gaetano Kanizsa" and BRAIN Centre for Neuroscience, University of Trieste, Italy — A sound-shape congruency effect related to the takete/maluma phenomenon (Köhler, 1929) has been demonstrated in a go/no-go task in which participants should respond to visual targets while ignoring sounds (focused attention paradigm). In Exp. 1 auditory irrelevant stimuli (spiky vs. soft sounds) and visual targets (spiky vs. curvy shapes) were presented to participants in congruent vs. incongruent conditions. Four luminance contrasts differentiated low- vs. high-efficiency visual targets. The response enhancement was maximal for low-efficiency targets in the multisensory congruent condition (according to the inverse effectiveness rule of multisensory integration). In Exp. 2 stimuli were presented at fixation. Contrary to data obtained in Exp. 1, the congruency effect was not obtained in central vision, confirming that only relatively weak stimuli can fully benefit from multisensory integration. In Exp. 3 participants responded to both visual and auditory targets in congruent and incongruent conditions (redundant target paradigm). Using the Race Model Inequality test (Miller, 1982) we inferred that the response enhancement in congruent trials was consistent with multisensory integration, while the response enhancement in incongruent trials could be explained by statistical facilitation only. In conclusion our results, obtained in an implicit association task, support conclusions from explicit paradigms involving cross-modal correspondences (Gallace & Spence, 2006).

A85

NEURAL REPRESENTATIONS OF SIGNAL MODALITY EFFECTS IN EXPLICIT TIMING Elaine Wencil[1], H. Branch Coslett[1]; [1]University of Pennsylvania — Psychophysical studies have consistently shown behavioral effects of signal modality in timing operations. The functional and neural mechanisms that lead to these differences remain unknown. We address this question by comparing regions activated during encoding, maintaining and comparing intervals while performing auditory and visual timing. Twelve participants performed a duration discrimination task during fMRI scanning (see Wencil et al, 2010 for details). During visual trials, participants monitor the duration of a green circle (VS1), presented for 300, 600, 900, 1200, or 1500ms. At VS1 offset a red circle appeared for 4000-6000 ms, permitting modeling of delay-period activity. A second green circle (VS2) was then presented (300-1500 ms in duration). Participants indicated if VS2 was longer than VS1. Auditory trials followed the same temporal structure as visual trials, with a 98Hz pure tone substituting the green visual stimuli (AS1/AS2) and 544Hz pure tone substituting for the red circles. Posterior parietal cortex and IFG are similarly activated regardless of modality. However, when modeling the memory component of temporal processing (that is, subtracting out visual or auditory input), we find activation in modality specific cortices: auditory cortices are strongly activated during memory of auditory stimuli whereas visual cortices are activated during memory for visual stimuli. These findings suggest that timing is achieved by means of a "simulation" of the input to be remembered in the cortex that processed the input.

A86

ACTIVITY WITHIN THE PRIMARY SOMATOSENSORY CORTEX FROM THE OBSERVATION OF TOUCH Jamie Ward[1], Henning Holle[1], Michael Banissy[2]; [1]University of Sussex, UK, [2]University College London, UK — Seeing touch tends to result in activity in the somatosensory system, in addition to the visual modality in which it is presented. However, there are many details of this visual-to-tactile mapping that are not understood. For instance, it is not clear how specific this is to human stimuli, objects or human-like stimuli (dummies) and nor is it clear whether it reflects somatosensory activity associated with the touching body part (e.g. the finger) as well as the body part being touched (e.g. the face). In two experiments using fMRI, with 16 participants, we explore these issues. Observed touch to human faces, dummies and objects were all associated with activity in somatosensory regions (including SI) but tended to be less somatotopically specific for dummies and objects. Merely observing a face or dummy (but not objects) without touch also engendered some activity in this region. In the second study, we compared touch delivered by a finger or paintbrush to the face or legs. Touch to the legs from a finger (relative to paintbrush conditions) activated both the somatotopically organised hand and leg regions in SI suggesting somatosensory coding of both the agent and recipient of touch.

A87

THE INFLUENCE OF CONTEXT IN RAPID VISUAL DISCRIMINATION W John Monopoli[1], Alyssa Compeau[1], Jonathan W Page[1]; [1]Dickinson College — Requiring participants to rapidly identify objects leads to an increase in visual discrimination errors. We wondered if contextual cues would influence this. Using behavioral measures of accuracy and reaction times, and the electrophysiological measure of error-related negativity (ERN), we showed participants a rapid series of visual stimuli and had them respond by pressing buttons on a keypad while recording brain activity. In the first test, participants viewed a series of trials consisting of a face, a visual noise mask, and an object in rapid succession. All faces had neutral expressions and either included personal effects (like jewelry, tattoos, etc.) or not. Objects were pictures of either weapons (handguns) or non-weapons (cell phones or wallets) that participants had to discriminate. The second test was the same as the first except an audio sound of either a buzzer or a chime replaced the face/mask; participants had to discriminate weapons and non-weapons. In the third test, negative or positive pictures from the IAPS set were shown subliminally followed by a mask and then a weapon/non-weapon for participants to discriminate. The fourth and final test was a memory recognition test using pictures of faces from the first test as "old" stimuli. We focused our analyses on error processing (misses and false alarms). Differences in cortical activity and behavioral responses were found in the three conditions and compared. Our results suggest that rapid discrimination leads to visual errors in discriminating weapons and non-weapons, and that the behavioral response has a neural correlate in the ERN.

Perception & Action: Other

A88

THE IMPORTANCE OF BEING RELEVANT: MODULATION OF MAGNITUDE REPRESENTATIONS Tali Leibovich[1], Liana Diesendruck[2], Orly Rubinsten[3], Avishai Henik[4]; [1]Department of Cognitive Sciences, Ben-Gurion University, [2]Department of Computer Sciences, Ben-Gurion University, [3]Department of Learning Disabilities, University of Haifa, [4]Department of Psychology, Ben-Gurion University — We studied the mental representations of symbolic and non-symbolic magnitudes, in a numerical Stroop task. Participants were presented with two integers and had to indicate, in separate blocks, the physically or numerically larger integer. The numerical and physical ratios of the compared integers varied from 0.1 (most dissimilar; e.g., 1 vs. 9) to 0.8 (most similar; e.g., 7 vs. 8). The representation of symbolic (numerical) magnitude followed Weber's law, independently of the relevant dimension indicated by task demands. In contrast, the representation of non-symbolic (continuous) magnitude changed with task demands. When the relevant magnitude was symbolic, the representation of (irrelevant) non-symbolic magnitude followed Weber's /Weber-Fechner's law. When the relevant magnitude was non-symbolic, its representation deviated from Weber's law—fitting a power function (i.e., Stevens' law). These findings raise some important suggestions: first, symbolic representation is automatic and accurate, whereas non-symbolic representation is inaccurate and depends on task demands; second, different representations can be co-activated in the same task; and third, magnitude representations depend on modality and task demands, and can be flexible. Altogether, our findings suggest that important constraints are in order regarding Moyer and Landauers' (1967) claim that numbers and physical magnitudes are compared in a similar manner.

A89

NEURAL CORRELATES OF TACTILE MOTION AND PATTERN PROCESSING IN THE HUMAN BRAIN Evelin Wacker[1], Bernhard Spitzer[1], Ralf Lützkendorf[2], Johannes Bernarding[2], Felix Blankenburg[1]; [1]Charite University Medicine Berlin, [2]Otto-von-Guericke University of Magdeburg — Compared with the extensive research on processing of motion and form in the visual system, the specific neuronal pathways underlying perception of complex tactile stimulus attributes remain poorly understood. Here, we used ultra-high-field functional magnetic resonance imaging (fMRI) to investigate the neural correlates of tactile motion and pattern processing in the human brain. Different types of dynamic stimuli were delivered to participants' index finger via a Braille-like display, creating the sensation of moving or stationary bar patterns during passive touch. In line with previous findings, activity in early somatosensory cortex was increased both during motion and pattern processing, compared to physically matched control stimuli. Moreover, we found evidence for motion directionality encoding in primary and secondary somatosensory cortices (SI and SII), as well as for pattern orientation encoding in the intraparietal sulcus (IPS). In higher-level cortical areas, tactile motion induced activity in the middle temporal cortex (hMT+/V5) whereas tactile pattern processing engaged the supramarginal gyrus (SMG). These responses covaried with participants' accuracy in identifying moving and patterned stimuli, suggesting that hMT+/V5 and SMG may particularly contribute to conscious perception of complex tactile stimulus attributes. An analysis of effective connectivity further revealed increased functional coupling between SI and hMT+/V5 during motion processing, as well as between SI and SMG during pattern processing. This provides direct evidence for an integration of specialized higher-level cortical areas into tactile processing circuits.

A90

FORMAT-SPECIFIC AND FORMAT-INDEPENDENT SMALL NUMBER REPRESENTATIONS IN HUMAN PARIETOFRONTAL CORTEX Sergey Fogelson[1], Lisa Sprute[1], Casey Murray, Kate Johnson[2], Elise Temple[1], Richard Granger[1]; [1]Dartmouth College, [2]Beloit College — Though particular frontal and parietal brain regions have been implicated in numerical processing, it has not been resolved whether individual numerical quantities (one vs. two vs. three) are encoded independent of the form of their presentation (e.g., pips on dice, Arabic numerals, written words). Using functional magnetic resonance imaging, we scanned 11 subjects as they viewed sequences of infrequently presented stimuli (interstimulus interval 6sec). Each stimulus presented a quantity (1-9) either as a dot array or as an Arabic digit (with orders randomized and counterbalanced across runs and subjects). After each sequence, a number was shown in word form, and subjects indicated whether this test number had occurred during the previous sequence. Using a multivariate searchlight, we were able to decode the individual numerical quantities denoted by the stimuli. Voxels that were selective for particular numeric values within a given format (either dot or digit) were distributed across a parietofrontal network that included superior and inferior parietal lobules, premotor, and lateral prefrontal cortex. Notably, we identified voxel clusters that, after training on numeric values in one format (dots or digits), could recognize the same number in the other format. These occurred in bilateral supramarginal gyri, left superior parietal lobule, and right anterior middle frontal gyrus. We forward the hypothesis that individual number representations are represented in a format-specific manner in an overlapping parietofrontal network, whereas amodal numeric representations rely on a distinct subset of cortical regions.

A91

IMAGING THE INTERRUPTIVE FUNCTION OF PAIN COMPARED TO AVERSIVE NOISE – AN FMRI STUDY Katarina Forkmann[1,2], Christoph Ritter[1,2], Michael Rose[2], Ulrike Bingel[1,2]; [1]Department of Neurology, UK Hamburg-Eppendorf, [2]Department of Systems Neuroscience, UK Hamburg-Eppendorf — As the nociceptive system is essential for reactions to potentially life threatening situations, pain achieves salience in naturally complex environments and interferes with ongoing processes. This effect is well characterized on the behavioral level, however, to date little is known about its neuronal basis. Bingel et al., 2007 reported reduced neuronal activity in visual object processing areas while viewing irrelevant images under pain resulting in reduced recognition rates of these images. The aim of this study was to test for the specificity of this 'interruptive' effect of pain on visual processing. We therefore developed a paradigm to compare the interruptive capacity of painful heat and aversive auditory stimuli in a model of visual object processing on the behavioral and neuronal level. In the first part of this experiment, participants (n=25) had to categorize 60 images as living or nonliving objects. Two-thirds of the images were randomly paired with individually adjusted heat pain or loud noise stimuli. To further quantify the consequences of this aversive stimulation, recognition rates were recorded in a subsequent surprise recognition task. Although noises were rated as more unpleasant, painful stimuli had stronger effects on visual object processing (increased reaction times) and object recognition (diminished recognition rate) on the behavioral level. Preliminary fMRI analyses support these behavioral findings by showing a modulation in object processing areas in the ventral visual system. Our results indicate a pain specific component in its interruptive capacity that is independent of the aversiveness of a stimulus per se.

A92

NEUROPHYSIOLOGICAL CORRELATES OF NONSYMBOLIC APPROXIMATE ADDITION Kenneth Parreno[1], Daniel Hyde[1], Elizabeth Spelke[1]; [1]Harvard University — Humans and many non-human animals possess the ability to represent the approximate numerical magnitude of a collection of items. Furthermore, behavioral studies suggest that this system may be engaged in arithmetic. We investigated the neurophysiological correlates of arithmetic by measuring event-related potentials (ERP) as participants (n =16) performed an approximate addition task. In this task, one set of dots appeared and moved behind an occulder, then another set of dots appeared and move behind an occulder, then the occluder disappeared to reveal a third set of dots. Subjects were instructed to mentally add the first and second set of dots and respond whether the third set of dots was more or less than the sum of the first two sets. Critically, we manip-

ulated the ratio between the third set of dots and the actual sum of the first two sets of dots. We observed that both the behavioral and brain response were modulated by ratio. More specifically, reaction time increased as ratio decreased, accuracy decreased as ratio increased, and the P2p component increased in amplitude as ratio increased. This pattern of brain response is consistent with previous observations of ratio-dependent modulation of P2p based on number, suggesting that the approximate number system was engaged. This response was not tied to specific visual properties of the display because the sum was never shown, only being created in the mind. Furthermore, this study links previously indentified behavioral signatures of arithmetic with the neural signatures of approximate number in the brain.

A93

ON THE SEGMENTATION OF OBSERVED ACTION: FMRI EVIDENCE Darja Kraft[1], Franziska Korb[1], D. Yves von Cramon[1], Ricarda I. Schubotz[1,2]; [1]1 Max Planck Institute for Neurological Research, Cologne, [2]Westfälische Wilhelms-Universität, Münster — People perceive activity around them in terms of events. It is assumed that activity segmentation helps us to process the perceptional stream by using event schemes. The present fMRI study explored the neural correlates of detecting event boundaries in observed action. Subjects watched movies showing all-day routine actions and were asked to indicate event boundaries by immediate button press. As we were interested in the segmentation of action on the basis of action knowledge rather than on the basis of basic surface stimulus properties such as change in speed or direction of movement, a baseline condition was employed where subjects performed the same task on tai chi movements; this condition controlled for the perception of motion, human body and person. The interaction of task (action, tai chi) by boundary (yes, no) yielded activations in the left superior frontal sulcus (SFS), the left angular gyrus (AG), the hippocampal formation and parahippocampal cortex. On the basis of their specific functional profiles, the interplay between these three areas can be considered to reflect the detection of action segments on the basis of long term memory action knowledge.

A94

DIFFERENTIAL THETA OSCILLATION FOR HUMAN WAYFINDING IN VIRTUAL ENVIRONMENTS WITH GLOBAL VS. LOCAL OBJECT LANDMARKS: AN EEG STUDY Wen-Jing Lin[1], Teng-Yi Huang[2], Chin-Teng Lin[2], Daisy L. Hung[1], Erik C. Chang[1]; [1]Institute of Cognitive Neuroscience, National Central University, Taiwan, [2]Brain Research Center, National Chiao-Tung University, Taiwan — Object landmarks play a key role in human wayfinding behavior. Previous studies from our lab showed that participants had better wayfinding performance in virtual environments with local than with global landmarks. The current study aimed to distinguish the differential brain dynamics in processing these two types of landmarks. Eleven healthy female adults were recruited to learn target positions in virtual environments with either global or local object landmarks. After their performance reached proficiency, scalp EEG data were recorded when participants were searching targets in each landmark environment. Independent Component Analysis (ICA) and to generate clusters through computing scalp topography, event-related spectral perturbation (ERSP), dipoles, ERPs, and inter-trial coherence were done with the EEGLAB toolbox. Based on previous findings, the ERSP of theta band in the frontal midline cluster was subjected to a two-way repeated-measure ANOVA, with condition (global/ local) and time (thirteen time windows of one second duration) as the two factors. The results showed that theta power was greater in global than in local condition immediately after the appearance of the target icons and in the beginning first second when one started to move. This suggests a higher demanding in computing target position when using global landmarks. However, this pattern reversed during the 2 to 4-second periods, and again reversed during the last five seconds during the cruising stage. To conclude, the cognitive loads varied across the entire wayfinding phase, depending on the type of available landmarks and the stage of one's progression toward the target location.

A95

CONTEXT FRAMES PROVIDED BY DOMESTIC SETTINGS MODULATE ACTION RECOGNITION: A FUNCTIONAL MAGNETIC RESONANCE IMAGING STUDY Moritz Wurm[1], Ricarda Schubotz[1,2]; [1]Max Planck Institute for Neurological Research, Cologne, Germany, [2]Westfälische Wilhelms-Universität Münster, Münster, Germany — Domestic rooms are specialized places for specific actions. Hence, they provide contextual information rendering some actions more likely to take place in a particular setting than others. In analogy to the effects of spatial context on object recognition, we hypothesized that compatibility between contextual setting and action modulates neural activity, particularly in the motor system, during action recognition. Subjects watched videos of context-specific everyday actions (e.g. cracking an egg) performed in rooms either compatible or incompatible with the action. Actions were also performed in empty rooms without any interior providing a neutral condition to distinguish between the effects of compatible versus incompatible settings. We found increased activity in the left inferior frontal gyrus (IFG, Brodmann areas 44/45 and 47) when actions were incompatible to the setting – either compared to the compatible or the neutral setting. The parahippocampal place area was activated when contrasting either of the room settings with the neutral setting. Results indicate that context frames activated by the setting modulate the perceptual analysis of actions. An incompatible setting may trigger action representations that interfere with the currently observed action. Alternatively, in order to make sense of the action embedded in the incompatible context, the system searches for more elaborate higher-level action representations compatible with both the observed action and the context frame.

A96

EMBODIMENT OF MOVEMENT SPEED IN A VISUAL TRACKING TASK AS REFLECTED BY EEG MU RHYTHM DYNAMICS Jordan Prendez[1], Jaime A. Pineda[1], Matt D. Schalles[1], Rabina Joshi[1], Robert F. McGivern[2]; [1]University of California, San Diego, [2]San Diego State University — We tested the hypothesis that mirroring provides a neural substrate for simulation and for the embodiment of movement speed by recording EEG mu rhythms over the sensorimotor cortex while participants engaged in a visual tracking task. Embodied Cognition Theory (ECT) proposes that action provides a framework for cognition. For humans, this might be a Mirror Neuron System (MNS) based ability to predict the goals and intentions of others through embodiment and to represent those actions in one's own motor circuits. It was expected that behavioral performance as well as modulation of mu rhythms, a presumed index of mirroring activity and embodied cognition, would vary as a function of stimulus speed. Secondly, it was expected that men would show an advantage in task accuracy that is consistent with previous research supporting the general male advantage in processing movement. Analysis of reaction times (RTs) in 32 participants (16 females, 16 males) showed that when tracking changed from slow movement speeds (3cm/sec) to faster speeds (9cm/sec) RTs decreased from 1.52s to 1.26s. Analysis of participant EEG showed more mu suppression in the faster tracking speed relative to the slower tracking speed. While quicker reaction times and suppressed mu rhythm were found in the fast speed condition as predicted, consistent with the neural embodiment of speed, however, there were no differences between the sexes in terms of mu suppression or task accuracy.

A97

CATEGORICAL REPRESENTATION OF PHYSICAL CAUSATION: AN EVENT-RELATED POTENTIAL STUDY Emily J Blumenthal[1], Jessica A Sommerville[1], Anna V Gorn[1]; [1]University of Washington & Institute for Learning and Brain Sciences — There is a robust and seemingly compulsory need for humans to understand events in terms of their causal structure. This allows us to make sense of the world, and to predict and plan future actions. However, how we perceive causality remains unknown. Experiment 1 exam-

ined how adults represent perceptual causality. Participants viewed Michottean launching events in which the spatial and temporal parameters were systematically varied. Using ERP, we measured how participants differentiated these events. Participants were familiarized with causal launching events. Oddballs differed in their temporal parameters: both oddballs were equally different from the standard, but one was within category (causal), and the other was categorically different (noncausal). There was a significant difference in P3 to events that crossed category boundaries, but not to within category events (all ps < .01). However, when familiarized with a noncausal event, there was no difference in participants' electrophysiological responses to other noncausal events. Adults categorized events by their underlying causal structure, rather than their surface features. Experiment 2 investigated the effects of context on the perception of launching events. Previous literature suggested that causal structure is a perceptual gestalt, extracted at the level of the visual system. However, behavioral responses indicate that adults differentially represent causal structure when the objects involved in the event are agents versus inanimate objects. Future work will determine whether this is a perceptual or conceptual distinction. These studies present novel evidence about the representation of simple causal events. Adults represent physical causation categorically, and differently from social causation.

A98

A VIRTUAL REALITY-BASED ASSESSMENT OF TOPOGRAPHICAL DISORIENTATION IN PARKINSON´S PATIENTS WITH AND WITHOUT DEMENTIA Francesca Morganti[1], Sascha Marrakchi[2], Jorn Timmermann[2], Peter P. Urban[2], Giuseppe Riva[3]; [1]University of Bergamo, Italy, [2]Asklepios Klinik Hamburg, Germany, [3]Istituto Auxologico Italiano - Milano, Italy — The ability to cope with orientation in everyday environment is highly relevant in order to manage the activities of daily living. Topographical disorientation is an often reported symptom in different forms of dementia as well as in Parkinson's disease where patients often report difficulties in wayfinding either in know as well as unknown places. According to this perspective 49 subjects (23 female, 26 male; age 50-80 years) were recruited at the department of Neurology at Asklepios hospital Barmbek in Hamburg, Germany and assessed for spatial orientation in the VR-Road Map Test (Morganti et al. 2009). 32 patients had a diagnoses of Parkinson's disease without dementia (PD) (MMSE: M= 28.94; sd =1.7); 17 patients had the diagnoses of Parkinson's disease with dementia (PDD) (MMSE: M= 25.59; sd=1,8). They were compared with a control group of healthy subjects (n=68). Regarding the Parkinson patients we found significant differences in performing on the VR Road Map Test (PD-patients: M = 5,5; sd= 4,1; PDD-patients: M= 2,18 ; sd=1,8). Controls subjects performed better (M = 15,53 SD 11,35). Data analyses over the differences between the three groups revealed highly significant differences in performance. PD-patients showed reduced ability to navigate in comparison to healthy controls of same age (p= 0.000), PDD-patients showed reduced topographical orientation compared to PD-patients (p = 0.000). These results appear to be congruent with recent studies according to which not only cortical areas appear be relevant for topographical orientation.

A99

FIRST-PERSON REPORTS OF TACTILE SENSATIONS IN EXPERIENCED MEDITATORS PREDICT CORRESPONDING AREA OF PRIMARY SENSORY CORTEX Kieran Fox[1], Matt Dixon[1], Pierre Zakarauskas[1], Kalina Christoff[1]; [1]University of British Columbia — Cognitive neuroscientists are increasingly studying meditation, but little research has focused on the technique of 'body-scanning,' a major part of Mindfulness and Insight (vipassana) meditation. As the technique involves focused awareness of bodily experience (in the absence of overt stimuli), it can be readily compared with psychophysical and neurophysiological measures of tactile sensitivity compiled from previous researchers' reports. Three such measures were correlated with novice and expert meditators' first-person reports to examine potential differences due to training. Methods: 'Novice' (n=4, mean meditation experience=19 hrs) and 'Expert' (n=6, mean experience=3004 hrs) meditators engaged in a 20-30 min session of body-scanning. Experts were familiar with the technique; an experienced instructor guided novices. Participants then completed a questionnaire examining the intensity and clarity of sensations detected in 20 body regions. Measures (culled from the literature) of tactile sensitivity (two-point discrimination (TPD) and point-localization (PL) thresholds) and neural representation (cortical area in primary somatosensory cortex, S1) for each of 20 body regions were correlated with first-person reports. Results: Experts' first-person reports correlated strongly and significantly with all measures, whereas all correlations with novices' reports were nonsignificant. Further, the differences between group means on all measures were highly significant. Individual correlations were predicted well, though nonsignificantly, by total hours of meditation experience. Conclusion: First-person meditation reports from experts, but not novices, significantly predict average human TPD and PL thresholds, and amount of cortex in S1 for 20 regions throughout the body. That total meditation experience trends toward predicting this relationship suggests training effects.

A100

DEVELOPMENTAL TOPOGRAPHICAL DISORIENTATION: A NEWLY DISCOVERED COGNITIVE DISORDER Aiden Arnold[1,2], Ford Burles[1,2], Jason J. S. Barton[3], Giuseppe Iaria[1,2]; [1]University of Calgary, [2]Hotchkiss Brain Institute, [3]University of British Columbia — In a recent study, we documented the first case of Developmental Topographical Disorientation (DTD), a disorder characterized by (1) a life-long inability to orient in both novel and familiar surroundings despite otherwise well-preserved cognitive functions and (2) the absence of a cerebral injury/malformation or other neurological condition. In this follow-up study, we described 120 new cases of DTD recruited via our website www.gettinglost.ca and assessed with an online battery evaluating a variety of cognitive skills. The aim of this study was to document the specific navigation and orientation deficits that people with DTD display compared to matched (age, gender, and education) healthy controls. Our battery consisted of nine tests: three tests designed to assess deficits in object recognition and face processing, and six tests designed to assess performance on tasks engaging cognitive processes specific to orientation/navigation (e.g. heading orientation, landmark recognition). We found that people with DTD differ from controls only in those skills confined to the orientation/navigation domain, among which the ability to form a cognitive map was the most significant factor that distinguished a person affected by DTD from control subjects. These findings are critical in order to isolate the symptoms specific to DTD that may be useful for clinical purposes, as well as to define a research protocol for further examination of the brain mechanisms responsible for this life-long cognitive disorder.

A101

DETECTING SOCIAL INTENTIONS Chiara Begliomini[1], Andrea Cavallo[2], Cristina Becchio[2], Luisa Sartori[1], Valentina Parma[1], Umberto Castiello[1]; [1]University of Padua, Dept. of General Psychology. Padua - Italy, [2]University of Turin, Center for Cognitive Science. Turin - Italy — The aim of the present study was to investigate the neural circuits underlying the observation of socially motivated vs. individually intended actions. Seventeen adults (7 males) aged 19-36 (mean 23.3 years) participated in an fMRI investigation. They were asked to observe video clips representing either socially motivated (i.e. cooperative and competitive) or individually intended actions. Stimuli consisted of video clips showing only the early stage of an object-directed reach-to-grasp movement: in social-type of video clips the final part of the movement, showing interaction with another agent, was masked as to equate these with the individual-type of video clips. In order to maintain a constant level of attention, following the presentation for each video, participants were asked to discriminate the congruency between a static image and a video clip. Results show that the observation of socially motivated actions produces a significant activation within the left inferior parietal lobule, the left middle frontal gyrus

and the inferior frontal gyrus bilaterally. These findings confirm and extend previous literature demonstrating that the neural circuits involved during the observation of explicit social interactions are also alerted when the social nature of the observed action is only intended.

A102

GLOBAL EFFECTS OF RTMS STIMULATION REVEALED BY SIMULTANEOUS RTMS-ERP DURING A TEMPORAL DISCRIMINATION TASK Martin Wiener[1], Dasha Kliot[2], Peter Turkeltaub[2], Roy Hamilton[2], David Wolk[2], H. Branch Coslett[2]; [1]Department of Psychology, University of Pennsylvania, [2]Department of Neurology, University of Pennsylvania — Recently, we (Wiener et al. 2010) demonstrated that repetitive Transcranial Magnetic Stimulation (rTMS) of the right supramarginal gyrus (SMG) selectively disrupted performance on a temporal discrimination task, such that a brief train of stimulation during a visual stimulus lengthened the perceived duration of that stimulus. While these results demonstrate the involvement of the right SMG in temporal discrimination, they speak little to possible downstream effects of stimulation. To further elucidate the neural mechanisms involved during stimulation, we combined rTMS with event-related potentials (ERP). Subjects performed an individually-adapted temporal discrimination task, in which they were required to judge whether a comparison visual stimulus was longer or shorter than a standard stimulus (600ms). Brief trains of stimulation (10hz) were applied to either the right SMG or an occipital control site, in separate sessions, 500ms prior to the onset of the standard stimulus. The behavioral data demonstrated a replication of our previous result: subjects were more likely to report the standard stimulus as longer when receiving rTMS to the right SMG. Following artifact-correction and standard ERP post-processing, the ERP data on rTMS trials revealed a global difference in neural signals throughout the scalp during the encoding phase of the standard stimulus. This difference took the form of a logarithmic positive-negative deflection from baseline (non-TMS) recording. Furthermore, the magnitude of this deflection was associated with the behavioral effect of rTMS. These results suggest that the behavioral effect of rTMS stimulation on temporal discrimination is the result of both local and distant neural structures.

A103

THE NEURAL CORRELATES OF MOVEMENT DIRECTIONALITY SCHEMAS Bianca Bromberger[1], Fiona Shaw[1], Anjan Chatterjee[1], David Wolk[1]; [1]University of Pennsylvania — We sought to observe if the direction in which one perceives an action to occur affects the processing and memory of the event. Sixteen participants completed a memory task while electroencephalography (EEG) was recorded. Participants were first presented with images of actions moving left-to-right, actions moving right-to-left, and static scenes. After a delay, they saw repeated images (studied), as well as an equal number of new images (unstudied) of the same types and asked to indicate whether they had seen the image previously. We found a significant difference in reaction time between responses to studied and unstudied left-to-right action images, but no significant difference in reaction times between studied and unstudied right-to-left action images. In addition, event-related potential (ERP) analysis revealed significant differences in mean amplitude of studied and unstudied left-to-right action images during several time epochs after stimulus presentation onset, most notably in frontal regions. Similar frontal effects have been frequently attributed to controlled processing and post-retrieval monitoring in other ERP studies of memory. These results are consistent with the hypothesis that actions with a left-to-right trajectory conform to an underlying directional schema, likely influenced by language. The greater difference in frontal activity and increased reaction times observed for unstudied relative to studied trials in the left-to-right condition may be a result of conflicting information for unstudied items. Left-to-right presentation may enhance the fluency of these items, which may produce a 'false' feeling of familiarity that needs to be overcome to correctly endorse the images as new.

A104

PAIN ATTENUATION DURING MINDFULNESS MEDITATION IN A ZEN MONK: AN MEG CASE-STUDY Kingson Man[1], Koji Inui[2], Ryusuke Kakigi[2]; [1]University of Southern California, [2]National Institute for Physiological Sciences, Japan — Is it possible to "think away the pain?" We are interested in the effects of Zazen mindfulness meditation on painful experiences. We recruited a Zen Buddhist monk with over 15 years of meditation experience as well as five naive control subjects to undergo MEG scanning during the application of painful stimuli. Pain stimuli were delivered to the dorsum of the palm using intra-epidermal needle electrodes, which selectively stimulate the pain-sensing a-delta nerve fibers. Neuromagnetic recordings were taken at the scalp during successive blocks of: rest with tactile stimuli; meditation with tactile stimuli; rest with painful stimuli; and meditation with painful stimuli. During meditation, all subjects reported a decrease in pain perception on the visual analogue scale. Our results show strikingly different neural responses to painful stimuli during the presence vs. the absence of meditation, for the naive subjects as well as for the Zen monk. Additionally, there was an effect of experience: for naive subjects during meditation, the short-latency components (100 ms) of the pain-related signal were reduced over the somatosensory cortices. However, for the Zen monk, signals over somatosensory cortex did not differ from rest to meditation; only the longer-latency components (>300 ms) of the pain-related signals were reduced, in a volume source-localized to the anterior cingulate cortex. These preliminary results suggest that meditation may effectively attenuate the experience of pain, and that greater meditation expertise leads to the recruitment of higher-level top-down mechanisms.

A106

TACTILE SUPPRESSION OF DISPLACEMENT: EVIDENCE FROM EVENT-RELATED POTENTIALS Mounia Ziat[1], Philip Servos[1], Vincent Hayward[2], Wafa Saoud[1]; [1]Wilfrid Laurier University, [2]UPMC Univ. Paris 06 — Similar to saccadic suppression of image displacement in vision, tactile suppression of displacement is a phenomenon where, in certain conditions of direction and amplitude of displacement, people fail to detect that a tactile feature changes location between, for example, their index and middle fingers as they scan a tactile display. We used event-related potentials (ERPs) to examine neural activity during trials in which subjects did not detect the displacement of a Braille dot (i.e., responded 'same location' when the dot changed location) and during trials in which they did detect the displacement (i.e., responded 'different location' when the dot changed location) or trials in which subjects detected no change in location (i.e., responded 'same location' when the dot remained in the same location). We found that stimuli where the dot remained in the same location evoked smaller N140 and P300 ERPs—components known to be sensitive to stimulus-related attention and stimulus categorization respectively—than stimuli that changed location. We also found that the amplitudes of N140 and P300 were larger in trials in which stimuli changed location when they were perceived to be in the same location than in trials in which stimuli changed location when they were detected as such. These findings suggest that the inability to detect the change in displacement leads to increases in the amplitude of the N140 and P300 ERP components.

A107

NEUROLOGICAL BASIS OF BRAIN-BASED BODY IMAGE SEX IN TRANSEXUAL FTM INDIVIDUALS Rosalynn Landazuri[1], Laura Case[1], Vilayanur Ramachandran[1]; [1]University of California, San Diego — Transsexual individuals perceive their body to be the "wrong" sex and often feel strongly that their biological breasts or genitalia do not match their body image. Despite years of research on transsexuality, most studies have focused on subjective dissatisfaction with the body or response to sexual stimuli. Several well-accepted neurological conditions also demonstrate acute discrepancies between body image and the physical body. Amputees with phantom limbs feel a limb on their body that no longer exists, while patients with Body Integrity Identity Disorders (BIID) consistently

report that they should not have been born with a certain limb. It has been proposed that BIID arises from a distorted supramodal body image representation in the right superior parietal lobule (SPL). When sensory input is inappropriate or disproportionate to SPL representation, body image may be compromised and distorted. Recent data from our lab demonstrate heightened skin conductance response and decreased SPL activation to stimulation of the affected limb, supporting this hypothesis. In the current study we compared skin conductance response to nonsexual tactile stimulation of the breast and leg in anatomically female, presurgical transsexual individuals and cissexual female individuals. We found an overall diminished GSR response in transsexual individuals, suggesting dissociation from the physical body, as well as a relatively heightened response to stimulation of the breast. Similar to BIID, this heightened sympathetic nervous system response suggests that sensation from the breast is not integrated normally in the SPL in transsexual individuals, suggesting differences in brain-based body sex between transsexual and cissexual individuals.

A108

ILLUSORY COOLING OF THE SKIN ('THREE COINS ILLUSION') DECREASES DERMAL TEMPERATURE: EVIDENCE FOR MIND-BODY INTERACTIONS V.S. Ramachandran[1], Elizabeth Seckel[1], Ananda Weerasura[2], David Brang[1]; [1]University of California, San Diego, [2]Mercer University School of Medicine — If the middle toe is placed on a coin at room temperature and the flanking toes (2 and 4) are placed on ice-cold coins, the middle toe also feels equally cold; a striking example of perceptual filling-in of temperature perception. When the temperature of the middle toe was measured, a significant decrease in skin temperature for the cold-neutral-cold coin condition was found, suggesting top down influences on skin temperature regulation modulated by the perceptual input of the adjacent toes. We call this new psychosomatosensory effect the "Cutaneous thermo-vascular response" (CTVR). CTVR may have relevance to clinical phenomena like Reflex Sympathetic Dystrophy (RSD) and Raynaud's phenomenon.

Sunday, April 3, 8:00 - 10:00 am, Pacific Concourse

Perception & Action: Vision

B1

OCCIPITAL GAMMA-OSCILLATIONS MODULATED BY EYE MOVEMENTS: SIMULTANEOUS EYE TRACKING AND ELECTROCORTICOGRAPHY RECORDING IN EPILEPTIC PATIENTS Eishi Asano[1], Tetsuro Nagasawa[1], Naoyuki Matsuzaki[1], Csaba Juhasz[1], Sandeep Sood[1]; [1]Children's Hospital of Michigan, Wayne State University — We determined the spatial-temporal dynamics of gamma-oscillations modulated by eye movements, using simultaneous eye tracking and intracranial electrocorticography (ECoG) recording. Patients with focal epilepsy underwent subdural electrode placement as a part of presurgical assessment for medically-uncontrolled seizures. They were asked to follow a target circle intermittently moving from one place to another either in a saccadic or smooth fashion during extraoperative ECoG recording. Movements of the target elicited augmentation of gamma-oscillations in the polar-lateral occipital region; subsequent voluntary eye movements elicited gamma-augmentation in the medial occipital region. Neither type of occipital gamma-augmentation could be explained by contaminations of ocular or myogenic artifacts. The degree and extent of such gamma-augmentation were larger around the onset of saccades compared to smooth pursuits. We also found that eye blink elicited gamma-augmentation in the medial occipital region. In addition to the aforementioned eye movement task, two patients were asked to read a single word. Gamma-augmentation was elicited in the polar-lateral and medial occipital regions following stimulus presentation. Gamma-augmentation in the anterior-medial occipital region was better time-locked to the onset of involuntary saccade occurring about 200-500 msec following stimulus presentation rather than the onset of stimulus presentation. Gamma-augmentation in the polar-lateral occipital region can be explained by increased attention to a moving target in the central visual field, whereas gamma-augmentation in the anterior-medial occipital region may be elicited by the realigned images in the peripheral field.

B2

STAGES OF NON-SYMBOLIC NUMBER PROCESSING IN OCCIPITO-PARIETAL CORTEX DISENTANGLED BY FMRI-ADAPTATION Chantal Roggeman[1,2], Seppe Santens[2,3], Wim Fias[2,3], Tom Verguts[2,3]; [1]Department of Women's and Children's Health, Karolinska Institute, Stockholm, Sweden, [2]Ghent Institute for Functional and Metabolic Imaging, Ghent University, Ghent, Belgium, [3]Department of Experimental Psychology, Ghent University, Ghent, Belgium — The neurobiological mechanisms of non-symbolic number processing are not yet unraveled. Computational modeling proposed three different stages for this processing: first, the spatial location of the objects is stored in an object location map; second, this information is transformed into a numerical summation code; and finally this summation code is transformed to a number-selective code. Here, we used fMRI adaptation to identify the three stages and determine their anatomical localization relative to one another. We adapted neurons by repeating the same number of dots on the same locations on the screen, interspersed by deviants with different numbers of dots on same or different locations. By creating orthogonal number and location factors in the deviants, we were able to calculate three independent contrasts, each sensitive to one of the stages. Non-numerical parameters were carefully controlled. We found a gradient across occipito-parietal cortex for the processing of non-symbolic number. The activation of the object location map was found in the earliest stage in the inferior and middle occipital gyrus, and then gradually decreased. The summation coding map exhibited a nonlinear pattern of activation along this stream, with first increasing and then decreasing activation, and most activity in the middle occipital gyrus. Finally, the number-selective code became pronounced further along the occipito-parietal processing stream, with an activation peak in the superior parietal lobe and the supramarginal gyrus. Summarizing, we disentangled the three stages of non-symbolic number processing predicted by computational modeling, and demonstrated that they constitute a pathway along the occipito-parietal processing stream.

B3

VISUAL SEARCH FOR NUMEROSITY Weiwei Zhang[1,2], Steve Luck[1,2]; [1]Dept. of Psychology, UC Davis, [2]Center for Mind & Brain, UC Davis — Ecologically important attributes in natural scenes not only arise from the surface features of isolated objects, but also from statistical representation of groups of discrete objects. For example, objects are often grouped in clusters, and it may be important to determine which clusters contain a large number of objects and which clusters contain a small number (e.g., when assessing which trees in an orchard contain a large number of apples or which checkout lines have fewer customers in a store). Much research has asked how the overall number of objects in a scene is perceived, but little research has focused on how numerosity is perceived within local regions. The present study aimed to test whether numerosity is a pre-attentive basic feature in early vision by looking at the relationship between attention and enumeration. We used a visual search task in which search items were dot clusters that contained various numbers of dots. We found visual search for smaller numerosity (e.g., search for a 10-dot target among 20-dot distractors) was inefficient with a 2:1 ratio for target-absent:target-present search slopes. In contrast, search for larger numerosity (e.g., search for a 20-dot target among 10-dot distractors) was much more efficient. This is the same search asymmetry pattern observed for other simple features, such as contrast and size, suggesting that the numerosity within a region is a basic feature in early vision. Thus, perceptual extraction of numeric information from clusters of dots can be as efficient as the perception of simple surface features.

B4

NEURAL CORRELATES OF VISUAL AWARENESS ASSESSED VIA EEG IN AN INATTENTION PARADIGM Michael Pitts[1], Antigona Martinez[1,2], Steven Hillyard[1]; [1]UCSD, [2]NKI — Proposed neural correlates of visual awareness include wide-spread recurrent activity and induced oscillations within the gamma-band. To test these hypotheses, we employed an inattention paradigm while recording the EEG. In the first phase of the experiment, subjects performed a peripheral distracter task while task-irrelevant line

segments presented centrally formed shape patterns or random configurations. During this phase, many subjects (N=19) failed to notice the patterns when queried and were thus considered inattentionally blind. In the second phase that followed the query, the task was the same, but now all subjects reported seeing the patterns. ERPs recorded over the occipital pole were more negative for pattern-present compared to pattern-absent stimuli (at 180ms) regardless of whether subjects noticed the patterns. At subsequent latencies (300ms), however, ERPs differed between pattern-present and pattern-absent stimuli only when subjects were aware of the patterns. In a third phase, the task was altered such that the patterns were task-relevant. Here, the same ERP components observed in phases 1 and 2 were evident, but were followed by additional more wide-spread activity that was absent in the first two phases. Single-trial analyses of EEG spectral power revealed significant gamma oscillations (35-45Hz, 300-400ms) only in phase 3, when the patterned stimuli were task-relevant. These results challenge existing theories concerning the neural basis of visual awareness, suggesting that widespread activity and gamma oscillations may reflect task-related object discrimination instead of visual awareness, which was indexed here by an ERP negativity with a medial occipital distribution at 300ms.

B5

PERCEPTUAL SERIAL DEPENDENCE: PERCEIVED ORIENTATION IS ATTRACTED TO PREVIOUSLY ATTENDED ORIENTATIONS Jennifer Shankey[1], Jason Fischer[1], David Whitney[1]; [1]University of California, Berkeley — The input to the visual system is noisy, but the physical world is generally continuous over time: objects tend not to appear and disappear suddenly, or change in identity spontaneously. The continuity of the physical world could provide the basis of a heuristic for the visual system: if the world is continuous over time, perception should be continuous over time as well. By biasing the current percept toward what was seen recently, smoothing visual perception in time, the brain could yield more stable and accurate visual estimates in the face of noisy input. Employing such a temporal good continuation heuristic would lead to serial dependence in visual perception, where the perception of the current stimulus depends on what was presented before it. Here, we tested for perceptual serial dependence using an orientation judgment task. Subjects reported the orientations of sequentially presented gratings, which were separated in time by several seconds. We found that on a given trial, a subject's perception of the grating orientation reflected not only the currently viewed stimulus, but also a systematic attraction toward the orientations of previously viewed stimuli. Perceptual serial dependence hinged on spatial attention, occurring only for stimuli at attended locations, and occurring most strongly when a series of attended stimuli remained at a constant retinal location. Our results reveal a systematic influence of recent visual experiences on perception at a given moment: visual percepts are attracted toward what was previously seen at attended locations.

B6

EYE MOVEMENT PATTERNS DURING THE PERCEPTION OF 3D OBJECT SHAPE: PREFERENTIAL FIXATIONS FOR REGIONS WITH CONCAVE SURFACE CURVATURE MINIMA Lina Conlan[1], Filipe Cristino[1], Candy Patterson[1], Steve Johnston[2], Charles Leek[1]; [1]School of Psychology, Bangor University, UK, [2]Brunel University, Uxbridge, UK — Although fixational eye movement patterns have been widely studied in a variety of domains, there have been no detailed analyses of eye movement patterns during three-dimensional (3D) visual object recognition. Here we provide some evidence that fixation patterns can be used to study local shape processing during three-dimensional (3D) object recognition in human vision. Participants eye movements were recorded while they either actively memorized (Exp 1) or passively viewed (Exp 2) sets of novel 3D objects and later performed a subsequent recognition memory task (test phase). During the memory task (test phase) previously seen objects were presented amongst visually similar distracters at both previously seen and novel viewpoints. The distributions of fixation patterns were compared with the distributions predicted by three models of local image processing: (i) low-level visual saliency and (ii) convex and (iii) concave surface curvature. Analyses of the eye movement data showed preference for fixation at regions of concave surface curvature minima during both the pre-test and test phases, and regardless of whether stimuli were actively or passively viewed in the pre-test phase. There was no evidence that fixation patterns are influenced by visual saliency. The results are interpreted within the context of recent viewpoint-dependent interpolation models of shape recognition. It is proposed that the fixation patterns reflect the operation of a depth-sensitive view interpolation process that is constrained by key points encoding regions of concave curvature minima.

B7

THE ROLE OF PRE-SUPPLEMENTARY MOTOR AREA IN THE COMPUTATION OF ABSTRACT SPATIAL TRANSFORMATIONS Stephen Johnston[1], Charles Leek[2]; [1]Brunel University, Uxbridge, UK, [2]Bangor University, Bangor, UK — A current debate in the literature involves the extent to which the supplementary motor area (SMA) is recruited specifically for the planning of motor responses as opposed to supporting motor and non-motor functions through the computation of spatial transformations. Here we present two functional imaging experiments that attempt to further elucidate the functional properties of SMA. In Experiment 1, participants were either shown a starting grid that could be empty (motor task) or contain a number (subtraction task). Participants then viewed a series of numbers interspersed with hash marks. In alternating blocks, participants performed (i) a motor task, where a finger tap was performed in response to number stimuli, and (ii) a subtraction task, where participants serially subtracted each number from the number presented in the starting grid. In Experiment 2, participants viewed a grid which could be empty (motor task) or contain a highlighted tile (visual transform task). A sequence of arrow stimuli, interspersed with hash marks followed. In alternating blocks, participants performed (i) a motor task, where participants finger tap in response to the arrow stimuli and (ii) a visuo-spatial transform task, where the starting tile moves one space in the direction indicated by the arrow. Results indicate that the anterior sub-division of SMA (pre-SMA), responds more strongly to demands associated with both non-motor tasks compared with the motor transformation tasks. We conclude that pre-SMA is involved in the computation of spatial transformations across a variety of cognitive tasks and its function is not restricted to movement planning.

B8

OCCIPITAL TMS FACILITATES AND HINDERS VISUAL PERCEPTION VIA A CONTRAST GAIN MECHANISM Francesca Perini[1], Luigi Cattaneo[1], Marisa Carrasco[3], Jens Schwarzbach[1,2]; [1]Center for Mind/ Brain Sciences, University of Trento, Italy, [2]Department of Cognitive Science and Education, University of Trento, Italy, [3]Department of Psychology and Center for Neural Science, New York University — The effects of transcranial magnetic stimulation (TMS) can vary radically according to the state in which the brain is at the moment of stimulation. Two possible mechanisms by which single magnetic stimuli produce different effects according to the initial activation state of targeted neurons have been proposed: (i) TMS suppresses neural signals and (ii) TMS adds random neuronal activity. Here we explore these two hypotheses by investigating the psychophysical effects of TMS on early visual cortex under different conditions of contrast adaptation. We tested six participants in an orientation discrimination task, where neuronal activation of visual cortex before each trial was altered through adaptation either to a blank screen or to two flickering gratings. In half of the trials a single TMS pulse was delivered simultaneously with target. Adaptation decreased performance. The effect of TMS on performance depended on the state of adaptation: it increased contrast sensitivity after adaptation but reduced it in the absence of adaptation. Correspondingly, TMS had a differential effect on threshold according to adaptation: it increased thresholds without adaptation but decreased them after adaptation. Notably, TMS did not affect the asymptote in any condition.

The fact that TMS changed thresholds but not asymptotes suggests that TMS acts at the input level of neuronal processing, i.e. at the synaptic level. Moreover, the finding that TMS had opposite effects on the two adaptation conditions, even at the same performance levels at threshold, contradicts the hypothesis of TMS state-dependency as a product of noise increase.

B9

HIGHER PRE-STIMULUS ACTIVITY IN THE DORSAL ATTENTIONAL NETWORK PARADOXICALLY LEADS TO LOWER CONFIDENCE Dobromir Rahnev[1,2], Floris de Lange[2], Hakwan Lau[1,2]; [1]Columbia University, Department of Psychology, New York, [2]Radboud University Nijmegen, Donders Institute for Brain, Cognition and Behavior, Netherlands — One recent study reported that when pre-stimulus fMRI activity in the dorsal attention network was high, the hit rate in an auditory detection task was surprisingly low. This result is puzzling because pre-stimulus activity in the dorsal attention network presumably reflects the subjects' attentional state, and high attention is supposed to improve perception, not impair it. However, it is important to distinguish between the capacity and decision/criterion aspects of perception. We provide empirical psychophysical to show that spatial attention can lead to conservation bias in detection, although it boosts detection capacity. Further studies confirmed the prediction, derived from signal detection theory, that this conservative bias in detection is coupled with lowered confidence ratings in a discrimination task. Based on these results, we used fMRI to test the hypothesis that low pre-stimulus ongoing activity in the dorsal attention network predicts high confidence ratings in a visual motion discrimination task. The results confirmed this counter-intuitive prediction, and further revealed that slow fluctuation at a specific frequency range (.04 - .05Hz) drove this effect on confidence. Activity at a distinct frequency range (.04 - .08Hz) drove a similar but opposite effect on accuracy – higher pre-stimulus activity led to higher accuracy. Taken together, these results support the notion that attention may have a negative impact on the decision/criterion aspects of perception. This negative relationship may explain various paradoxes like the vividness of peripheral vision and the overconfidence in naïve subjects in change blindness experiments despite their poor performance.

B10

THE ROLE OF MOTOR PROGRAMMING IN THE RETRIEVAL OF OBJECT KNOWLEDGE Heath Matheson[1], Patricia McMullen[1]; [1]Psychology Department, Dalhousie University — Mounting evidence from behavioral research demonstrates that passively viewing images of tools both primes motor responses and activates fronto-parietal networks responsible for programming action. To account for these findings, embodied (or grounded) theories of cognition propose that the same neural networks are involved in encoding and retrieving object knowledge. However, most evidence to date has been based on correlations between viewing manipulable objects and fronto-parietal activity. In the present study, we investigated whether motor programs play a necessary role in the retrieval of object knowledge/identity. Participants performed an object naming task while squeezing a sponge with either their right or left hand. The objects were either manipulable (e.g. hammer) or non-manipulable (e.g. horse), and were oriented favoring a right or left hand grasp. If activation of motor programs is necessary to retrieve object knowledge, we hypothesized that this arbitrary motor act would alter object naming performance, especially for objects oriented towards the occupied hand. Participants showed slower naming for all objects oriented towards the occupied hand. These results suggest that motor programming can play a role in the retrieval of object knowledge/identity. These effects were independent of object category and may depend on low-level visual characteristics of objects (i.e. an orientation favouring a left or right hand grasp).

B11

MODELING MECHANISMS OF REVERSED EFFECTS OF MANIPULABILITY ON NAMING AND CATEGORIZING OBJECTS Joshua Salmon[1], Patricia McMullen[1], Thomas Trappenberg[2]; [1]Psychology Department, Dalhousie University, [2]Computer Science Department, Dalhousie University — Our behavioural research has shown that manipulable objects are named more quickly and categorized more slowly than non-manipulable objects (Salmon & McMullen, 2009). This pattern of effects was explored using extensions of a computational model of Yoon, Heinke and Humphreys' (2002) Naming Action Model (NAM) by determining the success of three possible mechanisms to simulate it. The first mechanism was based on semantic organization of the system (crowded versus sparse domains) whereby crowded categories (those consisting of many objects) were postulated to be categorized more quickly and named more slowly than sparse categories. The second mechanism was more perceptual, and based on the input of visually similar objects whereby highly visual similar objects were postulated to be categorized more quickly and named more slowly. The third mechanism was based on the effect of a dedicated Action Module postulated in the NAM model to be active for manipulable but not for non-manipulable objects. This Action Module was postulated to speed the naming of manipulable objects, but slow their categorization. Our computational simulation supported a "reversal effect" due to the first two mechanisms, but not the third. Hence, a sparse versus crowded semantic architecture and visual similarity of the input objects could account for the "reversal effect" but a dedicated Action Module could not. These results suggest that actions associated with objects can affect their identification at specific and non-specific levels without appealing to a module dedicated to coding these associations.

B12

MORE OR LESS HUMAN: THE ANIMATE–INANIMATE DISTINCTION IN VISUAL CORTEX MAY BE MORE CONTINUUM THAN DISTINCTION Andrew C. Connolly[1], J. Swaroop Guntupalli[1], M. Ida Gobbini[1,2], James V. Haxby[1,3]; [1]Dartmouth College, [2]Università di Bologna, [3]University of Trento — Numerous studies suggest that the animate–inanimate distinction is a central principle for representing objects in ventral visual cortex. Yet less is known about the organization of representations within these large domains. We aimed to investigate the finer structure of representations within the animate domain using fMRI. We analyzed activity patterns associated with viewing a range of animal species in a multi-condition protocol. Our main findings include the observation of two distinct neural similarity structures: one based on low-level visual attributes localized to activity in and around primary visual cortex, and another that reflects category structure – i.e., superordinate animal classes – most strongly represented in the ventral temporal (VT) cortex and mirrored in other regions including lateral occipital, inferior parietal sulcus, and inferior frontal gyrus. The VT similarity structure is characterized by a single dominant dimension that separates animal species into their respective superordinate classes but also suggests a hierarchy among species with more human-like animals at one end (e.g., monkeys) and the least human-like animals at the other (e.g., ladybugs). Activation-based contrasts revealed that the invertebrate animals were associated with greater activity compared to vertebrates in regions typically associated with viewing inanimate objects – i.e., medial fusiform and inferior temporal gyri, while vertebrates more strongly activated areas normally associated with animates – lateral fusiform and middle and superior temporal gyri. These results suggest that the animate-inanimate distinction may actually reflect a continuum – encoding differences not only between animates and inanimates, but also among exemplars within the animate domain.

B13

OBJECT SUBSTITUTION REDUCES FACE-SPECIFIC PROCESSING BY DISRUPTING PRIOR VISUAL PROCESSING IN LOWER-LEVEL SENSORY CORTEX Joseph Harris[1], Solange Ku[1], Alex McMahon[1], Marty Woldorff[1]; [1]Duke University — In the relatively recently characterized method of disrupting visual awareness known as object substitution masking (OSM), delaying the offset of a four-dot cue surrounding a briefly presented target image results in a marked decrement in a viewer's ability to detect and categorize the image. This tool for disrupting visual awareness can be used in conjunction with neuroimaging methods to examine the extent of visual neural processing that occurs with and without awareness. Although the attenuation of electrophysiological indices of face-specific processing (N170 difference wave) with OSM has been reported, helping to circumscribe a possible locus of disruption, the specific mechanisms of OSM have yet to be determined. The present experiment explores these mechanisms by tracking the face-specific N170, as well as lower-level indices of basic visual processing, across awareness states as disrupted versus not disrupted by OSM. The face-specific ERP negativity was disrupted by OSM, both at its early N170 phase and at a later recurrent phase. In addition, with the use of certain control conditions, we observed a disruption by OSM of reentrant activity associated with low-level visual processing, temporally localized to ~150 ms after the onset of the target image. Given the temporal and spatial distribution of this effect of attenuation, we conclude that object substitution exerts its disruptive influence by attenuating basic target processing at the level of early reentrant extrastriate processing, which then ramifies to later object-category-specific processes reflected by the face-specific N170.

B14

CONTEXT AND HAND POSTURE MODULATE THE NEURAL DYNAMICS OF TOOL-OBJECT PERCEPTION Nikhilesh Natraj[1], Victoria N. Poole[2], J.C. Mizelle[1,5], Andrea Flumini[3], Anna M. Borghi[3,4], Lewis Wheaton[1]; [1]Georgia Institute of Technology, [2]Purdue University, [3]University of Bologna, [4]Institute of Cognitive Sciences and Technologies, [5]Atlanta Veterans Affairs Medical Center — The human mirror neuron system (MNS) overlaps with brain areas underlying complex tool-use. Prior research has linked visual perception of tools with plausible motor strategies (action affordances). Mere observation of tools and a hand functionally grasping a tool activates areas common to MNS and tool-use (left fronto-parietal areas). However, tool-use movements are performed in specific contexts and grasp postures. Therefore, we sought to understand how context and hand grasp postures together modulate action affordances. 64-channel electroencephalography (EEG) was recorded from 16 right-handed subjects while viewing images depicting three classes of tool-object Contexts: Functionally Correct (e.g. hammer-nail), Functionally Incorrect (e.g. hammer-shirt) and Thematic (e.g. hammer-wood). These Contexts were modified by Hand interactions: No Hand, Hand near the tool, Functional posture (grasp hammer handle) and Manipulative posture (grasp hammer head). Subjects visually assessed correctness of tool-object associations. A separate behavioral study recorded reaction times of this decision process. When Context is Correct, only Manipulative posture resulted in delayed reaction times and extended time-voltage activations over right fronto-parietal areas, characterized by a right frontal theta power modulation ($p<0.01$, [400-600ms], [4-8Hz]). This suggests engagement of a right neural system to evaluate correct action affordances when Hand posture does not support action (Manipulative). Additionally, when tool-use Context is ambiguous (Thematic), Manipulative posture alone resulted in delayed perceptual judgment and extended left motor, bilateral fronto-parietal time-voltage activations, with beta band power modulations ([$p<0.01$, [400-600ms], [12-16Hz, 20-25Hz]). These results point to existence of other neural networks evaluating tool-object associations when motoric affordances are not readily apparent.

B15

SHORT PRACTICE ON MENTAL ROTATION AFFECTS SHAPE ENCODING OF NOVEL OBJECTS ALONG THE VENTRAL STREAM Giorgio Ganis[1,2,3], Haline Schendan[2,3]; [1]Harvard Medical School, [2]Massachusetts General Hospital, Charlestown, MA, [3]University of Plymouth, Plymouth, Devon, UK — Mental rotation processes have been shown to engage both posterior parietal regions in the dorsal stream, thought to index spatial transformation processes, and occipito-temporal regions in the ventral stream, thought to index shape-based processes. However, the relative sensitivity of these regions to practice is still not clear. To address this issue, sixteen participants carried out eight runs of mental rotation of realistic 3D shapes during an fMRI scanning session. All stimuli were different in order to assess improvement in mental rotation processes per se, rather than item-specific repetition processes. Regression lines fit through the behavioral data (angle of rotation versus response times) showed the typical linear increase in response times as a function of angle of rotation. Practice resulted in faster response times, but, importantly, it did not decrease the slope of the regression lines, usually believed to index spatial transformation processes, suggesting that a short practice session may not affect these processes. The neuroimaging results support this view. Activation increased linearly with angle of rotation both in occipito-temporal and posterior parietal cortex. However, practice effects were found mostly in the ventral stream, where activation decreased with practice. These results indicate that a short practice session on mental rotation affects mainly shape-based processes, perhaps involved in the initial encoding the 3D shapes. A longer practice period may be required to affect spatial transformation processes.

B16

LITERACY BREAKS THE SYMMETRY OF ALPHABETIC VISUAL OBJECTS Felipe Pegado[1,2,3,4], Kimihiro Nakamura[1,2,3,4], Laurent Cohen[5,6,7], Stanislas Dehaene[1,2,3,4]; [1]INSERM, U992, Cognitive Neuroimaging Unit, F-91191 Gif/Yvette, France, [2]CEA, DSV/I2BM, NeuroSpin Center, F-91191 Gif/Yvette, France, [3]Université Paris-Sud, F-91405 Orsay, France., [4]Collège de France, F-75005 Paris, France, [5]AP-HP, Groupe hospitalier Pitié-Salpêtrière, Department of Neurology, Paris, France, [6]Univ Paris 6, Faculté de Médecine Pitié-Salpêtrière, F-75005 Paris, France, [7]INSERM, ICM Research Center, UMRS 975, Paris, France — All primates, including humans, recognise images in a left-right invariant-way. This mirror-invariance is useful to recognise objects both from left or right perspectives, but this very competency has to be 'unlearned' for reading acquisition in order to correctly identify letters (e.g. to distinguish a 'b' from a 'd'). In a first study, we presented pairs of visual stimuli (faces, houses, tools, strings and false-fonts), whose left-right orientation was manipulated, to adult literates and illiterates. The task was to judge if the pairs were 'same' or 'different', regardless of orientation (identity task). The subjects were explicitly instructed to assign 'same' for mirror-inverted pairs. The results showed an important behavioural cost to respond 'same' in mirror-trials, proportional to the literacy level, but only for strings and falsefonts. A strong bias to respond 'different' in mirrored-strings was also observed in good readers but not in illiterates. In a second study (Neuroimage, in press), we used an fMRI priming paradigm to probe the neural discrimination of mirror-inverted pairs of stimuli in skilled readers. We demonstrate that the left occipito-temporal cortex, namely the Visual Word Form Area (VWFA) distinguishes the left-right orientation of single letters, and yet exhibits mirror invariance for simple matched pictures. These results clarify how letter shapes, after reading acquisition, escape the process of mirror invariance which is a basic property of the ventral visual shape recognition pathway.

B17

IS THE WHOLE THE SUM OF ITS PARTS? Denise Soria Bauser[1], Irene Daum[1]; [1]Institute of Cognitive Neuroscience, Dept. of Neuropsychology, Ruhr University Bochum, Germany — It is well known, that human bodies elicit a prominent electrophysiological component called N170 which is thought to be related to structural encoding of faces and bodies. The aim of the

present study was to investigate whether bodies or faces and shredded faces and bodies elicit the same component. This would imply that even body parts are encoded as a whole supporting the significance of these stimuli. According to that, we used a matching to sample task and two manipulations which were assessed in previous studies: the inversion effect and intact versus shredded stimulus presentation. For both categories, performance was better for intact compared to shredded stimuli while this effect could not be observed for houses. Additionally, stimulus distortion seems to affect the perception of bodies disproportionally greater than the perception of faces. On the electrophysiological level we found enhanced N170 amplitudes for intact faces and bodies compared to shredded stimuli. Furthermore, we observed an inversion effect for intact but not shredded bodies. The current data suggest that faces and bodies might be processed by distinct mechanisms as the experimental variation affected bodies more than faces.

B18

EVIDENCE OF A COARSE-TO-FINE CATEGORIZATION OF VISUAL SCENES USING MOVIES OF SPATIAL FREQUENCY FILTERED SCENE IMAGES Carole Peyrin[1], Coralie Giavarini[1], Benoit Musel[1], Nathalie Guyader[2], Alan Chauvin[1]; [1]Laboratoire de Psychologie et NeuroCognition, CNRS UMR 5105, Grenoble, France, [2]Laboratoire Grenoble Image, Parole, Signal et Automatique, CNRS UMR 5216, Grenoble, France — Complex natural scenes are very quickly categorized, faster than 150 ms, suggesting a simple and efficient processing. Recent models of visual recognition have suggested that perceptual analysis may start with a parallel extraction of different spatial frequencies (SF), but using a preferential coarse-to-fine (CtF) sequence of SF processing. A rapid extraction of low spatial frequencies (LSF) may thus provide an initial and crude parsing of the scene, subsequently refined by slow but more detailed high spatial frequencies (HSF). However, a fine-to-coarse (FtC) being sometimes preferred to a CtF sequence depending on task demands. The present experiment aims to investigate whether a CtF processing allows faster scene categorization rather than a reverse FtC processing. To constrain SF processing according to these sequences, we presented brief movies of successive SF-filtered scenes with opposite SF sequences (either from LSF to HSF, or the reverse), allowing us to experimentally "decompose" the visual inputs in either CtF or FtC sequences. Movies last 150 ms and were composed of six SF-images of the same scene, filtered either at 1, 2, 3, 4, 5, 6 cycles/degree of visual angle for CtF movies or the reverse for FtC movies. Thirty five participants performed a categorization task (indoors vs. outdoors) on these movies. Results showed that they categorized CtF movies significantly faster than FtC movies. Using for the first time dynamic stimuli, these results provide critical support to recent models of vision. The current stimuli seem therefore well appropriate to highlight the neural basis of the CtF categorization.

B19

SPATIAL FREQUENCY PROCESSING DURING LARGE NATURAL SCENE CATEGORIZATION IS MAPPED RETINOTOPICALLY IN THE HUMAN OCCIPITAL CORTEX Benoit Musel[1], Cédric Pichat[1], Sylvie Chokron[2], Jean François La Bas[3], Carole Peyrin[1]; [1]Laboratoire de Psychologie et NeuroCognition, UMR 5105 CNRS- UPMF, Grenoble, France, [2]Unité Fonctionnelle Vision & Cognition, Fondation Ophtalmologique Rothschild, Paris, France, [3]INSERM U836/Université Joseph Fourier - Institut des Neurosciences, Grenoble, France — Recent models suggest that visual scene recognition is mainly based on parallel extraction of spatial frequencies of an image. Physiological data from humans reveal that low spatial frequencies (LSF) were mostly extracted from peripheral rods/parasol ganglion cells whereas high spatial frequencies (HSF) were mostly extracted from central cones/midget ganglion cells. Then, the processing of spatial frequencies in early visual areas would be retinotopically mapped. The aim of this fMRI study was to evaluate cerebral correlates and retinotopic processing of spatial frequencies in the occipital cortex during large natural scene perception. Twelve participants performed a categorization task (indoors vs. outdoors) of black and white photographs of natural scenes filtered in LSF (below 1 cycle per degree of visual angle) and HSF (above 6 cycles per degree of visual angle), sized 24°x18° of visual angle, during block-designed fMRI recording sessions. LSF (relative to HSF) scene categorization elicited significant bilateral activations within the medial aspect of the occipital lobe, at the anterior half of the calcarine fissures, in correspondence with the location of the peripheral representation in the visual cortex. Additional activations were obtained within the left anterior lingual gyrus. HSF (relative to) LSF scene categorization elicited significant bilateral activations more posteriorly in the occipital lobes, including the cunei, the posterior lingual gyri and the middle occipital gyri, in correspondence with the foveal representation. These results provide supplementary evidence for retinotopic mapping of spatial frequency processing at early levels of visual analysis in human occipital cortex.

B20

INVESTIGATING THE INFLUENCE OF AFFECT AND ENVIRONMENTAL RELEVANCE ON AWARENESS IN A BINOCULAR RIVALRY PARADIGM Caitlin J Mouri[1], Leandra Desjardins[1], Avi Chaudhuri[1]; [1]McGill University — In binocular rivalry, two conflicting visual stimuli are presented simultaneously to each eye, and subsequently compete for awareness. In this study, we use the phenomenon of rivalry to examine the influence of emotional content and environmental relevance on perceptual awareness. Emotional content is known to influence perceptual dominance through arousal, as emotional images tend to dominate over neutral images (Alpers, 2007), while positive and negative images compete equally for access to awareness (Sheth & Pham, 2008). In the absence of awareness, emotion information can influence behavior through pathways in the amygdala (Carlsson et al., 2004). More generally, these pathways are thought to select for biological relevance (Adolphs, 2008). To determine whether emotional content can influence rivalry by way of biological relevance, we selected images from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) associated with reward or threat. Reward-related images with positive valence and fear-related images with negative valence were matched on IAPS ratings of arousal and valence magnitude. Image pairs were presented to each eye simultaneously to induce rivalry. We found a significant effect of valence on image dominance, which contradicts previous findings that positive or negative valence does not alter perceptual awareness (Sheth & Pham, 2008). As our stimuli were specifically selected for image content rather than valence alone, this provides support for our hypothesis that environmental relevance influences rivalry in conjunction with emotional salience.

B21

PERCEPTUAL LEARNING OF INVERTED FACES ACROSS DIFFERENT SPATIAL FREQUENCY BANDS Adélaïde de Heering[1], Daphne Maurer[1]; [1]McMaster University, Hamilton, Ontario, Canada., [2]McMaster University, Hamilton, Ontario, Canada — Small amounts of practice can improve accuracy for recognizing upright faces. However little is known about the effects of practice on recognition of inverted faces (1,2). Here we hypothesized that adults might be better at learning to recognize inverted faces if trained with low spatial frequency images (<5 cpi; LSF) than full spectrum (FULL) or high spatial frequency images (>24 cpi; HSF) since newborns learn to recognize upright faces despite poor visual acuity (3). We trained 3 groups of 16 adults in a 10-AFC task with LSF, HSF or FULL inverted faces presented with different viewpoints. Although reaction times became significantly faster for all groups during training, accuracy improved only in the FULL (14%) and HSF (7%) groups. Improvements from before to after training were assessed by comparisons to an untrained control group on 4 tasks. The FULL group showed more improvement in both accuracy and reactions time than controls on the delayed matching task of full spectrum inverted faces, thereby demonstrating generalization of training to novel faces. They were also faster on the same task with upright faces. The HSF group showed increased and decreased holistic processing of full spectrum inverted and upright faces, respectively, as indexed by reaction times on the composite face

effect. Despite no improvement in accuracy during training, the LSF group improved more than controls on reaction times to match simultaneously presented full-spectrum inverted faces. These results suggest that perceptual learning of inverted faces and its generalization depend strongly on their spatial frequency content.

B22

THE PRECISION OF SHORT-TERM MEMORY FOR NATURALISTIC OBJECTS Michele Veldsman[1], Alejandro Vicente-Grabovetsky[1], Rhodri Cusack[1]; [1]Medical Research Council, Cognition and Brain Sciences Unit — Visual short-term memory (VSTM) is important for many everyday cognitive tasks, but its capacity is highly restricted. Our work aims to examine the neural basis of this limitation. Recent studies have begun to distinguish two limits, the number of items that can be remembered, and the precision with which each is remembered. Participants perform a whole report task in which they are asked to select a probed item from many possibilities, instead of simply detecting a change. We extend this in two ways. First, we use fMRI to investigate the neural basis of precision and object number limits. Second, we adapt the report paradigm to naturalistic objects, which recruit a wider range of visual representations and are more relevant for everyday memory performance. A parameterised circular continuum for each stimulus was created ranging from its original intact state to a heavily distorted state. We estimated the capacity and precision of memory representations for complex and naturalistic objects. We found that meaningful objects are remembered with higher resolution than distorted objects. Using fMRI, we found that unlike previous results from simple stimuli, varying the number of complex objects does not change the recruitment of the ventral (occipito-temporal) and parietal visual (superior intraparietal sulcus) regions. This is presumably because even remembering a single complex object, to the precision required for a report task, can fully consume all visual memory resources. However, remembering two objects recruited a fronto-parietal multiple demands network, presumably due to the demand of maintaining distinct objects.

B23

JUDGING 'NATURALNESS' OF DEPTH IN STEREOSCOPIC AND PSEUDOSCOPIC PICTURES - EXAMINING DIFFERENCES IN BRAIN ACTIVITY USING FUNCTIONAL MRI Norberto Eiji Nawa[1], Hiroshi Ando[1]; [1]National Institute of Information and Communications Technology (NICT), Kyoto, Japan — Binocular disparity is one of several cues used by the human visual system to perceive depth. Though several brain regions have been found to selectively respond to binocular disparity and to be associated more generally with processes related to the perception of depth, little is known about the regions involved in the perception and judgment of the quality of perceived depth, for instance, when viewing images in artificial settings such as 3D displays and movies. We were particularly interested in the quality of 'naturalness', i.e., the notion of how similar the experience of depth enabled by stereoscopic displays is to what one encounters in real life. To investigate that, we measured hemodynamic brain activity using functional magnetic resonance imaging (fMRI) while participants classified the 'naturalness' of depth of pictures under stereoscopic (left and right images displayed to the respective eyes), pseudoscopic (left and right images displayed to the opposite eyes), and monoscopic (same image displayed to both eyes) conditions. Participants used a three-alternative scale to grade the pictures (Natural/Unnatural/Neither one), which portrayed six daily life objects in grayscale, aligned in the same plane with one object partially occluding another. We examined neural responses in a priori regions specified in a previous block design study using similar images. Comparing event-related responses evoked by pseudoscopic stimuli against stereoscopic stimuli, we found a focus of increased activity in the left superior frontal gyrus. These results strongly indicate a major involvement of frontal areas in the judgment of depth quality in stereo images.

B24

DYNAMIC AND STATIC FACIAL EXPRESSIONS DECODED FROM FACIAL MOVEMENT SENSITIVE AREAS IN THE MACAQUE Nicholas Furl[1], Fadila Hadj-bouziane[2], Ning Liu[2], Bruno Averbeck[1], Leslie Ungerleider[2]; [1]Laboratory of Neuropsychology, NIMH/NIH, [2]Laboratory of Brain and Cognition, NIMH/NIH — Many animals including humans visually communicate important social cues via facial movements such as emotional expressions. Although expressions are dynamic, the role of motion representation in expression perception is not yet specified. The macaque provides a model neural system, as its superior temporal sulcus (STS) possesses discrete brain areas selective for static faces as well as areas sensitive to biological and low-level motion. We carried out functional magnetic resonance imaging while monkeys viewed static and dynamic monkey faces with specific emotional expressions. Using multivariate analysis, we found that information about facial expressions could be robustly decoded only from areas sensitive to facial movement; whereas face-selective patches, defined as areas responsive to faces versus places and objects contained relatively little information about facial expressions. Interestingly, the areas sensitive to facial movement showed weak responses to static faces, but still contained more information about static expressions than face selective patches. Although facial movement areas located in posterior and middle STS resembled areas already known to be sensitive to low-level motion (translating dots and optic flow), the dynamic face stimuli also revealed another, more anterior facial movement area. Importantly, facial movement areas coded dynamic and static presentations of the same expressions using distinct response patterns. Our results raise the possibility that motion representation contributes to perception of both dynamic and static facial expressions and show that dynamic and static expressions are associated with separate neural codes.

B25

TRACING A SPATIAL THOUGHT VIA EEG IN A SEQUENTIAL MENTAL ROTATION TASK Heinrich R. Liesefeld[1], Hubert D. Zimmer[1]; [1]Saarland University, Germany — The value of orientation dependent information changes as a stimulus is rotated, while the value of orientation independent information does not. We earlier found behavioral evidence that in mental rotation tasks only orientation dependent but not orientation independent spatial relational information (let alone a visual representation) is actually rotated. In a sequential mental rotation task specially designed to manipulate the amounts of these two types of information we expected to find electrophysiological markers for the differential processing of these information types. Findings include: (1) As stimuli are initially encoded visually, the P300 to the initial stimulus is sensitive to visual complexity only. (2) The amount of to be performed rotation influences the amplitude of the P300 following the onset of the rotation cue and that of the ensuing slow wave. (3) As only orientation dependent information is actually rotated, only the amount of this type of information influences the shape of the rotation related slow wave. (4) As orientation independent information is not included in the representation that is rotated, it is not readily accessible for comparison at the onset of the target stimulus. Therefore, detection of a non-match in orientation independent information takes longer than detection of other non-matches. This becomes evident in both decision times and P300 latencies. Taken together, this study neatly exemplifies the tracing of encoding, manipulation and comparison processes involved in mental rotation via EEG and provides converging evidence for the claim that mental rotation works on a representation that includes orientation dependent information only.

B26

ENTRY INTO ATTENTIONAL AWARENESS AS A FUNCTION OF TOP-DOWN ACTION-RELATED ACTIVATION VERSUS BOTTOM-UP PERCEPTUAL SALIENCE Tara C. Dennehy[1], Ezequiel Morsella[1,2]; [1]San Francisco State University, [2]University of California, San Francisco — What causes an otherwise subliminal stimulus to be 'released from masking' to enter atten-

tional awareness? In two studies, we examined the relative contributions of action-related top-down activation versus salient bottom-up perceptual signals to the conscious detection of backward masked visual stimuli (targets). Following the technique of Pessiglione et al. (2008), backward masking was employed to render visual targets (nonsense shapes) subliminal. Building on previous research showing that action-related processing can influence release from masking, Study 1 (n = 19) investigated whether performing a motion (e.g., rotating the hand) that was similar in nature (isomorphic) to a target (e.g., a circular shape) could cause a backward masked target to enter conscious awareness. We found no effect of isomorphic action, $F(1, 18) = .607$, $p > .05$. In a second study (n = 54), we contrasted the effects of action-related top-down activation (a button-press that seemed to cause the appearance of targets) and a salient bottom-up cue (a red square around the first pattern mask) and found that the bottom-up cue, but not the causal action, significantly increased entry of the target into attentional awareness, $F(1, 51) = 34.593$, $p < .001$. Together, these findings support theoretical frameworks proposing that entry into awareness is mediated primarily by perceptually-related processing.

B27

BRAIN ORGANIZATION OF EXPERT PERCEPTION IN CHESS Amy L. Boggan[1], Daniel C. Krawczyk[1,2], James C. Bartlett[1]; [1]The University of Texas at Dallas, [2]UT Southwestern Medical Center — Chess, long a fascination of cognitive science, provides an ideal context for studying visual expertise. Chess expertise is quantified by a reliable rating system (the Elo system) based on demonstrated performance. Chess experts are able to parse complex relationships among the pieces in a game display in seconds. Since chess pattern recognition has important similarities (necessity of both part-based and configural processing) and differences (no fixed first-order configuration or biological characteristics) with face recognition, we have begun to explore whether face recognition and expert chess recognition might rely on similar or shared networks. In the present study, functional Magnetic Resonance Imaging (fMRI) was conducted as chess experts (Grandmaster and International Masters rated 2447-2564), mid-level tournament players (rated 1332-1634), and chess novices viewed faces, outdoor scenes, everyday objects, and chess game displays in a one-back recognition task. Some game displays were drawn from real games while others represented randomized configurations of pieces. Novices reported no ability to differentiate between real and scrambled chess displays. Functional MRI contrasts allowed us to identify areas associated with perceiving faces, scenes and chess games. For experts, viewing chess games was associated with relative activation in the posterior occipital cortex, medial parietal cortex, and regions of the visual association cortex compared with other stimulus categories. Additionally, experts displayed more activation in the medial and lateral occipital cortex when viewing real games as compared to randomized chess displays. These findings suggest that expert game perception involves distinct, separate neural populations than those associated with face recognition.

B28

BILATERAL FUNCTIONAL AND ANATOMICAL CONNECTIVITY PREDICTING PERFORMANCE IN A DIGIT SYMBOL SUBSTITUTION TASK Ehsan Shokri Kojori[1], Ilana Bennett[1], Michael Motes[1,2], Daniel Krawczyk[1,2], Bart Rypma[1,2]; [1]The University of Texas at Dallas, [2]University of Texas Southwestern Medical Center at Dallas — Functional connectivity analyses can be used to assess correlations between brain regions engaged during cognitive tasks. Moreover, anatomical connectivity analyses investigate neuronal pathways underlying these functional networks. The extent to which connectivity measures, particularly associations between bilateral regions, contribute to task performance remains poorly understood. During functional Magnetic Resonance Imaging, participants (n=21, 18-27 years old) performed a modified Digit Symbol Substitution Task, within which an array containing nine digit-symbol pairs appeared above a single digit-symbol probe. Participants indicated whether the probe pair matched a digit-symbol pair from the array. Clusters of significant group-level activity were selected for further connectivity analyses ($z=2.3$, cluster threshold: $p<0.01$, at least 10mm apart). Functional connectivity was assessed by correlating time-series corresponding to bilateral clusters within prefrontal cortex, frontal pole, occipital cortex, motor cortex, and cerebellum. The square of these correlation coefficients was used to index Similarity in Bilateral Activity (SIBA). Anatomical connectivity was assessed with Diffusion Tensor Imaging tractography between the bilateral clusters. Results revealed correlations between accuracy and SIBA in cerebellum ($r=-0.53$, $p=0.01$) and occipital cortex ($r=-0.38$, $p=0.08$). A negative correlation between response-time and SIBA in frontal pole regions indicated that fast performers exhibit more synchrony in activity across frontal poles ($r=-0.57$, $p=0.007$). However, higher integrity (Fractional Anisotropy) of the tract connecting bilateral frontal pole regions was associated with lower accuracy ($r=-0.42$, $p=0.06$).These results suggest that functional and anatomical connectivity analyses can differentially predict performance measures (e.g. accuracy, response-time) and provide new insights into neural mechanisms mediating individual differences in task performance.

B29

GAMMA OSCILLATIONS REFLECT GOAL-DIRECTED MODULATION OF NEURAL ACTIVITY IN OCCIPITAL AND PARAHIPPOCAMPAL REGIONS Melanie Cohn[1,2], Cornelia McCormick[1,2], MaryPat McAndrews[1,2], Andrea B. Protzner[1,2], Taufik A. Valiante[1,2]; [1]Krembil Neuroscience Centre and Toronto Western Research Institute, [2]University of Toronto — Previous studies have demonstrated attentional modulation of primary and of associative visual areas. In one fMRI study (Gazzaley et al.,1995, JOCN), both enhancement and reduction of the BOLD signal in parahippocampal gyrus (PHG) when viewing scenes was observed with variations of task instructions. Here, we investigate the oscillatory underpinnings of these attentional modulations using intracranial EEG in one patient with electrode coverage encompassing the left occipital lobe and PHG. We used a working memory task in which faces and scenes were presented under three types of instructions: 1) Scenes relevant (faces irrelevant), 2) scenes irrelevant (faces relevant), 3) passive viewing. Power spectral analyses of the PHG electrode revealed that the enhancement (scenes relevant>passive) and suppression (scenes passive>irrelevant) effects were associated with an increase and decrease of gamma power respectively in the first 200ms after stimulus presentation. These modulations were specific to viewing scenes, not faces. Increases in gamma power with attentional enhancement was also observed in the occipital electrode, but no decrease was noted for the suppression effect (relevant>irrelevant>passive). Here, no material specificity was observed. Our results indicate that the goal-directed effects on down-stream visual areas manifest as changes in gamma oscillations, which are thought to represent the activity of local neuronal populations. The dissociation between primary and associative visual areas with respect to the suppression effect may be related to the presence/absence of material or object specialization in these regions.

B30

CONCEPTUAL TASKS ACTIVATE PERCEPTUAL NETWORKS BETWEEN 150-250MS David Brang[1], Vilayanur S. Ramachandran[1], Mingxiong Huang[1], Seana Coulson[1]; [1]University of CA, San Diego — Research suggests that access to conceptual color information engages regions in the temporal lobe highly responsive to perceptual colors. However, as fMRI is unable to track the time-course of neural activity, the stage at which this activation occurs is unknown. In order to understand the time-course of object-based information and whether these concepts elicit activity in modality specific perceptual regions, magnetoencephalography (MEG) was recorded while subjects performed color and action property verification tasks. Each trial began with either a color or action word, followed by an object word (e.g. orange – basketballs; throw – basketballs), and subjects were instructed to press a button when the attribute failed to match common properties of the object (50% of trials). Additionally, to precisely localize activity within visual area V4, each subject underwent an MEG retinotopy task. Extending previous findings, results showed dissociable

perceptual networks for color and action properties. Specifically, color-based judgments elicited enhanced activity in visual cortex, particularly in color area V4, and action properties differentially activated classic motor areas, including primary motor cortex and the inferior frontal gyrus, along with regions in the superior temporal sulcus and the inferior parietal lobe. Activation of these networks began between 150-250ms, revealing a fast engagement of regions typically reserved for sensory processing. These MEG data reveal modality specific brain activation during the initial stages of word processing, consistent with models that posit an important role for perceptual networks in conceptual tasks.

B31

DISSOCIATION BETWEEN GENERAL HOLISTIC PROCESSING AND HOLISTIC FACE PROCESSING: EVIDENCE FROM THREE CASES OF ACQUIRED PROSOPAGNOSIA Thomas Busigny[1,2], Bruno Rossion[1]; [1]University of Louvain, Belgium, [2]University of British Columbia, Canada — Many studies have shown that acquired prosopagnosia is characterized by impairment at holistic/configural processing (e.g., Levine & Calvanio, 1989). However, it is not clear whether this holistic processing impairment is general or can be specific for faces, at least in some cases. Here we tested three cases of acquired prosopagnosia who have preserved object recognition: PS (Rossion et al., 2003), LR (Bukach et al., 2006) and GG (Busigny et al., 2010). These patients were tested with the Navon hierarchical letters, testing general holistic processing, and two tests measuring holistic face processing, the face inversion effect and the whole-part advantage. We show that the three patients present with an entirely normal response profile in the Navon task: they are as fast as controls and they have a normal global-to-local interference during identification of local letters. In contrast, the three patients do not present with the normal effects in the holistic face processing tasks: they have neither a face inversion effect, nor a whole-part face advantage. Thus, all three patients appear to encode facial information feature-by-feature, independently of the other features embedded in the whole facial context. These observations indicate that general holistic processing as measured with global/local interference in the Navon paradigm is functionally distinct from the ability to perceive an individual face holistically. Moreover, they show that brain damage in adulthood may lead to selective recognition impairment for faces, because this is the only category of visual items for which holistic processing at a fine-grained (individual) level is necessary.

B32

INDIVIDUALS WITH AUTISM SHOW A SELECTIVE DEFICIT FOR THE UNDERSTANDING OF INTERACTING ANIMATED OBJECTS Nicole David[1], Johannes Schultz[2], Kai Vogeley[3], Andreas Engel[1]; [1]Department of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf, [2]Max Planck Institute for Biological Cybernetics, [3]Department of Psychiatry and Psychotherapy, University of Cologne — A focus on social deficits in autism spectrum disorders (ASD) has, for a long time, obscured the existence of lower-level perceptual abnormalities, although the earliest descriptions of autism included abnormalities in oculomotor behavior and visual attention. More recently, however, abnormalities in perception and attention have increasingly been discussed as influential factors in ASD-specific psychopathology. To this end, the perception of coherent motion in random-dot kinematograms, biological motion in point-light walkers and agency in animated shapes have been investigated in ASD but their relationship remains a matter of debate. It also is unclear whether ASD-related deficits result from difficulties in global motion perception or in processing motion that contains socially relevant signals (e.g. a body and actions). We tested 18 individuals with high-functioning autism and 16 age-, gender- and IQ-matched control participants, who performed three tasks on a continuum of motion cues and social complexity: (1) low-level translational motion that moved up or down, (2) complex motion of a single dot that moved in an animate or inanimate way, (3) complex motion of two dots that interacted or not. None of these tasks contained objects with human shape and only the first task contained global motion. Participants with autism were selectively impaired in detecting social interaction between two animated shapes (task 3), while low-level motion processing (task 1) and the detection of isolated agents (task 2) were preserved. These findings suggest a distinct social impairment in ASD in understanding interacting agents.

B33

THE ASYMMETRY OF THE OPTIMAL VIEWING POSITION: IS EARLY VISUAL PROCESSING ASYMMETRIC? AN ERPS STUDY Wen-Hsuan Chan[1], Thomas P. Urbach[1], Marta Kutas[1,2]; [1]University of California, Cognitive Science, San Diego, [2]University of California, Neurosciences, San Diego — Visual word recognition is faster and more accurate when fixating at a left-of-center position within a word (the optimal viewing position, OVP). Some researchers have attributed OVP asymmetry to left hemispheric language dominance. OVP asymmetry, however, may not be language specific reflecting instead a more general property of early visual processing. We thus investigated the asymmetry of visual processing using behavioral and scalp-recorded event-related brain potential, ERP measures, as a first step toward answering this question. Participants were asked to detect a target letter embedded in a non-wordlike letter string presented either spanning fixation or non-foveally lateralized to one or the other visual field (VF). Recognition accuracy dropped-off with target distance from fixation, more so in the left- than right-VF. Other effects that also were more pronounced in the left-VF were lower accuracy, the greater the number of letters in the target's VF and the greater the target distance from fixation. Over non-occipital sites, the P2 was smaller and later for lateralized than for bilaterally-symmetric stimuli. The occipital N190 to bilaterally-symmetric stimuli was asymmetric -- larger over the right than left hemisphere. The N190 onset and peaked earlier for foveally-lateralized than for bilaterally-symmetric stimuli, over contralateral occiput. For non-foveally-lateralized stimuli, the N190 was larger over contralateral than ipsilateral occiput, with smaller ipsilateral amplitudes relative to those for bilaterally-symmetric stimuli. These systematic changes as a function of stimulus foveation, lateralization and visual fields, suggest that electrophysiological investigations of this type may prove useful to an understanding of the asymmetry of OVP.

B34

DIFFERENTIAL EFFECTS OF NATURAL AND ARTIFICIAL DISTINCTIVENESS ON FACE LEARNING AND ITS NEURAL CORRELATES Claudia Schulz[1], Alexander Kurt[1], Juergen M. Kaufmann[1], Stefan R. Schweinberger[1]; [1]University of Jena, Germany — Distinctive faces are easier to learn and recognize than typical faces. We used spatial caricaturing to investigate effects of natural compared to artificial distinctiveness on performance and neural correlates of face learning. Naturally distinctive faces and spatial caricatures of other faces (matched for rated distinctiveness) were identified in a pilot study. In a blocked learning paradigm, we presented naturally distinctive, non-distinctive, and caricatured faces that were later recognized among novel faces in a face familiarity test. We presented different pictures of the same identity at learning and test to avoid picture learning. A main effect of distinctiveness indicated higher accuracy for naturally distinctive than for spatially caricatured faces, which in turn were recognized better than non-distinctive faces. Reaction times showed a similarly clear advantage of naturally distinctive faces. During learning, both types of distinctive faces compared to non-distinctive ones elicited more negative occipitotemporal ERPs during the P200 and N250 time windows. During recognition, only naturally distinctive learned faces elicited a more negative N250. Overall, although both types of distinctiveness seemed to affect face encoding in a similar manner during learning, spatial caricaturing alone is not sufficient to elicit recognition benefits similar to those caused by natural distinctiveness.

B35

CATEGORICAL REPRESENTATION OF VISUALLY SUPPRESSED OBJECTS IN VISUAL CORTEX Gideon Caplovitz[1,2], Michael Arcaro[2], Sabine Kastner[2]; [1]University of Nevada Reno, [2]Princeton University — The relationship between the fMRI-derived object representations and the conscious experience of a particular object remains poorly understood. Recent studies suggest that in the absence of awareness, specific cortical regions differentially represent different objects categories. However, drawing strong conclusions about a categorical representation within specific brain regions is difficult since these studies have focused only on pairs of object categories and constrained analyses to very restricted and/or loosely defined regions of cortex Here, we applied fMRI combined with continuous flash suppression to investigate representations of visually suppressed objects across occipital, parietal, and temporal cortex, including faces, houses, tools and scrambled objects in our analyses. Univariate and multivariate (MVPA) analyses were conducted within functionally defined retinotopic areas: V1, V2, V3, V4 and V3A/B, V7, IPS1-5, SPL1 and object category areas: OFA, FFA, PPA, LOC and EBA. In the invisible conditions, univariate analyses found no differences in BOLD signal across object category in any ROI. In contrast, the MVPA yielded above-chance performance classifying the four image categories within the FFA and PPA as well as IPS2, IPS3, IPS4 and IPS5. However, secondary pairwise MVPA revealed that this performance was largely mediated by differentiating between intact and scrambled images in all but the FFA in which faces could be dissociated from houses. However, within the FFA the MVPA could not dissociate faces from tools or scrambled pictures. We therefore find little evidence for categorical representation of suppressed images and reveal an intermediate 'intactness' stage of representation in both the ventral and dorsal streams.

B36

THE BINDING RING: CONFIGURAL CONSTRAINTS ON SIZE PERCEPTION J. Daniel McCarthy[1], Colin Kupitz[1], Gideon P. Caplovitz[1]; [1]University of Nevada, Reno — Our percept of an object's size arises from the integration multiple sources of visual information including retinal size, perceived distance and relative size. This constructive process is revealed through a number of classic illusions such as the Mueller-Lyer illusion, the Ebbinghaus illusion and those illustrating size constancy. Here we present a novel size illusion that we have named the Binding Ring Illusion that is not easily explained by existing models of size perception. The perceived radius of a circular array of elements will be smaller if an additional circle is superimposed upon the array. Methods: Using the method of constant stimuli, observers were presented with two arrays (one with a binding ring and one without), and asked to decide which was bigger. The results of Experiment 1 indicate the influence of the binding ring is quite strong and consistent across subjects. In experiments 2 and 3 we investigated possible role of occlusion and depth ordering of the binding ring. Paradoxically, the results of the latter two experiments suggest that the size distortion depends upon the entire binding ring being visible and consistent with it being in front of the array. We consider the results of the current study in context of models of size perception.

B37

THE CAUSAL ROLE OF IPS IN VISUAL CONSCIOUS EXPERIENCE: A FUNCTIONALLY-GUIDED TMS INVESTIGATION Chiara Mazzi[1], Francesca Mancini[1], Silvia Savazzi[1]; [1]University of Verona — In a recent study we found that TMS applied over the intraparietal sulcus (IPS), can generate contralateral static phosphenes. One important question is whether IPS phosphenes are uniquely generated by the parietal cortex, independently from the contribution of occipital areas. To answer this question we better characterized the parietal phosphenes to find possible differences in terms of detection threshold (PT), eccentricity, size, vividness and brightness with those evoked by stimulation of the occipital cortex. Single-pulse magnetic stimulations were administered with a 90 mm figure-of-eight coil, assisted by an optical neuronavigational system. Individual stimulation sites were functionally identified in a region within a circle of 2 cm of diameter centered on P3 or O1 by stimulating with supra-threshold intensities. To determine PT the "method of constant stimuli" was used. In addition, subjects were requested to make drawings of the phosphenes as to obtain the exact eccentricity and size and to rate their sensation with respect to the vividness and brightness of previous evoked perceptions on a scale (from 1 to 10). Eleven subjects participated in the study. Results showed that the PT was reliably lower for occipital (64.7% of maximum stimulator output, MSO) than for parietal (76.3% of MSO) TMS stimulation. Also, eccentricity, size and perceptual features were modulated by the stimulation sites. These findings corroborate out hypothesis that parietal cortex can be an independent neural generator of phosphenes. These data are in line with fMRI data proving the existence of small visually responsive areas in parietal lobes.

B38

THE BLURRING OF BODY TIME AFTER RIGHT IPL GLIOMA RESECTION Silvia Savazzi[1], Barbara Emanuele[1], Barbara Santini[1,2], Andrea Talacchi[1,2], Giada Zoccatelli[2], Franco Alessandrini[2]; [1]University of Verona, [2]Borgo Trento Major Hospital, Verona — In the Libet's task subjects are asked to push a button at the time of their own choosing and to report the position of a clock's hand when they first make a decision to move. This task can thus tap the ability to consciously identify the instant in time when an intention to move emerges. Again, if a rubber-hand and the subject's (hidden) hand are stroked, repeatedly and synchronously, the subject feels as if the rubber-hand were part of her/his own body. Importantly, this effect disappears if the stimulation is asynchronous, indicating a strict time window for this illusion to emerge. Here, a 43 years old right-handed woman was asked to perform both tasks before and after resection of a right inferior parietal lobe glioma. With the Libet's task, before surgery the patient estimated the time she first intended to move 306 ms in advance of the movement onset (estimate of movement execution -73 ms); after surgery, however, the time of the intention to move (-96 ms) and the time of the movement execution (-68 ms) were estimated close to that of movement onset. With the rubber-hand illusion (RHI), before surgery a RHI for both hands was found for synchronous stimulation only. However, after surgery, for the left (contralesional) hand the illusion was also present for asynchronous stimulation. These data show that a right IPL lesion can affect body time, both in terms of awareness of motor intentions and of the integration in time of visual and somatosensory information.

B39

FAILURE TO RECOGNIZE A MANIPULATED TARGET DURING SEARCH Grayden Solman[1], Daniel Smilek[1]; [1]University of Waterloo — Two experiments were conducted using a novel search paradigm, in which observers use the mouse to sort through a 'stack' of items to locate the target. In these experiments we find that with surprising frequency observers will select and move the target during search, but fail to recognize it. In these cases, where the target has been errantly rejected, subsequent search is in some cases both slower and less efficient than on comparable non-miss trials. The experiments presented show that the prevalence of this error is not influenced by either set size or dual task manipulations. However, both the prevalence and the consequences of the error are greater when observers search among items that require focal inspection to be identified. We argue that this is a novel kind of performance error, arising from the embodied character of the search task. In particular, we suggest that the error reflects a dissociation between the perceptual processes responsible for sampling the available information in the display, and the motor processes responsible for rearranging the display to make more information available. We propose that the error occurs when these two processes operate on different items, a situation made more likely by increasing the similarity between targets and distractors, forcing perceptual processes to use focal inspection, while motor processes may operate on both focal and peripheral items.

B40

WHO DID WHAT? THE INTERACTION BETWEEN TOOL AFFORDANCE AND THE SENSE OF AGENCY IN THE EXTRASTRIATE BODY AREA Hyojeong Kim[1], Jeongho Park[1], Do-Joon Yi[1]; [1]Yonsei University, Seoul, Korea — While we interact with the other people or objects, the brain continuously updates our own body schema to recognize the agent of observed actions. The Extrastriate Body Area (EBA) provides an initial interface for the sense of agency by integrating visual inputs of body parts with internal signals related to self-generated body movements. Less is known, however, about how the functional use of tools contributes to such processes. Here, we investigated whether tool-specific affordance would differentially affect the neural responses in the EBA depending on the agency of imaginary actions. In each trial we presented a picture of an object in a rectangular frame. Objects were either the tools typically brought towards the body (body tools; e.g., cup, earphones) or away from the body (world tool; e.g., pen, dice; Rueschemeyer et al., 2010). Depending on the color of the frame, participants imagined either themselves or the other person using the tool (self vs. other conditions). These four types of trials were randomly intermixed with blank trials. As results, independently localized EBA regions of interest showed greater activation when participants imagined themselves using body tools than using world tools whereas no such differential activations were found when they imagined the other person using the tools. The postscan test revealed no significant difference in vividness of imagery between the self and other conditions. Our results suggest that the EBA incorporates functional affordance of tools into the body schema in order to enhance the sense of agency and to guide our own actions.

Thinking: Decision Making

B41

AUTOMATIC PROCESSING OF POLITICAL PREFERENCES IN THE HUMAN BRAIN Anita Tusche[1], John-Dylan Haynes[1]; [1]Bernstein Center for Computational Neuroscience Charité - Universitätsmedizin, Berlin — Political preferences are widely assumed to be based on rational and thoughtful deliberations. However, recent evidence indicates that preferences might be considerably influenced by fast, automatic processes. Using functional magnetic resonance imaging we investigated whether brain responses during automatic processing and automatic mental associations could be used to reveal individual political preferences. More precisely, the study tested whether neural activation patterns obtained during implicit processing of faces of famous politicians encode preferences for associated political parties. To address this question, 18 participants were instructed to perform a demanding visual fixation task while their brain responses were measured. From time to time, task-irrelevant faces of German politicians were presented in the background of the screen. Subsequent to scanning, explicit and implicit measures of party preference as well as face-specific valuation ratings were obtained. Importantly, during the acquisition of brain responses participants were naïve about the necessity of these subsequent preference judgments and were busy performing the fixation task. Multivariate pattern classification was then applied to search for brain areas that contain reliable information on party preferences. Activation patterns in the dorsomedial Prefrontal Cortex (dmPFC) were found to contain stable information on preferred and non-preferred political parties associated with politicians presented in the experiment. Moreover, average neural responses within this brain region showed strong linear correlations specifically with implicit measures of party-preference (D-score of Implicit Association Test). This reliable information on party-preference in the dmPFC might reflect automatic mental associations triggered by the task-irrelevant faces of politicians.

B42

PREFRONTAL ACTIVITIES CONTRIBUTING TO REWARD EXPLORATION James Cavanagh[1], Christina Figueroa[1], Michael Cohen[2], Michael Frank[1]; [1]Brown University, [2]University of Amsterdam — This investigation sought to determine the EEG reflections of exploratory decisions and reward feedback evaluation in a reinforcement learning task. Participants performed a "time-conflict" task in which reward frequency, magnitude, and expected value varied as a function of response time, requiring exploration to discover the optimal response. Previous work has suggested that participants make exploratory response time adjustments in the direction of greater outcome uncertainty, and that this uncertainty-driven exploration varies as a function of prefrontal activation and genotype. However, the timecourse of uncertainty computations, and their relation to neural signatures of feedback evaluation, remain unknown. To quantify uncertainty and reward expectation, a reinforcement learning model was fit to individual participant responses. Model fits indicated that participants adjusted responses in the direction of greater outcome uncertainty. Relative uncertainty was associated with broad frontopolar and lateral frontal power increases during response decision times, fitting with previous fMRI findings. Mediofrontal ERP components to feedback (N2,P3,N4) showed a clear distinction whereby negative prediction error (PE) signals were larger than positive PE signals. Replicating previous studies, the degree of negative PE significantly correlated with mediofrontal theta power. Unlike previous studies and unlike the ERP findings, the degree of positive PE significantly correlated with mediofrontal theta power, with an additional significant relationship with mediocentral delta. These findings suggest that there are a multitude of overlapping effects that contribute to EEG signatures of learning and exploration. Anterior frontal areas appear to contribute to pre-response exploratory decisions whereas mediofrontal areas contribute to post-response performance evaluations.

B43

WHY DO WE VALUE FREEDOM? GENETIC POLYMORPHISM PREDICTS THE IMPACT OF CHOICE ON LEARNING Jeffrey Cockburn[1], Michael J. Frank[1]; [1]Brown University — It is typically assumed that prediction errors encoded by the midbrain dopamine system provide a global learning signal to the basal ganglia. However, unstructured learning signals such as these can result in poor spatial credit assignment, with prediction error signals assigning credit (or blame) to neural populations that should not be associated with the unpredicted outcome. We hypothesise that the basal ganglia helps solve its own credit assignment problem by imposing a structure upon prediction errors targeting the striatum via disinhibitory projections from basal ganglia output onto neurons in midbrain dopamine system. We investigate this hypothesis by examining individual learning differences in a variant of a probabilistic learning task that has been associated with polymorphisms of genes expressed in striatum. During a training phase, pairs of stimuli were presented and participants were asked to learn their reward contingencies. Half of the stimulus pairs could be freely sampled, whereas sampling in remaining pairs was forced. Our results revealed an effect of gene group on task performance and on the structure of the Q-learning model that best explained trial-by-trial performance in line with our proposed hypothesis such that participants with increased basal ganglia gating exhibited benefits of superior spatial credit assignment. These results suggest that decisions improve spatial credit assignment, and thus provide a potential explanation for the apparent inherent reward of the freedom to choose.

B44

BOLD RESPONSE DURING PASSIVE VIEWING OF STIMULI PREDICTS SUBSEQUENT ECONOMIC CHOICE Alec Smith[1], Doug Bernheim[2], Colin Camerer[1], Antonio Rangel[1]; [1]California Institute of Technology, [2]Stanford University, [3]California Institute of Technology, [4]California Institute of Technology — We studied whether brain activity during passive viewing of food images contains information that is predictive of later choices.

The study has two objectives: First, does the brain compute value automatically, or are values only computed at the time of choice? We also ask a methodological question: can BOLD signals acquired during passive viewing of choice items be used to predict subsequent choices? 17 hungry subjects passively viewed images of foods during functional imaging. After scanning, the subjects made choices from pairs of the foods shown in the scanner. We extracted the BOLD signals corresponding to each food and used these signals together with subject choices to train a penalized logistic classifier to predict out-of-sample choices from BOLD signals. The classification procedure correctly predicted greater than 60% of subjects' choices (between subject average). This average prediction rate is significantly better than chance. On an individual level, prediction rates for a majority of subjects were significantly greater than chance at a 5% threshold. These results suggest that neural activity during passive viewing contains information that is predictive of future choices. The results provide evidence that the brain automatically encodes components of value, and that these components are both observable and predictive of choices.

B45

THE VMPFC COMPUTES VALUES AT THE TIME OF DECISION-MAKING EVEN WITHOUT CONSCIOUS AWARENESS OF THE STIMULI Leila Montaser-Kouhsari[1], Ralph Adolphs[1,2], Christof Koch[1,2], Antonio Rangel[1,2]; [1]Division of Humanities and Social Sciences, California Institute of Technology [2]Computation and Neural Systems, California Institute of Technology — A large number of studies have shown that the vmPFC encodes stimulus value signals at the time of decision-making. We used human fMRI to investigate the influence of perceptual awareness on value computation. Specifically, we asked if perceptual awareness was necessary for the neural computation of stimulus value, and if not, whether similar networks are involved in computing stimulus value in both the presence and absence of perceptual awareness. Participants completed two tasks. In Experiment 1, they viewed aversive or appetitive food items and indicated how much they would like to eat them. In Experiment 2, we used forward and backward masking to induce perceptual invisibility. The same food items from Experiment 1 were presented twice (visibly and invisibly) and the same participants were asked again to rate how much they would like to eat each food item. Participants were asked to make these decisions naturally by focusing on whatever freely came to their mind for both visible and invisible trials. For visible trials, we found that neural activity in the vmPFC and ventral striatum correlated with each participant's subjective value for food items collected in Experiment 1. For invisible trials, although participants' behavioral rating was at chance level, neural activity in these regions again reflected the participant's decisions from Experiment 1. In sum, we found that similar networks are involved in computing the stimulus value at the time of decision-making both in the presence and absence of perceptual awareness.

B46

VISUAL FIXATIONS AND PURCHASING DECISIONS Ian Krajbich[1], Dingchao Lu[1], Antonio Rangel[1]; [1]Caltech — We now know that visual fixations play a crucial role in two-item and multi-item choice by biasing the drift-diffusion choice process towards the item that is being fixated. Here, we investigate whether visual fixations play a similar role in purchasing decisions. In the first stage of the experiment, subjects reveal their values for 50 different consumer goods using an incentive-compatible BDM auction. In the second stage (300 trials), subjects see one of the items and one of six random prices. Their decision is whether to purchase the item at that price. During these decisions we record subjects' eye movements at 50Hz, as well as their choices and reaction times. We then use maximum likelihood estimation on the choices and reaction times to fit a modified drift-diffusion model where there is more evidence accumulated for an option when it is fixated than when it is not fixated. The naïve hypothesis was that purchasing decisions would obey the same drift-diffusion process as with two-item or multi-item choice, since the unchosen item(s) can be thought of as an opportunity cost, analogous to a real dollar cost. Instead, we find that the decision process in purchasing decisions is substantially different. We no longer find a strong drift bias due to visual fixations. As before, we find that final item fixations are shorter than the other item fixations, cut short by barrier-crossings, but for final price fixations we find no such trend.

B47

TRANSACTION RELATED VALUE SIGNALS IN THE BRAIN ARE ASSOCIATED WITH SUBOPTIMAL TRADING IN AN EXPERIMENTAL STOCK-MARKET Cary Frydman[1], Nicholas Barberis[2], Colin Camerer[1,3], Peter Bossaerts[1,3,4], Antonio Rangel[1,3]; [1]Division of Humanities & Social Sciences, Caltech, [2]Yale School of Management, [3]Computational and Neural Systems, Caltech, [4]SFI, Ecole Polytechnique Fédérale Lausanne — A growing body of evidence suggests that investors often make sub-optimal financial decisions. It has been proposed that some of these mistakes result from value computations by the brain's decision making circuitry that induce individuals to maximize the hedonic experience associated with individual trades, instead of maximizing overall portfolio returns. We tested this hypothesis by measuring neural activity with fMRI while subjects made buying and selling decisions in an experimental stock market. With respect to selling mistakes, we found that activity in the ventromedial prefrontal cortex (vmPFC) and ventral striatum (vSt) correlated with a realization utility signal at the time of making selling decisions that measured the profit or loss associated with selling individual stocks. The strength of the realization utility signals correlated with individuals' propensity to make selling mistakes. With respect to buying mistakes, we found that activity in the vSt correlated with a regret signal at the time of price updates that measured the forgone profits from not having purchased a successful stock. The strength of the regret signals correlated with individuals' propensity to make buying mistakes.

B48

LOSS AVERSION IN RISKY CHOICE IS MODULATED BY DIFFERENTIAL ATTENTION TO LOSSES Vanessa Janowski[1], Antonio Rangel[1]; [1]California Institute of Technology — A large body of behavioral evidence has shown that individuals exhibit loss aversion at the time of risky choice in the sense that losses are weighted more heavily than gains of equal magnitude and likelihood. Based on recent research by our group, which has shown that attention affects the computation and comparison of values during simple choices, we hypothesized that differences in loss aversion could be modulated by differential attention to losses. In particular, we hypothesized that individuals who pay more relative attention to losses would exhibit more loss aversion, and that controlling for value, random increases in the relative amount of attention paid to losses would result in more loss averse choices. We tested these hypotheses using a simple eye-tracking choice task in which subjects made binary choices between risky options and a constant sure outcome. Each lottery was comprised of a gain and loss component, as well as percentages indicating the likelihood of receiving each, all of which varied across trials. Eye-tracking allowed us to observe the amount of time subjects spent looking at both gains and losses. We then estimated the parameters of a prospect theory model for each subject, and also for pooled trials with above and below average relative fixations to losses. Consistent with the first hypothesis, we found that more loss averse subjects paid more relative attention to losses. Consistent with the second hypothesis, we found that individuals were more loss averse in trials in which they paid more relative attention to losses.

B49

AN FMRI STUDY OF THE BASAL GANGLIA'S ROLE ACROSS MULTIPLE CATEGORY-LEARNING SYSTEMS Brian Spiering[1], Kurt Braunlich[1], Carol Seger[1]; [1]Colorado State University — Multiple systems in category learning have been established throughout the last decade via multiple research methods. The current fMRI study investigates the neural correlates associated with the most commonly studied systems. Prior to scanning, participants learned the following three different category structures: unstructured (US), ruled-based (RB) and information-integration (II). In

US tasks, each stimulus is learned individually; there is no rule, verbal or nonverbal, that facilities performance. In RB tasks, participants learn to correctly classify the RB stimuli via an explicit reasoning process. In II tasks, information from both stimulus dimensions is integrated at a predecisional stage. The participants saw similar stimuli for each structure, but a colored box around the stimulus cued the three different structures, i.e., red for US, blue for RB, and green for II. Participants were cued to switch between three different structures every 15-20 trials. Basal ganglia (BG) activation and left hippocampal deactivation were associated with successful categorization across all category structures. Additionally, successful US categorization was associated with activation in the parietal cortex, successful RB categorization was associated with activation in the frontal lobe, and successful II categorization was associated with activity in both parietal cortex and frontal areas, as well as strong activation in visual areas. Switching between the respective systems modulated activity in the basal ganglia.

B50

ANTICIPATION AND HEDONIC REACTION TO REWARDS VERSUS LOSSES IN SCHIZOPHRENIA Jenna Reinen[1], L. Fredrik Jarskog[1,2,4], Robert J. Kribs[1], Catherine Insel[1], Andrew Rosenfeld[2], Daphna Shohamy[1], Tor Wager[3], Edward E. Smith[1,2]; [1]Columbia University, [2]New York State Psychiatric Institute, [3]University of Colorado at Boulder, [4]University of North Carolina at Chapel Hill — Converging evidence in human and animal studies has shown that dopamine signaling underlies incremental, feedback-based learning, which supports the brain's ability to anticipate outcomes from associative cues. Dysfunctional signaling may result in deficits in predicting and/or updating hedonic value of outcomes, which has been shown to exist in patients with schizophrenia. However, the extent to which dysfunction is related to the motivational deficits associated with the negative symptom domain of schizophrenia (e.g., anhedonia, avolition, flattened affect), and how this differs in goal-seeking versus loss-avoiding contexts, is not well understood. To address this question, we tested patients with schizophrenia with a range of symptom pathology, and healthy controls. On each trial, subjects made a choice, received feedback, and then received a reward. In the "reward" condition, correct feedback was associated with monetary gain, whereas in the "loss" condition, correct feedback was associated with avoiding monetary loss. Our findings indicate that while controls outperformed patients, the patients performed relatively better in the loss condition than the gain condition, as indicated by selection of optimal choices, feedback sensitivity, and model-based analyses. Further, performance in the gain condition was negatively correlated with increasing negative symptoms. Performance in the loss condition was positively correlated with working memory. These findings suggest a relatively selective deficit in incremental learning in the context of seeking rewards, which may be related to dysfunctional signaling in cortico-striatal dopamine pathways. FMRI is currently being used to examine brain systems supporting choice, anticipation, and hedonic reaction in patients with schizophrenia and controls.

B51

VALUE TRANSFER IN SENSORY PRECONDITIONING IN PARKINSON'S DISEASE AND HEALTHY AGING G. Elliott Wimmer[1], Karin Foerde[1], Erin Kendall Braun[1], Daphna Shohamy[1]; [1]Columbia University — When stimuli are related through coinciding experiences, subsequent rewards and punishments associated with one pair member can impact preferences for the other. This value transfer effect, as demonstrated in the sensory preconditioning paradigm, has been known experimentally since the early days of conditioning research. However, the neural and cognitive mechanisms supporting sensory preconditioning remain largely unknown. Guided by recent animal research, we hypothesized that value transfer in this paradigm may depend on multiple cognitive processes and neural systems: the dopamine-innervated basal ganglia may support initial value learning, while the medial temporal lobe may be necessary for successful transfer of value. To explore the effects of aging and the role of dopamine in value transfer, we tested individuals with Parkinson's disease, healthy older adults, and healthy younger adults. In our sensory preconditioning paradigm, stimuli are first incidentally paired (with no reinforcement). Then, one stimulus from each pair is used as a predictor of reward. Finally, preferences are assessed in a test phase. Preliminary results indicate that Parkinson's patients were able to learn the reward and loss associations, with better learning for rewards than losses. Value transfer, assessed by preference for the incidentally paired but unrewarded stimuli, was variable in all groups, with moderately higher transfer of value for reward than loss. Preliminary results using additional measures of transfer suggest that Parkinson's patients show a different memory signature of value transfer than older adults, possibly due to its dependence on the interaction of memory systems susceptible to age- and disease-related functional impairments.

B52

MANIPULATION OF SENSORI-MOTOR TRANSFORMATIONS IN PERCEPTUAL DECISION MAKING Drew Erickson[1], Andrew Kayser[1]; [1]Ernest Gallo Clinic And Research Center — The ability to link sensation and action is integral to even the most simple and quick decisions. Previous studies have revealed a role of parietal cortex in both sensory and motor processing during perceptual decisions, but often these components can be difficult to dissociate. Recently, we demonstrated that a sensory manipulation of a decision task including relevant and irrelevant visual stimulus features dissociates BOLD activity within the intraparietal sulcus (IPS). If IPS is involved in sensori-motor transformations, then BOLD activity in the IPS should also dissociate during a motor manipulation of a decision task, with an increase when sensori-motor transformations are performed. In a variation of our previous task, subjects performing a dot-motion discrimination task responded with either button presses or saccades after a delay. Information for response modality and/or within-modality response mapping was given either during the presentation of the dot-motion stimulus or during the motor response cue, allowing for motor components to be dissociated from sensory discrimination components. Subjects' responses were increasingly accurate with increasing motion coherence, with no significant variation for task or modality. Investigation of BOLD activity in IPS showed that during the stimulus cue, activity is significantly greater when response information is given. Furthermore, activity following the response cue is stronger when the response information is given then instead, indicating that this increase coincides with the point when the subject is performing sensori-motor transformations. Examination of other regions of interest, such as FEF and IFS, should further define the network underlying motor planning and execution.

B53

OUTCOMES IN REWARD-PUNISHMENT CIRCUITRY – AN FMRI STUDY Krishna Pancholi[1], Shashwath Meda[1], Michael Stavens[1,2], Godfrey Pearlson[1,2,3]; [1]Olin Neuropsychiatry Research Center, Institute of Living at Hartford Hospital, [2]Dept. of Psychiatry, Yale University School of Medicine, [3]Dept. of Psychiatry, Johns Hopkins University — Background: Few neuroimaging studies focus on the outcome of tasks assessing reward/punishment. We hypothesized that fMRI-measured brain activity in 178 screened, healthy subjects during performance of a monetary incentive delay (MID) task in reward and punishment outcomes would differ in regions comprising a well-described human reward neural system. Methods and Materials: From the above total, 95 subjects (age 24.76 ± 9.5 yrs, 65% women) had sufficient numbers of reward and 100 (age 25.26 ± 10.22yrs, 67% women) sufficient punishment trials to estimate brain activation. One-sample t-tests in SPM5 using small volume correction examined $5 reward relative to non-reward contexts, and $5 punishment relative to non-punishment outcomes for preselected regions-of-interest in NAcc, amygdala, insula, mesial prefrontal cortex (MPFC) and orbitalfrontal cortex (OFC) (significance evaluated using FDR). Results: In the Reward vs. Non-Reward outcome comparison, participants had greater activation to reward in bilateral NAcc ($q<.0.0001$), right MPFC ($q<.0.005$), right OFC ($q<.0.009$), and right amygdala ($q<.0.006$). Insula

activity was not significantly greater in the actual reward delivery context. Contrast of $5 Punishment vs. Non-Punishment outcome trials found that participants had greater activity in left and right MPFC ($q<.0.001$) and left and right OFC ($q<.0.0001$). Conclusions: Consistent with previous reports, most of the brain's reward system was shown to be engaged when actual rewards were delivered, emphasizing the personal salience of receipt rather than just knowledge of winning. In contrast, actual receipt of punishment elicited greater activation only in MPFC and OFC, suggesting these regions play a broader role in evaluating behavioral contingencies.

B54

RESPONSE-RELATED BRAIN POTENTIALS FOLLOWING CORRECT AND INCORRECT RESPONSES: EVIDENCE FROM TEMPORAL-SPATIAL PCA Tanja Endrass[1], Moritz Ischebeck[1], Norbert Kathmann[1]; [1]Humboldt-University Berlin, Germany — Two event-related brain potential components have been repeatedly reported following correct and incorrect responses, the error-related negativity (ERN) and the correct-related negativity (CRN). The functional significance of these components and its underlying processes are part of an ongoing debate. Recently, it was shown with independent component analysis (ICA) that the negativities following both responses can be accounted for by the same independent component that is corresponding to a dipolar source in the rostral cingulate zone. However, differential effects on ERN and CRN were reported with clinical or motivational variables. Further, ICA might not be capable to dissociate two components with similar timing and topography. With the present study we studied performance monitoring in a visual discrimination task with three difficulty levels and utilized a temporal-spatial principal components analysis (PCA) to examine whether ERN and CRN could be explained with one or more factors. Results indicate that the ERN was reduced with higher task difficulty whereas the CRN did not vary across difficulty levels. PCA revealed two spatial factors within the time course of response-related negativities that were characterized by a fronto-central distribution and significantly differed between correct and incorrect responses. These data support the idea that ERN and CRN might reflect a combination of two underlying cognitive processes that contribute to both components.

B55

DISTINCT REWARD-SEEKING AND LOSS-AVERSE SIGNALS DURING DECISION-MAKING IN THE BALLOON ANALOGUE RISK TASK (BART) Rena Fukunaga[1], Joshua W. Brown[1], Tim Bogg[1]; [1]Indiana University, Bloomington, IN — There is debate over the roles of the anterior insula (INS) and anterior cingulate (ACC) in decision-making. The present study focuses on distinguishing decision-making and feedback-related processes in the Balloon Analog Risk Task (BART) when subjects decide whether to pursue a gain while the probability of loss increases parametrically. We modified the BART relative to previous studies to address a confound between decision-related and feedback-related signals by including a longer variable delay, which allowed for independent analysis of choice vs. feedback-related brain activity. The results showed within-subjects correlations of brain activation with the probability of explosion during the decision-making period. When subjects chose to discontinue inflating the balloon (win option), we observed greater bilateral INS activity at the time of decision as the probability of explosion increased, consistent with increased loss-aversion. In contrast, we found robust ventral medial prefrontal cortex (vmPFC) and medial frontal gyrus (meFG) activity when subjects chose to continue inflating the balloon (risky option), consistent with reward-seeking. However, in the regions of ACC, right INS, thalamus (THAL), and middle frontal gyrus (MFG), BOLD activation decreased when subjects chose to inflate as the probability of explosion increased, —findings consistent with a reduced loss-aversion signal. This is the opposite of what has been found in previous studies that did not distinguish decision-making vs. feedback signals. Our results highlight the existence of distinct reward-seeking and loss-averse signals during decision-making, as well as the importance of distinguishing decision and feedback signals. Supported by NIH AA017877 (TB), A13650 (PF), DA026457 (JB).

B56

GENDER DIFFERENCES IN THE FEEDBACK-RELATED NEGATIVITY (FRN) IN A SIMPLE GAMBLING TASK Jill Grose-Fifer[1], Sheneeka Saul[1], Ozlem Yuksel-Sokmen[1], Tina M. Zottoli[1], Steven Hoover[1], Katherine Navarro[1]; [1]John Jay College of Criminal Justice, CUNY — Men are generally reported to show higher rates of risk taking than women. To investigate whether this prevalence might be related to gender differences in feedback processing, we compared the feedback related negativity (FRN) elicited in a simple monetary gambling task, in men and women. The FRN is thought to reflect the arrival of a dopaminergic reward prediction error in the anterior cingulate cortex (ACC), which serves as a rapid, relatively automatic, but coarse appraisal of the motivational impact of ongoing events. The error signal is believed to be important in developing avoidant behaviors that minimize risk taking. In this study, EEG was recorded while participants chose between two colored cards that appeared on the computer screen and then received feedback about their choice. Consistent with previous studies, the FRN was found be larger to losses than to gains. However, males but not females, also showed a significant magnitude (large, small) x valence (win, loss) interaction. Both males and females showed significantly larger FRNs for large losses compared to large wins. However, only females showed a significant difference between small wins and small losses. This suggests that while females clearly differentiated between wins and losses of any magnitude, males processed a small win much like a loss. Our results may help to explain why risk taking is more prevalent in men than women, since it appears that a small win is less rewarding for males.

B57

THE VALUE OF VICTORY - NEURAL MECHANISMS OF THE WINNER'S CURSE Wouter van den Bos[1], Arjun Talwar[1], Sam McClure[1]; [1]Stanford University, Department of Psychology — One of the most interesting but unresolved phenomena in auction behavior is the winner's curse — the strong tendency of participants to bid more than rational agent theory prescribes, often at a significant loss (Kagel & Levin, 2002). In order to determine the nature of the mechanisms that underlie this bidding behavior we set up a hyper-scanning (Montague et al., 2002) experiment in which 5 participants were simultaneously scanned while they participated in a competitive common value auction. In total, 25 healthy adults participated in this study from which we acquired 22 usable fMRI data sets. In a previous behavioral study we have showed that the level of social competition in auctions predicted the magnitude of the winner's curse (van den Bos et al., 2008). Furthermore, we observed that the magnitude of the curse declined over time, suggesting that bidding decisions are made on the basis of feedback acquired during the auction. Based on the hypothesis that bidding strategies (which depend on the expected values of bids) are the result of feedback-based learning and social values, we develop and employ an extended reinforcement learning model to fit behavioral and neuroimaging data. Our behavioral analyses showed that this model is able to predict the behavior of naïve auction participants. More importantly, fMRI analyses revealed that neural systems implicated in reinforcement learning (particularly the ventral striatum) correlate significantly with reward prediction errors from the best fitting learning models.

B58

EFFECT OF SINGLE MINIMAL DOSE OF ANTIPSYCHOTICS ON HEALTHY SUBJECTS: AN ERP STUDY IN A PRIMED SEMANTIC-CATEGORIZATION TASK Marie-Eve Hoeppli[1,2], Siamak Molavi[1], Mitchell Rodier[1,3], Marie Prevost[1,2], Claire Lionnet[1], J. Bruno Debruille[1,2]; [1]Research Center of the Douglas Mental Health University Institute, [2]Department of Neurology and Neurosurgery, McGill University, [3]Department of Psychiatry, McGill University — Previous research demonstrated effects on event-related brain potentials (ERPs) of symptoms of schizophrenia patients and of

schizotypal traits of healthy subjects. A recent work also showed ERP effects of the induction of paranoid feelings in healthy subjects. The present study was aimed at exploring the effect of a single and minimal dose (i.e., 2.5mg) of antipsychotic (i.e., olanzapine) taken on the eve of the testing of healthy subjects. We used the visual primed semantic-categorization task utilized in previous studies in normals and patients. Healthy participants (N=47) were tested in a double-blind placebo-control cross-over paradigm. With the medication, ERPs were slightly less negative in the N400 time window at fronto-central electrode sites for both the exemplars and the non-exemplars of the category used (i.e., the animal category). Unexpectedly, anterior slow positive waves (ASPWs) were larger with olanzapine than with the placebo within a 700-1200 ms post-onset time-window. ASPWs have been proposed to be related to more in-depth, re-evaluation processes that delay the return of the ERPs to the baseline. Further analyses of these data were made to investigate the focus of such re-evaluation. They revealed: 1) that the amplitudes of the ASPWs correlate with reaction times: faster subjects had greater ASPWs than slower subjects and, 2) that the ASPW difference found between the two conditions (placebo vs. olanzapine) does not exist in the case no response choice had to be made in the task. These results suggest that antipsychotics could boost re-evaluations of our choices.

B59

HOW ATTRACTIVENESS MODULATES THE SOCIAL INTERACTION IN THE ULTIMATUM GAME: AN ERP STUDY Nai-Shing Yen[1,2], Pei-Ling Chen[1]; [1]Department of Psychology, National Chengchi University, Taipei, Taiwan, [2]Research Center for Mind, Brain, and Learning, National Chengchi University, Taipei, Taiwan — Solnick and Schweitzer (1999) found the physical attractiveness did influence the decisions in the ultimatum game. However, the study didn't differentiate the underlying process and how the brain processes the information. In our experiment, the attractiveness of the proposer was manipulated. The reaction time, EEG data and subjective rating of participants as responders were recorded. Thirty undergraduates (15 males vs. 15 females) from National Chengchi University in Taiwan were recruited as participants. In subjective rating, it revealed that subjects rated the attractive proposers more attractive than non-attractive proposers. In behavior data, 2(attractiveness) X2(gender) X3(offer) ANOVA showed the reaction times under offer 10 and offer 30 were both longer than offer 50. Furthermore, the acceptance rate at offer 10 was lower than offer 30 and offer 50, also the acceptance rate of offer 30 was lower than offer 50. The other effects remained non-significant. In EEG data, a 2(attractiveness) X2(gender) X3(offer) x3(position) ANOVA was performed. A two-way interaction of attractiveness and gender and a three-way interaction of attractiveness, offer and position were observed in FRN (feedback-related negativity). It showed the non-attractive proposers elicited larger FRN than attractive proposers in female participants, but no difference was found in male participants. Furthermore, FRN was larger in frontal (FZ) when participants faced non-attractive proposers than attractive proposers under offer 30, but no difference was found under offer 10 and offer 50. With the findings of FRN, it revealed the attractiveness only had an influence under conflict situation in the ultimatum game.

B60

SIGNALS IN HUMAN STRIATUM ARE APPROPRIATE FOR POLICY UPDATE RATHER THAN VALUE PREDICTION Jian Li[1], Nathaniel Daw[1,2]; [1]Department of Psychology, New York University, New York, NY 10003, [2]Center for Neural Science, New York University, New York, NY 10003 — Influential reinforcement learning (RL) theories propose that "prediction error" signals in the brain's nigrostriatal system guide learning for trial-and-error decision-making. However, since different decision variables can be learned from quantitatively similar error signals, a critical question is what is the content of decision representations trained by the error signals. We used functional magnetic resonance imaging (fMRI) to monitor neural activity in a two-arm-bandit counterfactual decision task that provided human subjects with information about foregone as well as obtained monetary outcomes so as to dissociate teaching signals that update expected values for each action, vs. signals that train relative preferences between actions (a "policy"). The reward probabilities of both choices varied independently from each other. This specific design allowed us to test whether subjects' choice behavior was guided by policy-based methods which directly map states to advantageous actions, or value-based methods such as Q-learning where choice policies are instead generated by learning an intermediate representation (reward expectancy). Behaviorally, we found participants' choices were significantly influenced by obtained as well as forgone rewards from the previous trial. We also found human subjects' blood-oxygen-level-dependent (BOLD) responses in striatum were modulated in opposite directions by the experienced and foregone rewards but not by reward expectancy. This neural pattern, as well as subjects' choice behavior, is consistent with a teaching signal for developing "habits" or relative action preferences, rather than prediction errors for updating separate action values.

B61

THE NEURAL CODING OF PREDICTION ERRORS: DISSOCIATIONS BETWEEN ACTIVE AND OBSERVATIONAL REWARD-BASED LEARNING Christian Bellebaum[1], Daniel Jokisch[2], Elke Gizewski[2], Michael Forsting[2], Irene Daum[1]; [1]Ruhr University Bochum, Germany, [2]University Hospital Essen, Germany — Associations between stimuli and financial outcomes can be learned actively or by observation. Recent electrophysiological evidence suggests that the neural mechanisms of feedback coding differ depending on the active involvement of the subject. The present study examined potential differences in prediction error coding in active and observational learning from feedback using functional magnetic resonance imaging (fMRI). Two groups of fifteen subjects each, one learning actively and one by observation, participated in the study. On each trial, active learners chose between two abstract visual stimuli, followed by a probabilistic monetary outcome stimulus (50 C win, 0 C or 50 C loss). Each observational learner watched the choices and accompanying outcomes of one active learner. Subjects in both groups learned to predict the outcomes associated with particular stimuli. In active learners, positive and negative prediction errors were coded in the right basal ganglia (Putamen and Caudate Nucleus) and amygdala, respectively, while in observational learners the right hippocampus and the left insula were involved. As revealed by direct comparisons between groups, the right caudate nucleus was activated more strongly in active learners compared to observational learners, whereas the reverse pattern was found for the right hippocampus. These findings show that the neural coding of outcome prediction errors depends on the relevance of the feedback for the learning subject's behavior. The BG appear to link actively performed behavioral responses and the accompanying outcomes. Differential recruitment of the caudate and the hippocampus in active and observational learning may further indicate differences in learning strategies.

B62

IDENTIFICATION OF GENERALIZATION LEARNING DEFICITS IN PARKINSON'S DISEASE PATIENTS WITH IMPULSE CONTROL DISORDERS Rachel Jonas[1], Mark A. Gluck[1], Einat Levy-Gigi[1], Panida Piboolnurak[2], Claire Henchcliffe[2], Benjamin J. Dorfman[2], Melissa J. Nirenberg[2]; [1]Rutgers Memory Disorders Project, Center for Molecular and Behavioral Neuroscience Rutgers University-Newark, NJ, [2]Department of Neurology and Neuroscience, Weill Cornell Medical College, New York, NY — A subset of patients with Parkinson's disease who are treated with dopamine agonist therapy develop impulse control disorders (ICDs) such as pathological gambling and compulsive eating (Nirenberg and Waters, 2006). It has been postulated that patients with Parkinson's disease who are prone to ICDs may have a variant of Parkinson's disease characterized by a disproportionate impairment of mesocorticolimbic versus nigrostriatal dopaminergic function (Rabinak, 2010). Since the mesolimbic pathway provides direct input to the hippocampus, we hypothesize that Parkinson's disease subjects with ICDs might be impaired at hip-

pocampal-dependent learning, as compared with Parkinson's disease subjects without ICDs. We tested subjects with Parkinson's disease on dopamine agonist therapy with and without ICDs. Subjects were tested using a computer-based acquired equivalence task, in which they first use feedback-based learning to acquire information, and must subsequently generalize this information to novel contexts without the aid of feedback. This task has previously been used to show that subjects with Parkinson's disease have impairment at the striatal-dependent acquisition phase, and subjects with hippocampal atrophy have impairment at the hippocampal-dependent generalization phase (Myers, et al., 2003). We show that, although subjects with Parkinson's disease with and without ICDs perform similarly at acquisition, those with ICDs are impaired at generalization. Thus, Parkinson's disease subjects with ICDs perform more like subjects with hippocampal atrophy than like non-ICD Parkinson's disease subjects, providing further evidence for a mesocorticolimbic subtype of Parkinson's disease and highlighting the potential role of hippocampal dysfunction in the pathogenesis of ICDs.

B63

THE RECOGNITION HEURISTIC STUDIED BY EVENT-RELATED POTENTIALS (ERPS) Timm Rosburg[1], Axel Mecklinger[1], Christian Frings[1]; [1]Saarland University — The recognition heuristic describes a simple decision rule, saying that, when two objects have to be ranked with regard to a criterion and only one of the objects is recognized, the recognized object is ranked higher. Here, we investigated this heuristic in a city size comparison task by means of ERPs. Participants had to decide which of two cities has more inhabitants. To enforce the usage of the heuristic, only pairs of well-known and relatively unknown city names were presented. Data analysis revealed that participants chose the well-known city name in 90.5 % of the trials, resulting in 79.3 % correct decisions. ERPs to well-known city names were characterized by a larger positivity at early latencies (300-450 ms and 450-600 ms), as compared to unknown city names, while at later latencies (1000-1500 ms) unknown city names elicited more positive ERPs. We tried to predict the participants' decision on the basis of single trial EEG data in a binary logistic regression analysis. Just taking into account the fronto-central EEG data of the earliest time window (the putative correlate of familiarity related memory processes), we could predict 55.8 % of the decisions. EEG data of this time window remained a significant predictor, even when EEG data of later time windows were added to the regression model. Findings indicate that familiarity assessment, i.e. a form of context-free recognition, contributes to decisions made on the basis of the recognition heuristic.

B64

THE MAGNITUDE EFFECT IN INTERTEMPORAL CHOICE RESULTS FROM INCREASED SELF-CONTROL Bokyung Kim[1], Anthony Liatsis[1], Ian Ballard[1], Samuel McClure[1]; [1]Stanford University — People value options less as a monotonic function of their delay until delivery and choose immediate rewards over larger, delayed rewards due to this tendency. Previous work on intertemporal choices has shown that discount rates decrease dramatically as the value of individual options is increased, a phenomenon known as the magnitude effect. The dominant explanation for this finding depends on curvature of utility functions as at larger magnitudes. We report that this explanation is insufficient. In three experiments we demonstrate that the magnitude effect remains under the mere impression of larger magnitudes as created by changing the denomination of monetary offers. For example, Koreans in America and Americans in Korea are significantly more patient for Korean Won than US Dollars (approx. 1100:1 conversion rate). We hypothesized that the magnitude effect results from enhanced self-control, rather than systematic differences between subjective values. We find support for this hypothesis in a functional MRI experiment with 15subjects instructed to choose between smaller/immediate rewards and larger/delayed rewards. We analyze brain activity in two conditions – high and low magnitude. We find that higher magnitude recruits more activation in the lateral prefrontal cortex and posterior parietal cortex. Previous studies have shown that these areas are involved in executive functions including self-control. Additionally, there was no difference in dopamine-related regions across conditions. This study has confirmed that deciding in favor of long-term outcomes, especially for higher stakes, depends on the exertion of cognitive control and this effect can be evoked by the mere reframing of outcomes.

B65

RELIABILITY OF REWARD-RELATED NEURAL SIGNALS: DO YOU GET WHAT YOU PAY FOR? Charlene C. Wu[1], Andrew J. Trujillo[1], Gregory Samanez-Larkin[1,2], Brian Knutson[1]; [1]Stanford University, [2]Vanderbilt University — Early studies using functional magnetic resonance imaging (FMRI) to examine reward processing in humans identified increased blood oxygenated level-dependent activation in the nucleus accumbens (NAcc) during reward anticipation and in the mesial prefrontal cortex (MPFC) in response to reward outcomes (Knutson et al., 2001). These reward-related neural responses have recently been linked to individual differences in impulsivity (Beaver et al, 2006) and psychopathy (Buckholtz et al., 2010). However, the test-retest reliability of reward-related activation has been questioned (Fliessbach et al., 2010), implicitly raising concerns about the robustness of links to individual differences. In this study, participants (n=6) completed two FMRI sessions of a monetary incentive delay (MID) task separated by 2 years. During the MID task, participants anticipated and experienced the outcomes of six cue types signaling varying amounts of potential monetary gains and losses (±0.00, ±$0.50, ±$5.00). To examine test-retest reliability of activation, peak individual responses were extracted from both NAcc and MPFC volumes of interest across the two sessions. Test-retest reliabilities during reward anticipation in the NAcc and in response to reward outcomes in the MPFC demonstrated significant test-retest reliability (intraclass correlation coefficients of ~0.6) for the highest level of gain (+$5.00) but not for the lowest level of gain (+$0.00). Loss trials did not induce reliable activation. These preliminary findings suggest that reward paradigms that use a range of incentives may better establish test-retest reliability of reward-related neural activation, thus strengthening the support for using FMRI to index individual characteristics with potential relevance to decision making.

B66

LATERALIZED READINESS POTENTIAL REFLECTS A DYNAMIC REPRESENTATION OF REWARD IN A SPEEDED DECISION-MAKING TASK Sharareh Noorbaloochi[1], Dahlia Sharon[1], James L. McClelland[1]; [1]Stanford University — In perceptual decision making tasks, prior knowledge about choice payoffs biases decisions toward the higher paying alternative. However, little is known about how payoff information affects the neural circuits underlying these biased choices in human subjects. In this study, we recorded electroencephalography (EEG) signals from 13 participants while they performed a deadlined two-alternative forced-choice task. The participants had to determine whether a rectangle was longer to the left or right of center and squeezed a dynamometer with their left or right hand to respond. On each trial, payoff information was disclosed 1.5 sec prior to stimulus onset. Two stimulus difficulty levels were employed, and the payoff was either balanced (equal reward for both alternatives) or unbalanced (one choice worth twice as much as the other). All conditions were randomly interleaved. Behaviorally, with unbalanced rewards, fast responses were associated with high reward bias; bias was reduced for slower responses. Neurally, reward bias was observed in the lateralized readiness potential (LRP), a response-related negative-going potential contralateral to the responding hand, in two ways: (1) a shift in the baseline activity toward the higher reward alternative prior to stimulus onset, (2) an abrupt rise in activity toward the higher reward alternative 150-200 ms after stimulus presentation, before stimulus information started to affect the LRP. These results suggest that payoff information is reflected in preparatory activity in movement planning structures before sensory information is available. Furthermore, this biased preparatory activity increases quickly once movement is allowed but before stimulus information is integrated.

B67

WITH AGE COMES WISDOM: DECISION-MAKING IN YOUNGER AND OLDER ADULTS Darrell Worthy[1], Marissa Gorlick[2], W. Todd Maddox[2]; [1]Texas A&M University, [2]University of Texas at Austin — Frontal brain regions are implicated in model-based and striatal brain regions are implicated in model-free reinforcement-learning (Glascher et al., 2010). The model-based system develops and tests specific hypotheses regarding the task reward structure to guide decision-making. In contrast, the model-free system uses reward prediction errors to guide behavior. Older adults are thought to use "frontal compensation" mechanisms to offset age-based neural declines (Park & Reuter-Lorentz, 2009). We propose and test the hypothesis that older adults rely more on the model-based system, and younger adults on the model-free system. We present behavioral data from two choice-dependent tasks where the rewards available were dependent on previous choices. Because optimal performance requires uncovering the choice-dependent nature of the reward structures used, older adults should perform better than younger adults if they are relying more on the model-based system. In both versions, the decreasing option is short-run optimal, but the more that the decreasing option is selected the smaller are the rewards associated with both options. In the Increasing-Optimal version, the long-run optimal strategy is to repeatedly select the increasing option. In the Decreasing-Optimal version, the long-run optimal strategy is to repeatedly select the decreasing option. Younger adults (aged 18-24) performed similarly on both tasks, showing relative insensitivity to the difference in optimal strategy. However, older adults (aged 61-86) were highly sensitive to the nature of the optimal strategy and earned more points than younger adults on both tasks. This suggests that older adults may be better at flexibly responding to the reward environment.

B68

DECISION MAKING WITH EXPLICIT RULES IN PATIENTS WITH MULTIPLE SCLEROSIS Ashley D. Radomski[1], Christopher Power[2], Kenneth G. Warren[3], Ingrid Catz[3], Scot E. Purdon[4], Derek J. Emery[5], Esther Fujiwara[1]; [1]Department of Psychiatry, Faculty of Medicine and Dentistry, University of Alberta, [2]Departments of Medicine and Medical Microbiology & Immunology, Faculty of Medicine and Dentistry, University of Alberta, [3]Department of Medicine (Neurology), Faculty of Medicine and Dentistry, University of Alberta, [4]Department of Psychiatry, Faculty of Medicine and Dentistry, University of Alberta and Alberta Hospital Edmonton, [5]Departments of Biomedical Engineering and Radiology and Diagnostic Imaging, Faculty of Medicine and Dentistry, University of Alberta — Introduction: Previous studies on decision making in multiple sclerosis (MS) so far only used the Iowa Gambling Task (IGT) and included only patients with relapsing-remitting MS subtype. When MS-patients were reported impaired in the IGT, their deficits were unrelated to other neuropsychological dysfunctions. Here we used the Game of Dice Task (GDT), sensitive to aspects of decision making that rely on executive functions, in a mixed sample of relapsing-remitting (RR) and secondary progressive (SP) MS-patients. Methods: Unlike the IGT, the GDT assesses decision making by displaying decision rules and probabilities explicitly and therefore focuses on decision making aspects that rely more on executive than emotional functions. RR, SP MS-patients and demographically-matched healthy controls were studied. Only patients with MRI-confirmed diagnosis of MS were included. The GDT, a standard neuropsychological battery, questionnaires on mood, fatigue and disability were administered to all participants. Results: GDT netscores (risky minus safe decisions) were lower in patients than controls, with more pronounced deficits in SP MS. Patients' ability to benefit from feedback in the GDT was also impaired. Patients' Expanded Disability Status Scale scores (a clinical index for MS disease-severity) were negatively correlated with GDT performance. In patients, GDT performance was related to neuropsychological indicators of frontal lobe dysfunction. While mood was uncorrelated with GDT performance, fatigue did influence GDT but did not eliminate the correlations with frontal lobe functions. Conclusion: The GDT revealed decision making impairments in MS patients that rely on executive functions and covary with disease severity.

B69

INTEGRATION OF DISCONFIRMATORY BUT NOT CONFIRMATORY EVIDENCE IS ASSOCIATED WITH INCREASED ACTIVITY IN THE DORSAL ANTERIOR CINGULATE CORTEX (DACC) AND DECREASED ACTIVITY IN THE DEFAULT NETWORK Katie Lavigne[1,2], Jennifer Riley[2], Paul Metzak[1,2], Jennifer Whitman[1,2], Woodward Todd[1,2]; [1]University of British Columbia, Vancouver, Canada, [2]BC Mental Health and Addictions Research Institute, Vancouver, Canada — In the current study, we investigated neural regions associated with the processing of integrating disconfirmatory evidence using event-related magnetic resonance imaging (fMRI). 20 healthy participants completed a perceptual interpretation task, in which they rated the degree to which a morphed image composed of two different animals (e.g., 40% koala, 60% cougar) appeared to be an image of one animal or the other. Following a delay, participants were either presented with the same image (confirmatory evidence condition) or a second image of the animals morphed at a different ratio (e.g., 60% koala, 40% cougar; disconfirmatory evidence condition), and were asked to re-rate the images. Constrained Principal Component Analysis for fMRI (fMRI-CPCA) revealed five components, one of which was specifically responsive to integration of disconfirmatory evidence, and another specifically responsive to confirmatory evidence. While both networks involved activation in visual and right lateral prefrontal cortex, that responsive to disconfirmatory evidence additionally involved activation in the dorsal anterior cingulate cortex (dACC) and deactivation in the default network. These results suggest that the dACC, which has been implicated in the detection of conditions that require adjustments in the current cognitive state, is activated during the processing of disconfirmatory but not confirmatory evidence.

B70

EFFECTS OF AMBIGUOUS FEEDBACK ON LEARNING AND FEEDBACK-RELATED BRAIN ACTIVITY Benjamin Ernst[1], Marco Steinhauser[1]; [1]University of Konstanz — Feedback processing is crucial for adaptive decision-making. However, feedback can be ambiguous and different sources of feedback can provide contradicting information. In this case, it is necessary to select relevant, valid feedback while suppressing the processing of irrelevant, potentially invalid feedback. The present study used event-related potentials to investigate how learning in a simple choice task is influenced by automatic processing of irrelevant feedback. During a learning phase, participants had to guess which one of two stimuli was associated with reward, and feedback had to be processed to learn the correct response. Feedback was a Stroop color-word compound consisting of an irrelevant word providing potentially invalid feedback and a relevant but delayed presented color providing valid feedback. Performance in a subsequent test phase indicated that learning was impaired when relevant and irrelevant feedback dimensions were incompatible. The analysis of feedback-locked brain activity revealed that this effect did not reflect automatic learning from invalid feedback but rather impaired processing of relevant feedback due to interference from irrelevant feedback. Irrelevant feedback was not associated with feedback-related brain activity but led to a reduced feedback-locked P300 for relevant feedback when relevant and irrelevant feedback dimensions were incompatible. These results demonstrate that learning from feedback in decision making is strongly affected by automatically processed, irrelevant feedback.

B71

THE ROLE OF COGNITIVE CONTROL IN SUCCESSFUL ADAPTION TO VOLATILITY OF THE DECISION MAKING ENVIRONMENT Amy Bland[1], Alexandre Schaefer[2]; [1]University of Leeds, [2]University of Durham — Making optimal choices in an uncertain world requires continuous tracking of the stimulus-response-outcome (S-R-O) probabilities in our environment. This task can be made particularly challenging by SRO volatility (unexpected uncertainty), i.e. when the underlying SRO rule is fre-

quently changed. It has been previously suggested that cognitive control is recruited to facilitate adaptation to volatile and uncertain environments (Bland & Schaefer, under review). In order to further examine this possibility, we used a decision-making task with high SRO volatility in which each decision trial was preceded by a task depleting cognitive resources. 25 participants took part in a decision making task interleaved with an Erikson Flanker task using a 2 [Volatility (Volatile vs. Stable)] x 2 [conflict (congruent vs. incongruent)] design. Behavioural results revealed that the behavioural effects of volatility were increased when decision-making was preceded by an incongruent flanker trial. EEG/ERP results showed a significant interaction of volatility and congruency in an N1 component, driven by a larger volatility-related N1 after incongruent compared to congruent flankers. Consistent with prior ERP research on cognitive effort, the Volatility X Congruency interaction may reflect greater volatility-related demands on cognitive control systems when cognitive resources are depleted. These findings highlight the importance of the role of cognitive control and attentional processes for successful adaptation to volatile and uncertain contexts.

B72

PROBLEM GAMBLERS EXHIBIT ATYPICAL REWARD PROCESSING IN FRONTAL CORTEX FOLLOWING FEEDBACK DURING GAMBLING Scott A. K. Oberg[1], Gregory J. Christie[1,2], Andrew Butcher[1], Matthew S. Tata[1]; [1]University of Lethbridge, [2]Simon Fraser University — Problem or Pathological Gambling (PG) is a serious mental health disorder that affects approximately 2% of the North American population. It is increasingly conceptualized as an addiction, rather than an impulse control disorder, however the mechanism of addiction remains unclear. Unlike substance abuse, gambling behaviour is driven by sensory feedback – wins and losses – during a cognitive task. In gambling, the addictive stimulus crosses the blood-brain barrier via the retinae and basilar membrane. Previous research in healthy participants has shown that feedback during gambling tasks triggers stereotypical neural responses evident in the electroencephalogram (EEG) and in the Event-Related Potential (ERP). These include the Feedback-Related Mediofrontal Negativity (FRN), the feedback-related P300, and an increase in induced theta-band (4 - 7 Hz) power. We tested the theory that abnormal feedback processing characterizes brain activity in problem gamblers while gambling. EEG was recorded from non-gamblers and self-identified gamblers while they engaged in a computer version of the Iowa Gambling Task. Feedback following high-risk/high-reward bets triggered the FRN in both gamblers and controls, however in gamblers the FRN was preceded by a larger fronto-central difference not found in non-gamblers. We localized this early FRN in gamblers to medial frontal cortex using distributed source imaging (LORETA). We also found that feedback-induced theta power commonly found in such tasks was absent in gamblers. We conclude that EEG and ERP techniques reveal neurophysiological differences between gamblers and non-gamblers and suggest that this may lead to insights into the broader problem of reward processing in addictive behaviours.

B73

ELECTROPHYSIOLOGICAL MARKERS OF NICOTINE DEPENDENCE AND ANHEDONIA Laura Olsen[1], Kathleen Kelsey[1], Marc Kiviniemi[2], Sandra Wiebe[3], Dennis McChargue[1], Rick Bevins[1]; [1]University of Nebraska-Lincoln, [2]University at Buffalo, NY, [3]University of Alberta — Nicotine indirectly stimulates midbrain dopamine neurons, thereby enhancing the rewarding effects of cigarettes as well as salient environmental stimuli. A reduced neural response to reward is associated with nicotine dependence. The present study examined the relation between electrophysiological correlates of reward processing, nicotine dependence, and self-reported anhedonia, or the ability to experience pleasure. The Iowa Gambling Task (IGT) was used to examine decision making in a sample of 24 participants (50% smokers) matched on age, sex, and years of education, who completed the task while high-density event-related potentials (ERPs) were recorded. At centro-parietal leads, a reduced P300 across both high and low monetary reward conditions was associated with increased nicotine dependence among smokers (p's <.05). A left-lateralized negativity was found at frontal leads (LFN) across all task conditions. For low monetary reward trials, a less negative LFN was associated with higher self-reported anhedonia among all participants, and increased nicotine dependence among smokers (p's <.05). Smokers had a smaller LFN relative to non-smokers on low-monetary-gain trials that remained robust after controlling for self-reported anhedonia (p <.05). Findings from the present study identify the P300 and LFN as neurophysiological correlates of reward processing that differ across smokers and non-smokers, where the P300 is broadly associated with nicotine dependence, and the LFN is sensitive to differences between smoking groups and self-reported anhedonia. A reduced neural response to reward is associated with smoking dependence and pleasure capacity.

B74

THE VALUE OF EXPERIENCE: A DOUBLE ECHO FMRI STUDY OF THE MODULATION OF VALUE JUDGEMENT BY RECENT EXPERIENCE Timothy Mullett[1], Richard J. Tunney[1]; [1]University of Nottingham — New models of decision making emphasize the effect of recent experience upon value judgements. Mounting behavioural evidence supports this assumption, yet there have been few studies employing imaging techniques to identify underlying neural representations of these effects. We report an fMRI study investigating the neural response to objectively identical monetary rewards when presented in blocks with either comparatively higher or lower average reward value. Results show that BOLD response for the critical overlap value was not modulated by recent experiences. However, initial analyses suggest an activation in the Posterior Cingulate Cortex where BOLD response is higher during high value blocks. This activation is not modulated by the absolute values of individual stimuli on a trial by trial basis, which suggests a representation of long term average value which changes with the environment.

B75

SINGLE UNIT AND LOCAL FIELD POTENTIALS RECORD IN HUMAN VENTRAL STRIATUM DURING A REWARD TASK Bradley Lega[1], Kareem Zaghloul[2], Gordon Baltuch[1], Michael Kahana[3]; [1]University of Pennsylvania, Department of Neurosurgery, [2]National Institutes of Health, Department of Neurosurgery, [3]University of Pennsylvania, Department of Psychology — Substantial evidence obtained from animal studies suggests that the ventral striatum plays a central role in reward processing. More recently, deep brain stimulation (DBS) surgery has enabled researchers to extend neurophysiological recording during reward experiments to human subjects. We present data recorded from human ventral striatum during DBS surgery for the treatment of medically refractory major depression as a participant played a video game coupled to visual reward images. We describe the first evidence of reward-sensitive single unit activity in the human literature, and we present novel findings of oscillations that are responsive to different types of feedback. Local field potential data identify a prominent alpha oscillation sensitive to positive rather than negative feedback, and a beta oscillation that exhibits significantly higher during reward-neutral trials as compared to positive or negative feedback. Our findings have implications for establishing the relationship between animal and human data and for future generations of DBS stimulation technology targeted to the ventral striatum.

B76

ANTICIPATION- AND OUTCOME-RELATED SKIN CONDUCTANCE RESPONSES IN AN EXPLORATION-EXPLOITATION TASK A. Ross Otto[1], W. Bradley Knox[2], Tyler Davis[1], Arthur B. Markman[1], Bradley C. Love[1]; [1]Department of Psychology, University of Texas at Austin, [2]Department of Computer Science, University of Texas at Austin — Decision-making in uncertain environments poses a conflict between the goals of exploiting past knowledge in order to maximize rewards and exploring less-known options in order to gather information. It has been demonstrated that frontopolar cortex activity reflects the decision-maker's level of internal conflict (or uncertainty) about the state of the decision environment, and further, it is active when decision-makers forego valuable options in

order to make exploratory decisions. We reasoned that if deciding to explore versus exploit requires arbitrating conflicting beliefs about the currently optimal action, we should find increased autonomic arousal just prior to making exploratory choices. Using a simple repeated-choice task that affords unambiguous classification of participants' choices as exploitative or exploratory, we find larger skin conductance responses (SCRs) prior to making exploratory choices compared with exploitative choices, suggesting that the conflicting demands of exploration and exploitation are indexed by autonomic arousal. We also find elevated SCRs in response to "prediction errors" upon presentation of outcomes that violate previously learned payoff expectancies. Further, we specify an ideal observer model that performs incremental belief updates with respect to the currently optimal action. By elucidating hidden decision variables, we are able to evaluate the hypothesis that anticipatory SCRs index the decision-maker's degree of belief that the to-be-explored option is superior—thus, engaging higher-level control mechanisms—rather than merely indexing anticipation of cognitive or monetary costs as suggested by previous work investigating involvement of the autonomic system in decision-making.

B77

THE VMPFC VALUE SIGNALS ARE COMPUTED BY INTEGRATING VISUAL AND SEMANTIC INPUTS FROM FUSIFORM GYRUS AND THE PSTG Seung-Lark Lim[1], John O'Doherty[1], Antonio Rangel[1]; [1]California Institute of Technology — Dozens of fMRI and electrophysiology studies have shown that the vmPFC encodes stimulus value signals at the time of decision to guide choices. But very little is known about how those value signals are actually computed. We hypothesized that the stimulus values are computed by first assigning separate values to the stimulus attributes, and then integrating them into a common value signal. We tested this hypothesis using a semantic learning paradigm with novel Korean words and a subsequent fMRI choice task in which subjects made decisions about T-shirts depicting the Korean word in different colors and fonts. Participants who had no prior knowledge of Korean completed initial visual and semantic liking-ratings (day 1) and Korean learning sessions (day 2-3). In the fMRI experiment (day 4), participants rated their likings for Korean word art T-shirts. We found that activity in the fusiform gyrus (FG) correlated with the visual ratings of the stimuli, but not with the semantic ratings, while the opposite was true for activity in the left posterior superior temporal gyrus (pSTG). Consistent with previous studies, overall stimulus values were represented in vmPFC. Consistent with our hypothesis, the vmPFC showed stronger functional connectivity at the time of choice with the pSTG for the T-shirt stimuli containing words for which they new the meaning. Our findings suggest that the vmPFC computes stimulus values at the time of decision by integrating attribute values computed elsewhere in the cortex.

Thinking: Development & Aging

B78

NEURAL CORRELATES OF NONSYMBOLIC AND SYMBOLIC NUMBER PROCESSING IN CHILDREN Lisa Sprute[1], Margaret Gullick[1], Elise Temple[1]; [1]Dartmouth College — Previous studies using the neural distance effect (increased brain activity when differentiating numbers closer together) have indicated that number representations rely on a parietofrontal network. However, there have been no investigations of simple symbolic (digit) and nonsymbolic (dot) representation across development from childhood to adulthood. In a pilot event-related fMRI design, 17 children (ages 5 to 17) and adults compared pairs of dot arrays or digits (one through nine). Accuracy, reaction time and BOLD signal were measured for close (1-3) and far (5-7) comparisons. Distance was associated with extensive parietofrontal activation in both children and adults, collapsed across format. In the nonsymbolic condition, the neural distance effect was associated with increased parietofrontal activation for both children and adults, although children showed greater frontal activation, consistent with previous developmental research. Comparatively, in the symbolic condition, there was less activity for distance overall, and adults showed more parietal activation than children. These findings of number processing differences related to format have not been reported in the developmental literature previously.

B79

AN EARLY ERP MARKER FOR ARITHMETIC ABILITIES IN 7-YEAR-OLD CHILDREN Linda P.M. Essers[1], Lisa Jonkman[1], Erik van Loosbroek[1]; [1]Maastricht University — Behavioral studies indicate that number representations possibly relate to differences in arithmetical skill. Numbers are represented as if they form a 'mental number line'. Numbers close to one another share more representational overlap than numbers far apart, resulting in greater cognitive demands and prolonged reaction times. This representational effect is known as the distance effect (DE) but the neurophysiological basis for the relation between DE and arithmetical abilities is unknown. In the present study, 7-year-old children performed serial symbolic (Arabic digits) and non-symbolic (dots) comparisons for quantities smaller than 10 while concurrently EEG was recorded. Children's addition and subtraction abilities were assessed using a standardized mental arithmetic test. Behaviorally both symbolic and non-symbolic comparisons showed no relation with mental arithmetic but EEG data did. Whereas normally DE arises around 170 ms at parietal sites, our results showed a DE-effect earlier in time (around 123 ms) and at more occipital sites. It had a higher amplitude for close distances and coincided with the first positive ERP component, P1, a component considered to be reflecting early sensory processing. More importantly, only the symbolic DE of this component was negatively associated with arithmetical abilities in general and with subtraction specifically. The association with subtraction may be due to higher computational demands that rely on number representations in subtraction than addition. Although P1 modulation as an orienting effect is known from the visuospatial domain, a more definite interpretation of the DE effect for P1 awaits further investigation.

B80

LONGITUDINAL PREDICTORS OF MATHEMATICAL REASONING DURING DEVELOPMENT Chloe T Green[1], Kirstie J Whitaker[1], Joel S Steele[2], Ferrer Emilio[2], Bunge A Silvia[1]; [1]University of California, Berkeley, [2]University of California, Davis — The development of fluid reasoning (FR) is critical for academic achievement, and is thought to rely on specific cognitive processes such as working memory (WM) and processing speed (PS). As part of our longitudinal study on the development of fluid reasoning, we aimed to investigate how specific cognitive factors, namely, PS, Spatial WM (SWM), and FR measured at one timepoint differentially predict later mathematical reasoning (as measured by WJ Number Series test) at a second timepoint. We collected behavioral data from 201 participants ages 6-18 (M=10.3, SD=3.2) on a wide battery of cognitive assessments. Participants returned for a second wave of data collection approximately 1.5 years later (n=75). Results from our longitudinal analysis reveal that FR at time 1, measured by WASI Matrices, was the strongest predictor of math reasoning 1.5 years later (p=.0001). Spatial Working Memory (SWM) at time 1, measured by a computerized cognitive testing battery (CANTAB), was also a significant predictor of later math reasoning scores (p=.005). By contrast, PS at time 1 did not significantly predict math reasoning scores (p=.52). Findings support the theory that FR paves the way for the development of quantitative abilities by serving as a scaffold that allows a child to acquire other cognitive abilities, including numerical relations (Cattell, 1984). WM supports the emergence of math reasoning, as it enables individuals to maintain and manipulate goal-relevant information (Engle et al., 1999b).

B81

LONGITUDINAL CHANGES IN ANALOGICAL REASONING FROM AGE 6 TO 19 Kirstie J Whitaker[1], Elizabeth D O'Hare[1], Chloe T Green[1], Emilio Ferrer[2], Silvia A Bunge[1]; [1]University of California, Berkeley, [2]University of California, Davis — The most rudimentary form of analogical reasoning is captured by propositional analogy problems (e.g., cat is to mouse as lion is to…?),

in which it is necessary to abstract the semantic relationship between the first two items to identify the correct response. To examine within-person changes in this form of reasoning over childhood and adolescence, we developed a propositional analogy task involving pictures of common objects. 1st-order problems identified objects that were semantically related to a cued object. 2nd-order problems followed the A:B::C:? format, with four answer choices: the correct response, a semantic lure (semantically related to item C, but did not fit the 2nd-order relationship), a perceptual lure, and an unrelated lure. 109 participants (age 6-19, M= 11.2) performed this task; 22 have returned for a second testing session, ~18 months later. Performance improved quadratically with age ($p<.001$), with a large improvement on semantic lure problems from age 6-10. We conducted a mixed effects linear regression with the fixed effects of age, matrix reasoning and vocabulary predicting accuracy, and allowing a random intercept for the subjects with repeated measures. 1st-order problem accuracy was predicted by matrix reasoning score over and above the quadratic effects of age ($p<0.005$), but was not significantly predicted by vocabulary. 2nd-order problem accuracy was predicted by both matrix reasoning ($p<0.005$) and vocabulary scores ($p=0.01$), after correcting for age. Our data demonstrate not only the depth of semantic knowledge required for analogical reasoning but also the power of abstract reasoning in solving analogical problems.

B82

NEURAL MECHANISMS OF LOSS AVERSION ACROSS DEVELOPMENT Emily Barkley-Levenson[1], Linda van Leijenhorst[1], Adriana Galván[1]; [1]UCLA — Adolescence is a time of increased risk-taking; understanding the cause of this behavioral change across development is critical to the goal of preventing negative consequences of risky behavior. People differ in their willingness to take risk, and these individual differences are driven by differences in the combination of cognitive and affective processes. These processes engage separable neural mechanisms, which have been shown to mature at different rates. Differences in the function of these mechanisms lead to measurable individual differences in loss aversion, the tendency to avoid losses rather than seeking gains. To date developmental research has focused on the role of reward sensitivity in adolescent risk-taking, while the influence of losses and loss aversion on risky decision-making in adolescents remains poorly understood. Our goal was to investigate the neurodevelopmental trajectory of loss aversion, and explore how sensitivity to gains and losses drives risk-taking behavior across development. In this study, adolescent participants completed a modified version of a loss aversion task, in which they accepted or rejected mixed gambles with various gain and loss amounts while fMRI data were collected. Preliminary analyses of task performance showed no behavioral changes across age. A preliminary analysis of the imaging data revealed age-related changes in brain regions that show greater activation increases with increasing gain amounts and greater deactivation with increasing loss amounts, including the ventromedial prefrontal cortex and ventral striatum. These findings shed light on the developmental changes in loss aversion that may contribute to differences in risk-taking behavior during adolescence.

B83

STRESS MODULATES REINFORCEMENT LEARNING IN YOUNGER AND OLDER ADULTS Nichole Lighthall[1], Mara Mather[2], Michael Frank[3], Marissa Gorlick[4], Andrej Schoeke[5]; [1]University of Southern California, [2]University of Southern California, [3]Brown University, [4]University of Texas, Austin, [5]University of Southern California — Animal research indicates that stress increases dopamine levels in brain regions involved in reward processing and research with humans shows that stress increases the attractiveness of addictive drugs. The current study tested the hypothesis that stress increases reward salience, leading to more effective learning about positive than negative outcomes in a probabilistic selection task. Given well-documented changes to dopamine pathways with age, this study also examined whether effects of stress on reinforcement learning differed for younger (age 18-34) and older participants (age 65-85). Cold pressor stress was administered to half of the participants in each age group and salivary cortisol levels were used to confirm biophysiological response to cold stress. Following the manipulation, participants completed a probabilistic learning task involving positive and negative feedback. Stress enhanced positive feedback learning, with similar effects in younger and older adults. In addition, higher cortisol levels were associated with poorer negative feedback learning across age groups. These results suggest that recent stress increases the salience of rewards relative to negative consequences and exert a similar effect on reinforcement learning in early and late adulthood. These findings underscore the importance of considering stress-related influences on learning.

B84

DEVELOPMENTAL DIFFERENCES BETWEEN EXACT AND APPROXIMATE SUBTRACTION Liane Moneta[1], Bruce McCandliss[1]; [1]Vanderbilt University — Exact and approximate numerical processing engage different brain networks in adults, with exact number processing showing increased recruitment of the angular gyrus and approximate number processing showing increased recruitment of the intraparietal sulcus. To examine the development of these systems we created a non-symbolic subtraction paradigm to directly contrast these two systems in early elementary school children (grades K-3). Children viewed videos of a woman removing a small set of discs (1-7) from a bucket and selected which of three disc pictures (1, 2 or 3) showed how many discs remained in the bucket. By varying the exposure time of the numerosities, this paradigm isolates exact vs. approximate arithmetic processing. In the exact subtraction version, children had ample time to identify both operands in the subtraction problems. In the approximate version children viewed the operands for 125ms. Performance degraded systematically with set size, yet in different ways across the duration manipulation. For approximate subtraction, all grades showed the same effect of set size and similar error patterns. In contrast, exact subtraction set size effects changed dramatically across grade levels, with strongest effects occurring in kindergarten age children. Additionally, exact subtraction error distribution (ratio of one-away errors to two-away errors) showed a sharpening of acceptable responses with grade level, potentially reflecting progressive sharpening of 'number neuron' tuning curves. This paradigm provides cognitive metrics separating exact and approximate processes critical to studying development of these brain systems in fMRI.

B85

WHITE MATTER STRUCTURE UNDERLYING INDIVIDUAL DIFFERENCES IN CHILDREN'S MATH AND READING ABILITIES Arnaud Viarouge[1], Suzanne Avery[1], Bruce McCandliss[1]; [1]Vanderbilt University, Nashville, TN — Microstructural properties of distinct white matter tracts correlate with individual differences in academic performance in both typically and atypically developing children. For example, multiple studies demonstrate a consistent association between fractional anisotropy (FA) in the left Superior Corona Radiata (lSCR) and children's reading scores that are distinct from other cognitive abilities such as short term memory (Niogi & McCandliss, 2006). However, recent investigations linking mathematical abilities to FA in the lSCR (Van Eimeren et al., 2009, 2010) raise new questions regarding cognitive specificity. To examine this issue, 3T HARDI DTI scans were collected on 28 typically developing children (ages 6 to 16) along with standardized behavioural measures of math and reading skills, and non-verbal IQ. LSCR regions of interest (ROIs) were individually selected using the Reproducible Objective Quantification Scheme (ROQS). Results replicated previous findings associating standardized reading scores with FA in this region, which remained significant after controlling for age and IQ. In contrast, although scores of mathematical abilities were only marginally associated with FA in this region, multiple regression analyses demonstrated that math skills accounted for unique variance in FA after controlling for reading, suggesting that this region plays a role in both reading and math development.

B86

COGNITIVE RELATIONSHIPS BETWEEN NONSYMBOLIC ENUMERATION AND SYMBOLIC MATH FLUENCY Gillian Starkey[1], Bruce McCandliss[1]; [1]Vanderbilt University — Functional neuroimaging studies of symbolic arithmetic skill development indicate a developmental shift from frontal to parietal activity with increasing math fluency (Rivera et al., 2005), yet such developments are critically dependent on earlier cognitive developments in exact enumeration skills (Barth et al., 2005). The present study investigates two forms of cognitive development supporting fluency in nonsymbolic exact enumeration: the ability to sequentially enumerate random arrays, versus the ability to more rapidly enumerate arrays arranged in subgroups such that early arithmetic insights can facilitate enumeration. Although previous fMRI studies in adults suggest both abilities are subsumed by the same cortical systems (Piazza et al., 2002), these abilities are likely dissociated in cognitive development of number skills. In the present study, children in kindergarten through third grade were asked to enumerate random and grouped arrays of dots while naming latencies were recorded. Enumeration was facilitated for grouped relative to random arrays, as evidenced by discrepancies between enumeration latencies for the two types of stimuli. Furthermore, this facilitation increased with age, and correlated with children's fluency scores in symbolic arithmetic. This paradigm lays the basis of novel developmental neuroimaging research to explore the neural correlates of nonsymbolic exact enumeration in children.

B87

WHITE MATTER INTEGRITY PREDICTS FLUID REASONING ABILITY THROUGH ITS INFLUENCE ON PROCESSING SPEED Joel S. Steele[1], Kirstie J. Whitaker[2], Chloe T. Green[2], Silvia A. Bunge[2,3], Emilio Ferrer[1]; [1]Department of Psychology, UC Davis, [2]Helen Wills Neuroscience Institute, UC Berkeley, [3]Department of Psychology, UC Berkeley — In this study we investigated the extent to which white matter integrity relates to the associations between fluid reasoning and processing speed in children and adolescents aged 6-19. Diffusion tensor imaging and behavioral data were collected from 85 participants (49 males, 36 females; Mean age = 11.79, SD = 3.73). Whole-brain white matter integrity (WMI) was assessed using fractional anisotropy, whereas fluid reasoning (FR) and Processing Speed (PS) were assessed using standardized psychometric measures. We hypothesized that strong WMI, measured across the whole brain, would predict both FR and PS. To evaluate this hypothesis, we tested two models: (a) high WMI leads to both FR and PS, and (b) high WMI leads to high PS only, and this, in turn, is predictive of FR. The results from these analyses indicated that the second hypothesis was more tenable. In particular, the findings indicate that whole-brain WMI is predictive of PS (? = .61, p < .01) and this, in turn, predicts FR (? = .84, p < .01). According to this model, including the direct path from WMI to FR was not necessary (?2 (1) = 0.56, p = .81). These findings illustrate the influence of global white matter integrity on the structural relations between FR and PS for children and adolescents. As neural pathways are reinforced during development, they influence PS directly, which in turn influences FR.

Thinking: Other

B89

GREATER NEURAL PATTERN DISSIMILARITY BETWEEN SIMPLE AND COMPLEX ADDITION IS ASSOCIATED WITH BETTER ARITHMETICAL ABILITIES Sarit Ashkenazi[1], Miriam Rosenberg-Lee[1], Vinod Menon[1]; [1]Department of Psychiatry & Behavioral Sciences Stanford University School of Medicine — What is the relationship between brain activity and task performance in cognitive domains? We investigated this question by comparing two types of addition problems in a verification task (e.g. 3 + 4 = 7) in 41 children (age 7-9). In complex problems: one operand ranged from 2 to 9, the other from 2 to 5; in simple problems: one of the operands was always '1'. The two conditions have the same sensory and response selection demands; but have different arithmetic processing demands. We used fMRI to compare brain activation between problem types. GLM analysis revealed that the complex compared to the simple problems, had higher activation in left lateral parietal areas. However, in none of these regions was activity significantly correlated with task performance. Next, we examined the similarity between the representation of simple and complex problems in cytoarchitectonically defined maps of parietal cortex. Representational similarity analysis considers the voxel-wise similarity between the activation patterns of task conditions within a region of interest (ROI). We hypothesized that the simple and complex conditions will have different representation in the brain areas that specifically process quantities, so we considered the intraparietal sulcus (IPS). The results indicated that dissimilarity levels in a left anterior IPS region predict individual differences in performance. Specifically, as the dissimilarity increases (i.e. larger differences between the patterns of activity for complex and simple) participants were faster and more accurate. These results suggest 1) Patterns of activation rather than levels of activity are fundamental for understanding variation in cognitive performance. 2) Distinct representations underlie task performance.

B90

STUDYING A SIMPLE METHOD TO COMMUNICATE WITH A SINGLE CEREBRAL HEMISPHERE Eric Altschuler[1], Resha Soni[1], Ahmed Meleis[1]; [1]New Jersey Medical School — The ability to be able to easily communicate with a single cerebral hemisphere would be of tremendous theoretical, practical (performance training and game playing) and clinical value. Currently, to communicate with a single cerebral hemisphere it is necessary to use an invasive procedure—intracarotid administration of sodium amobarbital—study the exceedingly rare commissurotomy patient or use an unwieldy and expensive apparatus with a bite bar and eye tracker. Leung et al. (Vision Sciences Society Annual Meeting 2008 Program page 10) found that when two random dot displays are cycled at 75 Hz individuals observe that the screen appears a uniform grey. However, when one moves one's eyes, saccades, or blinks the screen then appears just the random dot pattern. With someone thus fixating on the center of the screen, stimuli can be shown on the left or right (or further top/bottom left/right) of the screen. Such images in the left (right) visual field will then go to only the right (left) cerebral hemisphere! Using this method we have replicated the known advantage of the left over the right hemisphere for reading in right-handers. For right-handed subjects there was no significant difference in reading ability between hemispheres for 1-3 letter words. However, for 4-8 letter words there was a very significant advantage of the left hemisphere for words of these lengths in aggregate ($p<0.001$) and for each individual letter length. For right-handed subjects there was no significant difference in reading ability for either hemisphere for words of any length individually or in aggregate.

B91

MANIPULATING INFORMATION STRUCTURE AS A METHOD OF LOCALIZING INFORMATION PROCESSING IN THE BRAIN Michael Ramscar[1], Samuel McClure[1]; [1]Stanford University — When formalized in terms of prediction and cue competition, symbolic learning takes two forms: learning to predict labels from the features of objects and events, or learning to predict features from labels. When the information available in training is structured in one or another of these formats, qualitative differences in symbolic learning occur. Discrimination learning is facilitated when objects precede labels, because the structure of information promotes cue competition between individual features. However, this competition is inhibited when labels predict objects (Ramscar et al, 2010). We report an fMRI investigation of these Feature-Label-Ordering effects in learning. Participants were trained and tested on a category-learning task while the frequency of confusable categories was manipulated so that successful discrimination was essential to successful categorization. Participants trained to predict labels from features showed higher levels of dorsal striatal activity (caudate and putamen), which correlated with overall performance at test. The opposite pattern was observed with ventrolateral prefrontal cortex (VLPFC) activation, which

was greater in participants trained to predict labels from features, and which correlated negatively with performance on the difficult to discriminate low frequency items. The increased striatal activity we observed in the Feature-to-Label-trained participants is consistent with evidence linking this area to discrimination learning, while the correlation between VLPFC activity and poorer discrimination in the Label-to-Feature-trained participants supports the idea that the structure of information in training forced participants to rely on working memory, fixating on cues that were frequent, salient, and yet ultimately uninformative.

B92

A HUMAN BRAIN ATLAS DERIVED BY PARCELLATION OF RESTING-STATE FUNCTIONAL MRI G. Andrew James[1], R. Cameron Craddock[2], Alexandre R. Franco[3], Helen S. Mayberg[3], Xiaoping P. Hu[3]; [1]University of Arkansas for Medical Sciences, [2]Baylor College of Medicine, [3]Emory University — We previously proposed spatially constrained spectral clustering for parcellating human functional neuroimaging data into an atlas of functionally independent subunits. Such an atlas would advance neuroimaging methods by providing standardized regions of interest (ROIs) for across-study comparisons, and by reducing the number of timecourses analyzed by statistical methods that are otherwise computationally intractable. Using resting-state fMRI data from 41 healthy control participants, we generated 100 atlases (ranging from 10 to 1000 ROIs in increments of 10). Cross-validity, content validity, and construct validity approaches were used to determine the ideal atlas. Leave-one-out cross-validation identified atlases with fewer than 300 ROIs as having the greatest reproducibility across participants. Content validity was assessed by examining these atlases for several neuroanatomic features such as bilateral symmetry and separation of cingulate from frontal cortex. The 120ROI atlas met the most neuroanatomic criteria with the fewest ROIs. Construct validity was assessed by an independent component analysis (ICA) of a separate resting-state dataset with a)all voxels, b)120ROI atlas, c)AFNI's Talairach-Tournoux atlas (TTatlas), and d)the Automated Anatomic Labeling (AAL) atlas. All atlases produced motor and visual networks comparable to (i.e. sharing high spatial correlation with) the voxelwise analysis. However, networks recruiting prefrontal cortex were better reproduced by the 120ROI atlas than either anatomic atlas. We attribute this disparity to the capability of anatomically and cytoarchitecturally homogenous frontal regions (such as Brodmann area 9) to mediate diverse cognitive tasks. These findings suggest that functionally derived atlases are more suitable for fMRI analyses than anatomically derived atlases.

B93

MINDFULNESS MEDITATION AS A TOOL FOR INVESTIGATING THE NEURAL BASIS OF SPONTANEOUS THOUGHT Melissa Ellamil[1], Sean Pritchard[2], Evan Thompson[3], Kalina Christoff[1]; [1]University of British Columbia, [2]Fielding Graduate University, [3]University of Toronto — Spontaneous mental processes (e.g., mind wandering) take up as much as one-third of our waking lives and are thus crucial areas for scientific inquiry. However, the lack of methods for direct, immediate, and reliable observation of spontaneous thought during neuroimaging experiments means its neural correlates remain unclear. Vipassana or mindfulness meditation, which trains introspective observation of moment-to-moment mental processes (i.e., metacognitive awareness), can provide the first-person expertise required for more precise investigations of spontaneous thought. Thus, rather than simply studying the effects of meditation on brain and behavior, we used experienced Vipassana meditators in fMRI experience sampling and neurofeedback paradigms to investigate the neural bases of spontaneous thought generation and awareness. To examine spontaneous thought generation, subjects practiced mindfulness during fMRI experience sampling, pressing a button whenever a thought (e.g., inner speech, images) arose. Reports of spontaneously arising thoughts were preceded by enhanced activation of the brain's default network, consistent with its hypothesized involvement in the generation of spontaneous thought content. To examine spontaneous thought awareness, subjects practiced mindfulness during real-time fMRI neurofeedback to increase the functional connectivity between the right rostrolateral prefrontal cortex (RLPFC) and right anterior insula (AI), which has been associated with metacognitive awareness. Together with real-time fMRI neurofeedback, mindfulness increased the functional connectivity between the lateral PFC and AI, providing more direct support for their joint role in metacognitive awareness. Thus, combining objective neuroimaging measures with subjective reports informed by meditation can lead to more specific theories about the underlying brain dynamics of spontaneous thought.

B94

IS CREATIVITY IN THE RIGHT HEMISPHERE? NAA! Alison Marshall[1,2], Sephira Ryman[2], Ranee Flores[1,2], Stephen Zamora[1,2], Veena Patel[1,2], Rex Jung[1,2]; [1]University of New Mexico, [2]Mind Research Network — The relationship between brain chemistry and creative cognition is a topic that has been poorly researched. Based on previous studies analyzing the lateralization of creativity in the brain, and studies showing concentrations of N-acetyl-aspartate (NAA) relating to cognitive ability and creativity (Jung et al., 2009); we sought to analyze metabolite lateralization in the brain using proton magnetic resonance spectroscopic imaging (1H-MRSI). Our study was comprised of 60 healthy young adults (27 Females). Subjects did not differ significantly in terms of age (mean = 23.4; S.D. = 3.7), sex, or intelligence (IQ = 115; S.D. = 8). Intelligence was measured using the Wechsler Abbreviated Scale of Intelligence (WASI). The Composite Creativity Index (CCI) was derived by summation of the Free Condition and Four Line Condition of the Design Fluency Test (DFT), and Uses of Objects Test (UOT). The Consensual Assessment Technique was used to determine creative quality of subject responses (Amabile, 1982). We defined an asymmetry variable as the difference between the two hemisphere's concentrations of brain metabolites (NAA left – NAA right). We then conducted a step-wise linear regression with each metabolite (NAA, Choline, Creatine) against the CCI. We found that relatively high NAA concentration in the right hemisphere of the brain predicted low CCI scores and, conversely relatively high left hemisphere NAA compared to right predicted high CCI scores ($F = 12.7$, $p = 0.001$, $r2 = 0.182$). These findings contradict the popular notion that creativity is localized in the right hemisphere.

B95

THE TIMING OF SPACE AND TIME IN PERCEPTUAL CAUSALITY Adam J. Woods[1], Matthew Lehet[1], Annika Hillebrandt[1], Anjan Chatterjee[1]; [1]University of Pennsylvania — The ability to infer causality is central to human cognition (Michotte, 1946/1963). Temporal contiguity and spatial continuity contribute to the perception of causality in simple launching events (Straube & Chatterjee, 2010). Individuals in our previous research were typically more sensitive to time (75%) than space (35%). Our experiments, like others, depicted launching events in which violations of temporal contiguity preceded violations of spatial continuity. We evaluated whether this order of relevant information influenced sensitivities to time or space for causal judgments. Participants (n=16) viewed launching events comprised of a blue ball approaching and contacting a red ball, which then moved away. Spatial continuity was parametrically manipulated with changes in the spatial angle of approach for the blue ball (0, 7.5, 15, 22.5, 30, 45, or 60 degrees) and temporal contiguity with different time delay before initial movement of the red ball (0, 33, 67, 100, 133, 200, or 267ms). Thus, the angle of the first moving ball was variable, unlike previous research in which the angle of the second ball varies. Logistic regression analyses demonstrated that 87.5% of participants were sensitive to violations of spatial continuity and 81% to violations of temporal contiguity. Compared to Straube & Chatterjee (2010), highlighting spatial variability first influenced sensitivity to space ($?2=10.5$, $p=.001$) without decreasing sensitivity to time ($?2=.18$, $p=.7$). These results suggest that while both space and time contribute to the perception of causality, time does so more robustly, and the relative contribution of space to perceptual causality is itself modified by timing.

B96

FRONTAL VERSUS PARIETAL CONTRIBUTIONS TO ELEMENTARY SCHOOL CHILDREN'S NUMBER CONCEPTS Edward M. Hubbard[1], Bruce D. McCandliss[1]; [1]Vanderbilt University — During early elementary schooling (K-3), children's number concepts undergo radical changes, especially in the small number range (5-9, the "counting range") where children can perform exact calculations. One of these critical conceptual changes is an increased understanding of the larger/smaller relations between numbers. While parietal regions are sensitive to differences in non-symbolic quantity in 4-month old infants, symbolic processing of quantities in this range depends on frontal circuitry more in children than in adults. To examine frontal and parietal contributions to symbolic and non-symbolic quantity processing in the counting range, we modified an fMRI-adaptation paradigm that has previously demonstrated quantity sensitivity in children and adults. Arrays of dots of a standard quantity (6 or 8) were presented repeatedly, alternated with rare deviants that were either numerically close to or far from (5 or 9) the standard, in either the same format (dots) or a different format (digits). Children and adults showed larger responses to far deviants than to close deviants (context-dependent dishabituation), but these responses included frontal regions in children that were not activated in adults. Additionally, responses to symbolic quantity differed: For adults, we observed context-dependent dishabituation for both dots and digits, while for children context-dependent dishabituation was reliably observed for dots, but was less reliable for digits. These results suggest that understanding numerical relations and explicit representations of the links between quantities and symbols are initially effortful processes, mediated by prefrontal cortex, with increasing practice and automaticity leading to increased specialization of parietal brain regions.

Thinking: Problem Solving

B97

THE NEUROMODULATORY BASIS OF CREATIVITY Soghra Akbari Chermahini[1], Bernhard Hommel[1]; [1]Leiden University-Cognitive Psychology section — Soghra Akbari Chermahini & Bernhard Hommel Leiden University Cognitive Psychology Unit & Leiden Institute for Brain and Cognition Leiden, The Netherlands Creative acts do not reflect the operation of just one process, brain area, or faculty but the interplay of multiple cognitive processes and neural networks. Importantly, the neurotransmitter dopamine (DA) seems to play an important role in organizing this interplay. So experiment 1 investigated: whether the spontaneous Eye Blink Rate (EBR) -a well-established clinical marker (Shukla, 1985) thought to index striatal DA production (Karson, 1983; Taylor et al., 1999)- would covariate with the individual performance of two types of creativity tasks, requiring divergent and convergent thinking, and experiment 2 investigated: a) whether mood induction has an effect on EBR; b) How is benefit of positive mood induction for people with different level of EBR. Results of two experiments show that flexibility in divergent thinking varies with the individual dopamine level (as assessed by spontaneous eye-blink rates; EBRs) in terms of an inverted U-shape pattern and improves with better mood in low but not medium-EBR subjects. In contrast, the quality of convergent thinking decreases with increasing dopamine levels Keyword: Creativity, Divergent thinking, Convergent thinking, spontaneous Eye Blink Rate (EBR), flexibility, Dopamine, Mood

B98

YOU CAN COUNT ON THE MOTOR CORTEX: AN FMRI STUDY ON THE EMBODIMENT OF NUMBER PROCESSING Nadja Tschentscher[1], Olaf Hauk[1], Martin H. Fischer[2], Friedemann Pulvermüller[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK, [2]The University of Dundee, Dundee, UK — Theories of Grounded Cognition suggest that basic sensory-motor concepts help to acquire and organize abstract concepts. In our event-related fMRI study, we asked whether the human cortical motor system is part of the representation of numbers, and whether organization of numerical knowledge is influenced by individual finger counting habits. Recent studies in human neuroimaging and developmental neuropsychology indicate that neural systems for perception and action are also engaged during higher cognitive processes. For number processing, developmental studies suggest a link between numerals and finger counting habits due to the acquisition of numerical skills through finger counting in childhood. In the current study single-digits 1 to 9 and corresponding number words were presented visually to groups of adults who either usually start counting with their left hand (left-starters) or with their right hand (right-starters). Participants performed a simple stimulus distinction task which required foot pedal responses. Depending on participants' finger counting habits, effects of hemispheric lateralization for small numerals (both digits and number words '1' to '5') were found in primary and pre-motor cortical areas: more left-hemispheric activation was found in the group of right-starters, and more right-hemispheric activation was found in the group of left-starters. Therefore, processing of numerical concepts activates brain areas that reflect the individually variable repertoire of finger counting. This provides neuroscientific evidence that number processing is grounded in sensory-motor experience.

B99

SHOULD MY MIND RELY ON MY HUNCH? THE SUBJECTIVE EXPERIENCE OF ACCURATE AND INACCURATE INTUITIONS DURING PROBLEM SOLVING Azurii K. Collier[1], Ken Paller[1], Paul Reber[1], Mark Beeman[1]; [1]Northwestern University — During intuitive decision-making, does an individual's subjective experience vary systematically according to the accuracy of the intuition? We investigated whether intuition would relate to the ability to make accurate coherence judgments, the relationship between differential confidence in accurate vs inaccurate intuitive decisions, and the subjective experience of "liking" related words during problem solving. Participants worked on Compound Remote Associate (CRA) problems, in which they viewed three words (crab, sauce, pine) and had to generate another word (apple) that formed a compound word with each of the trial words (crabapple, apple sauce, pineapple). Seventy CRAs shown were coherent (i.e., solvable) and thirty were incoherent (i.e., unsolvable). Participants (n=35) had five seconds to make a coherence judgment and then were asked to rate how confident they were in their coherence judgment on a Likert scale of 1-7. Immediately after each problem and ratings, participants viewed seven words one at a time and rated how much they liked each word on the same Likert scale. Unbeknownst to the participant, after each coherent trial, one of the words presented was the solution word and the other words were unrelated. There was a significant association between participants' coherence judgments and the actual coherence of the problem. Of the unsolved problems, participants demonstrated higher confidence following accurate coherence judgments (i.e., hits and correct rejections) compared to inaccurate coherence judgments (i.e., misses and false alarms). Taken together, these data suggest intuition can reliably facilitate accurate decision-making during problem solving.

B100

RIGHT HIPPOCAMPAL CONTRIBUTIONS TO CALCULATION IN CHILDREN WITH AUTISM SPECTRUM DISORDER Teresa Iuculano[1,2], Miriam Rosenberg-Lee[1], Amirah Khouzam[1], Jennifer M. Philips[1], Antonio Hardan[1], Lucina Q. Uddin[1], Vinod Menon[1]; [1]Stanford University School of Medicine, [2]University College London — We investigated the neural correlates of calculation abilities in a population of children with Autism Spectrum Disorder (ASD) (n = 10). Children with ASD were matched on IQ, gender and age to a group of typically developing children (TD) (n = 10). No significant differences were found on standardized measures of reading and mathematics, assessed by the WIAT-II. During fMRI scanning, children verified addition equations (e.g. 7+2 = 9). Level of difficulty was manipulated by having two types of problems: Simple where one of the addends was equal to '1' (e.g. 3+1=4), and Complex where none of the addends was '1' (e.g. 5+3=8). Performance in the scanner did not differ between the groups on either accuracy or reaction times. Both groups

activated frontal and parietal cortex regions associated with numerical and arithmetical processing in children. However, TDs had greater prefrontal cortex activation than children with ASD. In contrast, children with ASD had greater activation in posterior visual areas and the right hippocampus. In children with ASD, visual cortex responses were inversely correlated with reaction time, whereas the opposite pattern held for TD children. In the right hippocampus, greater activity was associated with higher scores on the Numerical Operations subtest of the WIAT-II in the ASD group only. Our results suggest that children with ASD engage an atypical set of brain areas during arithmetic and further point to the hippocampus as a key brain region underlying an 'islet of ability' in this group.

B101

INTELLIGENCE MEDIATES NEURONAL RESPONSE DURING MEDIAN NERVE STIMULATION Rex Jung[1,2], Lauren Bullard[2], Ashley Jaramillo[2], Kim Paulson[2], Andrei Vakhtin[2], Andre Van der Merwe[2], Cassandra Wooten[2], Michael Weisend[2]; [1]University of New Mexico, Department of Neurosurgery, [2]Mind Research Network — Intelligence is defined as "The aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment" (Wechsler, 1944). Measures of intelligence have been well linked with educational and occupational attainment and recently linked with health outcomes (Batty et al., 2004) and even longevity (Gottfredson et al., 2004). Intelligence scores have also been systematically linked with brain biochemistry, white matter integrity and cortical volume (Jung & Haier, 2007). We were interested whether intelligence would be related to basic physiological processes, such as the neuronal correlates of median nerve stimulation. Subjects were scanned with a 306 channel Elekta NeuroMag scanner. Intelligence was measured with the Wechsler Abbreviated Scale of Intelligence (WASI). Subjects for the Magnetoencephalography (MEG) somatosensory experiment were normal, college educated, subjects with high average intelligence (Mean = 114.7, standard deviation = 12.7). In 19 subjects, controlling for age, we found a significant relationship (r = .58, p = .01, r2 = .34) between the Full Scale Intelligence Quotient and the peak latency in the left sensory cortex of the M20 response elicited from median nerve stimulation of the dominant (right) hand. This same relationship was found on a second MEG run conducted on a second day (r = .45, p = .04). To our knowledge, this is the first report wherein individual differences in intelligence accounts for significant variance (.34) in such basic brain-behavior processes.

B102

ALPHA WAVE TOPOGRAPHY IN CREATIVITY-ENHANCING NEUROFEEDBACK Alexei Smaliy[1], Joseph Dien[1], Timothy G. George[1], Henk J. Haarmann[1]; [1]University of Maryland, College Park — We previously reported a method for boosting performance on a creative problem-solving task that combined incubation with EEG neurofeedback (NFB) (Haarmann, et al., 2010). The NFB was aimed at modulating the alpha-band power of an electrode over right parieto-occipital cortex (i.e., PO8), in view of its association with insight solutions (Jung-Beeman et al., 2004). In our NFB study, subjects who showed a high change in alpha power at this site solved more creativity problems. Here we present a new analysis of the EEG data from this study to determine whether the effect of the NFB on alpha power was global or localized to right parieto-occipital cortex. Forty-seven healthy adults received 30 minutes of EEG neurofeedback using a visual stimulus while their whole-head EEG was recorded. The NFB was aimed at increasing alpha power over PO8 in one participant group and at decreasing it in another group. A scree test indicated the presence of three substantial alpha-band topographies. A right parieto-occipital alpha component interacted significantly ($p<.05$) with training segment and group. The other two components (left parieto-occipital alpha and frontal alpha) did not significantly respond to these two factors . These results indicate that EEG neurofeedback using a learning signal from PO8 induces a topographically selective increase in alpha activity rather than an unselective global increase.

B103

AN MEG INVESTIGATION INTO THE TEMPORAL DYNAMICS OF BASIC MATHEMATICAL PROCESSING Douglas K. Bemis[1], Liina Pylkkänen[1]; [1]New York University — The neural bases underlying mathematical calculation have been the subject of an extensive number of hemodynamic investigations (see Arsalidou & Taylor, 2010). The preponderance of evidence implicates the intraparietal sulcus (IPS) as critically involved in all numerical processing (Dehaene et al., 2003). Additionally, an extended network of neural regions including the posterior superior parietal lobe, angular gyrus and dorsolateral prefrontal cortex (DLPFC) also play varying roles during mathematical processing, depending upon the required calculation and context. Several EEG studies have investigated the time course of these processes, generally finding two posterior positivities during calculation, suggested to reflect basic calculation (350ms) and problem difficulty (550ms) (Ku et al., 2010). However, the spatial limitation of EEG prevents a straightforward mapping between these positivities and past fMRI results. In our study, we sought to elucidate this connection using MEG, which possesses the fine-grained temporal resolution of EEG but with an increased spatial resolution. We employed a minimal paradigm investigating basic calculation (i.e. the addition of two small numbers) that isolated increases in activity at the precise point that calculation commenced compared to non-additive (i.e. working memory) processing of identical stimuli. We found three periods of increased activity within the left IPS during addition, peaking at 250ms, 350ms, and 500ms. The first effect was also accompanied by a significant increase in activity in the left DLPFC. These results support previous fMRI evidence implicating both regions in basic addition (e.g. Audoin et al., 2005) and provide an initial temporal map of their dynamics during calculation.

Thinking: Reasoning

B104

UNDERSTANDING LESS THAN NOTHING: AN FMRI STUDY OF NEGATIVE NUMBER COMPARISONS Margaret M. Gullick[1], George L. Wolford[1], Elise Temple[1]; [1]Dartmouth College — Little work has examined how the mental number system accommodates counterintuitive quantities like negative numbers, which extend the left end of the mental number line and reverse the established relationship between digit magnitude and value. This study aimed to determine whether adults demonstrate differences between responses to negative and positive numbers in a simple comparison task performed during an fMRI session. Mixed pairs (with one positive and one negative number) were also included. Different patterns were seen within each sign condition. Negative number comparison pair responses were slowest and least accurate, but showed a behavioral (close pair responses slower than far) and neural (greater intraparietal sulcus activity for close pairs than far) distance effect. No distance effect was seen for positive pairs either behaviorally or neurally, potentially due to paradigm design. Interestingly, mixed pair responses were fastest, but varied in effect directions. Polarity sensitive pairs, requiring attention to the minus sign for accuracy, showed faster far than close pair responses and no significant neural effect of distance; insensitive pairs (in which sign was irrelevant) evoked a reverse behavioral and neural distance effect. This pattern may indicate that participants used an integrated, holistic strategy for polarity sensitive pairs but a componential one for polarity insensitive. Adults may demonstrate a mature bidirectional number line, but usage of negatives remains different from that of positives. This work expands our knowledge of the flexibility of the mental number system and its ability to represent difficult quantities.

B105

THE ROLE OF HUMAN PREFRONTAL CORTEX IN ANALOGICAL REASONING: AN INVESTIGATION USING EVENT-RELATED POTENTIALS Vyacheslav Nikitin[1], Robert G Morrison[1]; [1]Loyola University Chicago — Patient-based and functional magnetic resonance imaging (fMRI) studies have implicated prefrontal cortex (PFC), specifically rostrolateral PFC

(RLPFC), as essential for analogical reasoning. However, relatively little is known about the computations performed by this ares of the brain that enable analogical processing. Early models of analogy hypothesized that the reasoner must first extract the relations between entities before mapping between relations. Bunge et al. (2009) designed a study that used fMRI methods to separate these operations. Across blocks of trials, participants either judged whether pairs of geometric objects were similar with respect to shape or texture (extraction) or whether two pairs of objects possessed the same abstract relation (mapping). The contrast between the mapping and extraction tasks was used to isolate relational integration (i.e., analogical mapping). Bunge et al. found differences in activation in left RLPFC. In order to study the time course of this activation and to investigate potential strategy differences, electroencephalography (EEG) data were collected during task performance. Subtractions of the extraction from the mapping task yielded event-related potentials (ERPs) that differed in mean amplitude in bilateral prefrontal electrodes beginning around 300 ms and continuing until response, and the voltage for the analogy condition was strongly correlated with accuracy, thus confirming the importance of PFC in analogy. However, the subtraction also yielded a difference in the N170, an ERP component frequently associated with analytic versus holistic processing. Together, these findings are consistent with fMRI studies suggesting RLPFC activity reflects the number of relations analytically processed during problem solving.

B106

NEURAL DYNAMICS OF MENTAL CALCULATION PROCESSES Christopher Tyler[1], Spero Nicholas[1]; [1]Smith-Kettlewell Eye Research Institute, San Francisco — To target cognitive calculation processes per se, the present study used non-repeating three-digit numbers, requiring the full calculation process on each trial. The further purpose of the present study was to break the mental calculation task down into a set of sequential operations and determine the role of each cognitive component to the contributory subnetworks of the cortical processing. BOLD responses were measured throughout the human brain with a time-jittered event-related design for sequenced stimuli consisting of a numeric equation followed by a 3-digit trial solution and an error feedback symbol. To estimate the temporal characteristics of the neural signals in each activated cortical region, a biophysically-based forward-optimization procedure for the functional imaging waveforms was constrained by a plausible parametrized model of local neural population responses, convolved with an overall hemodynamic response. For the calculation phase the pattern of activation was strongly bilateral throughout the cortex, with activation of the supplementary motor area, the ventral motor area, ventrolateral prefrontal area, intraparietal sulcus, fornix, and grapheme area of the ventral temporal lobe, and the peripheral representation of primary visual cortex (V1). While the responses to the initial number and operator presentations were typically brief throughout retinotopic cortex, responses in IPS1-4 showed strong involvement number memory and calculation, while IPS5 was predominantly active during the evaluation and response selection for the trial solution. Waveform optimization allows estimation of the neural signal dynamics underlying the BOLD waveforms in the processing sequence throughout the cortex during a demanding calculation task.

B107

HOW HYPOTHESIS-CONFIRMING AND HYPOTHESIS-DISCONFIRMING INFORMATION IS TREATED ACROSS THE PSYCHOSIS CONTINUUM Ryan Balzan[1], Paul Delfabbro[1], Cherrie Galletly[1]; [1]University of Adelaide — Background: In recent years there has been increasing attention to how individuals with active delusions and those identified as "delusion-prone" treat hypothesis-confirming and -disconfirming information. Initial research suggested that individuals with delusions typically exhibit a jumping to conclusions (JTC) bias when administrated the probabilistic reasoning "beads task" (i.e., decisions made on limited evidence and/or decisions are over-adjusted in light of disconfirming evidence). More recent research instead proposes that that the "beads task" may instead represent a hyper-salience to hypothesis-evidence matches. Moreover, other tasks have found that disconfirming evidence is actually ignored rather than being over-adjusted to. This study attempted to clarify this set of findings across two cognitive-reasoning tasks. Methods: A total of 75 participants were recruited, consisting of 25 individuals diagnosed with schizophrenia and 50 controls (25 delusion-prone; 25 non-delusion prone, as identified with the Peters et al Delusions Inventory). Cognitive tasks employed included two "confirmation bias" tasks, where participants evaluated pieces of information which were either consistent or conflicting with the given hypothesis. Results: The results suggested that people with delusions and delusion-prone individuals were hyper-salient to hypothesis-confirming evidence, whilst tending to downplay hypothesis disconfirming information, as compared to healthy controls. Conclusion: Taken together, these findings suggest individuals with delusions are more hyper-salient to hypothesis-evidence matches yet under-employ disconfirming evidence. This bias may influence delusion formation and/or maintenance.

B108

THE ROLE OF OSCILLATORY ACTIVITY IN THE COMPARISON OF COMPETING HYPOTHESES DURING A PROBABILISTIC REASONING TASK Jennifer Whitman[1], Todd Woodward[1]; [1]University of British Columbia — We used MEG to investigate the oscillatory activity involved in making comparative judgments between competing hypotheses. On each trial of our probabilistic reasoning task, participants judged the probability that a given focal hypothesis, rather than its alternative, was true. Evidence was objectively quantifiable and visually presented. The focal hypothesis was either more or less probable than the alternative to which it was compared, and the comparison was either difficult (similar levels of support) or easy (very different levels of support). Oscillatory activity was localized onto each individual's structural MRI using a DICS beamformer as implemented in Fieldtrip software. Beta (18-24 Hz) power decreased along the precentral and postcentral gyri contralateral to the hand used for responding. Alpha (8-12 Hz) power decreased bilaterally in superior and inferior parietal cortex (BA7 & 40), the middle and inferior occipital gyri (BA 39 & 19), and the cerebellum. Theta (3-7 Hz) power increased bilaterally in the lingual gyri and calcarine fissure (BA 17 & 18), the medial superior frontal gyrus (BA 8 & 9), and bilateral orbitofrontal cortex (BA11). Both increases in theta activity and suppression of alpha activity were modulated more by difficult comparisons than by easy ones. This is consistent with the interpretation that both processes are involved in the optimal allocation of attentional resources in response to cognitive difficulty.

B109

THE NEURAL SUBSTRATES OF PROBABILISTIC REINFORCEMENT LEARNING IN ADULTS WITH AUTISM SPECTRUM DISORDERS Marjorie Solomon[1,2,3], Michael J. Frank[4], Anne C. Smith[5], Stanford Ly[1,2], Cameron S. Carter[1,3]; [1]U. C. Davis, Department of Psychiatry, [2]MIND Institute, [3]Imaging Research Center, [4]Brown University, Department of Cognitive and Linguistic Sciences, [5]U.C. Davis, Department of Anesthesiology and Pain Medicine — Autism spectrum disorders (ASDs) are common impairing neurodevelopmental disorders. Individuals with ASDs have difficulty extracting meaning from complex patterns of reinforcement. The goal of the study was to investigate the neural substrates of this deficit using functional magnetic resonance imaging (fMRI), and to relate findings to repetitive behavior symptoms in affected individuals. Participants were young adults aged 18 – 40 with ASDs (n=8) and age, IQ, and gender-matched controls (n=12). They were scanned while completing a probabilistic reinforcement learning task including three stimulus pairs with 80%, 70%, and 60% valid reinforcement contingencies. Two hypotheses were derived from a model of the inter-workings of prefrontal cortex (PFC), orbito-frontal cortex (OFC), and basal ganglia (BG) during the paradigm (Frank et al., 2004). These were (1) that individuals with ASDs would show less activation in fronto-striatal neural circuits required for flexible learning, and (2) that repetitive behaviors would be associated with poor top down control of the BG. The probability of learning (assessed by

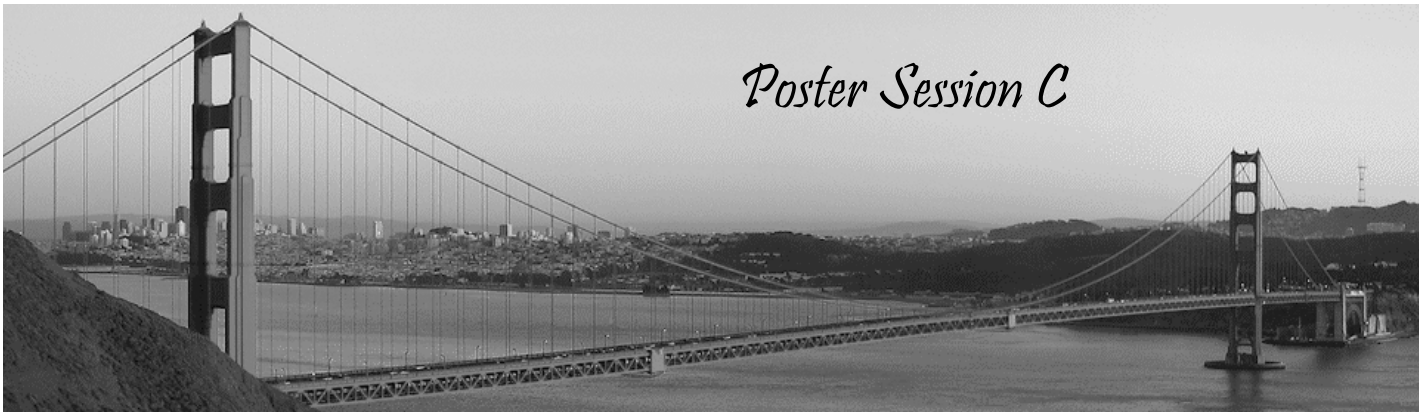
using individuals' state-space learning curves as parametric modulators in the GLM) was associated with activation in the PFC, OFC, and basal ganglia in neurotypical adults. In individuals with ASDs, rituals/sameness behavior was negatively associated with activation in the OFC (r = -.67, p = .098) and positively associated with activation in the putamen (r=.64, p =.12). Findings provide support for the hypotheses of the model that ASDs involve atypical activation in fronto-striatal neural circuits, which are related to repetitive behaviors found in the disorders

B110

REPETITION SUPPRESSION FMRI REVEALS DOMAIN-SPECIFIC AND DOMAIN-GENERAL COMPONENTS OF THE THEORY OF MIND NETWORK Adam S. Cohen[1], Scott T. Grafton[1], Michael B. Miller[1], Tamsin C. German[1]; [1]University of California Santa Barbara — Central to social cognition is the ability to explain, predict, and interpret another person's behavior in terms of mental states. The current study concerns whether there are specialized mechanisms for processing beliefs, desires, intentions, and other mental states or general-purpose mechanisms that process not only mental representations but also non-mental, "other" representations such as photos, maps, and signs. On each trial, participants read a hybrid false-belief/false-other story followed by a prime-target sentence pair that related back to the story. Participants had to provide true/false responses to each of the two statements, which were either about mental or non-mental representations. We predicted that if there are domain-specific mechanisms that support theory of mind, then we would observe repetition suppression of the BOLD signal whenever mental primes preceded mental targets and release from suppression when non-mental primes preceded mental targets. Suppression of the BOLD response in temporal parietal junction (TPJ) was observed in the mental-mental condition. As predicted, release from suppression in TPJ was observed in the other-mental condition, but only in the right hemisphere. In the left hemisphere, suppression persisted even when mental targets were preceded by non-mental primes. This suggests that specialization might be lateralized to the right hemisphere, whereas left-lateralized parts of the theory of mind system have a broader response profile. These results are considered with respect to theories that differ in their emphasis on specializations in theory of mind processing.

B111

THE NEURAL BASIS OF NON-VERBAL ANALOGICAL REASONING Christine E. Watson[1], Anjan Chatterjee[1]; [1]University of Pennsylvania — Reasoning analogically requires the ability to ignore superficial features of stimuli and appreciate abstract, relational similarities, instead. Only recently has attention turned from the behavioral to the neural basis of analogical reasoning, with most studies implicating left anterior prefrontal cortex (aPFC) as critical for analogy. Many studies have used verbal stimuli, potentially contributing to the lateralization of aPFC activity. Moreover, analogical reasoning is often more difficult than reasoning tasks that do not require attention to relational similarities, appropriately matched control condition are sometimes not used. We used functional magnetic resonance imaging (fMRI) while participants solved non-verbal, visuospatial analogies. While the analogy task required participants to evaluate the abstract similarities between the colored shapes used as stimuli, the high-level, perceptually identical control task only required attention to concrete stimulus features. Based on previous studies of analogy and abstract spatial relations, we predicted greater activity during the analogy task in aPFC, inferior frontal gyri, and parietal cortex. Conversely, we predicted greater activity during the control task in areas involved in object identification. Within anatomically-defined regions-of-interest (ROIs), we observed greater activity during the analogy task in right, but not left, aPFC. We also found greater involvement of right inferior parietal cortex and inferior frontal gyrus ROIs in analogical reasoning. No differences between analogy and the high-level control were observed in object identification areas. These results suggest that the lateralization of aPFC involvement depends on the visual or verbal nature of the stimuli or information derived during the analogical reasoning process.



Sunday, April 3, 1:00 - 3:00 pm, Pacific Concourse

Attention: Auditory

C1

RAPID DETECTION AND FOCUSING OF ATTENTION TOWARD AUDITORY TARGETS EMBEDDED IN AN ARRAY OF AUDITORY STREAMS Marissa Gamble[1], Marty Woldorff[1]; [1]Duke University — Gamble and Luck (In Press) recently reported an electrophysiological correlate (termed the "N2ac") of lateralized auditory attentional focusing toward target sounds during simultaneously presented left and right auditory stimulation, similar to the N2pc, which has been used to study lateralized shifts of attention within visual arrays. Here, we investigated the neural dynamics of auditory target detection and attentional focusing when the stimuli are distributed across both time and space. Each trial consisted of ten 40-millisecond sounds (half to each ear, in pseudo-random order), separated by 10-ms interstimulus intervals. Eight of the ten sounds were standards and two were deviants (a high and a low tone), presented to opposing ears. On each run, one of the deviant types was designated as the target, with pseudo-randomized target/nontarget presentation side and within-trial order. Participants attended for the designated target deviant within the tone series and discriminated whether it was pure or amplitude modulated. Subtracting the standard-tone ERP (on the same side) from the nontarget ERP yielded the contribution of the mismatch negativity (MMN). By comparing the target-minus-standard and the nontarget-minus standard difference waves contralateral to the tone, the N2ac activity specific to the lateralized focus of attention toward the target could be isolated. This activity started ~120 ms after target onset and closely followed the MMN. Furthermore, enhanced activity to the target, compared to the nontarget, in the N1/MMN latency range was observed. This suggests an early preparatory top-down template for the target sound, despite lack of foreknowledge of its location or timing.

C2

DOES THE TEMPORAL ORIENTING LATE POSITIVITY REFLECT MOTOR INHIBITION? Kathrin Lange[1], Alexa Lampar[1]; [1]Heinrich Heine Universitaet Duesseldorf, Department of Experimental Psychology — It has been shown repeatedly that temporal orienting enhances a late, P3-like positivity - even for stimuli that do not require any response. The present study tested a motor inhibition account of this effect, which has recently been proposed as an explanation of the NoGo-P3. In a temporal orienting task, the participants were asked to respond when a rare violin or piano sound (deviant) was presented at the time point indicated by the cue, but not when a burst of white noise (standard) was presented. Only stimuli at the attended time point required a response. Therefore, motor activation should be higher for the attended than the unattended time point. Because standard stimuli never required any response, these should trigger motor inhibition, particularly if presented at an attended time point. Crucially, the amount of advance knowledge about the possible response alternatives was also varied: More specific advance knowledge about the possible response should lead to an overall increase of motor activation and should, consequently, require even stronger motor inhibition in the case of a standard stimulus. In a specific preparation condition, the same response was required for both types of deviants. In an unspecific preparation condition, violin and piano sounds required different responses. Thus, if the enhanced P3-like positivity to temporally attended standard stimuli reflects enhanced motor inhibition, this effect should be larger for the specific preparation condition than for the unspecific preparation condition. Consistent with this notion, the P3-like positivity was larger in the specific than the unspecific preparation condition.

C3

IMPAIRED GAP DETECTION DURING CONCURRENT SOUND PERCEPTION: TOP-DOWN OR BOTTOM-UP EFFECTS? Ada W.S. Leung[1,2], Claude Alain[1,2]; [1]Rotman Research Institute, [2]University of Toronto — The perception of a brief silent interval (i.e., gap) is more difficult when listeners hear two concurrent sounds than when they hear a single sound object. This impairment may reflect low-level interaction (bottom-up effects) or a division of attention (top-down effects) among the sounds which interfere with signal detection. To distinguish between these two possibilities, we measured event-related brain potentials (ERPs) to complex harmonic tones that might comprise a mistuned harmonic and/or a gap. Sixteen participants, eleven women and aged between 18 and 35, either indicated on every trial whether the complex sound comprised a gap irrespective of mistuning (active listening) or watched a subtle muted movie of their choice while the same sounds were presented (passive listening). The result showed that gap detection performance was lower when the complex sound comprised a mistuned harmonic that popped out of the complex as a separate sound object. The analysis of the ERP data revealed an early gap related activity that was little affected by mistuning during both active and passive listening. However, there was a mark decrease in the late positive wave that indicated decision and response-related processes for sounds containing mistuned harmonics during active listening. In conclusion, the results suggest that the limitation in detecting the gap is related to attention rather than deficits in encoding the gap in sensory memory.

C4

FUNCTIONAL BRAIN CONNECTIVITY IN CHILDREN AND ADULTS DURING AUDITORY SELECTIVE ATTENTION Tony Herdman[1], Sam Doesburg[2]; [1]University of British Columbia, [2]Child and Family Research Institute — We recorded magnetoencephalography (MEG) to investigate the brain's functional connectivity in children (11-13 years old) and adults (18-35 years old) performing an auditory selective attention task. Our main hypothesis was that during selective attention children recruited frontal networks to a greater extent than adults. We performed time-frequency analyses on beamformed brain sources for task-dependent event-related synchronizations (ERS) and desynchronizations (ERD) within six frequency bands spanning from 7 to 90 Hz. We found several significant ERS and ERD peaks throughout the brain that served as regions of interest for phase-coherence analyses. Cost-efficiency functions and small-world properties of a brain's network connectivity were determined using Graph Theory methods. We found that the average adult brain

had large beta-band (15-22 Hz) ERD within temporal, frontal and parietal regions whereas the average child brain had large beta-band ERS within frontal regions and less prominent beta-band ERD elsewhere. Functional connectivity results showed wide-spread beta-band phase desynchronizations throughout the brain, which were larger and more distributed in adults than children. Notably, children's beta-band phase synchronizations showed significant small-world properties with stronger functional couplings between frontal-frontal and frontal-parietal regions that were not as evident in adults. These findings fit with emerging evidence that children recruit more frontal executive networks to facilitate control of auditory attention.

C5

TRAINING ATTENTIONAL FILTERING IN TRAUMATIC BRAIN INJURY Neil Dundon[1], Suvi Korpelainen[1], Niamh Merriman[1], Sarah Clarke[1], Ian Robertson[2], Paul Dockree[2]; [1]Headway, 1-3 Manor Street Business Park, Manor Street, Dublin 7, Ireland, [2]School of Psychology and Trinity College Institute of Neuroscience, Dublin 2, Ireland — Patients with Traumatic Brain Injury (TBI) are less able to filter out interfering information (e.g., concurrent conversations in a room, traffic noise, background music etc. See Arciniegas et al. 1999; 2000) This debilitating problem means that TBI patients show impairments when attending to and encoding information. In the current study, TBI patients were engaged in a dichotic listening procedure designed to drive improvements in their signal-to-noise processing capabilities. Training blocks were administered in eight 1-hour blocks conducted once a week over an eight-week period. Training was based on a modified version of Attention Process Training (Sohlberg & Mateer, 2001) in which participants were required to sustain attention and identify infrequent auditory targets. One group of patients (Adaptive Training Group; n=10) were engaged in adaptive training to concurrent and distracting speech noise. Noise intensity was systematically increased from baseline (no-noise) across five decibel-level steps. Patients were required to attain auditory target detection performance equivalent to 80% baseline level before progressing to the next level of noise distraction. A second group of patients received equivalent attention training with concomitant noise but were not trained adaptively (non-adaptive training group; n=10). Results from a key outcome measure -speech-in-noise processing - revealed that a linear decline in performance as a function of increasing distraction was offset by training. To conclude, cognitive remediation techniques for retraining cognitive deficits after Traumatic Brain Injury can improve engagement with everyday activities.

C6

ELECTROPHYSIOLOGICAL CORRELATES OF AUDITORY DISTRACTION IN NORMAL LISTENERS AND LISTENERS WITH ATTENTION-DEFICIT HYPERACTIVITY DISORDER Karla D. Ponjavic[1], Matthew S. Tata[1]; [1]University of Lethbridge — The auditory Event-Related Potential (ERP) has been used to investigate focused attention. In classic cue-target paradigms the N1 amplitude of the ERP waveform is greater when the target is validly cued and smaller when invalidly cued. This suggests that early auditory mechanisms handle task-relevant and task-irrelevant input differently. We tested the hypothesis that N1 amplitude evoked by task-relevant (i.e. attended) stimuli would be modulated by different levels of distraction, despite a constant endogenous attentional instruction to maintain focus on the target. We further hypothesized that susceptibility to distraction would be severe in subjects with Attention Deficit Hyperactivity Disorder (ADHD). Healthy controls and adults with a prior diagnosis of ADHD were recruited for this study. The ADHD group was split into individuals taking stimulant medication (e.g. Ritalin) and those who were un-medicated. Participants focused their attention on a stream of long and short noise bursts presented to one ear while simultaneously ignoring a pre-recorded story (high distraction) or amplitude matched broadband noise (low distraction) presented to the other ear. Behavioral data showed significantly higher sensitivity to detect targets (d') under low distraction relative to high distraction conditions across all groups. N1 amplitude was greater when evoked by targets in the low distraction relative to high distraction conditions across all groups. Both listener sensitivity and N1 amplitude varied similarly across groups and across low and high distraction conditions. These results suggest that modulations of N1 amplitude indicate the degree of distraction in healthy controls and in individuals with ADHD.

C8

THE RELATIONSHIP OF ALCOHOL USE DISORDERS, SENSORY GATING AND NEUROPSYCHOLOGICAL FACTORS Emerson Epstein[1], Per Lysne[1], Jason Long[1], Bobby Sena[1], Molly Monnig[1], Jessica Pommy[1], Jeff Lewine[2], Robert Thoma[1]; [1]University of New Mexico, [2]The MIND Research Network — Sensory gating, a neurophysiologic measure of sensory filtering, is impaired in psychotic disorders, and some studies have shown impairment in alcohol use disorders (AUD). For the current study, participants were healthy controls (HC, N = 10), alcohol use disorder-current (AUD-C, N = 10), and alcohol use disorder-remission (AUD-R, N = 10). Concurrent EEG and MEG data were collected during an Auditory Paired Click Paradigm to measure auditory sensory gating, which is the ratio of the amplitude of responses from two identical stimuli (clicks) presented with an ISI of 500 ms. The Drinker Inventory of Consequences (DrInC; Miller, 1996) was also used as a measure of negative consequences of alcohol use apart from dependence symptoms. A neuropsychological battery was devised to assess a range of neuropsychological domains and to test those domains expected to be impaired in those with ETOH histories. A marginally significant positive correlation was found between DrInC score and left hemisphere gating in the AUD groups ($r(31) = .33$, $p = .07$), suggesting that alcohol has a harmful effect on left hemisphere gating over the long term. Further confirmation of this effect was found in the neuropsychological test scores, with DrInC score predicting poorer sustained attention (CPT overall attention index score, $r(31) = .44$, $p = .02$), and poorer executive ability (Trail Making Test Part B, $r(31) = .36$, $p = .05$) in the AUD groups. These results suggest that left hemisphere gating as well as cognitive functions are impaired in the long term by alcohol use disorders.

C9

PARENTING INTERACTS WITH DRD4 TO PREDICT YOUNG CHILDREN'S ATTENTION AND NON-VERBAL IQ Alice Graham[1], Anna Dennis[1], Theodore A. Bell[1], Helen J. Neville[1]; [1]University of Oregon — Recent work has emphasized children's biological sensitivity to context (BSC) as a means of understanding differential effects of parenting. According to the BSC hypothesis, genetic factors will be harmful or beneficial depending on the quality of the caregiving environment. Variation in the DRD4 gene appears to play a role in determining sensitivity to parenting. Previous work has identified children carrying the 7r allele of the DRD4 as exhibiting higher levels of externalizing problems in the context of insensitive parenting, and showing greater gains in the context of parenting interventions. The current study sought to extend this work to the cognitive domain in a low SES sample of 3-5 year olds. One set of analyses focused on the influence of traditional parenting values, including an emphasis on parental control and a structured environment, on children's selective auditory attention. A significant interaction between parental traditionalism and children's DRD4 classification emerged such that traditionalism predicted higher levels of selective attention indexed by ERPs only for children carrying the 7r allele. For children not carrying the 7r allele there was no significant effect of traditionalism. In a separate analysis we examined the effects of an intervention focused increasing child attention and structure in the home. In children carrying the 7r allele the intervention condition was associated with an increase in non-verbal IQ in comparison to the control group. These results are discussed in the context of the BSC hypothesis and the potential importance of children's attention and a structured home environment.

C10

CHANGE DEAFNESS: A CASE OF "MISALLOCATION" OF AUDITORY ATTENTION Kristina Backer[1,2], Claude Alain[1,2]; [1]University of Toronto, [2]Rotman Research Institute at Baycrest Centre — Change deafness describes the surprising failure of listeners to detect salient changes in complex auditory scenes consisting of several concurrent sound objects. The underlying causes of change deafness are not well understood but could include a failure in concurrent sound segregation, working memory, and/or a misallocation of attention. In the present study we investigated the role of attention in change deafness. First, we generated complex auditory scenes composed of three different sounds arising from unique loudspeaker locations. A control experiment was conducted to choose a subset of auditory scene stimuli, in which the three sounds could be easily segregated, to use in the change deafness experiment. During the change deafness experiment, we used a delayed match-to-sample paradigm in which participants reported if the two auditory scenes were identical or different. If they noticed a change, then they indicated which sounds switched locations. On some trials, participants' attention was directed to one sound via a visual spatial or semantic cue (71% valid). Relative to uncued trials, performance was enhanced (decreased reaction time (RT) and increased accuracy) when presented with a valid spatial or semantic cue. However, when attention was invalidly directed to the non-changing sound in the scene, participants' performance suffered (increased RT and decreased accuracy). This suggests that change deafness arises, at least in part, from a "misallocation" of attention to a non-changing sound, even when listeners can segregate concurrent sounds within an auditory scene.

Attention: Development & Aging

C11

VISUAL ATTENTION AND DEVELOPMENTAL DYSLEXIA. PARAMETER-BASED ASSESSMENT OF DISORDERED AND INTACT COMPONENTS OF VISUAL ATTENTION Johanna Egetemeir[1], Kathrin Finke[2], Prisca Stenneken[1]; [1]Bielefeld University, [2]Ludwig Maximilians University Munich — Despite the clinical heterogeneity of developmental dyslexia, neurocognitive studies have repeatedly described that persons with dyslexia show impaired performance in tasks which require visual attention. However, specific aspects of visual attention that may cause this deficit have not yet been unequivocally identified. In this study, a group of children affected by developmental dyslexia and a matched control group without any reading disorder performed whole report and partial report of brief letter arrays. In whole report, five letters were vertically arranged in the left or right visual hemi-field. Participants had to report as many letters as possible. In partial report, red target letters were presented either alone or accompanied by a second target or a green distractor letter presented in the same or in the opposite hemi-field. Here, participants had to report only target letters. Based on mathematical equations provided by the Theory of Visual Attention (TVA), the response patterns from these tasks were used to estimate four mathematically independent, quantitative measures of attentional components: perceptual processing speed, storage capacity of visual working memory, efficiency of top-down control, and spatial distribution of attention. A comparison of parameter estimates between groups revealed reduced perceptual processing speed and reduced storage capacity of visual working memory in the dyslexic group, whereas top-down control and spatial distribution of attention were unimpaired. Moreover results indicated a correlation between storage capacity of visual working memory and the severity of the reading disorder. Results are discussed in relation to a previous TVA-study investigating visual attention in dyslexic adults.

C12

EXPRESSION OF FACILITATION AND SUPPRESSION IN VISUAL SELECTIVE ATTENTION IN ADOLESCENTS Jane Couperus[1], Brittany Alperin[1]; [1]Hampshire College — Selective attention modulates activity at early levels of visual processing, as is reflected in changes in the P1 event-related potential (ERP) component. Recent research suggests that the process of selection may involve both the relative enhancement of the signal of the attended stimulus as well as relative suppression of the unattended stimulus (e.g., Couperus and Mangun, 2010). However, while studies suggest facilitation is present even in young children (e.g., Harter et al., 1989), the development of suppression in visual selective attention has not been deeply explored. This study examined these two processes in adolescents (11-15 years) and adults using a spatial cuing paradigm. We examined target and distracter processing as a function of the expectancy of distracter presence versus absence. Participants were cued to the spatial location of a target (100% valid cues) as well as to the presence or absence of distracters in the opposite hemifield (70% valid cues). Analysis of distracter-present displays in adults showed that in addition to relative enhancement of the occipital P1 in the hemisphere contralateral to the target, processing contralateral to distracters was reduced when a distractor was anticipated compared to when the presence of a distractor was not anticipated. In contrast, only relative facilitation contralateral to the attended target was seen in adolescents. These findings suggest that both enhancement and suppression are involved in visual-spatial selective attention in adults, but that suppression may still be undergoing development in adolescence.

C13

RELIANCE ON CS-MODULATION VS. US-MODULATION MECHANISMS FOR BLOCKING IN CATEGORY LEARNING VARY WITH AGE Dale Swanton[1], Mark Gluck[1]; [1]Center for Molecular and Behavioral Neuroscience, Rutgers University, Newark — Blocking refers to the finding that when a compound of two cues is associated with an outcome, learning about one of the cues can be prevented if the other cue has been previously associated with the same outcome (Kamin, 1969). Two competing theories have arisen to account for why learning about a cue can be blocked. The Rescorla-Wagner model (Rescorla & Wagner, 1972) argues that blocking occurs due to modulation of the reinforcing US's ability to promote learning through reduction in prediction error. Conversely, Mackintosh (1975) posited that blocking occurs because of a modulation of the cue's ability to enter into learning. Allen, Padilla and Gluck (2002) offered support for the former US-modulation mechanism in the blocking found during rabbit eye-blink conditioning, while Kruschke and Blair (2000) offered support for the latter CS-modulation mechanism in human category learning. In the current experiment, subjects learned to predict which disease a fictional patient had based on that person's symptoms (adapted from Kruschke & Blair, 2000). We found that both healthy young adults and healthy older adults show the basic blocking effect and that younger adults show attenuation of the blocked cue in a transfer test, supporting a US-modulation mechanism. In contrast, older adults showed no evidence of sustained attenuation of learning to the previously blocked cue, indicating that their previous learning was mediated solely by US-modulation mechanisms. The current results suggest that blocking can occur in two qualitatively different ways and that the mechanism by which blocking occurs may change with age.

C14

SIMULTANEOUS ERP/FMRI HIGHLIGHTS FRONTAL-STRIATAL INTERACTIONS IN AGEING Joshua Balsters[1], Redmond O'Connell[1], Sophia Kilcullen[1], William Campbell[1], Arun Bokde[1], Robert Lai[2], Neil Upton[2], Ian Robertson[1]; [1]Trinity College Institute of Neuroscience, Trinity College Dublin, Dublin, IRELAND, [2]Neurosciences Centre of Excellence for Drug Discovery, GlaxoSmithKline, UK — As the elderly population increases so too will age-related cognitive decline and dementia. Establishing more precise biomarkers of age-related cognitive decline is an essential first step in developing more focussed pharmaceutical and cognitive inter-

ventions. Here, we present a multi-modal assessment (simultaneous EEG/fMRI) of attentional engagement in young and elderly populations. The oddball task elicits a robust P3 ERP component which is a sensitive biomarker of attention. By using a 3-stimulus oddball we were able to investigate distinct P3 topographies relating to distractor processing (P3a) and target detection (P3b). Fourteen elderly (65-80yr) and fifteen young (18-30yr) participants showed no differences in task performance. ERP results replicated the well documented P3 age-effects (decreased amplitude and increased latency). No significant within-or between-group differences were found when comparing recordings taken inside or outside the MRI scanner. Distractor and target onsets were modelled in an fMRI general linear model with single-trial amplitudes from electrodes FZ and PZ included as parametric modulators. This approach allowed us to identify unique EEG-informed fMRI activations that were not apparent when analysing fMRI alone. The elderly group showed increased activity within the prefrontal cortex(BA9), striatum, and hippocampus during target detection and increased prefrontal(BA44), parietal(BA7), cingulate(BA23) and striatum activity during distractors. It has been previously shown that ageing produces a general shift in activity from posterior-to-anterior regions. By combining EEG with fMRI we demonstrate that the elderly group were able to match the attentional performance of young participants by recruiting a more complicated network of regions, particularly frontal-striatal circuits.

C15

SENIORS SHOW INCREASED VISUAL SENSORY ATTENUATION WHEN MIND-WANDERING Lindsay Nagamatsu[1], Nicole Laurence[1], Teresa Liu-Ambrose[1], Todd Handy[1]; [1]University of British Columbia — Mind-wandering refers to the natural ebb and flow of how much attention we pay to what we're doing over time. When in a mind-wandering state, our attention has momentarily drifted off-task. Recently, it has been shown in young adults during these "off-task" attentional states, there is a decrease in visual sensory-evoked activity specific to the upper visual hemifield. Here we examined the extent to which the visual sensory effects of "off-task" attentional states change with age. Participants (aged 65-75 years) performed a simple target detection task at fixation while task irrelevant probes were presented in the upper and lower visual hemifield. At the end of each task block, participants reported on whether their attention had been on- vs. off-task. We found that visual sensory-evoked activity decreased for probes in both hemifields just before reports of off-task vs. on-task attention, as measured via the P1 ERP component. Our findings suggest that age-related changes in visual sensitivity during mind-wandering may contribute to clinical problems in seniors, most notably falling.

C16

MATURATION OF VERBAL AND NON-VERBAL MISMATCH NEGATIVITY AND AUDITORY EVENT-RELATED POTENTIALS Natacha Paquette[1,2], Mélanie Lefrancois[1,2], Phetsamone Vannassing[1], Mélissa Sue Sayeur[1,2], Michelle McKerral[2], Franco Lepore[1,2], Maryse Lassonde[1,2]; [1]Centre de Recherche, University Hospital Center Sainte-Justine, Montreal, QC, Canada, [2]Centre de Recherche en Neuropsychologie et Cognition, Université de Montréal, Montréal, QC, Canada — The Mismatch Negativity (MMN) is an auditory event-related potential (AERP) corresponding to the automatic detection of a change in the acoustic environment that can be measured in infants, children and adults. The aim of this study was to examine for the first time the maturational changes of the MMN and the AERPs in response to both speech and non-speech stimuli, which may respectively reflect language and attention processing. Using an oddball paradigm, AERPs were recorded in 24 healthy participants at different developmental stages (4-7 years old, 10-13 years old and young adults (mean age: 22), n=8 in each group) using a 128-channel Geodesic Sensor Net and system. Verbal stimuli were the frequent (standard) syllable /Da/ and the rare (deviant) /Ba/; non-verbal stimuli were frequency synthesized, using the second and third formants of the verbal stimuli. Results revealed group differences in the MMN and AERP components in response to both verbal and non-verbal stimuli. In young children, the P1 and N2 components were of higher amplitude and longer duration compared to those observed in the adult response. N1 and P2 components were not found in the younger children but were present in the two older groups. A negative mismatch response was elicited in adults and older children whereas a positive mismatch was observed in the younger group. These differences in maturation of the cortical activation in response to speech and non-speech stimuli are discussed in light of the central auditory development involved in attention and language processing.

C17

PROLONGED DISENGAGEMENT FROM ATTENTIONAL CAPTURE IN NORMAL AGING Nathan Cashdollar[1], Keisuke Fukuda[2], Edward Vogel[2], Adam Gazzaley[1]; [1]Departments of Neurology, Physiology, and Psychiatry, W. M. Keck Center for Integrative Neurosciences, University of California, San Francisco, [2]Department of Psychology, University of Oregon, Eugene, OR — Visual working memory performance declines in normal aging and has often been attributed to interference by distracting sensory information. However, it has recently been proposed that susceptibility to being 'captured' by distracting stimuli may not differ greatly between individuals, but instead the speed in which one disengages from capture is what varies. Here, we tested younger and older adult's susceptibility to visual capture by relevant and irrelevant flankers and their time of disengagement by jittering stimulus onset asynchronies (SOA) of the flankers before the onset of a target array. Using this approach, we demonstrated that although both age groups were equally captured at the shortest SOA (50 ms), older participants display a prolonged disengagement from visual capture in the presence of relevant flankers (?350 ms), compared to younger adults (250 ms). Furthermore, an extended time of disengagement from relevant capture (550 ms) in a subgroup of older participants was related to lower working memory capacity. A similar relationship recently found in younger participants, supports the notion that prolonged disengagement from visual capture of relevant sensory information may be related to a misallocation of working memory resources. Therefore, declines in working memory performance commonly reported in normal aging may be the result of a delay in the speed of disengagement from distracting information and not the result of a greater magnitude of distraction.

C18

YOUNG CHILDREN CAN ADJUST THE SCALE OF VISUAL SELECTIVE ATTENTION William Bush[1], Jane Couperus[2], Lisa Sanders[1]; [1]University of Massachusetts Amherst, [2]Hampshire College — Adults contract or expand the size of an attended region to match a cued area or attended object (Eriksen & St. James, 1986; Castiello & Umilta 1990; Eimer, 1999; Muller & Hubner, 2002). Due to the challenges of measuring covert visual spatially selective attention in young children little is known about the development of this ability. However, the available behavioral data suggest control of the scale of attention develops later than the ability to orient attention (Enns & Girgus, 1985; Akhtar & Enns, 1989). In the current study, small and large line drawings of different objects were presented simultaneously. Nineteen adults and fifteen 4- to 6-year-olds were instructed to monitor only one of the objects to detect rapid changes in the color of the lines. Steady state visually evoked potentials (SSVEPs) were measured time locked to the different flicker rates of the two objects. Adults evidenced greater amplitude SSVEPs in response to attended compared to unattended objects. There was no interaction between attention and object size, suggesting adults are equally capable of attending to large and small objects. The 4- to 6-year-olds also showed attention effects on SSVEP amplitude with the same pattern of results observed in adults. Children in this age group are capable of adjusting the size of an attended area to facilitate monitoring an object. Further, the finding that the modulation of SSVEP amplitude was largest over posterior regions suggests that this facilitation occurred at perceptual stages of processing.

C19

LATERAL PREFRONTAL ABNORMALITY IDENTIFIED WITH MAGNETOENCEPHALOGRAPHY IN ADOLESCENTS WITH ALCOHOL DEPENDENCE Bobby Sena[1], Jason Long[1], Per Lysne[1,3], Mollie Monnig[1,3], Megan Schendel[3], Jessica Pommy[1,3], Ronald Yeo[1,3], Robert Thoma[1,2,3,4]; [1]University of New Mexico, Albuquerque, NM, [2]University of New Mexico School of Medicine, Albuquerque, NM, [3]MIND Research Network (MRN), Albuquerque, NM, [4]Center on Alcohol, Substance Abuse, and Addictions (CASAA), Albuquerque, NM — In adults with alcohol use disorders (AUDs) prefrontal cortex is one of the regions most affected by alcohol use. It was hypothesized that binge-pattern exposure to alcohol during adolescence would result in reduced frontal lobe activation and poorer scores on tests of attention and executive ability. Magnetoencephalographic (MEG) data and magnetic resonance images (MRI) were collected from thirty adolescent volunteers comprising three groups: ten healthy, non-drinking control adolescents (HC), ten adolescents with DSM-IV criteria for alcohol abuse or dependence (AUD-C), and ten non-drinking adolescents considered to be at high risk for alcohol use disorders (HR), ages 12-18. Magnetoencephalographic (MEG data were recorded during an auditory oddball paradigm including standard stimuli (1000 Hz), target stimuli (1500 Hz) requiring response, and truly novel stimuli, which consisted of a variety of sounds randomly interspersed among other stimuli. Neural activation in HC and HR began in sensory cortex, was mirrored shortly thereafter in cingulate cortex, and then progressed to highly distributed cortical regions, most notably, strong lateral and medial prefrontal cortical responses in the novel and oddball conditions beginning at approximately 300 ms. There were no group differences in M100 activation in auditory cortex. In the left lateral prefrontal cortex, HC had greater M300 activation than HR and AUD-C (who were equivalent), suggesting that left hemisphere abnormality is a risk factor for AUDs. In the right lateral prefrontal cortex, HC and HR showed equivalent activation and had greater responses than AUD, suggesting that alcohol use results in reduced right M300 activation.

C20

MATURATION OF SELECTIVE AUDITORY ATTENTION IN ADOLESCENTS: AN EVENT-RELATED POTENTIAL STUDY Elif Isbell[1], Christina Karns[1], Helen Neville[1]; [1]University of Oregon — The ability to selectively attend to relevant information and to suppress distractors starts developing in the early years of life. Research has demonstrated that neurophysiological markers of selective auditory attention can be observed in children as young as 3 years old. However, the characteristics of such neurophysiological responses observed in children differ markedly from the responses of adults. While these differences have been documented between adults and children, there is little research that focuses on how this ability develops during adolescence and when it matures. To investigate the development of selective auditory attention throughout adolescence, we recorded event-related potentials (ERPs) from 13 year-olds, 16 year-olds, and young adults in a dichotic listening paradigm that included both linguistic and nonlinguistic probe stimuli. The results revealed a complex developmental trajectory for selective auditory attention. The attentional modulation of linguistic stimuli displayed a more linear path such that the observed attention effect became more adult-like as age increased. On the other hand, the attentional modulation of nonlinguistic probes appeared to follow a non-linear course, such that during late adolescence a more idiosyncratic profile was observed compared to earlier and later stages of development. These findings suggest that distinct elements of selective auditory attention are not mature even in late adolescence and continue to develop into adulthood.

C21

PERCEIVING TIME ACROSS A LIFETIME: THE EFFECTS OF TIME PERCEPTION ON ATTENTION IN YOUNGER AND OLDER ADULTS Carson Pun[1], Tracey A Herlihey[1], Susanne Ferber[1]; [1]University of Toronto — We all experience the passage of time and this experience seems to change as we get older. Interestingly, the perceived passage of time seems to influence cognition and also has clinical implications. For example, older adults with faster time perception experience less clinical depression, have an enhanced sense of purpose and a "younger" perceived age. However, the mechanisms underlying this effect are still unclear. Some researchers have attempted to study time perception by altering the sense of time using cross modality stimuli (e.g., visual and auditory) or by depleting working memory resources. Here we present a novel technique that can alter the perception of time using a purely visual manipulation. We took advantage of an established temporal replication paradigm in which judgments of the passage of time are measured by replicating a standard duration. We manipulated the display by presenting dots that moved in a circular pattern around a target stimulus at various speeds. Our results demonstrate that a simple visual manipulation can indeed alter an observer's sense of time: slow moving dots induced a sense of time that was slower and fast moving dots induced a sense of time that was faster. We also show how an altered perception of time can influence attention: reaction times differed significantly on a basic reaction time task depending on the observer's sense of the passage of time. We explored these effects across younger and older adults to gain further insight into the mechanisms underlying time perception changes in aging.

C22

BEHAVIORAL AND NEUROIMAGING STUDIES OF EMOTIONAL SPEECH TONE EFFECTS ON DRIVING FOR YOUNGER AND OLDER ADULTS Li Hsieh[1], Sean Seaman[1], Richard Young[1]; [1]Wayne State University — Evoked Response Potential (ERP) and functional Magnetic Resonance Imaging (fMRI) recordings shed light on underlying neural mechanisms for higher cognitive processes and attention allocation during multitasking of cell phone conversations and driving. Behavioral results indicate that hands-free cellular phone conversations cause statistically significant but small reaction time effects (compared to no conversation) for braking responses to visual events during simulated and on-road driving. The validated Static Load driving paradigm gives rise to high correlations of red light reaction times between lab and road. We used that paradigm during ERP and fMRI brain imaging. Our results with subjects younger than 65 confirm as expected that cellular conversations increase brain activation in language and attention areas. The novel finding is that an angry emotional tone improves behavioral reaction time performance compared to a neutral tone; and at the same time, elicits the right frontoparietal networks and desynchronizes or dampens the left frontal activity. Preliminary results of subjects older than 65 showed significant effects of conversation and emotion on performance measures in addition to reaction time (e.g., accuracy; central vs. peripheral positions of the visual event). We conclude that an emotional speech tone provides a processing advantage compared to neutral speech during hands-free conversations while driving. The neural mechanism may be linked to an early central negativity and later posterior positivity, or an enhanced "readiness to respond" in central and posterior cortical regions linked to attention. These findings could have prominent implications for automotive telecommunication designs.

Attention: Multisensory

C23

MULTISENSORY DISTRACTION OR ENHANCEMENT: STIMULUS PRESENTATION RATE DETERMINES THE NEURAL INTERACTION OF IGNORED VISUAL STIMULATION Ulrike Zimmer[1], Robin Mi[1], Marty Woldorff[1]; [1]Center for Cognitive Neuroscience, Duke University — Previous studies have shown that the auditory mismatch negativity (MMN) can be modulated by focused auditory spatial attention, particularly when the stimulus presentation is rapid. Adding a visual stimulus to an auditory, depending on the circumstances, can result in either multisensory enhancement or suppression. Here, we asked if and how the stimulus presentation rate might influence auditory MMNs in unisensory versus multisensory attentional contexts. We utilized two auditory selective-

attention paradigms, differing only in the stimulus-onset-asynchronies (SOAs) (120-320ms versus 240-640ms), that required subjects to attend to one of two dichotically presented tone streams. Half of the sounds were accompanied by a spatially and temporally aligned visual flash. Reaction times were shorter for unisensory than multisensory conditions at fast rates, but longer at slow ones. Correspondingly, in the unisensory conditions the MMN amplitude increased with attention in the fast but not the slow paradigm, consistent with previous studies. Importantly, however, multisensory MMNs were smaller than unisensory ones at fast rates, but larger at slow ones. This pattern suggests that when sounds are presented rapidly and half of them are accompanied by a visual stimulus, then the visual stimuli are temporally also so close together that they form a strong template stream of their own, thus decreasing their ability to capture auditory attention on individual events. In contrast, more slowly presented visual stimuli are more clearly separated, allowing residual auditory resources, which are greater at slow rates, to spread and bind to the synchronously presented visual stimulus, resulting in multisensory enhancement of processing.

C24

ATTENTIONAL CUEING MODULATES PERCEIVED STIMULUS CONTRAST AND EARLY CORTICAL PROCESSING Viola S. Störmer[1], John J. McDonald[2], Steven A. Hillyard[3]; [1]Max Planck Institute for Human Development, Berlin, [2]Simon Fraser University, [3]University of California San Diego — In a recent study we found that auditory cueing of attention can boost the perceived contrast of subsequent visual objects by increasing the signal strength in early visual pathways (Störmer, McDonald, Hillyard, 2009). Previous psychophysical studies had demonstrated that visual cueing of attention can also increase apparent stimulus contrast (Carrasco, Ling, Read, 2004). To determine whether this unimodal cueing effect of attention similarly arises from early sensory enhancement, we recorded event-related potentials (ERPs) while participants judged the relative contrast of two Gabor patches ($2^o \times 2^o$; 4cpd) presented to the left and right visual fields following an unpredictive lateralized visual cue (black dot; cf. Carrasco et al. 2004). Visual cueing of attention increased the perceived stimulus contrast and was accompanied by an enhanced positivity over the occipital scalp contralateral to the visual cue beginning 140ms after target onset, similar to our findings with cross-modal cueing of attention. To investigate the mechanism of this exogenous attentional cueing effect, we examined the ERPs in the cue-target interval on trials in which no target stimulus occurred (30% of trials). An enhanced positive deflection was found over the occipital scalp contralateral to the cue starting at about 200ms after cue onset and lasting for about 250ms. This occipital positivity was also found even when the initial cue was auditory. We conclude that the exogenous cueing of attention increases the neural response in early visual pathways, thereby preparing the perceptual processing of possible subsequent targets at that location.

C25

MUSIC ENHANCES VISUOSPATIAL WORKING MEMORY IN WOMEN BUT NOT MEN Julia Mossbridge[1], Marcia Grabowecky[1], Satoru Suzuki[1]; [1]Northwestern University — Many people listen to music while performing tasks requiring working memory (WM), but it is not clear how simultaneous music affects WM performance. There is disputed evidence from other laboratories that music helps performance on visual WM tasks such as remembering the identity of objects, while music may hurt verbal WM tasks such as remembering letters and words. In the present study, in each trial of a dual 1-back task, 32 subjects (16 female) had to remember both the position (one of four possible locations) and identity of an abstract, non-verbalizable image and respond when the position or identity of this image, or both, matched that on the previous trial. These subjects also performed a verbal version of the task with pronounceable nonsense words instead of images. Women were significantly more accurate on the visual WM task while listening to instrumental music as compared to no music whereas men's accuracy trended toward worsening with music. Music had no effect on accuracy in the verbal WM task. In a second experiment, the same protocol was repeated (n=32, 16 females), except that a looped recording of a baby crying was used in place of music. Performance was not affected by the presence of the baby-crying sound, suggesting that music itself, not just any auditory stimulus, preferentially assists female visuospatial WM performance. The mechanism underlying this effect is currently under investigation. In summary, it appears that some sounds can facilitate visuospatial WM, especially among women.

C26

DIFFERENTIAL ELECTROPHYSIOLOGICAL RESPONSE DURING REST, SELF-REFERENTIAL AND NON-SELFREFERENTIAL TASKS IN HUMAN POSTEROMEDIAL CORTEX Mo Dastjerdi[1,2], Brett Foster[1,2], Sharmin Nasrullah[1,2], Andreas Rauschecker[3,4], Robert Dougherty[4], Jennifer Townsend[1], Catie Chang[1,5], Michael Greicius[2], Vinod Menon[2,6], Dan Kennedy[7], Josef Parvizi[1,2]; [1]Laboratory of Behavioral & Cognitive Neurology, Stanford University, [2]Department of Neurology & Neurological Sciences, Stanford University, [3]Neurosciences Graduate Program & Medical Scientist Training Program, Stanford University, [4]Department of Psychology, Stanford University, [5]Department of Electrical Engineering, Stanford University, [6]Department of Psychiatry and Behavioral Sciences, Stanford University, [7]Division of Humanities and Social Sciences, California Institute of Technology, Pasadena, CA — The electrophysiological basis for higher brain activity during rest and internally-directed cognition within the human default mode network (DMN) remains largely unknown. Here we use intracranial recordings in the human posteromedial cortex (PMC), a core node within the DMN, during conditions of cued rest, autobiographical judgments, and arithmetic processing. We found a heterogeneous profile of PMC responses in functional, spatial, and temporal domains. While the majority of PMC sites showed increased broad gamma band activity (30-180 Hz) during rest, some PMC sites, proximal to the retrosplenial cortex, responded selectively to autobiographical stimuli. However, no site responded to both conditions even though they were located within the boundaries of the DMN identified with resting-state functional imaging and similarly deactivated during arithmetic processing. These findings, which provide novel electrophysiological evidence for heterogeneity within the core of the DMN, will have important implications for neuroimaging studies of the DMN.

C27

INTERNAL VERSUS EXTERNAL BODY-FOCUSED ATTENTION HAVE OPPOSITE EFFECTS ON SOMATOSENSORY PERCEPTUAL DECISION-MAKING Laura Mirams[1], Ellen Poliakoff[1], Richard J Brown[1], Donna M Lloyd[1]; [1]The University of Manchester — Although 'body-focused attention' is thought to affect somatic perception, the concept is not always well defined and different types of body-focused attention may have opposing effects. The current research investigated the effects of interoceptive and exteroceptive body-focused attention on somatic perception using the somatic signal detection task (SSDT). Healthy participants often erroneously report near-threshold vibrations presented to their fingertip in the absence of a stimulus on this task, particularly when a nearby light flashes. In experiment one, thirty-seven participants completed the SSDT without and after performing an interoceptive heart beat perception (HBP) task. The HBP task was expected to raise levels of sensory noise during the SSDT, leading to increased touch reports due to confusion between internal bodily sensations and the target vibration. The HBP task led to a more liberal response criterion, due to increased touch reports both in the presence and absence of a target vibration. This finding is consistent with suggestions that attending internally contributes to symptom reporting in patients with medically unexplained symptoms. In experiment two, forty participants completed the SSDT before and after an exteroceptive grating orientation task (GOT). The GOT task was expected to reduce touch reports by decreasing sensory noise. The GOT led to a more stringent response criterion, due to decreased touch reports in the presence and absence of the target. This work demonstrates that internal and external body-focused attention can have opposite effects

on somatic perceptual decision-making and suggests that attention training could be useful for patients with medically unexplained symptoms.

C28

TEMPORAL DURATION JUDGEMENTS: EFFECTS OF MODALITY, LOCATION SHIFT AND ATTENTION Chrysa Retsa[1], Tristan Bekinschtein[2], Thomas Bak[1]; [1]University of Edinburgh, [2]Cognition and Brain Sciences Unit, Cambridge — Temporal perception can be affected by several factors such as attention, modality and spatial position. Recent studies reported an overestimation of the duration of stimuli presented on the right side and underestimation of those presented on the left. We conducted a series of experiments to investigate the effects of modality and location on duration judgments. Participants were presented with a standard stimulus followed by a comparison stimulus and were asked to indicate whether the comparison stimulus was longer or shorter than the standard. Comparison stimuli were presented either on the same or different location than the standard. We varied the position (left/right, top/bottom) across visual and auditory modalities. Visual and auditory trials were presented separately as well as intermixed. Across all experiments we found no effect of location (left versus right, top versus bottom). However, in the experiments where different modality trials were intermixed, in visual condition participants were overestimating the durations when comparison stimuli were presented at different locations to the standard. In the conditions where the location of the comparison was different to the standard, visual stimuli were judged to be longer than the auditory. However, when the location of the comparison stimulus was at the same side as the standard a reverse effect was observed. These findings call into question a static influence of the position per se on temporal judgments. Instead, the effects of position could be accounted for by a shift of spatial attention between two locations and by peri-saccadic effects such as chronostasis.

C29

INTERMODAL ATTENTION BIASES MULTISENSORY INTERACTIONS IN THE VISUAL AND TACTILE PERIPHERY: AN FMRI STUDY Christina Karns[1], Mark Dow[1], Jolinda Smith[1], Scott Frey[1], Helen Neville[1]; [1]University of Oregon — Intermodal attention may enhance neural processing relatively early in the sensory stream independently of spatial and selective-attention (Karns & Knight 2009), therefore we hypothesized that intermodal attention also biases multisensory interactions. We employed fMRI to determine the degree to which coregistered vision and touch interact and to characterize mechanisms of intersensory attentional selection for unisensory and multisensory stimuli. Weak lights and air-puffs were coregistered in far-peripheral visual space, ~45° above or below the right eye, to elicit robust multisensory interactions. In a whole brain analysis, we modeled the effects of visual stimuli, tactile stimuli, and super- and subadditive interactions relative to embedded rest blocks. Among task-positive regions with a robust BOLD response to visual stimulation, two areas were superadditive with visual attention to multisensory stimuli: the contralateral lateral occipital complex (LOC) -- overlapping with motion sensitive regions (V5/MT+) and extending into the posterior fusiform -- and the superior parietal gyrus. Task-positive regions more responsive in tactile blocks included the posterior and middle insula, supramarginal gyrus, parietal operculum, precentral sulcus, and inferior central sulcus (BA6). Weak BOLD increases in the middle insula were superadditive and only with tactile attention. In task-negative regions of the ipsilateral intraparietal sulcus, inferior postcentral sulcus, occipital pole, and anterior calcarine sulcus, multisensory blocks were more negative than their unisensory counterparts. Overall, the results are consistent with an intermodal selection mechanism that operates in sensory cortices and influences multisensory interactions: with intermodal selection, multisensory-interactions are shifted to brain regions biased toward the attended sensory modality.

C30

IS ATTENTION TO THE BODY ABNORMAL IN PEOPLE WITH UNEXPLAINED SYMPTOMS? AN INVESTIGATION USING THE MODALITY SHIFT EFFECT PARADIGM Eleanor Miles[1], Richard J Brown[2], Ellen Poliakoff[2]; [1]University of Sheffield, UK, [2]University of Manchester, UK — It has often been assumed that people with medically unexplained symptoms (MUS) have an attentional bias for the body, which leads them to amplify normal physical sensations and experience them as symptoms. However, this conclusion is largely based on self-report measures of attention. Experimental investigations have the benefit of providing more direct evidence for an attentional bias, and can also provide more specific evidence about the nature of the bias. The current study applied an experimental paradigm from the attention literature (the modality shift effect; cf. Spence, Nicholls & Driver, 2001) to an analogue MUS group and a control group, in order to investigate whether symptom experience was associated with a deficit in the ability to shift between touch and vision. Both groups showed a relative RT benefit when the same modality was repeated across two trials (and a relative cost when the modality switched), and this effect decreased over time after target presentation. However, the analogue MUS group showed a longer-lasting benefit when the tactile modality was repeated. This might imply that impaired disengagement from tactile stimuli is the key attentional process contributing to symptom experience. Future research should take into account the possibility that attentional deficits in MUS are more complex than simply attending towards the body.

Attention: Nonspatial

C31

A DOUBLE-DISSOCIATION BETWEEN FEATURE-BASED ATTENTION AND VISUAL AWARENESS IN MAGNETO-ENCEPHALOGRAPHIC SIGNALS Ying Liu[1,2,3], Anne-Lise Paradis[1,2,3], Catherine Tallon-Baudry[1,2,3]; [1]Université Pierre et Marie Curie–Paris 06, Unité Mixte de Recherche (UMR) 7225, S-975, Centre de Recherche de l'Institut Cerveau-Moelle (CRICM), [2]CNRS (Centre National de la Recherche Scientifique), UMR 7225, CRICM, [3]Inserm (Institut National de la Santé et de la Recherche Médicale), UMR-S 975, CRICM — There is growing evidence that spatial attention and visual awareness are distinct and independent processes. However, spatial location may not be an intrinsic component of the content of awareness, in the sense that one may be aware of an object without knowing precisely where this object is located. Attention to intrinsic features of an object, such as shape or color, might be much more relevant because those features determine the content of awareness. We therefore designed an experiment in which we manipulated simultaneously attention to color and awareness. Color cues indicated, on each trial, the most likely color of the upcoming stimulus. On top of the color target, a faint grating, at threshold for conscious detection, was presented. Physically identical stimuli could therefore be attended or not and consciously seen or not. We observed typical attentional effect, with a shortening of reaction times for attended targets in the aware condition. However, magneto-encephalographic data results revealed distinct and independent neural correlates for visual awareness and feature-based attention. Attention to color modulated event-related fields around 220ms, and this attentional modulation was present for both consciously seen and unseen stimuli. Stimuli that were later reported as consciously seen elicited larger responses between 260 and 300ms than undetected stimuli. Our results therefore suggest that feature-based attention can operate on neural activity independently from awareness, and conversely that there can be neural correlates of awareness independently from feature-based attention. These results strongly support the idea that attention and awareness correspond to two distinct neural mechanisms.

C32

AN ELECTROPHYSIOLOGICAL CORRELATE OF RAPID ATTENTIONAL CAPTURE BY BIOLOGICAL MOTION Laura Chubb[1], James Thompson[1], Craig McDonald[1]; [1]George Mason University — Recent work provides evidence of top-down attentional influences in the processing of biological motion. However, bottom-up, salience-based attentional processing may also play a role in certain contexts. To test this possibility, we recorded event-related potentials (ERPs) while participants performed a variant of the three-stimulus oddball task. Participants were probed with task-irrelevant point light walker (PLW) and scrambled point light walker (sPLW) stimuli in the context of a target detection task. The PLW and sPLW served as probes in separate blocks. Common and target stimuli were various forms of tool motion. We found that the PLW elicited a significantly larger occipital P1 component than did the sPLW. This effect was localized to the right hemisphere. The N1 component elicited by the PLW was also significantly larger in the right hemisphere. In addition, we found a significant hemisphere by stimulus interaction for the P3a component. However, this right-lateralized increase in amplitude only approached significance. Importantly, the P1, N1 and P3 components elicited by target stimuli did not differ in amplitude between PLW and sPLW blocks. Our findings provide electrophysiological evidence of rapid (<150 ms), involuntary attentional capture by biological motion.

C34

FEATURE-BASED ATTENTION PARAMETRICALLY MODULATES DIRECTION-SELECTIVE ELECTROMAGNETIC RESPONSES IN HUMANS Christian Stoppel[1], Hans-Jochen Heinze[1,2], Jens-Max Hopf[1,2], Mircea Ariel Schoenfeld[1,2,3]; [1]Otto-von-Guericke University Magdeburg, [2]Leibniz-Institute for Neurobiology Magdeburg, [3]Kliniken Schmieder Allensbach — Attentional selection on the basis of non-spatial stimulus features produces a sensory gain enhancement by increasing the firing-rate of individual neurons tuned to the attended feature, while responses of neurons tuned to opposite feature-values are suppressed. Here we recorded event-related potentials (ERP) and event-related magnetic fields (ERF) in human observers to investigate analogous neural correlates of global feature-based attention at the population level. During the task subjects attended to the direction of a moving transparent surface located in the left visual field, while in the right visual field a second transparent surface moved briefly into varying directions. The direction of these movements deviated from the motion-direction of the attended surface by 0°, 45°, 90°, 135° or 180° and were completely irrelevant for the task. The spatiotemporal analysis revealed that the neural activity elicited by these probe stimuli was localized to the contralateral motion-sensitive area human MT and was parametrically modulated as a function of the similarity between their motion-direction and the direction of the attended surface. These results provide strong support for the "feature-similarity gain" hypothesis by showing that the feature-based attention related multiplicative scaling of single-neuron activity converges into an enhanced direction-selective response at neural population level.

C35

NEURAL BASES OF ONE OF THE FUNCTIONS OF FOCUS OF ATTENTION: AN FMRI STUDY ON UNPREDICTABILITY Chandramallika Basak[1], Cris Hamilton[1], Yu-Hsuan Chang[1], Debshila Basu Mallick[1]; [1]Rice University — In addition to accessing and updating information (Oberauer, 2003), focus of attention (FoA) has been proposed to direct attention to the relevant informational unit (Basak & Verhaeghen, in press). (Un)predictability of stimulus occurrence in the sequence determines whether focus switching cost, the process of switching information in and out of FoA, is constant or increases with working memory load (N); the latter is indicative of controlled search process outside the FoA. In the current study, we manipulated the stimulus predictability across blocks for N>2, with the rest of the parameters remaining constant, in a new continuous memory-updating paradigm (N varied from 1 to 3). In the predictable sequence, e.g. 2-pred, the sequences appeared in a known sequence whereas in the unpredictable sequence, e.g. 2-unp, the stimulus appearance was random. The main goal was to determine the neural substrate of pointer unpredictability in FoA (i.e., unp>pred contrast). For this contrast, we found significant activations in hippocampus, left insula and post-central gyrus. In addition, there was significant predictability (pred, unp) by set-size (N=2, N=3) interaction for hippocampus/ para hippocampus gyrus (PHG), left insula and middle frontal gyrus. In accordance to previous researchers, we found increased significant activations for items in FoA, compared to outside FoA, in the frontal pole, anterior cingulate cortex (ACC), precuneus and insula (Oztekin et al., 2010; Osaka et al., 2007; Nee and Jonides, 2008). These findings suggest that the neural substrates of controlled search induced by pointer unpredictability are based on hippocampus, fronto-insula network.

C36

ATTENTION CAPTURE MODULATES THE ATTENTIONAL BLINK Simon Nielsen[1], Tobias Andersen[1]; [1]Technical University of Denmark, Richard Petersens Plads, Lyngby, Denmark — When two targets (T1 & T2) are presented in rapid succession, observers often fail to report T2 if they attend to T1. Bottleneck theories propose that this attentional blink (AB) is due to T1 occupying a slow processing stage when T2 is presented. Accordingly, if increasing T1 difficulty increases T1 processing time, this should cause a greater AB. Attention capture hypotheses suggest that T1 captures attention, which cannot be reallocated to T2 in time. Accordingly, if increasing T1 difficulty, decreases T1 saliency, this should cause a smaller AB. Studies examining how T1 difficulty affects the AB have reported inconsistent results. For example, some found a negative correlation between T1 contrast and T2 performance (Chua, 2005) where others find a positive correlation (Christmann & Leuthold, 2004). Here, we use additive Gaussian noise to tease apart the exogenous capture effect from the effect of T1 contrast. The capture effect is varied by the overall contrast energy for signal and noise. In two T1 conditions we adjust T1 performance to 60% by signal to noise ratio (SNR). However, we vary T1 contrast energy by between conditions by approximately a factor 10. From 17 observers we find that T2 performance correlates negatively with T1 contrast energy. Our results indicate that T1 capture modulates the AB. We suggest that this effect has confounded previous studies on the effect of T1 difficulty. In an electrophysiological version of the study we will further examine the implied relation between attention capture and the AB.

C37

PUPILLOMETRY AND P3 INDEX THE LOCUS COERULEUS-NORADRENERGIC AROUSAL FUNCTION IN HUMANS Peter R. Murphy[1], Ian H. Robertson[1], Joshua H. Balsters[1], Redmond G. O'Connell[1]; [1]Trinity College Institute of Neuroscience, Trinity College Dublin, Dublin 2, Ireland — The adaptive gain theory (Aston-Jones & Cohen, 2005) has recently highlighted the pivotal role of the brain's locus coeruleus-noradrenergic (LC-NE) neuromodulatory system in regulating task engagement and optimizing performance according to environmental contingencies. Understanding of the functional dynamics of LC-NE activity in humans has been hampered, however, by an absence of reliable and easy-to-acquire neurophysiological markers that have sufficient temporal resolution to index the tonic and phasic shifts that are observed to occur within this system. The present study evaluated the utility of two candidate psychophysiological markers of the LC-NE system: the P3 event-related potential (ERP) and pupil diameter. Twenty-four participants completed a 37-minute auditory oddball task concurrent to both pupillometry and EEG data collection. As predicted by the adaptive gain theory, pre-stimulus pupil diameter exhibited a significant inverted-U shaped relationship with both P3 amplitude and task performance such that largest P3 amplitudes and optimal performance occurred at the same intermediate level of pre-stimulus pupil diameter. Large phasic pupil dilations, by contrast, were elicited during periods of poor performance and were followed by re-engagement in the task and increased P3 amplitudes. These results support recent proposals that pre-stimulus pupil diameter and the P3 are sensitive to LC-NE mode. We further argue that the large pha-

sic pupil dilations we observed may reflect phasic LC responses driven by higher-cortical performance-monitoring mechanisms.

C38

ENHANCEMENT AND SUPPRESSION IN ATTENTIONAL SELECTION OF VISUAL FEATURES Søren K. Andersen[1,2], Jasna Martinovic[3], Steven A. Hillyard[1], Matthias M. Müller[2]; [1]University of California in San Diego (UCSD), [2]University of Leipzig, Germany, [3]University of Aberdeen, UK — In a series of experiments, attentional selection of features was assessed by recording steady-state visual evoked potentials (SSVEPs) to multiple concurrently presented random dot stimuli together with behavioral data. Voluntary cued shifts of feature-selective attention to one of two spatially overlapping stimuli were marked by both to an enhancement of the attended as well as a suppression of the unattended stimulus. Interestingly, the enhancement of the attended stimulus preceded the suppression of the unattended stimulus by some 130ms. Analysis of single trial amplitudes revealed that this pattern of results can possibly be explained by the combined effects of a sensory gain mechanism biasing the competition between the overlapping stimuli, which then leads to a suppression of the unattended stimulus. Additionally, the time-course of SSVEP amplitudes was found to be closely related to reaction times. To examine possible interactions of bottom-up biases and top-down stimulus selection on stimulus processing, in a further experiment stimulus contrast was manipulated in order to produce a bottom-up bias towards one or the other stimulus. Both voluntary attention and higher stimulus contrast lead to higher SSVEP amplitudes. The absolute size of the attention effect increased with higher contrast, however the relative attentional enhancement remained constant. Hence, even when stimuli are presented overlapping and thus directly compete for processing resources, both bottom-up and top-down factors independently influence signal gain at early levels of visual processing.

C39

RESOURCE SHARING CANNOT EXPLAIN THE ATTENTIONAL BLINK Hannah Pincham[1], Denes Szucs[1]; [1]University of Cambridge — The attentional blink refers to a deficit in processing the second of two masked targets (T1 and T2) presented in rapid serial visual presentation. Considerable debate questions whether cognitive resource sharing underpins the attentional blink. Increasing the resources allocated to T1 may reduce the resources available for T2 processing, causing T2 to go undetected. We systematically investigated this claim by manipulating the difficulty of T2 detection. Specifically, the T2 mask enabled T2 detection on approximately half of the experimental trials. We used the electroencephalography P3 component to index the resources allocated to each target. If the resource sharing account holds, the T1 P3 should be reduced on T2-detected trials versus T2-undetected trials. 24 healthy adult participants completed an alphanumeric attentional blink task. The lag between T1 and T2 was set at three items to ensure that T2 fell within the 'blink' period. The targets were masked with a computer symbol such that T2 was accurately detected on approximately 50% of trials. Participants also indicated their confidence levels using a ranking scale. The results indicated that the peak latency and amplitude of the T1 P3 did not differ as a function of T2 accuracy. Not surprisingly, however, the amplitude of the T2 P3 was significantly reduced on T2-undetected trials. Therefore, even though resource sharing may play a role in the attentional blink deficit, these results suggest that resource sharing should not be viewed as the primary contributing factor.

C40

EXPLORING THE NEUROCHEMICAL BASIS OF THE P300: EVIDENCE OF DOPAMINERGIC AND NORADRENERGIC INFLUENCE Redmond O'Connell[1], Jessica Barnes[2], Peter Murphy[1], Sanjay Nandam[2], Angela Dean[2], Ian Robertson[1], Mark Bellgrove[2]; [1]Trinity College Institute of Neuroscience, Trinity College Dublin, Dublin 2, Ireland, [2]School of Psychology and Queensland Brain Institute, University of Queensland, St Lucia, Queensland, Australia — The P300 has been one of the most extensively studied event-related potentials (ERP) and has demonstrated strong sensitivity to aspects of attention and memory. Despite the large amount of interest in this component as a clinical and neuro-cognitive marker its neurochemical origins remain poorly understood, limiting its potential utility. The present study explored the effects of three monamine (dopamine, noradrenaline and serotonin) agents on P300 amplitude. Twenty-five healthy participants entered a randomised, cross-over controlled trial in which they received a single dose of methylphenidate (a noradrenaline and dopamine re-uptake inhibitor), atomoxetine (a noradrenaline re-uptake inhibitor), citalopram (a serotonin re-uptake inhibitor) or placebo before each of four testing sessions, one-week apart. EEG data were acquired while participants performed two versions of the visual oddball paradigm: a two-stimulus version designed to elicit the P3b target-detection component and a three-stimulus version designed to elicit the P3a distracter-processing component. Relative to placebo, methylphenidate and atomoxetine led to significant improvement in RT and RT variability and increased P3b amplitude over centro-parietal scalp sites on the two-stimulus task. On the three-stimulus task, only methylphenidate had a significant effect, leading to improved target detection and decreased reaction time in addition to a significant increase in P3a amplitude over fronto-central scalp sites. No significant behavioural or electrophysiological effects were observed for citalopram with either task. Our data provide clear support for the role of catecholamines in generating the P300 and suggest that the P3a and P3b components are differentially sensitive to changes in dopamine and noradrenaline.

C41

WHAT'S IN A PICTURE: COLOR CUES EMBEDDED IN COMPLEX VISUAL SCENES ATTRACT ATTENTION E. Menton McGinnis[1], Andreas Keil[1]; [1]University of Florida — Affectively relevant objects attract attention and enhance perception. What remains unknown is what kind of features in emotional stimuli attract resources and how. Here, we examined cueing versus interference of color cues embedded in naturalistic picture stimuli. Effects of affective color cues on cortical processing of a concurrent color stimulus were examined by means of frequency tagging as afforded by steady-state visually evoked brain potentials (ssVEPs). Participants viewed a series of images from the International Affective Picture System (IAPS), modified such that the top 5% of the red pixels in the mutilation images were standardized across all images, and were replaced by red or green pixel values in otherwise gray-scale images. Cueing effects were examined by either a 14 Hz frame (Experiment 1) or by an embedded 15 Hz central foveal probe (Experiment 2), flickering in either red or green. In both experiments, viewing affective pictures was associated with suppressed ssVEP amplitude, suggesting arousing images compete for resources in matched cue/probe conditions, irrespective of color. Green probe conditions produced an enhanced ssVEP in affective images irrespective of cue color, also consistent between experiments. Additionally, red cues produced enhanced ssVEP amplitude in arousing images, suggesting the context-appropriate red cue in mutilation images resulted in facilitation of the emotionally salient feature, irrespective of probe color. These findings suggest affective stimuli hinder the allocation of resources in visual image processing; however, within affective stimuli, context-appropriate color cueing is beneficial.

C42

DISSOCIATING FORMS OF ATTENTIONAL CONTROL USING THE DISTRACTOR CONDITION SUSTAINED ATTENTION TASK: PATIENTS WITH SCHIZOPHRENIA VERSUS CHILDREN Elise Demeter[1], Sally Guthrie[1], Stephan Taylor[1], Martin Sarter[1], Cindy Lustig[1]; [1]University of Michigan — Attentional deficits represent a core cognitive impairment in schizophrenia, persisting across both periods of psychosis and remission (e.g., Wohlberg and Kornetsky, 1973). The distractor condition sustained attention task (dSAT) can be used to assess attention in both rodents and humans. Because of the dSAT's translational potential, the Cognitive Neuroscience Treatment to Improve Cognition in Schizophrenia (CNTRICS) initiative selected it as a candidate tool for measuring attentional control deficits in schizophrenia (Nuechterlein et al., 2009). The paradigm compares performance in the standard sustained attention

task (SAT) versus a condition with a distracting flashing background (dSAT). In the present study, the SAT and dSAT were performed by patients with schizophrenia and age- and gender-matched controls. To address concerns about ceiling performance in the SAT by the original control group, two additional control groups were tested. The first consisted of school-age children, who are also thought to have reduced attentional control compared to healthy adults. The second was another group of adult controls tested under conditions that increased uncertainty about signal duration and location. Patients with schizophrenia showed only small impairments on the SAT but were differentially impaired by the distractor (dSAT) compared to the other groups. Children were the only group to show time-on-task effects on the basic SAT. These results demonstrate the feasibility of using the dSAT with schizophrenic patients, and suggest that their distraction-related impairments can be dissociated from general performance impairments and from the performance of other groups (i.e., children) for whom reduced attentional control arises for different reasons.

C43

DISTRACTION VERSUS DETECTION: EVIDENCE FOR DIFFERENTIALLY-LATERALIZED FRONTOPARIETAL CONTROL PROCESSES FROM THE DISTRACTOR CONDITION SUSTAINED ATTENTION TASK Anne Berry[1], Elise Demeter[1], Mary Askren[1], Martin Sarter[1], Cindy Lustig[1]; [1]University of Michigan — Sustained attentional performance requires both the long-term maintenance of top-down control to keep attention on the task, and moment-by-moment attentional shifts to detect and respond to relevant signals. The sustained attention task (SAT) and its distractor condition (dSAT) were originally developed to investigate attentional mechanisms in rodents. It has been validated for human use (Demeter et al., 2008), and selected by the CNTRICS (Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia) initiative as a candidate measure of attentional control (Nuechterlein et al., 2009). A recent block-design study (Demeter et al., 2010) found that right middle frontal gyrus activity selectively increased in response to the distractor. Here we report an event-related fMRI study of SAT and dSAT trials in healthy young adults. On each trial, participants monitored for a brief, centrally-presented signal, indicating its presence or absence in a subsequent response period. During dSAT trials, the background screen flickered, impairing performance. Consistent with previous studies of top-down attention, performance of SAT and dSAT activated frontoparietal control networks. However, while the distraction contrast (dSAT vs SAT) revealed right prefrontal activation, consistent with our previous findings, a contrast of hits (correct signal trials) versus correct rejections (correct nonsignal trials) revealed prefrontal and parietal activations that were largely left-lateralized. Future analysis will include trial-type and trial sequence effects to further examine potential links between fMRI activation measures in humans and neurotransmitter release patterns in animal models.

C44

CORTICAL ACTIVATION CHANGES ASSOCIATED WITH INTENSIVE MEDITATION TRAINING ARE RELATED TO VIGILANCE PERFORMANCE Manish Saggar[1], Katherine A. MacLean[5,2], Stephen R. Aichele[2], Tonya L. Jacobs[2], Anthony P. Zanesco[2], David A. Bridwell[3,2], Brandon G. King[2], Baljinder K. Sahdra[2], Erika L. Rosenberg[2], Phillip R. Shaver[2], Emilio Ferrer[2], B. Alan Wallace[4]; [1]University of Texas at Austin, [2]University of California-Davis, [3]University of California-Irvine, [4]Santa Barbara Institute for Consciousness Studies, Santa Barbara, CA, [5]JHU School of Medicine, Baltimore, MD — Cortical activation changes were assessed in a 3-month meditation retreat group (RG1) (n=22) compared to a matched wait-list control group (CG) (n=22), which later underwent its own 3-month retreat (RG2). Training consisted of focused attention techniques (4-6 hrs/d) and practices of generating beneficial emotions (0.5-1.5 hr/d) (Wallace, 2006). 88-channel EEG was obtained pre-, mid-, and post-retreat while participants rested with their eyes-closed (1-min) before engaging in eyes-closed focused attention meditation (6-min of mindfulness of breathing). Second-order blind source separation was used for removal of putative non-neural signals. Individual mean alpha frequency (IAF) was calculated during rest and was used to determine EEG bands for each participant. Significant reduction in IAF was found at mid and post test-points in both RGs but not the CG. Changes in scalp current density spectral power across test-points were assessed using nonparametric cluster-based analysis. During meditation (for both RGs) reduction in beta power was found bilaterally over parieto-occipital and midline fronto-central areas at mid and post test-points compared with the pre test-point. During pre-meditation rest reduced alpha and beta power was found at frontal, central and parieto-occipital areas in both RGs at mid and post test-points. Further, pre-to-post reduction in upper alpha band power during the pre-meditation rest predicted improved performance in a sustained attention task (RG2) (MacLean et al 2010). These results suggest that training in focused attention increases activation of attention-related systems during meditation. These effects appear to generalize to non-meditation periods and may underlie observed improvements in tasks that require sustained attention.

Attention: Other

C45

GREY AND WHITE MATTER LESIONAL CORRELATES OF VISUOSPATIAL NEGLECT: A COMBINED STRUCTURAL MRI AND TRACTOGRAPHY APPROACH Monica N. Toba[1,2], Raffaella Migliaccio[1,2,8], Michel Thiebaut de Schotten[2,3], Pascale Pradat-Diehl[4,5], Catherine Loeper-Jeny[6], Paolo Bartolomeo[1,2,7,8]; [1]Université Pierre et Marie Curie - Paris 6, Centre de Recherche de l'Institut du Cerveau et de la Moelle épinière, UMR-S975, Paris, France, [2]Inserm, U975, Paris, France, [3]Natbrainlab, Department of Forensic and Neurodevelopmental Sciences, Institute of Psychiatry, King's College London, London, UK, [4]Inserm, U731, Paris, France, [5]AP-HP, Pitié-Salpêtrière, Service de Médecine Physique et Réadaptation, Paris, F-75013, France, [6]Hôpital National de Saint-Maurice, Saint-Maurice, France, [7]AP-HP, Pitié-Salpêtrière, Fédération de Neurologie, Paris F-75013, France, [8]Department of Psychology of the Catholic University, Milan, Italy — Patients with right hemisphere lesions and visual neglect fail to orient and respond to left-sided objects. There is general agreement that neglect is a heterogenous, multicomponential syndrome, but the location and identity of the relevant lesion sites remain debated. Twenty-five right-handed patients with subacute strokes in the right hemisphere performed a paper-and-pencil neglect battery. Their performance (scores on each individual neglect test) was mapped to cortical lesions by using voxel-based lesion-symptom mapping (VLSM) method. The principal white matter (WM) association bundles were reconstructed by using diffusion tensor imaging (DTI) tractography. DTI-derived metrics of WM integrity for each tract (fractional anisotropy, mean diffusivity and radial and parallel diffusivities) were also obtained. Distinct cortical regions including the right angular and supramarginal gyri, as well as the middle frontal gyrus were specifically associated with deficits obtained on specific tests. VLSM and tractography both revealed that damage to the right anterior segment of the arcuate fasciculus, connecting Broca's territory with the inferior parietal lobe, correlated with pathological scores in all the tests used. These results indicate an essential role of the WM damage in neglect and open the way for an interpretation of performance dissociations in neglect on the basis of WM bundles disconnections.

C46

ELECTROPHYSIOLOGICAL EVIDENCE FOR THE ROLE OF INDIVIDUATION AND VISUAL WORKING MEMORY IN QUANTITY ESTIMATION Silvia Pagano[1], Veronica Mazza[1,2]; [1]Center for Mind/Brain Sciences (CIMeC), University of Trento, Italy, [2]Department of Cognitive Sciences and Education, University of Trento, Italy — Estimation of small sets of objects is crucial in our daily life. This ability seems to rely both on the selection of objects mainly through their spatial locations (individuation) and on the maintenance of the selected objects in a visual working memory (VWM) system

that eventually maps the symbolic quantity of the set onto a specific number. However, the role of these mechanisms in quantity estimation has typically been studied in isolation. In the present study we assessed the contribution of the individuation and VWM mechanisms in visual estimation by using a novel approach based on the N2pc and CDA, two Event-Related Potential (ERP) measures of visual selection and VWM maintenance, respectively. Participants saw a variable number (1, 3, 5, 7) of lateralized,uniquely colored targets presented among distracters, and their task was to report the number of targets. Results showed that the N2pc amplitudes increased as a function of target numerosity, reaching an asymptote at approximately 5 elements, in line with the capacity limit proposed by some models of individuation. CDA amplitudes showed a peculiar inverted U-shape pattern, with a marked decrease in activation for the largest numerosity in the set, in line with previous research showing a predominant guessing strategy in the so-called end effect. Overall, the present results indicate that the individuation and VWM mechanisms jointly contribute to visual estimation of small quantities.

C47

THE INFLUENCE OF REWARD ON COMPETITION BASED ATTENTION AND ITS ELECTROPHYSIOLOGICAL CORRELATES Jessica Sänger[1], Edmund Wascher[2]; [1]Heinrich-Heine-University Düsseldorf, [2]Leibniz Research Centre for Working Environment and Human Factors — The biased competition approach on visuo-spatial attention proposes that the selection of competing information is effected by the saliency of the stimulus as well as by an intention- based bias of attention towards behavioural goals. Wascher & Beste (2010) could show that the detection of relevant information depends on its relative saliency compared to irrelevant conflicting stimuli. Furthermore the N1pc, N2pc and N2 of the EEG varied with the strength of the conflict. However, this system should also be modulated by rather global mechanisms like attentional effort. The present study investigates such modulations by testing the influence of the reward system on the selection of competing stimuli. Participants had to detect a luminance change in various conditions among others against an irrelevant orientation change. Half of the participants were motivated to maximize their performance by announcing a monetary reward for correct responses. Participants who got rewarded had lower error rates than participants who got no reward. The event-related lateralizations of the EEG showed no reward-related effect on the N1pc, which reflects the initial saliency driven orientation of attention towards the more salient stimulus. The subsequent N2pc was enhanced in the reward condition. Reward was also accompanied by an enhanced fronto-central N2. Thus, the data provide evidence that the improvement of selection performance when giving a reward was not due to changes in the initial saliency based processing of information but was foremost mediated by improved higher-level mechanisms.

C48

ENHANCED CORTICAL ORIENTING RESPONSE TO NOVELTY IN OBSESSIVE-COMPULSIVE DISORDER Norbert Kathmann[1], Moritz Ischebeck[1], Tanja Endrass[1]; [1]Humboldt University at Berlin — Experimental research in obsessive-compulsive disorder (OCD) has shown that OCD patients perform abnormally in some attentional tasks. We hypothesized that a hypersensitive threat detection system in OCD patients evokes increased cortical orienting responses reflected in enhanced novelty P3 (NP3) amplitudes of the event-related brain potential (ERP). Novel pictures which were task-irrelevant but had either neutral or negative affective valence were presented among frequent standards and rare targets. As expected, aversive novels elicited larger NP3 amplitudes than neutral novels across groups. OCD patients had increased NP3 amplitudes compared to healthy control probands after novel stimuli, but not after targets. Moreover, affective valence had no effect on group differences. This pattern was confirmed in a replication study. In a further experiment we studied auditory novelty responses during a memory task in which in context A only neutral and in context B mixed (neutral and aversive) pictures were memorized, in order to evaluate the effect of affective context. Here, enhanced auditory NP3 amplitudes were found primarily in the neutral condition. It is concluded that novel events elicit larger ERP responses in OCD patients than in controls probably indicating augmented involuntary shifts of attention to infrequent irrelevant events. This abnormally high cortical orienting response is independent from the affective significance of event or context, and may constitute an endophenotype of OCD which can be helpful in the search for the genetic basis of the disorder.

C49

VIDEO GAME TRAINING AND CORTICAL RECRUITMENT OF THE ATTENTIONAL AND DEFAULT-MODE NETWORKS Lyla Mourany[1], Ruchika Shaurya Prakash[1], Hyunkyu Lee[2], Michelle W. Voss[2], Kirk I. Erickson[3], Walter R. Boot[4], Chandramallika Basak[2], Mark B. Neider[2], Daniel J. Simons[2], Monica Fabiani[2], Gabriele Gratton[2], Arthur F. Kramer[2]; [1]The Ohio State University, [2]University of Illinois at Urbana-Champaign, [3]University of Pittsburgh, [4]Florida State University — We examined the effect of strategy on neural recruitment during video game play. Fifty participants completed 30 hours of training under one of two training regimes: Fixed Emphasis Training (FET), in which participants practiced all the aspects of the Space Fortress (SF) game at once or, Hybrid Variable Priority Training (HVT), in which participants practiced while prioritizing selective aspects of game play at different times. After 30 hours of training, data indicated a significant advantage for the two training groups relative to a no-training control group. Following training, both groups showed reduced activation in cortical areas involved in attentional control, namely the dorsolateral prefrontal cortex, anterior cingulate cortex, and parietal cortices. The control group continued to show activation in these areas post-training, suggesting that the attentional demands of the task were not reduced for control participant but were reduced for trained participants. In contrast, areas of the default-mode network showed an increase in activation post-training in the training groups. Initially poor performers improved more with HVT than FET, and those receiving HVT also showed a greater reduction in the activity of prefrontal and parietal regions. Training strategy did not produce differences in activation magnitude of initially high performing participants. These data suggest that training reduced the attentional demands of SF, and this reduction was most evident in the HVT training group.

C50

PREDICTORS OF COGNITIVE REHABILITATION SUCCESS ON A SIMULTANEOUS MULTIPLE ATTENTION TASK IN PEOPLE WITH SCHIZOPHRENIA Eniana Agolli[1], Amelia Lewis[1], Matthew M Kurtz[2,3], Mara De Maio[2,3], Sarah Raskin[1]; [1]Trinity College, [2]Institute of Living (IOL), [3]Hartford Hospital — Research has suggested that computer assisted Cognitive Rehabilitation (CR) can produce significant improvement in daily functioning for people with schizophrenia. The goal of this research is to examine performance on a simultaneous attention task used as part of a CR training program and determine which variables predict improvement in training. Specifically, we analyzed two measures. The first is improvement, defined as the difference between the first goal set in treatment and the highest goal attained. The second measure was just the highest goal reached on the CR task. These were compared to two predictor variables: symptomatology (Positive and Negative Syndrome Scale (PANSS)) and cognitive pre-tests (Brief Test of Attention (BTA), Penn Continuous Performance Task (PCPT), Digit Span and Trails A & B). Preliminary results showed that reaction time on the PCPT is significantly correlated with total improvement in CR. In Trails A, a measure of attention and speed of processing, time predicts the highest goal that will be attained. Most notably the BTA, a measure of auditory divided attention, predicted total improvement. The data from PANSS negative scale revealed a correlation with improvement for the passive/apathetic social withdrawal measure. Based on the results, it appears that specific baseline cognitive abilities measuring attention may be useful in predicting success as well one aspect of negative symptomatology. Therefore, we may be able to predict who will most benefit from CR.

C51

DO DIFFERENT PERCEPTUAL TASK SETS MODULATE SUBSEQUENT UNCONSCIOUS MASKED VISUO-MOTOR PRIMING? ATTENTION TO SHAPES AND COLORS PUT TO THE TEST Monika Zovko[1], Markus Kiefer[1]; [1]University of Ulm, Germany — According to classical theories of automaticity and attention unconscious automatic processes are insusceptible to higher level attentional influences such as intentions and task sets. Recent evidence, however, shows that the cognitive system has to be configured in a certain way for automatic processes to occur. Our attentional sensitization model (Martens & Kiefer, 2010) suggests that automatic processes require an attentional enhancement in task-relevant pathways: Automatic processes can only be initiated if the process-relevant stimulus dimension matches the active attentional set. The present event-related potential (ERP) study investigated whether unconscious visuo-motor priming depends on a sensitization of processing pathways for shape in contrast to color. Prior to the masked visuo-motor priming task, a shape or a color decision task was presented in order to induce corresponding attentional sets. In the masked visuo-motor priming task, participants had to respond according to the shape of a visible target object, which was preceded by either a response-congruent or incongruent masked prime shape. ERP data should clear influences of the induction tasks on subsequent masked visuo-motor priming effects. We found priming effects over occipito-parietal regions only subsequent to the shape induction task in early (140-240 ms) and late time windows (350-500 ms). No such effects were found in the color induction task. The results strongly support our notion of a differential attentional sensitization of unconscious processing pathways: As a function of an attentional top-down signal, sensitization can also occur within perceptual subdomains, such as shape and color of objects.

C52

RESILIENCE OF AUDITORY CHANGE DETECTION AGAINST MIND WANDERING Julia W. Y. Kam[1], Maria Stanciulescu[1], Hamish Tildesley[2], Todd C. Handy[1]; [1]University of British Columbia, [2]Dartmouth College — The propensity of the human mind to wander is evident in our everyday life, as our thoughts frequently drift off-task. Despite the ubiquity of mind wandering however, little is known about its influence on cognition itself. While recent evidence suggests sensory and cognitive processing of external stimuli are reduced during mind wandering states (Kam et al., 2010), whether ongoing cognitive processes are directly modulated by mind wandering are currently unknown. To address this issue we examined the influence of task-related attention on auditory change detection. The mismatch negativity (MMN), an ERP component elicited by deviant stimuli, serves as an index of change detection. In this study, participants were presented a stream of auditory stimuli with deviant tones embedded among standard tones, which they were instructed to ignore, while they read a book. Occasionally, they were asked to report on their attentional state--on task or mind wandering. The MMNs immediately preceding these subjective reports were then examined as a function of whether participants were in an "on-task" or "mind wandering" state. Difference waveforms were obtained by subtracting ERP responses to standard tones from that to deviant tones separately for both on-task and mind wandering conditions. The MMN of the difference wave elicited during mind wandering states was significantly greater than the MMN elicited during on-task states ($F(1,15) = 4.59$, $p < 0.05$). Our results suggest that preattentive attentional processes can be amplified when our thoughts drift off-task, a finding that demonstrates the adaptive nature of information processing during mind wandering states.

C53

DISTRIBUTED ATTENTIONAL DEFICITS IN CHRONIC METHAMPHETAMINE ABUSERS: EVIDENCE FROM THE ANTI TASK Ruth Salo[1], Shai Gabay[2], Catherine Fassbender[1], Avishai Henik[2]; [1]UC Davis Medical Center, [2]Ben-Gurion University of the Negev — Long-term methamphetamine (MA) abuse is associated with a broad range of attentional deficits which may reflect neural damage across numerous brain regions. In order to examine patterns of cognitive function following long-term MA abuse, we administered a distributed attentional network task of cognitive function (ANTI) to 30 chronic MA abusers (mean age = 39.4 + 8.7 yrs) who were currently drug abstinent (range 1 mos to 4 yrs) and 23 controls (mean age = 30.1 + 8.8 yrs). Mean duration of MA use was 14.2 years. In this task subjects identified the direction of a centrally presented arrow using a keypress. We examined the interaction between group (MA and controls), alerting tones, location cueing and congruency between the target arrows and flanking distractor stimuli. All participants were faster when the tone preceded the trial onset, but no group differences emerged ($p = .12$). Both groups were faster on trials in which a valid cue preceded the location of the target arrow, but again no group differences were observed ($p=.33$). Of primary interest was the finding that the MA abusers had a bigger congruency effect than controls ($p = .048$). That is, MA abusers were more influenced by the conflict between the peripheral arrows and the central target arrow. These results suggest that chronic MA abusers display cognitive deficits that may reflect a specific vulnerability to distraction. These findings are consistent with other studies that have reported deficits in anterior attentional systems and top-down cognitive control. Keywords: methamphetamine, attention [DA021847; NARSAD].

C54

PHASE RESETTING OF DYNAMIC ATTENDING SIGNALS Karl Doron[1], Mari Jones[2], Hermann Hinrichs[3], Michael Gazzaniga[1,4]; [1]University of California, Santa Barbara, [2]Ohio State University, [3]Otto von Guericke University of Magdeburg, [4]Sage Center for the Study of the Mind — Attention to events in the natural environment can be controlled by temporal context. An oscillatory process that is capable of entraining to rhythmic sequences can model the neural and behavioral results observed in some attention experiments. An important aspect of an entrained oscillator is its flexibility: it demonstrates a capacity to adjust its period and phase to changes in the external driving rhythm. These adjustments to external rate changes can be observed in phase resets of an entrained EEG or MEG signal. To date, no studies in humans have investigated low frequency entrainment to a rhythmic visual stimulus, nor have phase resets to temporal perturbations been reported. Here, we report phase resetting in MEG signals recorded during rhythmical presentations of a lexical decision task. The phase of the delta band (1-3Hz) and the period of amplitude peaks in the alpha band (8-12Hz) entrain to the stimulus rate (1.667Hz) and also demonstrate phase shifts to temporal perturbations (+/- 120ms). These results show that neural oscillations in humans entrain to rhythmic visual input and further, that their adaptive behavior conforms to that of a limit-cycle oscillator when a stimulus arrives out of phase with an expected onset time.

C55

EMOTIONAL ENHANCEMENT OF RECALL UNDER DEPLETED VISUAL ATTENTION: AN EVENT-RELATED POTENTIAL INVESTIGATION Claire Pottage[1], Adam Rickart[2], Alexandre Schaefer[2]; [1]University of Leeds, [2]University of Durham — The current study used event-related potentials (ERPs) to investigate the role of attention in the emotional modulation of memory encoding. 25 participants viewed a series of negative and neutral images, and next undertook a free recall test. During the presentation of images at encoding a rapid number sequence was visually presented, superimposed on each image. During Full Attention conditions participants were instructed to ignore this number sequence. During Divided Attention conditions participants were asked to watch this sequence closely and were then asked how many "5's" appeared. Behavioural results show that division of attention severely impaired recall performance, however a significant effect of emotion on recall (negative images were recalled more frequently than neutral) was still observed in the Divided Attention condition. ERP waveforms were formed according to the subsequent memory effect in which encoding-related ERPs are separated based upon whether items were subsequently recalled or forgotten. In addition, ERPs were separated according to emotion (Negative vs. Neutral) and attention (Full Attention vs. Divided Attention). Results show a robust subsequent memory effect (ERPs are more positive-going for sub-

sequently recalled vs. forgotten items) in an early time window. The subsequent memory effect was present only for negative items in a late time window, and this effect was present in both attention conditions. These results suggest that emotion can modulate encoding-related neural activity even in conditions where visual attention is severely depleted. These findings can inform long standing debates about the role of pre-attentive processes in emotional memory formation.

C56

CONTROLLING THE UNCONSCIOUS: ATTENTIONAL TASK SETS MODULATE SUBLIMINAL SEMANTIC AND VISUO-MOTOR PROCESSES DIFFERENTIALLY Markus Kiefer[1], Ulla Martens[2], Ulrich Ansorge[3]; [1]University of Ulm, Germany, [2]University of Osnabrück, Germany, [3]University of Vienna, Austria — Are unconscious processes susceptible to attentional influences? In classical theories of automaticity and attention, unconscious automatic processes are thought to be independent of higher-level attentional influences. In contrast to this classical view, our attentional sensitization model (Kiefer and Martens 2010) proposes that automatic processing depends on attentional enhancement of task-congruent processing pathways: A stimulus can only elicit an automatic process if the process-relevant stimulus dimension belongs to the active attentional set. This hypothesis was tested with a novel procedure for masked semantic priming of words (Experiment 1) and masked visuo-motor priming of geometrical shapes (Experiment 2). Before masked prime presentation, participants attended in an induction task either to semantic or perceptual object features designed to activate a semantic or perceptual task set, respectively. Behavioral and electrophysiological effects showed a differential modulation of subliminal priming by the induction tasks: Semantic priming, involving access to conceptual meaning, was found after the semantic but not after the perceptual induction task. Visuo-motor priming was only observed after the perceptual but not after the semantic induction task. This demonstrates that unconscious cognition is influenced by attentional control. Unconscious processes in perceptual and semantic processing streams are coordinated in congruency with higher-level action goals. Hence, in line with the attentional sensitization model automatic processing of unconscious stimuli is susceptible to top-down control for optimizing goal-related information processing. Reference Kiefer, M., & Martens, U. (2010). Attentional sensitization of unconscious cognition: Task sets modulate subsequent masked semantic priming. Journal of Experimental Psychology: General, 139, 464-489.

Attention: Spatial

C57

DYNAMIC CORTICAL NETWORKS UNDERLYING ANTICIPATORY DEPLOYMENT OF SPATIAL ATTENTION REVEALED BY MAGNETOENCEPHALOGRAPHIC IMAGING Gregory Simpson[1], Corby Dale[2,3], Felix Darvas[4], Darren Weber[5], Dimitrios Pantazis[6], Steven Bressler[7], Richard Leahy[6], Tracy Luks[2]; [1]BPI, [2]UCSF, [3]NCIRE, [4]Univ Wash, [5]Buck Institute, [6]USC, [7]FAU — Although it is well established that multiple frontal, parietal and occipital regions are involved in anticipatory deployment of visual spatial attention, our understanding of the functional interactions between brain regions and the dynamics of large-scale cortical networks is just emerging. We used whole-head MEG source imaging to derive measures of local synchronization and cortical-cortical synchronization that reveal the functional organization of cortical systems underlying anticipatory deployment of visual spatial attention. A symbolic cue instructed subjects to covertly deploy and hold attention to the left or right in anticipation of a unilateral S2 stimulus occurring one second later at either the cued or uncued location (50/50 probability). Subjects performed a go/no-go target discrimination if the S2 occurred at the cued location. Source imaging of single trial data to the cortical surface was performed and reduced to regions of interest for analyses. Local synchronization was measured within each cortical region at multiple frequency bands. Cortical interactions between regions were assessed in each frequency band via phase-locking values. Results demonstrate direction-specific modulations of local synchronization in frontal, parietal and sensory regions during the delay following the cue, in support of large-scale networks. Significant cortical interactions were found not only between parietal-sensory regions and frontal-sensory regions, but also between frontal and parietal control regions. The results reveal the dynamic modulation of sensory regions by control regions and the coordination of control processes between frontal and parietal regions during anticipatory deployment of attention.

C58

THE ADAPTIVE CHARACTER OF THE ATTENTIONAL SYSTEM: EVIDENCE FROM EVENT RELATED POTENTIAL Xiaonan Liu[1], Matthew Walsh[1], Lynne Reder[1]; [1]Carnegie Mellon University — The limited capacity of the human attentional system necessitates a mechanism for effectively selecting and responding to goal-relevant stimuli while disregarding irrelevant ones. To examine the adaptive character of the attentional system and theoretical accounts of the negative priming effect, we recorded response times (RT) and event-related potentials (ERP) in a target localization task that varied the probability of a distractor appearing in each of the 4 possible locations while targets were equi-probable in each location. A target and distractor were flashed briefly and the subject quickly indicated the target location. A pair of displays, prime followed by probe, defined a trial. A negative prime trial occured when the location of the target in the probe display was the distractor location in the prime display. RTs were faster when the distractor occurred in its frequent location and when targets appeared in the location that never contained a distractor. ERP results showed that the N2 component, often associated with inhibition, was of higher amplitude when the distractor occurred in its frequent location. Negative-prime, compared with positive-prime or control trials, were slowest and also showed the largest P300 amplitude; however, these negative-priming effects, both in RT and P300 amplitude, were smallest when targets followed distractors in the frequent distractor location, a finding that is inconsistent with the episodic-retrieval account (e.g., Neil, 1997). These results indicate that the attentional system is sensitive to statistical patterns and can make short- and long-term adjustments in preferences based on prior history of inspecting unsuccessful locations.

C59

ELECTROPHYSIOLOGICAL PATTERN OF INTRAMODAL ATTENTIONAL MECHANISMS: EVIDENCE FROM A CAR DRIVING SIMULATION STUDY Manfred F. Gugler[1], Claudia Sannelli[2], Stefan Haufe[2], Ruth Schubert[1], Michael Tangermann[2], Gabriel Curio[1]; [1]Charité University Medicine, Berlin, Germany, [2]Technical University, Berlin, Germany — The goal of the present study was to examine processing mechanisms in an intramodal divided visual attention task by means of EEG. Therefore we used a paradigm with two different conditions. In Condition C1 participants looked at a grey screen and had to react as fast as possible to a randomly appearing red light by pressing a foot pedal. In Condition C2 the grey screen was replaced by a lane change task with subjects driving a simulated car while they additionally were asked to react to the randomly appearing red light. The analysis of the alpha band power of the pre-stimulus EEG showed a decreased parieto-occipital alpha band activity for C2 in contrast to C1 indicating a higher visual processing demand in C2. Furthermore, a decreased frontal alpha band activity was present for fast compared to slow reaction times. This latter finding indicates that fast processing of a demanding dual task with intramodal stimulus competition requires more activation of executive frontal cortices shown by an alpha suppression. Interestingly, a previous study using an intermodal (auditory-visual) setting found an increased parieto-occipital alpha band activity preceding fast reactions to auditory stimuli compared to slow reaction times. These complementary studies reveal that the relation between alpha rhythms and reaction times can be interpreted only in its specific context, that is, both (decreased and increased) alpha states are reasonable correlates of an efficient sensory-motor coupling leading to fast

reactions depending on whether the focus of attention is directed to the visual or auditory modality.

C60

EXPLORING THE MODULATION OF ATTENTIONAL CAPTURE BY SPATIAL ATTENTIONAL CONTROL SETTINGS: CONVERGING EVIDENCE FROM EVENT-RELATED POTENTIALS Yoko Ishigami[1], Jeff P Hamm[2], Jason Satel[1], Raymond M Klein[1]; [1]Dalhousie University, [2]University of Auckland — Automatic attentional capture by a salient distractor can be prevented by spatial attentional control settings (ACSs) (e.g., Yantis & Joinides, 1990). Recently, converging evidence for a spatial ACS (Schubö et al., 2007) was found in event-related potentials (ERPs). In these studies, the ACS was defined by a single target-relevant location. In an important extension, Ishigami et al. (2008) demonstrated a successful ACS in performance that was based on multiple (two) target-relevant locations. The purpose of the current study is to seek converging evidence from ERPs for a spatial ACS defined by multiple (two) target-relevant locations, using the methods in Ishigami et al. Any one of four figure-8s brightened uninformatively (cue) before presentation of a digit target, calling for a speeded identification (2 or 5). A spatial ACS was encouraged because in different blocks, the digit targets appeared only on the horizontal or vertical axis. Performance was more impaired following the attended invalid cues than following unattended invalid cues, consistent with Ishigami et al. and verifying a successful spatial ACS. Cue-elicited visual evoked potentials (VEPs) by the same cue were different for different ACS orientations: the amplitudes of early VEPs were greater when the location the cue was presented in was target-relevant than when the location was target-irrelevant. These results re-affirm that attentional capture by irrelevant salient stimuli can be modulated by spatial ACSs defined by multiple target locations in performance and provide converging evidence from ERPs for the previously established behavioral findings.

C61

VOLUNTARY ORIENTING OF ATTENTION WITHOUT CONSCIOUSNESS ? Federica Rastelli[1], Ana Belen Chica[1], Paolo Bartolomeo[1,2]; [1]INSERM-UPMC, Centre de Recherche de l'Institut du Cerveau et de la Moelle epiniere, UMR-S975, Paris, France, [2]Catholic University, Milan, Italy — Automatic processes are claimed to be independent of attention or intention and do not require consciousness, while controlled processes require both intention and consciousness (Posner & Snyder, 1975). Would it then be possible to voluntarily orient attention without consciousness? In the present study participants detected supra-threshold lateralized targets preceded by subliminal semantic central cues. Our results demonstrated that when the semantic value of the cue predicted the target location (i.e. on 85% of the trials a "left" cue indicated a left presented target), participants were able to orient attention and respond faster at the attended location, even if the cue was never reported subjectively, and cue d' was not significantly different from zero in all participants. Importantly, when the semantic value of the cue was counterpredictive (i.e. the cue predicted on 15% of the trials the location of the target, therefore a "left" cue indicated a right presented target on 85% of the trials), participants responses were faster at the semantically indicated location during the first block of trials, but the effect reversed during the second block, in which participants were faster at the statistically predicted location. This indicates that even in the absence of consciousness of the cues, participants were able to detect cue-target contingencies and voluntary orient attention. This finding questions the traditional view of control processes, which might be exerted in the absence of consciousness of stimuli (in the present study) or its contingencies (Bartolomeo et al. 2005).

C62

THE ROLE OF DISTINCT PARIETAL REGIONS ON COVERT AND OVERT INHIBITION OF RETURN Alexia Bourgeois[1,2], Ana, B Chica[1], Raffaella Migliaccio[1,4], Michel Thiebaut de Schotten[1,5], Antoni Valero-Cabré[1], Paolo Bartolomeo[1,3,4]; [1]INSERM-UPMC UMR-S 975, Groupe Hospitalier Pitié-Salpêtrière, F-75013 Paris, France., [2]Université Paris VI, Paris, France., [3]AP-HP, Groupe Hospitalier Pitié-Salpêtrière, Fédération de Neurologie, Paris, France., [4]Department of Psychology, Catholic University, Milan, Italy., [5]Natbrainlab, Department of Forensic and Neurodevelopmental Sciences, Institute of Psychiatry, King's College London, London, UK. — When two consecutive events appear at the same spatial location, responses to the second event are slower than those to the first. This effect, known as inhibition of return (IOR), reflects a bias to preferentially attend to novel locations, which is necessary to explore our environment efficiently. Patients with right brain damage and left visual neglect explore their environment asymmetrically, with a bias towards processing right-sided stimuli more efficiently than left-sided ones. We demonstrate that neglect patients have impaired manual IOR for right-sided, ipsilesional targets when orienting attention covertly (without eye movements), but their saccadic IOR (overt orienting) may be preserved. All patients with impaired covert IOR had either parietal damage or fronto-parietal disconnection. In a second experiment, we used off-line repetitive Transcranial Magnetic Stimulation (rTMS) on normal participants to determine the role of two parietal regions in the right hemisphere right (intraparietal sulcus –IPS, and temporo-parietal junction -TPJ) in covert and overt IOR. rTMS on right IPS disrupted ipsilateral IOR in both covert and overt conditions. TPJ results are currently under analysis; we expect to observe a dissociation between overt and covert IOR similar to that occurring in neglect patients.

C63

DORSAL AND VENTRAL PARIETAL CONTRIBUTIONS TO SPATIAL ORIENTING Ana B. Chica[1], Antoni Valero-Cabré[2], Paolo Bartolomeo[1]; [1]INSERM UPMC U975, [2]CNRS UMR 7225 — Influential models based on fMRI have outlined a dorsal fronto-parietal network for the orienting of both endogenous and exogenous attention, and a ventral system in attentional re-orienting to task-relevant events. Nonetheless, given the low temporal resolution and susceptibility to epiphenomenal BOLD responses of fMRI, such depictions remain highly debated. We hereby benefited from the high temporal resolution and causal power of event-related Transcranial Magnetic Stimulation (TMS) to explore the implications of key dorsal and ventral parietal regions in endogenous and exogenous attention. We provide for the first time causal evidence of right intraparietal sulcus (IPS) involvement in both types of attentional orienting. Temporo-parietal junction (TPJ), on the other hand, was selectively implicated in exogenous orienting.

C64

LEFT/RIGHT HEMISPACE DIFFERENCES IN STIMULI PERCEPTION AND IMAGINATION: A CASE STUDY Anna Grzybkowska[1]; [1]Jagiellonian University, Krakow, Poland — The goal of this study was to investigate the left/right hemispace differences in the egocentric (related to subject's body) and allocentric (related to object) coordinates of space. 28 year-old, left-handed man with agenesis of the corpus callosum participated in the study. He was asked to compare angles between clock hands of the two clocks presented or imagined on the right or left side of the screen (egocentrically). The clock hands were localized on the right or left side of the clock (allocentrically). The subject made responses with his left or right hand. Only correctness level was analyzed because of generally low level of performance (reaction time data for incorrect responses were excluded). The left-side priority of stimuli perception was observed in the egocentric and allocentric conditions. In the allocentric condition of imaginary task the level of performance was higher when stimuli were localized on the left side. In the egocentric one priority of right-sided stimuli was observed. There was no influence of hand. Generally, these results are in agreement with results obtained from normal subjects which show priority of left-sided stimuli (Bowers & Heilman, 1980). The influence of hand was hypothesized according to Kinsbourne's theory of attention (Kinsbourne, 1970).

C65

THE ROLE OF THE PULVINAR IN DISTRACTOR PROCESSING AND VISUAL SEARCH H. Strumpf[1], G.R. Mangun[2], C. Stoppel[1], M.A. Schoenfeld[1], H.-J. Heinze[1], C.N. Boehler[1], J.-M. Hopf[1]; [1]Leibniz Institute for Neurobiology and University of Magdeburg, Magdeburg, Germany, [2]Departments of Psychology and Neurology and Center for Mind and Brain, University of California, Davis — The pulvinar nuclei of the thalamus are hypothesized to be involved in attentional selection in vision. Different models have, however, been proposed for the precise role of the pulvinar in attention. One proposal is that the pulvinar mediates shifts of spatial attention; a different proposal is that it serves the filtering of distractor information. At present the relation between these possible operations and their relative importance in the pulvinar remains unresolved. We address this issue by contrasting both proposals in two fMRI experiments. We used a visual search paradigm that permitted us to dissociate neural activity reflecting shifts of attention from activity underlying distractor filtering. Both, distractor filtering and shifts of attention produced activations in regions of the central-lateral intralaminar and medio-dorsal nuclei of the thalamus outside the pulvinar. In contrast, distractor filtering, but not the operation of shifting attention, was associated with strong activity enhancements in dorsal and ventral regions of the pulvinar, indicating that distractor filtering is the preponderant attentional operation subserved by the pulvinar.

C66

EEG DYNAMICS OF INHIBITION OF RETURN AS REVEALED BY INDEPENDENT COMPONENT ANALYSIS Sven Hoffmann[1], Edmund Wascher[1]; [1]Leibniz Research Centre, Dortmund — Inhibition of Return (IOR) is one of the best investigated effects in experimental psychology. However, up to now there is still an open debate about the mechanisms involved and their neurophysiological implementation. In the present study, IOR was tested by means of the well known cue-target design with varying SOAs and the EEG was simultaneously acquired from 60 electrodes. The analysis of standard event-related potentials (ERPs) replicated already known effects. However, a deeper analysis of the event-related EEG-activity by Independent Component Analysis revealed a complex interaction of brain sources contributing to the IOR effect. An unexpected but core result is that fronto-central structures, which have been assigned to executive control, cannot easily be related to the IOR effect. Though the components accounting for the correct response negativity (CRN) did vary with the cueing of the target location, they did not show a data pattern which fits into theories about the generation of the CRN or current theories about IOR, i.e. they were more pronounced for uncued compared to cued targets indicating cue-target correspondence rather than IOR. Furthermore, a complex modulation of component activity accounting for early event-related potentials was found, which indicates a considerable contribution of low-level attentional processes to the IOR effect. Lateralized components over parieto-occipital areas were less activated if a target was cued as if it was uncued. This effect was stronger for the left visual field compared to the right one. A corresponding component interaction was found for occipital components indicating inhibition of cued target locations.

C67

ENCODING A SPATIAL RELATIONSHIP BETWEEN TWO OBJECTS REQUIRES SELECTION OF EACH OBJECT Lauren E. Kahn[1], Steven L. Franconeri[1]; [1]Northwestern University — Object recognition relies on a network that codes object identities across diffuse regions of the visual field, often leading to uncertainty about the locations of any given object. One solution to this problem may be to isolate a single location with selective attention, allowing recovery of the object identity at that location. We show that this solution is used in the simplest displays involving just two objects (e.g., a green circle on the left, a red circle on the right). When participants are required to encode the relative spatial location of two colored patches, eye movements reveal that they systematically select the two objects in a left-to-right sequence. This sequence remains even when participants are explicitly instructed to maintain fixation. A control experiment shows that when object locations are made irrelevant by changing the task to a same-different identity judgment, the left-to-right bias disappears. When identity must be attached to object locations, each object may need to be selected sequentially, but not when a task allows identity to be diffusely coded across space. This sequential selection effect raises a puzzle: If we must select one object at a time, how can we recover the relative spatial location between two objects, to judge that the red is to the right of the green? We speculate that the sequence itself can be used to produce this judgment: extracting the vector created by the shift of attention (rightward) would provide the relative location of the object that was selected second (red).

C68

SPATIO-TEMPORAL CORRELATES OF MULTIPLE-OBJECT-TRACKING Christian Merkel[1], Christian Stoppel[1], Jens-Max Hopf[1], Mircea Ariel Schoenfeld[1]; [1]Otto-von-Guericke University, Magdeburg — The theoretical framework of multiple objects tracking is a matter of debate. In the current study we employed EEG/MEG recordings in conjunction with a modified multiple objects tracking task to investigate the spatiotemporal correlates of the underlying neural processes. Four out of eight different objects were presented as to be tracked targets by 2 brief subsequent brightness alternations. During a 3 second randomized movement all objects moved into a final spatial configuration that was identical in each trial. Four objects were again highlighted by a brief brightness increment (probe) of same spatial configuration that could contain all possible combinations of targets and distractors. Subjects pressed one of two buttons to indicate whether the probe contained all targets or not and were faster and more accurate when the probe contained either all 4 or none of the targets. ERPs and ERFs time-locked to the probe showed an early amplitude modulation in the time range of the N180 that correlated with the subject's behavioral measures. A second amplitude effect in the time range of the N270 component correlated with the number of targets contained in the probe regardless of the subject's behavior. Source analyses revealed bilateral sources localizing to the object-perception sensitive area LO for the N180 effect and in the medial parietal cortex for the N270 component effect. The results suggest that multiple-object-tracking was facilitated by the segmentation of a geometrical shape from the spatial configuration of the target objects.

C69

VISUAL ORIENTING IS ASSOCIATED WITH SPECIFIC NEUROTRANSMITTER GENETIC MARKERS Rebecca Lundwall[1], Dongchuan Guo[2], James Dannemiller[1]; [1]Rice University, [2]University of Texas Health Science Center at Houston — There is currently a sense that individual differences in visual orienting show little variation by genotype (Fan, Wu, Fossella, & Posner, 2001). Yet in previous research using this paradigm, costs have been combined with benefits into an overall validity score. If costs and benefits are determined by (even partially) distinct neural mechanisms, then they should be analyzed separately. This is consistent with Posner's formulation of orienting as a three-step process of disengaging, moving and then re-engaging attention at a new location. This is important because disengaging attention (which is necessary for invalid but not for valid cues) could have separate genetic influences. Here we show significant associations between visual orienting and genetic markers (on COMT, DAT1, and APOE; R2s from 4% to 9%). We used Posner's (1980) cued-orienting paradigm and added trials with dual cues of unequal luminance (Kean & Lambert, 2003). Normal subjects (N = 161) responded manually to the location of a target that appeared after the presentation of one or two cues. One measure in particular -- the mean RT cost of a single dim, invalid cue -- was associated with dopaminergic markers on COMT and DAT1. Variations in the APOE genotype based on the ?2/?3/?4 alleles were also associated with mean RT differences produced by simultaneous cues with unequal luminances. Additionally, we find increased RT variability in subjects with the GG genotype on COMT (rs4680). We conclude that individual differences in visual orient-

ing are related to several different neurotransmitter-related genetic markers.

C70

SUBJECTIVE HAPTIC VERTICAL AFTER STROKE – NEUROANATOMY AND NEUROPSYCHOLOGY Kathrin S. Utz[1], Helmut Hildebrandt[2,3], Karin Oppenländer[4], Ingo Keller[4], Georg Kerkhoff[1,5]; [1]International Research Training Group 1457 "Adaptive Minds", Saarland University, Saarbruecken, Germany, [2]Carl von Ossietzky University, Oldenburg, Germany, [3]Hospital of Bremen-Ost, Bremen, Germany, [4]Schoen Clinic Bad Aibling, Germany, [5]Saarland University, Saarbruecken, Germany — Studies in stroke patients who were tested with the subjective visual vertical (SVV) identified the posterior insula as well as the parietal cortex as crucial cortical substrates for visual verticality perception. As the vestibular system is organized in a multisensory way it appears straightforward to assume a cortical representation of verticality in other senses, i.e. in the haptic modality. To our knowledge, little is known about the neural representation of the haptic vertical in humans. Here, we analysed which brain areas are typically lesioned in patients with unilateral right-hemispheric stroke showing deficits in the subjective haptic vertical (SHV) in the frontal (roll) plane. Patients were blindfolded and stabilized in their head-and-trunk-position and had to adjust a movable metal rod until they perceived it as vertical. One half of the patients showed a significant tilt in the SHV, while performances of the other half were within the normal range. Lesions were analyzed according to Rorden & Brett (2000) using MRIcro 1.40. Subtraction analysis revealed that the right inferior and medial temporal gyrus might be one crucial cortical substrate of impaired performance in the SHV. However, the diffuse lesion overlap of the impaired patients seems to argue for a complex postcentral network for estimating the haptic vertical. In conclusion, these results show that a diffuse right-hemispheric parieto-temporal network is involved in the processing of gravity information in the haptic modality.

C71

RAPID ATTENTIONAL SELECTION OF VISUAL ITEMS IN THE ABSENCE OF COMPETING DISTRACTORS John J. McDonald[1], David J. Prime[1,2]; [1]Simon Fraser University, [2]Douglas College — The lateralized organization of the visual system has made it possible to investigate the selective processing of salient items in visual search displays. Attending to such an item is known to elicit a lateralized component of the event-related potential (ERP) called the N2pc, which is thought to reflect attentional processing in the contralateral occipital lobe. Basic sensory explanations for the N2pc have been ruled out using balanced displays containing a relevant singleton on one side of fixation and an equally salient but irrelevant singleton on the other side of fixation. The drawback of this method is that is does not permit investigation of attentional processing of a visual stimulus presented in an otherwise empty visual field (e.g., peripheral cue or target). To study attentional selection of such stimuli, we examined ERPs elicited when a lateral stimulus was attended and when it was ignored. In separate blocks, participants performed demanding discrimination tasks involving the peripheral stimulus (peripheral condition) or non-lateralized changes at fixation (fixation condition). Comparison of the ERPs in the two conditions revealed lateralized selection negativities in the peripheral condition but not in the fixation condition. The earliest lateralized selection negativity occurred 120-180 ms after display onset and was focused over the lateral occipital scalp. This "early N2pc" was absent in the fixation condition, indicating that it was due to attention rather than lateral sensory imbalance. These results indicate that spatial attention can be allocated rapidly to targets in the absence of competing nontargets.

C72

ABNORMALITIES OF THE P3A WAVE IN INDIVIDUALS HIGH IN PSYCHOPATHIC PERSONALITY TRAITS Patrick Carolan[1], Fern Jaspers-Fayer[1], Isabel Taake[1], Kevin Douglas[1], Mario Liotti[1]; [1]Simon Fraser University — Psychopathy, a subcategory of the DSM-IV diagnosis of Antisocial Personality Disorder (APD), is characterized by two key traits: diminished emotional capability, and the tendency to engage in impulsive, antisocial behaviours. Abnormalities in the visual attention processes of individuals with psychopathic personality disorder have been previously observed, particularly with relation to the posteriorly distributed "P3b" component. In contrast, the influence of psychopathy on the anteriorly distributed P3a wave has not been investigated. We hypothesized that high-trait individuals would show abnormal P3a amplitudes. The current high-density electroencephalography (EEG) study examines differential effects of a novel stimulus Oddball task on psychopathy using a between groups design comparing subjects rated high and low in traits related to the condition. High-trait and low-trait individuals were identified using the Short Form of the Psychopathic Personality Inventory (PPI-SF). Subjects performed a modified visual Oddball task that allowed selective averaging not only of frequent irrelevant standards (76%) and infrequent task-relevant targets (12%), but also infrequent novel distracters (12). Standard and target stimuli were numbers, while novel stimuli were a variety of shapes. High-trait individuals, relative to low-trait individuals displayed not only reductions of the P3b amplitude to targets, but also a marked decrease in voltage of the anterior P3a waves to both targets and novel stimuli. While additional research must be conducted on the relation of the "P3a" component to psychopathy, the present results suggest that psychopathy may entail abnormal processing of target relevance and novelty in frontal brain regions like the anterior cingulate and dorsolateral prefrontal cortex.

C73

THE SPATIAL PROFILE OF SELECTIVE ATTENTION INTERACTS WITH SEGMENTATION Yee-Joon Kim[1], Preeti Verghese[1]; [1]Smith-Kettlewell Eye Research Institute — We investigated how selective attention to a target embedded in a textured background interacts with segmentation processes. Observers attended to an eccentric target surrounded by a concentric annulus that was either coextensive with the target (unsegmented) or segmented from it by the introduction of a small gap, or a phase offset. A brief contrast increment appeared on the target on 50% of the trials. Successful detection of the increment required selecting the target and suppressing the surround, particularly when the target did not segment from the surround. We used steady state visual evoked potentials (SSVEP) with target and background tagged with different frequencies, to unambiguously monitor the response from target, background, and nonlinear-temporal interactions between them at the sum and difference frequencies. We hypothesized that selective attention would suppress the surround in the unsegmented condition, resulting in a weaker response at the background frequency, and a stronger interaction between target and surround regions. For each observer we collected high-density EEG data from increment-absent trials. We then used a minimum norm inverse procedure combined with realistic MR-derived head models and retinotopically-mapped visual areas to estimate cortical activities for target, annulus, and interaction terms. Attention to the unsegmented target decreased the response to background in area V1 (relative to the unsegmented condition), and increased the target/background interactions in retionotopic areas. The evoked response to the target remained unchanged across the different conditions. These results indicate that selective attention involves an active suppression of textured backgrounds that appear co-extensive with the target.

C74

IT'S TEA TIME! THEANINE AND CAFFEINE EFFECTS ON VISUAL ATTENTION AND PERCEPTION FOLLOWING EXPOSURE TO AN ACUTE STRESSOR Stephanie Gagnon[1,2], Caroline Mahoney[1,2], Tad Brunye[1,2], Grace Giles[1,2], Robin Kanarek[1]; [1]Tufts University, [2]US Army NSRDEC, Natick, MA — Tea is often perceived as less arousing and more relaxing than coffee, even though both beverages contain similar amounts of caffeine. The amino acid theanine, naturally occurring in tea and more recently being added to energy drinks, may be responsible for these reported differences by influencing brain activity, cortisol, mood, and cognition. Here we investigated whether theanine, alone or in combination with caffeine, would reduce stress response and impact cognitive performance on two tasks involving visual attention and perception. Participants completed four test sessions, receiving a combination of caffeine (0 mg, 200 mg) and/or theanine (0 mg, 200 mg). After treatment administration, participants viewed a highly arousing and negatively valenced video, and then completed the attention network task (ANT) and a hierarchical pattern task. Our findings suggest that a dose of 200 mg caffeine or theanine does not affect relatively lower order visual attention (i.e., alerting or orienting), but does influence executive control (i.e., conflict resolution). While caffeine consumption enhanced executive control following exposure to stress, theanine reversed this effect, perhaps due to its anxiolytic properties. We also found that theanine mitigated a caffeine-induced global processing bias, such that performance was no different than with placebo or theanine alone. Given theanine's growing consumption rates in the US, these results carry implications for the way in which people attend to and process information, and further enhance our understanding of how caffeine and theanine might modulate brain activity in areas mediating visual attention, such as the anterior cingulate and prefrontal cortex.

C75

ALPHA-BAND EEG POWER CHANGES WITH WORKING MEMORY LOAD AND WITH ATTENTION Rodolphe Nenert[1], Darcy Dubuc[1], Shivakumar Viswanathan[2], Kristina Visscher[1]; [1]University of Alabama at Birmingham, Department of Neurobiology, [2]University of California, Santa Barbara, Department of Psychology — Since they were first observed, alpha EEG oscillations have been implicated in many different processes. First thought to reflect an idling rhythm, this hypothesis has been largely overtaken by a framework where the amplitude of alpha oscillations reflects a level of cortical inhibition. However, some studies found contradictory results and the precise nature of brain alpha oscillations is still a matter of debate. Sixteen healthy subjects performed three visual attention tasks including one or two consecutive stimuli (containing 2, 4 or 6 oriented rectangles) and a probe. Depending on the task, subjects were instructed to ignore or to remember one of the stimuli, and indicate whether the remembered stimulus matched the probe or not. Alpha (12 Hz) oscillations were analyzed over a time window starting before the first stimulus and ending at the probe onset. Before the appearance of the first stimulus, preparation to ignore a stimulus elicited significantly higher alpha power in frontal electrodes compared to preparation to memorize a stimulus. This difference lasted until after stimulus presentation. During the memory maintenance phase, alpha power significantly increased as the number of shapes increased. This difference evolved over time, and was located in left central region earlier, and in left occipito-central and right frontal regions later. Moreover, left parietal electrodes showed an increased coherence with left central electrodes as memory load increased. Considering the temporal and spatial evolution of these results, it is therefore likely that alpha oscillations reflect processes that can have different manifestations in different brain regions.

C76

WHEN "IT" BECOMES "MINE": ATTENTIONAL BIASES TRIGGERED BY OBJECT OWNERSHIP David Turk[1], Joanne Brebner[1], Olav Krigolson[2], Todd Handy[3]; [1]University of Aberdeen, [2]Dalhousie University, [3]University of British Columbia — Previous research demonstrates that higher order cognitive processes associated with the allocation of selective attention are engaged when highly familiar self-relevant items are encountered, such as one's name, face, places and the like. The goal of our study here was to determine whether these effects on attentional processing are triggered on-line at the moment self-relevance is established. We recorded event-related potentials (ERPs) as participants viewed common objects (e.g., apple, socks, ketchup) in the context of an "ownership" paradigm, where the presentation of each object was followed by a cue indicating whether the object nominally belonged either to the participant (a "self" cue) or the experimenter (an "other" cue). We found that "self" ownership cues were associated with increased attentional processing, as measured via the P300 component. In addition, that at a visual-perceptual level, spatial attention became more narrowly focused on objects owned by self, as measured via the lateral occipital P1 ERP component. Taken together, our findings indicate that self-relevant attention effects triggered by the act of taking ownership of objects are associated with both perceptual and post-perceptual processing in cortex.

C77

FMRI HYPOACTIVATION ON A VISUOSPATIAL ATTENTION TASK AFTER DIFFUSE MILD TRAUMATIC BRAIN INJURY Fan-Pei Yang[1], Tracy Luks[1], Sara LaHue[1], Shelly Cooper[1], Anne Heffernan[1]; [1]University of California, San Francisco — The present study investigated the impact of acute mild traumatic brain injury (TBI) on the neural circuitry of visuospatial attention. Eleven controls and 10 patients (1 month post injury) were enrolled in the study. In an event-related flanker task. , the congruent trials consisted of five arrows in the same direction, whereas the incongruent trials contained flankers in the opposite direction as the center arrow. The neutral condition consisted of only one arrow. fMRI was acquired on a 3T GE scanner. All image processing was performed using SPM5. Comparison of the incongruent and congruent conditions revealed that both healthy controls and patients engaged bilateral cingulate for conflicting information but controls had additional activations in dorsolateral prefrontal cortex (DLPFC) and pre-supplementary motor area (pre-SMA). In the incongruent>neutral contrast, relative to controls, patients showed decreased activations in left DLPFC and bilateral fusiform and hippocampus but increased activations in occipital gyri. In the congruent>neutral contrast, in comparison with controls, patients demonstrated decreased activation in left DLPFC, left ventrolateral prefrontal cortex, and bilateral premotor and motor cortices such as pre-SMA, SMA, precentral and postcentral gyri. Lower activations in DLPFC and medial PFC in the incongruent condition suggest disrupted conflict processing in the flanker task. Increased activations in the occipital cortex for incongruent condition suggests more effortful visual information processing. The decreased activations in pre-motor and prefrontal areas in patients in response to conditions without conflict may reflect impaired engagement of the attention network in general.

C78

EXOGENOUS ATTENTION MODULATES ECHO SUPPRESSION Sam London[1,2], Christopher W. Bishop[1,2], Lee M. Miller[1,2,3]; [1]University of California, Davis, [2]Center for Mind and Brain, [3]Department of Neurobiology, Physiology, and Behavior — In noisy acoustic environments, the brain can suppress distracting information through high-level processes such as exogenous attention. It can also use relatively early “unimodal” mechanisms such as the precedence effect, or echo suppression, to achieve the same purpose. The goal of this study was to investigate whether exogenous attention exerts top-down modulation of echo suppression. In a psychophysical experiment, human subjects (N=22) were presented with pairs of noise bursts: a leading burst followed 2-15 msec later by a lagging or “echo” burst, 36 degrees apart in frontal space. The sound pairs

occurred either with or without a light flash 300 msec before sound onset, intended to orient exogenous attention. These flashes were co-localized with either the leading sound, thus orienting attention to the veridical location, or the lagging sound, thus diverting attention away from it. On each trial, subjects reported with a button press whether they heard one or two distinct sounds (echo suppressed or not suppressed, respectively). In a repeated measures ANOVA, compared to a no-flash condition, the echo suppression rate increased by 8.23% ($p<0.05$) with a flash at the leading sound location, and decreased by 9.85% ($p<0.01$) with a flash at the lagging sound location. The results show that exogenous attention can modulate the much earlier process of echo suppression, thereby improving perception of distinct objects in complex auditory environments.

C79

DISSOCIATION BETWEEN FRONTAL AND PARIETAL LESION IN SPATIAL NEGLECT PATIENT Arnaud Saj[1], Vincent Verdon[2], Claude-Alain Hauert[3], Patrik Vuilleumier[4]; [1]Department of Neurology, University Hospital of Geneva, Geneva, Switzerland, [2]Unity of Neuropsychology, NHE, Neuchâtel, Switzerland, [3]Department of Psychology, University of Geneva, Geneva, Switzerland, [4]Department of Neurosciences, University of Geneva, Geneva, Switzerland — Spatial neglect is a perplexing neuropsychological syndrome, in which patients fail to detect contralesionnal stimuli. A recent study showed that spatial neglect may reflect a combination of different component deficits, two of which were associated with lesions in the right prefrontal and inferior parietal regions, respectively. The present study tested for dissociable behaviors across two tasks designed to probe for such components in 14 patients with right frontal versus parietal damage, respectively. In the "attention control" task, patients had to respond to visual stimuli presented centrally in three conditions. Only the frontal patients showed slower reaction times when central stimuli were presented with a right distractor. In the "spatial remapping" task, patients were asked to detect a target in a series of successive visual stimuli presented horizontally across three conditions. The parietal patients were unable to benefit from the predictability of the target position, with similar reaction times across all conditions; by contrast, patients with frontal lesions showed progressive decreases in reaction times in conditions with a regular succession of stimuli (compared to the random condition). Taken together, these results support the view that frontal damage may contribute to left inattention by disrupting top-down control and resistance to distractors, while parietal damage may disrupt the maintenance of stable locations in space across eye movements or time. This further suggests that left neglect may arise as a combined breakdown or impaired connectivity between frontal and parietal regions involved (respectively) in the executive and storage components of spatial working memory.

C80

ERP CORRELATES OF OVERT AND COVERT ORIENTING Nathan Parks[1], Arthur Kramer[1]; [1]Beckman Institute for Advanced Science and Technology, University of Illinois — There has long been a link proposed between overt eye movements and covert shifts of visual spatial attention. A variety of behavioral and neuroimaging studies have demonstrated considerable overlap between human attention and saccadic cortical networks. Here, we used event-related potentials (ERP) to examine similarities and differences in those networks. Covert and overt orienting were manipulated between blocks as subjects performed a standard spatial cuing task. A foveal arrow cue indicated the location of an upcoming target (small black or white dot) with 75% validity. Upon the onset of the target stimulus subjects either maintained fixation and gave a manual response to the target (covert) or performed a saccade to the target location (overt). ERPs time-locked to the onset of the symbolic spatial cue revealed that the posterior P2 and late directing attention positivity (LDAP) components exhibited greater amplitude in overt relative to covert conditions. These results are consistent with the proposal that overt and covert orienting share overlapping cortical networks but vary in the gain within those networks.

C81

VISUAL SEARCH FOR A POPOUT TARGET INCREASES INDUCED THETA POWER OVER CONTRALATERAL VISUAL CORTEX Jarrod R. Dowdall[1], Artur Luczak[1], Matthew S. Tata[1]; [1]University of Lethbridge — The efficiency of visual search for a target in a cluttered scene is known to depend on the similarity between targets and distractors, however the differences between the neural mechanisms subserving different kinds of search are poorly understood. Recent work has focused on components of the visual event-related potential (ERP) evoked by the onset of a visual search display. The best studied of these is a negative deflection of the ERP, known as the N2pc, which appears when the ERP waveform over contralateral scalp sites is contrasted with that over ipsilateral sites. Much less is known about differences in induced (i.e. non-phase locked) electroencephalographic (EEG) activity during efficient and inefficient search. Our goal was to characterize these differences with respect to both phase and amplitude. Participants searched for either a C among Os (efficient) or an O among Cs (inefficient). EEG was recorded at 128 scalp sites and induced (i.e. time-frequency) activity was analyzed, as well as the evoked N2pc. We found the expected N2pc contralateral to the target side. We also found that efficient search, but not inefficient search, was characterized by low-frequency (i.e. delta and theta) inter-trial amplitude increases present over the contralateral scalp.

C82

FACILITATION AND INHIBITION OF RETURN USING NUMBERS AS ATTENTIONAL CUES Danielle Hoffmann[1], Valérie Goffaux[1,2], Christine Schiltz[1]; [1]University of Luxembourg, [2]University of Maastricht — Behavioural studies have shown a relation between numbers and space (DeHevia et al., 2008). Fischer and colleagues (2003) showed that digits can act as central spatial cues in a target detection task, resulting in shorter reaction times (RT) for left-sided targets when preceded by small numbers and for right-sided targets when preceded by large numbers. This facilitation effect indicates that numbers orient visuo-spatial attention to the left or right hemifield, depending on their magnitude. To date no studies investigated whether this facilitation is followed by inhibition of return at longer intervals, as could be expected with visuo-spatial attention shifts. To this aim, we designed an analogous paradigm to Fischer et al.'s, introducing additional longer intervals. Participants (n=22) were presented a task irrelevant digit (1,2 vs. 8,9) for 400ms and had to detect a brief (100ms) lateral target appearing after a variable interval (100, 250, 500, 750, 1000, 1250ms). A 2x6 repeated measures ANOVA of mean RT, with congruency and interval as within-subject variables yielded a significant interaction ($F(5,21)=2.59$, $p=0.03$). As expected, targets were detected significantly faster when appearing in the congruent (small-left, large-right) hemifield after 250ms ($t(21)=2.01$, $p=0.029$) (cf. Fischer et al., 2003). At 1250ms interval, targets were detected significantly slower when they appeared in the congruent compared to the incongruent hemifield ($t(21)=2.29$, $p=0.016$). These findings provide the first evidence that digits not only produce facilitation effects at shorter intervals, but also induce inhibitory effects at longer intervals, confirming the visuo-spatial nature of the attention shifts associated with Arabic digits.

C83

SHIFTS OF SPATIAL ATTENTION CUED BY IRRELEVANT NUMBERS: ELECTROPHYSIOLOGICAL EVIDENCE FROM A TARGET DISCRIMINATION TASK Anne-Marie Schuller[1], Danielle Hoffmann[1], Christine Schiltz[1]; [1]University of Luxembourg — Using a target detection task, Fischer and colleagues (2003) demonstrated that a centrally presented number can shift attention to the left/right when its magnitude is small/large. Two recent electrophysiological studies measured the time course of these spatial shifts and showed attentional effects on visual evoked potentials on central parietal sites (Sallilas et al 2008; Ranzini et al 2009). Here we explore these shifts in a target discrimination task to further characterize the subtle spatial attentional mechanisms triggered by numbers. Event-related potentials (ERPs) were recorded on 64 electrodes while subjects performed a color discrimination task. They were presented a task irrele-

vant digit (1,2 vs. 8,9) for 400ms and had to discriminate the color (red/green) of a brief (100ms) lateral target appearing after a variable interval (250ms, 500ms). The target location could be congruent (left target/small magnitude; right target/large magnitude) or incongruent to the shifts of spatial attention induced by the digit. Target-locked ERPs were calculated for congruent and incongruent trials in time windows of -100to800 milliseconds post-target onset. Mean average amplitude was measured on a moving 40 ms window every 10 ms. We observed a typical distribution of visual components (P1 and N1) on the occipito-parietal sites and the N1 component was significantly enhanced in the congruent compared to the incongruent trials in both hemispheres for the intervals between 170-230 ms (all ps<0.05). These results demonstrate that irrelevant digits also induce attentional shifts in a target color discrimination task and thus confirm the visuo-spatial nature of attention shifts associated with numbers.

C84

GAZE AND HEAD ORIENTATION REDUCE ATTENTIONAL BLINK FOR SUBSEQUENT VISUAL EVENTS Chiara Maddalena Comparetti[1,2], Swann Pichon[2], Patrik Vuilleumier[2]; [1]University of Milano-Bicocca – Italy, [2]Laboratory for Behavioral Neurology and Imaging of Cognition, Medical School, University of Geneva – Switzerland — Others' gaze direction and body position are powerful social cues indicating the presence of relevant information in the environment. We investigated how the processing of gaze direction (averted, directed) and head position (deviated, frontal) diminishes attentional blink (AB) for subsequent visual events. AB refers to the reduced detection of a stimulus (T2) during a brief time-window (~250ms) following the detection of another first target stimulus (T1). Subjects had to report the gender of a face (T1) with different gaze and head orientation, and then categorize an indoor or outdoor scene (T2). Both targets were embedded in a rapid stream of distractors. Behavioral data showed that, outside the AB refractory-period, faces with gaze contact (vs. averted) facilitated the identification of T2_scenes, independently of head position. Recognition performance for T2_scenes was diminished during the AB period, except after identification of T1_faces with direct gaze and frontal head position. Comparison of trials where T1_faces or T2_scenes were correctly vs incorrectly detected showed increased activity in FFA and PPA respectively. Activity in bilateral IPS decreased during AB in parallel to the decrease in T2 recognition performance. Analysis of trials where T1 and T2 were correctly recognized showed that gaze contact increased activity within bilateral TPJ plus regions of the face perception network (OFA, STS and anterior insula, but not FFA), but these responses were drastically diminished during AB. These results show that body and gaze position are powerful social cues that modulate the AB effect and influence the observer's attention for subsequent visual stimuli.

C85

VISUAL ATTENTION AND PERSONALITY: ELECTROPHYSIOLOGICAL DISSOCIATIONS BETWEEN CONSCIENTIOUS AND OPEN INDIVIDUALS ON A LOCALIZED ATTENTIONAL INTERFERENCE TASK Kristin E. Wilson[1], Stephen M. Emrich[1], Jacob B. Hirsh[2], Megumi Noda[1], Vince Brienza[1], Susanne Ferber[1]; [1]University of Toronto, [2]Northwestern University — Attentional abilities alter how we experience the world, thus contributing to both cognitive and personality development. This link between attention and personality may be most evident in two of the Big Five personality traits, namely Conscientiousness (C) - characterized by self-control, rule-following, skill on highly structured problems – and Openness (O) – characterized by exploration, creativity, and noticing peripheral information (Ackerman, 1996; 1997; Peterson et al., 2002). To explore this relationship, participants completed a personality questionnaire before performing a Localized Attentional Intereference (LAI) task, while EEG was recorded. The task consisted of a search array (200ms), containing a single coloured target (T) presented at different separations (Sep1, Sep3, Sep5) from a distractor (L) among gray place-holders, positioned around an invisible circle. Results showed a significant increase in accuracy from Sep1 to Sep3 (LAI effect), where the challenge is to overcome interference and focus attention on the target; however, at Sep 5 accuracy dropped to that of Sep1, indicating that the challenge may be to broaden the scope of attention. C was positively correlated with Sep1 and 3 accuracy and marked by smaller Ptc amplitude, a measure of ability to inhibit distractors. This may suggest superior performance in conditions that rely on focused attention and distractor inhibition, reducing the load on processing indexed by the Ptc. O showed a significant positive correlation with Sep5 accuracy and Ptc amplitude, suggesting an advantage in this condition resulting from the deployment of a broad scope attention and not inhibiting distractors, producing larger Ptc amplitude.

C86

INTERHEMISPHERIC METABOLIC ASYMMETRIES ASSOCIATED WITH VISUAL EXTINCTION IN CHRONIC PATIENTS Valentina Varalta[1], Andrea Lupi[2], Carlo A. Marzi[1], Nicola Smania[1], Elena Natale[1,3]; [1]University of Verona, [2]Nuclear Medicine, San Bortolo Hospital, Vicenza, [3]University of Milano-Bicocca — Visual extinction is a spatio-temporal disorder of visual awareness observed in stroke patients under conditions of stimulus competition. When examined with the confrontation technique right hemisphere damaged patients with extinction frequently miss the left stimulus on trials with double bilateral stimuli, whereas correctly detect it if presented alone. Moreover, in temporal order judgement (TOJ) tasks these patients usually need the left stimulus to be presented with a temporal lead in order to be perceived as simultaneous to the right one. The neural correlates of these impairments are still a matter of issue. We used position emission tomography at rest to measure possible differences between the cortical metabolism of two patients: one showing visual extinction, both at confrontation and TOJ tasks, at a chronic stage; the other one who recovered from extinction at a chronic stage. In both patients, brain damage involved the fronto-temporo-parietal, but not the occipital cortex, in the right hemisphere. We found that the structurally intact visual cortex of the extinction patient was hypometabolic in the right as compared to the left hemisphere, whereas no hemispheric asymmetry in the metabolism of visual cortex was found in the patient without extinction. Our data show that extinction is associated with neural changes in structurally intact occipital areas. This is in keeping with neurophysiological evidence of abnormal activity in visual areas of extinction patients performing visuospatial tasks and suggests that this functional impairment might be crucial to explain the lack of visual awareness for contralesional stimuli in chronic extinction patients.

C87

LARGE SCALE BETA AND GAMMA COUPLING DURING DIRECTED AND AUTOMATIC VISUAL SEARCH Lawrence Behmer[1], Ira E. Hyman[2], K. J. Jantzen[2]; [1]Washington State University, [2]Western Washington University — Detecting changes in the environment involves both top-down visual attention and bottom up processing of unique visual features. We used a change blindness flicker paradigm in conjunction with EEG to investigate the neural dynamics of bottom up and top down processes during visual search. We used phase locking value as a measure of large-scale neural coupling in the high beta (20-30 Hz) and gamma bands (>30 Hz). Nine participants searched for the change of a single letter embedded among a field of distracters. Images were displayed for 400 ms and separated by a 200 ms grey mask. For top-down searches the change occurred along a conjunction of features and thus require directed attention. Conversely, for bottom-up conditions the change occurred on a single unique visual feature such that detection is rapid and automatic regardless of the number of distracters, A benefit of the change-blindness paradigm is that EEG can be time locked to search and detection processes regardless of the number of distracters or search time. For both conditions changing targets were embedded among either 4 or 16 distracters. We observed frontal-parietal phase locking in the beta band during top-down searches and significantly greater gamma activity during bottom-up searches. These findings are in keeping with recent animal (Buschman & Miller, 2007) and human (Phillips & Takeda, 2009) work and

suggest that differences in frequency band for frontal-parietal phase coherence may represent neural processes during bottom-up and top-down searches.

Neuroanatomy

C88

INVESTIGATING THE NEUROANATOMY OF SPATIAL NEGLECT WITH MULTI-VOXEL PATTERN ANALYSIS David V. Smith[1], John A. Clithero[1], Christopher Rorden[2], Hans-Otto Karnath[3]; [1]Duke University, [2]Georgia Institute for Technology, [3]University of Tuebingen — Techniques for relating brain lesions to a resulting behavioral deficit have improved dramatically over the past decade. Nevertheless, lesion symptom mapping techniques are inherently univariate, typically examining a single region (or voxel) in isolation, ignoring the contributions of neighboring brain regions. We addressed this limitation by using multi-voxel pattern analysis to identify brain regions that predict the presence or absence of spatial neglect in a sample of lesion patients (N=140; 78 with neglect). We employed a common machine-learning technique, sparse multinomial logistic regression, to classify individuals based on high-resolution structural brain scans. Performance of the classifier was tested using 140-fold cross-validation; all classification was based on a leave-one-out testing procedure. We first identified the best univariate predictor of neglect, which was a single voxel in superior temporal gyrus. We then utilized two approaches for the multi-voxel analyses: 1) whole brain analysis, in which all voxels are submitted to the classifier; and 2) combinatoric region of interest (ROI) approach using ROIs from the Automated Anatomical Labeling and Juelich atlases. We found that the whole brain approach was more predictive than the best-performing single voxel. Similarly, using the combinatoric ROI approach, we found several ROI pairs that were more predictive than the best-performing single voxel: precentral gyrus and superior temporal pole; angular gyrus and corticospinal tract; precentral gyrus and middle temporal pole. These results highlight the utility of multivariate approaches in lesion mapping, potentially pointing to a revolutionary approach for using lesion data to study brain function.

C89

ABNORMALITIES IN WHITE MATTER CONNECTIVITY IN ADOLESCENTS WITH CONDUCT DISORDER Emily Haney-Caron[1], Michael Stevens[1,2]; [1]Olin Neuropsychiatry Research Center, The Institute of Living/Hartford Hospital, [2]Department of Psychiatry, Yale University School of Medicine — Objective: Previous neuroimaging studies of brain structure have found only limited or no evidence for white matter volume abnormalities in Conduct Disorder (CD), perhaps in part due to heterogeneity as a result of frequently comorbid AD/HD in studied samples. No previous studies have tested whether CD youth have microstructural major white matter tract abnormalities using diffusion tensor imaging (DTI). We hypothesized that DTI would detect frontal and temporal lobe white matter tract abnormalities in CD youth without any psychiatric comorbidities. Participants and Methods: We used a tract-based spatial statistics (TBSS) approach to compared fractional anisotropy (FA), a measure of preferential diffusion along major white matter tracts, between 17 CD adolescents and 26 healthy controls (ages 12-18) with SPM8 two-sample t test, clusterwise corrected for searching the whole brain. Results: CD adolescents had significantly lower clusters of FA in 9 tracts. In the right posterior temporal lobe, this included the inferior front-occipital fasiculus, posterior thalamic radiation, and sagittal stratum. CD deficits were also present in the genu and body of the corpus callosum, internal capsule, cerebellar peduncles and midbrain. Conclusion: As hypothesized, fractional anisotropy was found to be decreased in pure CD adolescents in the temporal lobe as well as numerous other major white matter tracts. The results support theories that frontotemporal brain dysfunction contributes to antisocial behavior disorder risk. This study indicates that abnormalities in the major white matter connective media among brain regions are more prevalent than previous evidence from volumetric-based studies would suggest.

C90

EFFECTS OF PERINATAL BRAIN INJURY ON WHITE MATTER TRACT DEVELOPMENT EXAMINED WITH DIFFUSION TENSOR IMAGING Pamela Moses[1], Shauna Geraghty[2], Ruth Carper[3]; [1]San Diego State University, [2]PGSP-Stanford PsyD Consortium, [3]University of California, San Diego — Children who sustain focal injury to the brain during perinatal development show resilience in their subsequent cognitive development. This resilience suggests plastic changes and alternative patterns of development in the intact white matter to support ongoing cognitive development. The purpose of this study was to examine the structural integrity of major white matter tracts in individuals with unilateral perinatal lesions (PL) to determine whether there are alterations following early injury. Six teenagers and young adults with PL caused by stroke or white matter injury and twenty-two matched controls were examined using diffusion tensor imaging (DTI). Bilateral measurements of fractional anisotropy (FA) were taken in regions of interest in the major tracts including the corticospinal tract, superior longitudinal fasciculus, inferior longitudinal fasciculus, inferior occipitofrontal fasciculus, uncinate fasciculus and the corpus callosum. Comparisons of FA values between the PL and control groups showed lower FA values in the PL group in multiple tracts within the lesioned hemisphere. This is indicative of disruption or maldevelopment of those tracts. Effects of the lesion were also seen as reduced FA values beyond the injured hemisphere in the corpus callosum and superior longitudinal fasciculus of the uninjured hemisphere. In sum, DTI analysis reveals alterations in the development of white matter following an early injury. The measures of FA suggest site-specific attenuation of the white matter, rather than evidence for compensatory growth in the remaining tracts, even in intact regions previously thought to be spared by the lesions.

C91

MINDFULNESS DISPOSITION IS ASSOCIATED WITH INCREASED CORTICAL THICKNESS IN OLDER ADULTS Daniel Snider[1], Arthur F. Kramer[2], Ruchika Shaurya Prakash[1]; [1]Deparment of Psychology, The Ohio State University, [2]Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign — Aging is associated with global cortical thinning, with morphological changes most pronounced in the prefrontal cortex. Previous research has demonstrated that lifestyle factors can significantly reduce the cortical atrophy associated with aging. Mindfulness disposition, a trait characteristic that describes the tendency to be mindful or aware at the present moment, has recently been found to have emotional and cognitive benefits for long-term practitioners of meditation and young adults. In this study, we examined if mindfulness disposition was associated with reduced age-related thinning of the cortex in community-dwelling older adults. Twenty-nine younger and twenty-eight older adults were administered the Five Factor Mindfulness Questionnaire to assess mindfulness disposition, and high-resolution T1 images were collected to examine cortical thickness. Whole-head, surface-based morphometry analyses were performed to examine if higher levels of mindfulness disposition were associated with increased cortical thickness for older adults. A direct comparison of young and old participants revealed widespread cortical thinning in the older cohort, with particular reductions in the prefrontal, parietal, and temporal cortices, consistent with previous research. We also found that mindfulness disposition was related to increased cortical thickness of the left superior frontal gyrus, medial orbital frontal cortex, left middle frontal gyrus, and the right inferior parietal lobule. These results suggest that mindfulness disposition may be an important factor in maintaining structural integrity of the brain and possibly prevent age-related cognitive decline. Further research investigating the effects of mindfulness training will help conclusively demonstrate the relationship between mindfulness and cortical thickness.

C92

A FUNCTIONAL POLYMORPHISM IN ESTROGEN SYNTHESIS IS ACCOCIATED WITH RIGHT HIPPOCAMPAL VOLUME IN HEALTHY YOUNG MEN Janine Bayer[1], Ulrike Schwarze[1], Gabriele Rune[1], Christian Buechel[1], Tobias Sommer[1]; [1]University Medical Center Hamburg-Eppendorf — Estradiol, as a prominent neurosteroid, is de novo synthesized in particular in the hippocampus. In addition to the well known functions in the reproductive system, neuroprotective and synaptogenetic effects of estrogen on hippocampal neurons have been observed. These functions of estrogen on the cellular level are in agreement with reports about fluctuations in memory performance, hippocampal activity and hippocampal size across the menstrual cycle. The conversion of testosterone to 17-beta estradiol, the most important estrogen, is catalyzed by the enzyme aromatase . A common single nucleotide polymorphisms (SNP) within the gene for aromatase, i.e. CYP19, has been linked to differences in the serum estradiol levels in men. In the present study, we explored whether variations in this SNP are associated with hippocampal neuroanatomical differences in healthy young men. We performed voxel-based morphometry on T1-weighted magnetic resonance images of 94 men (aged 18 - 46; mean age: 26) acquired by a 3T MR scanner. Age and the genotype in a SNP of the BDNF-gene (brain-derived neurotrophic factor) was used as covariates because both factors correlate with hippocampal size. In line with our hypothesis, we found that the more efficient aromatase allele was associated with greater volume of the hippocampus in an allele-dose-dependent fashion. In conclusion, higher levels of estradiol might lead via its neuroprotective and synaptogenetic functions to greater hippocampal volume.

C93

CROSS-METHOD COMPARISONS GENERATE NEW HYPOTHESES IN COGNITIVE NEUROSCIENCE Nicholas C. Hindy[1], H. Branch Coslett[1], Sharon L. Thompson-Schill[1]; [1]University of Pennsylvania — Patient lesion studies, functional imaging, and transcranial magnetic stimulation (TMS) are powerful tools for discovering structure-function relationships in the brain. While we expect converging evidence from studies using different methodologies, this is often not the case. However, in accord with strong within-method citation biases (Fellows et al., 2005), much diverging evidence across methods goes unaccounted. When diverging cross-method evidence is cited, these differences are generally dismissed as due to minor variations in the procedures and task demands of the experiments. We outline four instances in which nearly identical tasks and procedures were employed in studies that used either patient lesion analysis, functional imaging, or TMS. Common tasks include particular versions of the recent probes task, line bisection task, temporal discrimination task, and anti-saccade task. In two instances, separate studies using different methods lead to similar functional-anatomical inferences. In the other two instances, conclusions made in different studies appear to contradict one another. To reconcile diverging conclusions, we examine inferential considerations specific to each method, and discuss evidence in the context of a recently developed framework for specifying cognitive ontologies (Price & Friston, 2005). Through the multiple-case-study approach, hypotheses arise that were not anticipated by data from any one method. We emphasize the utility of cross-method comparisons made possible only by using the same experimental procedure across paradigms.

C94

HIGH DEFINITION FIBER TRACKING OF CORTICOSTRIATAL PROJECTION SUBFIELDS IN VIVO Timothy Verstynen[1,2], Kevin Jarbo[1,2], Jeff Phillips[1,2], Sudhir Pathak[1,2], Walter Schneider[1,2,3]; [1]Center for the Neural Basis of Cognition, University of Pittsburgh, [2]Learning Research and Development Center, University of Pittsburgh, [3]Department of Psychology, University of Pittsburgh — Histology studies in non-human primates have identified specific regions within the basal ganglia that receive projections from distinct cortical and subcortical sites. While some of these projection topographies have been mapped in vivo using diffusion tensor imaging (e.g., frontal, limbic, motor) little is known about the microstructural topographies of these fiber projections in humans (e.g., somatotopic organization of fibers from motor cortex). We used a combination of high angular resolution diffusion spectrum imaging (DSI), generalized q-ball imaging (GQI) reconstruction, and region-of-interest based deterministic tractography to produce maps of the cortical projections into the basal ganglia at a sub-millimeter resolution. Fiber streamlines were tracked from a collection of anatomically distinct regions throughout the neocortex. Across subjects (N=8), a consistent topographic organization was observed for cortical projections into the caudate and putamen. The spatial arrangement of these projection fields was consistent with previous histological findings in non-human primates. Within these macroscopic projection fields, we were also able to detect consistent microstructural topographies. For example fiber projections from motor and somatosensory areas were organized in a somatotopic manner, while prefrontal projections were segregated into several distinct subfields. These microscopic topographies can yield valuable clues as to the relevant computational units of the different segments of the basal ganglia, as well as provide more sensitive tools for identifying basal ganglia dysfunction in clinical neurological populations.

C95

HIGH DEFINITION FIBER TRACKING (HDFT) IN NEUROSURGERY & TRAUMATIC BRAIN INJURY Sudhir Pathak[1], Timothy Verstynen[1,2], Kevin Jarbo[1], Walter Schneider[1,2,3,4], Juan Fernandez-Miranda[4]; [1]Learning Research and Development Center, [2]Center for the Neural Basis of Cognition, [3]Department of Psychology University of Pittsburgh, [4]Department of Neurosurgery University of Pittsburgh Medical Center — We describe High Density Fiber Tracking (HDFT) Diffusion Weighted Imaging (DWI) to produce high resolution images of fiber tracts to reliably follow the tracts through crossings to the cortex. Most previous techniques have poor ability (<10%) to tract fibers through double and triple crossings. Our HDFT can reliably track fibers to cortex, show the shape morphology of the contact surface of the cortex, show clear gyral patterns, and allow quantification of the tract volume and integrity. We utilize the techniques in an advisory capacity to evaluate neurosurgical and traumatic brain injury cases. In neurosurgery the methods have been examined in over twenty patients and in the majority of cases the information was viewed as valuable to plan the approach and in a third influenced to procedure. HDFT methods provided historic first real-time use of HDFT to visualize fiber tracts in the operating room to guide surgery during tumor removal and enabled quantification of surgery-induced fiber damage. In Traumatic Brain Injury (TBI) cases we detected and quantified substantial fiber breakage using HDFT finding breakage that could not/was not detected by current CT or MRI methods. We have detected very high breakage rates (>50%) in TBI patients where normal control subjects typically showed low breakage rates (<5%) and were traditional imaging methods could not detect the breaks.

C96

THE VENTRAL AND DORSAL VISUAL STREAMS IN POSTERIOR CORTICAL ATROPHY Raffaella Migliaccio[1,2,6], Federica Agosta[1], Elisabetta Pagani[1], Elisa Canu[1], Stefania Sala[1], Francesca Caso[3], Giuseppe Magnani[3], Alessandra Marcone[4], Elisa Scola[5], Andrea Falini[5], Paolo Bartolomeo[1,6], Massimo Filippi[1]; [1]Neuroimaging Research Unit, Scientific Institute and University Hospital San Raffaele, Milan, Italy, [2]INSERM, U975 Centre de Recherche de l'Institut du Cerveau et de la Moëlle Epinière (CRICM), Hôpital de la Salpêtrière, Paris, France, [3]Department of Neurology, Institute of Experimental Neurology, Division of Neuroscience, Scientific Institute and University Hospital San Raffaele, Milan, Italy, [4]Department of Clinical Neurosciences, San Raffaele Turro Hospital, Milan, Italy, [5]Department of Neuroradiology, Scientific Institute and University Hospital San Raffaele, Milan, Italy, [6]Department of Psychology, Catholic University, Milan, Italy — Objective: To explore the integrity of ventral and dorsal brain networks underlying the cognitive deficits in posterior cortical atrophy (PCA) patients, which typically presents with visual

and visuo-motor symptoms reflecting widespread posterior cerebral dysfunction. Methods: Cognitive and structural and diffusion tensor (DT)-MRI data were collected from seven PCA patients. Using DT-MRI tractography, bilateral inferior longitudinal (ILF), inferior fronto-occipital (IFOF), arcuate, and fronto-parietal superior longitudinal (SLF) fasciculi were obtained in patients and 13 healthy controls (HC). Corpus callosum (CC) and cortico-spinal tracts (CST) were also studied. From each tract, mean diffusivity (MD), fractional anisotropy (FA), as well as axial and radial diffusivity (D) were obtained. Grey (GM) and white matter (WM) atrophy was assessed using voxel-based morphometry. Results: PCA patients showed a clinical syndrome mainly characterized by visual agnosia and prosopagnosia. Compared with HC, patients had significantly higher MD, axial D, and radial D, and lower FA in left ILF and IFOF; higher MD and radial D and lower FA in right ILF, and higher MD in CC. Fronto-parietal SLF, arcuate fasciculus, and CST were spared, bilaterally. PCA showed GM atrophy in posterior bilateral temporal, inferior parietal and occipital cortices, and WM atrophy in the bilateral ventral occipito-temporal regions. Conclusions:PCA patients showed damage to the ventral visual WM pathways of both hemispheres, with relative sparing of dorsal fronto-parietal connections. Accordingly, the patients showed mainly deficits on recognizing faces and objects. These results contribute to our understanding of the network changes in PCA and to explain the different phenotypes of the syndrome.

Sunday, April 3, 5:00 - 7:00 pm, Pacific Concourse

Methods: Electrophysiology

D1

ASSOCIATION BETWEEN ACADEMIC PERFORMANCE AND ELECTROCORTICAL PROCESSING OF COGNITIVE STIMULI IN COLLEGE STUDENTS Mary M Wolf[1], Joseph Clifton[1], Dawson Hedges[1], Scott Steffensen[1], Bruce Brown[1]; [1]Brigham Young University — As event-related potentials (ERPs) can reflect individual differences in intellectual ability, individual differences in college grade-point average (GPA) may be associated with specific components of the ERP waveform, such as the P300. In this regard, our objective was to determine whether differences in GPA are reflected in ERPs while controlling for gender and menstrual phase. We obtained GPAs from 22 right-handed college students (11 male, age range 22 to 26 and 11 female, age range 17 to 24) at a university with high admission and retention standards. We assessed menstrual phase by measuring luteinizing hormone levels across the cycle and obtained ERPs with a 64 channel EEG system for each male participant and ERPs during each phase of the menstrual cycle for each female participant in an object-recognition visual pop-out protocol using Net Station (Electrical Geodesics, Inc., Eugene, Oregon) and E-prime (Psychology Software Tools, Inc., Sharpsburg, Pennsylvania) software. High GPA (4.0) in females and males was associated with a positive peak at approximately 689 ms that was not present in males or was significantly diminished in females in the low-GPA (<2.0) group. Electrocortical processing of cognitive stimuli may differ between college students with high and low GPAs.

D2

EARLY CORRELATES OF WORD RECOGNITION IN FIXATION-RELATED AND EVENT-RELATED POTENTIALS: A COMPARISON USING SIMULTANEOUS EYE TRACKING AND EEG Olaf Dimigen[1,2], Michael Dambacher[2,3], Werner Sommer[1], Reinhold Kliegl[2], Arthur Jacobs[3], Olaf Hauk[4]; [1]Humboldt Universität zu Berlin, [2]Universität Potsdam, [3]Freie Universität Berlin, [4]MRC CBU, Cambridge — Electrophysiological correlates of visual word recognition have typically been studied with single-word paradigms, or using word-by-word presentation (RSVP). An alternative approach to study word recognition under more natural conditions is to record fixation-related potentials (FRPs) time-locked to individual fixations during saccadic reading. While previous research has demonstrated the feasibility of this approach, existing FRP studies have focused on late and comparatively easy-to-measure components in the N400 latency range. The goal of the present study was to test for early effects of word frequency in FRPs and to compare their timing to effects in conventional event-related potentials (ERPs). Eye movements and EEG were simultaneously recorded while participants read lists of unrelated German nouns, which varied in word frequency. In half of the trials, participants read the lists in a normal, left-to-right fashion. In the other half, lists were presented in RSVP at a pace matched to reading speed in the FRP condition. To control for influences of correlated word properties (e.g. length) and oculomotor behavior, linear mixed models (LMMs) were specified for each sampling point of the event-related EEG. Word frequency modulated fixation duration and had two temporally separable effects in the FRP: One peaking at 550 ms after fixation onset, and one around 200 ms, that is, during the duration of the first fixation. Both effects were replicated with traditional RSVP presentation. Results suggest that it is feasible to identify early EEG correlates of lexical processing under natural reading conditions, allowing direct comparisons between EEG measures and fixation time.

D3

EFFECT OF INTENSE PHYSICAL ACTIVITY ON TIME PERCEPTION AND EEG Irina Polikanova[1], Olga Sysoeva[1,2], Alexander Tonevitsky[1]; [1]Moscow State University, Moscow, Russia, [2]Washington University School of Medicine, St Louis, MO — The goal of the study was to examine the effect of intense physical activity on time perception and resting EEG. Nine male student-wrestlers (mean age 19+/-1) perform short block of tests including subjective assessment of their current state (health, activity and mood questionnaire), Spielberg state and trait anxiety questionnaire, reaction time tests and 3 types of tapping: comfort (press the "space" button at any comfortable rate), maximal (press the "space" button with maximal speed), subjective second (press the "space" button each second. This block was performed in the baseline condition and within 15-30 minutes after the intense physical exercise (combat wresting training with the mean heart rate HR 159?7). Before each block the resting EEG (256 channels) was recorded. Significant increase on subjective assessment of activity (4.6 vs 5.3, t(9)=3.1, p=0.01) and decrease in subjective second(1223 vs 1027, t(9)=2,7, p=0.03) were found after the physical exercise compared to baseline condition. The differences in these parameters showed significant correlation (r= -0.69, p=0.04), indicating that degree of increased subjective assessment of activity is related to degree of decrement in subjective second. Significant correlationwas found between subjective second and individual alpha frequency (IAF) in occipital region in the baseline condition (r = 0.78, p=0.12). The study showed that intense physical activitychanges the subjective perception of time and this changes correlates with changes in self-assessed activity. The relationship of this phenomenon with parameters of peripheral and central nervous system will be discussed.

D4

ENHANCEMENT OF HIPPOCAMPAL SYNAPTIC PLASTICITY IN NEUROGRANIN NULL MICE BY PHORBOL ESTER Freesia Huang[1], Kuo-Ping Huang[1]; [1]Developmental Neurobiology Program, NICHD, NIH — Neurogranin (Ng) is a brain-specific, postsynaptic, apo-calmodulin (CaM)-binding protein, which has been shown to enhance synaptic plasticity through increasing Ca2+ transients. In vitro, Ng is a specific substrate of protein kinase C (PKC) and the phosphorylated Ng exhibits lower affinity for CaM. Deletion of Ng in mice (NgKO) causes deficits in learning and memory and the high frequency stimulation (HFS)-mediated long-term potentiation (LTP). Previously, we showed that environmental enrichment could not improve cognitive behavior or LTP of these mutant mice. Using acute hippocampal slices, we showed here that PDBu caused a dose-dependent facilitation in CA1 region of hippocampus, optimally at 4-8 μM and lasted more than 2h. The facilitation (LTF)

was not inhibited by APV, KN93, U0126 or anisomycin, suggesting that the phorbol ester/ LTF was not mediated through NMDA receptor, CaMKII or MEK and didn't require new protein synthesis. The facilitation was retarded by PKC inhibitor, and its effect was less pronounced once the LTF was established. The phorbol ester/LTF was more effective in the slices from the dorsal than from the ventral hippocampus. The extent of facilitation in NgKO was comparable to those of the wild type mice, though, the KO mice clearly display deficit in tetanus-mediated LTP. It seemed that the phorbol ester/LTF was mediated by a pre-synaptic mechanism not involving Ng/CaM interaction at postsynaptic sites. These findings suggested the possibility of using PKC activator for enhancing the hippocampal synaptic plasticity and providing therapeutic guidance for correcting the behavioral abnormalities of these NgKO mice.

D5

FREELY AVAILABLE MATLAB SOFTWARE FOR MASS UNIVARIATE ANALYSIS AND VISUALIZATION OF EVENT-RELATED POTENTIALS David M. Groppe[1], Thomas P. Urbach[1], Marta Kutas[1]; [1]University of California, San Diego — Event-related brain potentials (ERPs) are typically analyzed via ANOVAs on mean voltages across a priori defined time windows. Advances in computing power and statistics have made possible an alternative -- mass univariate analyses consisting of thousands of univariate statistical tests (e.g., a t-test at each electrode and time point from 100 to 900 ms post-stimulus) with savvy corrections for multiple comparisons (e.g., control of the false discovery rate). Relative to conventional ANOVAs, mass univariate analyses have the advantage of weaker assumptions about when and where effects occur and provide greater temporal and spatial resolution. Thus, this approach is much better at addressing questions as to when effects begin and may reveal unexpected effects missed by a priori time windows. While these benefits come at the cost of some loss of statistical power, the power that remains may often be more than adequate. Thus, mass univariate analyses are a valuable complement to and, in some cases, may obviate the need for conventional analyses (indeed mass univariate analyses are commonly used in fMRI research). Here we illustrate how two savvy corrections for multiple comparisons (permutation-based control of the family-wise error rate and false discovery rate control), summarize their pros and cons, and explicitly show that they provide an unconventional window on ERPs at times revealing unexpected effects. We also present a freely available set of Matlab functions (compatible with EEGLAB and ERPLAB) for performing such analyses on ERP data and for visualizing their results.

D6

FREE VIEWING OF EMOTIONAL IMAGES: EVIDENCE FROM SIMULTANEOUS EYE MOVEMENT AND EEG RESPONSES Jaana Simola[1,2], Jari Torniainen[1], Mona Moisala[1], Teemu Peltonen[1], Markus Kivikangas[2], Christina Krause[1]; [1]University of Helsinki, [2]Aalto University — Processing of emotional visual stimuli modulates the EEG (electroencephalography) brain oscillatory responses in the 4 – 6 Hz frequency range. In the current study, we recorded EEG and eye movements simultaneously from 11 right-handed participants while they viewed images with varying emotional valence (International Affective Picture System, IAPS). Sets of four images were presented either serially or simultaneously. An 'emotional' image set included one image of high positive or high negative valence among neutral images. A 'neutral' set comprised of four neutral images. After having seen a four–image set, the participants indicated which picture - if any - was emotional and rated the selected image on the valence and arousal dimensions (self assessment manikin scale, SAM). In the free viewing condition, the same sets of four images were presented simultaneously on the screen, and the brain oscillatory EEG responses were analyzed time-locked to the eye fixations on an emotional image. This experimental setting allowed for direct comparisons between the serial and free viewing conditions. The results from both presentation conditions showed greater brain oscillatory EEG responses in the 4 – 6 Hz frequency range for the negative as compared to the neutral images. However, the effect was somewhat more prominent in the serial presentation condition. From a methodological viewpoint the results show that analyzing brain oscillatory EEG responses time-locked to the eye fixations on a specific target image is a valid technique to assess brain oscillatory responses related and triggered by natural sequence of perceptual events (free viewing of images).

D7

P300 VS. FRONTAL POSITIVITY FOR BRAIN-COMPUTER INTERFACE SPELLER CLASSIFICATION Matthew Miller[1], Siri Kamp[1], Emanuel Donchin[1]; [1]University of South Florida — The goals of this study were (1) to investigate the component structure of the event-related potential (ERP) elicited in the P300 based brain computer interface (BCI; Farwell and Donchin, 1988) and (2) to compare classification accuracy when the selection was based on individual components. A principal component analysis (PCA) revealed two major ERP components that distinguished between flashes of target and non-target rows and columns. As expected, target flashes elicited a parietally-distributed P300 component. In addition, the PCA revealed an earlier frontal positivity peaking around 250ms after the target flash. We generated two linear discriminant functions, each on the virtual ERPs of each spatial factor. Using these discriminant functions for offline classification, we found that both components successfully discriminated between target and non-target flashes in the oddball paradigm implemented in the P300-based BCI. Classification based on the frontal component lead to higher discrimination accuracy than classification accuracy based on the parietal P300. When the P300 was used for classification, trials incorrectly selected as targets showed a waveform that was comparable to target trials, containing a strong P300. This indicates that erroneous selections were due to non-target flashes eliciting a P300 component for some trials. When classification was based on the frontal positivity, incorrectly selected trials did not elicit a larger frontal component that targets, indicating that erroneous decisions were caused by other factors, such as high background noise. Frontal accuracy was greater, indicating that BCI accuracy may be improved by looking at patterns of ERP activity rather than singular components.

D8

THE EFFECTS OF A SELF-EVALUATION TASK ON THE P300 EVENT RELATED POTENTIAL Tyler Grindstaff[1], Justin Karr[1], Joel Alexander[1], Ronald Alexander[2]; [1]Western Oregon University, [2]Wartburg College — It has been shown that P300 amplitude is sensitive to self-identity stimuli (e.g., name) and emotional self-evaluation (Alexander, et al., 2005). The present study is a replication of the Alexander et al. 2005 study with more electrode locations and participants. The study was designed to capture an introspective moment during a task that required emotional self-evaluation related to an infrequent, random stimulus void of self-identity qualities. The design of the study was different from previous stimulus-driven self-identity stimulus studies in that the base sensory discrimination task was constant across all conditions. Participants started with a standard tone discrimination task (oddball) during condition 1. In conditions 2 and 3 participants completed a secondary cognitive task in addition to the oddball task where they made a second stimulus-related judgment after their initial response. Condition 2 required subjects to index a mental count if the tone was a target, in addition to oddball. Condition 3 required subjects to self evaluate it they were surprised by the occurrence of the target, given the random/infrequent nature of the target tone presentation. During these conditions, ERPs were recorded across 32 electrode sites. Similar to the self-identity stimulus studies, results indicated a large increase in P300 amplitude during the condition with the self-evaluation component compared to the other conditions. The increase in recording sites allowed for the delineation of the Parietal lobe being the location of the greatest increase in P300 Amplitude. These results imply that self-evaluation may utilize more cortical resources than non-self related cognitive-discrimination tasks.

Methods: Neuroimaging

D9

UNSUPERVISED BRAIN PARCELLATION FROM FUNCTIONAL NEUROIMAGING DATA Michael Hanke[1,2], Yaroslav O. Halchenko[1], James V. Haxby[1]; [1]Dartmouth College, [2]Otto-von-Guericke University Magdeburg — Recent findings from multivariate pattern (MVP) classification of neural data have shown the potential of these algorithms. Consequently, they are increasingly often employed to investigate information encoding in certain areas of the brain. However, in the vast majority of studies region of interest (ROI) selection is still based on univariate localizer contrasts or hand-drawn anatomical masks. While the former might suffer from limitations of the employed statistical methods or data smoothing requirements, the latter doesn't account for inter-subject variability in the functional organisation of the brain. To address these problems and allow for multivariate ROI generation beyond the scope of existing localizer paradigms (e.g. retinotopic mapping, fusiform face area) we propose an independent component analysis (ICA) based parcellation strategy in combination with a rich multi-modal stimulus (a feature-length movie) paradigm. We investigate the utility of several algorithm variants regarding the identification of homologous areas in a functional magnetic resonance imaging (fMRI) dataset across multiple subjects throughout the whole brain. This includes cross-subject matching of individual ICA components and multi-criterion (anatomical and functional) alignment to group template, as well as application of multi-subject ICA analyses. We demonstrate that this unsupervised method can be used to derive common ROIs across multiple subjects that account for both anatomical and functional properties of individual brains. These ROIs can be used, for example, to streamline MVP group analysis and aid in situations where a voxel-to-voxel correspondence across subject datasets cannot be achieved and negatively impacts results (e.g. a searchlight analysis).

D10

LOCATING CORTICAL COMPUTATION USING SIGNAL CORRELATION TECHNIQUES IN MAGNETOENCEPHALO-GRAPHY Andrew Thwaites[1], Paula Buttery[2], Ian Nimmo-Smith[1], William Marslen-Wilson[1]; [1]The MRC Cognition and Brain Sciences Unit, [2]University of Cambridge — The brain processes information about the world in largely unknown ways. How can we determine what these processes are? The field of cognitive neuroscience has made partial progress on this difficult task, but it is only with the recent advent of cognitively plausible models of computation from the field of artificial intelligence that testing for the existence of complex deterministic functions using brain imaging data can start in earnest. We construct a new method which uses high temporal resolution electrophysiological imaging techniques such as electroencephalography and magnetoencephalography to obtain evidence about the existence of specific computational processes in the cortex. The method operates by matching localised patterns of neural activity with the activity pattern derived from the hypothesised process. This gives the location (in a source-space reconstruction of the cortex) and timings of the processes of interest (measured in milliseconds, relative to the stimulus onset). We test this method on various auditory processes including pitch and intensity. Preliminary results suggest that an intensity process starts bilaterally in Heschl's gyrus 85ms after sound onset, with change-in-intensity at the same place at 130ms, while a change-in-pitch-related process can be detected bilaterally in auditory cortex at 45ms. Current work is extending this technique to higher-order aspects of cortical computation.

D11

SIMILARITIES AND DIFFERENCES IN BRAIN NETWORKS INVOLVED IN SOURCE MONITORING AS IDENTIFIED BY CPCA AND ICA Paul Metzak[1,2], Todd Woodward[1,2]; [1]University of British Columbia, [2]BC Mental Health and Addictions Research Institute — In the current study, we sought to investigate the neural networks that underlie successful contextual memory performance. While undergoing function MRI scanning, 21 healthy controls performed the recall portion of a contextual memory task in which they were asked to indicate which of four operations they had previously performed while encoding each word (reading, hearing, semantically associating, or unscrambling letters). The data was analyzed using two separate multivariate fMRI analysis packages: CPCA (http://www.nitrc.org/projects/fmricpca/), and ICA (http://icatb.sourceforge.net/). For the CPCA analysis, components were selected on the amount of variance explained, whereas for the ICA analysis, components were selected on the basis of the R-square value obtained from regressing the ICA component activity time courses on the design matrix used to conduct the CPCA analysis. The results indicated a wide overlap between the two methods in terms of the brain regions identified as being activated/deactivated during the performance of this task, which implies that they were converging on a common signal in the data. These areas included the dorsal anterior cingulate, insula, and occipital cortices. However, there were differences in the between the methods in terms of how these regions were organized into functionally connected networks, as well as in the estimate of the activity levels in these functional networks in the various experimental conditions.

D12

EVIDENCE FOR A DOSE-SENSITIVE RESPONSE TO FMR1 GENE EXPRESSION IN THE FRONTO-PARIETAL CORTEX FOR THE NUMERICAL PROCESSING So-Yeon Kim[1], Ryu-ichiro Hashimoto[2], Tony J. Simon[1], Susan M. Rivera[1]; [1]University of California, Davis, [2]Showa University School of Medicine, Tokyo — Mutations of the fragile X mental retardation 1 (FMR1) gene are the genetic cause of fragile X syndrome (FXS), the most common inherited form of mental retardation. Hypermethylation of the FMR1 promoter region, along with repeat expansion, results in deficiency or absence of the FMR1 protein (FMRP), ultimately causing cognitive impairments. Patients with partial methylation or patients with a mixture of full and premutation cells may have some FMRP expression, resulting in a less severe phenotype (i.e. FX mosaicism). Using fMRI, we examined whether the cognitive deficits associated with fronto-parietal brain functions is sensitive to FMRP level. We recruited adults on the FX spectrum, including females with FXS and males and females with FX mosaicism, and tested the effect of FMRP on numerical processing using a magnitude estimation task. During the task, participants saw side-by-side displays of sets of rectangles and were asked to indicate the set containing more objects. Numbers of objects in the sets differed by 1-3 ("small") or 5-7 ("large"). The "distance effect" on cortical activations was estimated by comparing activation between the "small" and "large" conditions. The results showed that neurotypical adults and FX participants showed equivalent task performance; however, distance effects on activation in the IPS, IPL, and DLPFC were significantly reduced in the FX group. Interestingly, regression analysis revealed a negative correlation between the fronto-parietal activation and CGG repeat size. Together, these results suggest a dosage response of FMR1 gene expression on the numerical functions in the prefrontal-parietal regions in FXS.

D13

IDENTIFYING FUNCTIONAL NETWORKS THAT GIVE RISE TO INTER-INDIVIDUAL VARIABILITY USING ICA Craig Bennett[1], Michael Miller[1]; [1]University of California, Santa Barbara — Individual differences in regional brain activity are a critical area of research in the struggle to understand the human brain. Recently, Miller et al. (2002) have used a whole-brain correlation technique to investigate inter-individual variability in fMRI results. The question that we sought to answer was whether the whole-brain inter-individual differences observed using Miller's cross-correlation approach could be localized to specific functional networks within the brain. To investigate this question we acquired fMRI data from 22 participants on an old/new episodic word recognition task. Subjects reported whether each displayed word was old (previously seen during encoding) or new (the first time seen). All preprocessing and modeling of the fMRI data was completed using SPM5. We then conducted the

standard Miller cross-correlation analysis to quantify inter-individual variability in the task>rest contrast across subjects. To investigate functional networks we used an independent components analysis (ICA) approach. We used the MELODIC toolbox from the FSL software suite to perform a joint tensor-ICA decomposition of the entire dataset. There were 146 components that resulted from this analysis. An analysis of the component timecourses using the FEAT toolbox revealed that 56 of these components had activity that was significantly related to the task. The subject/session mode from a subset of 14 components was significantly correlated (r = 0.32 to 0.45) with the inter-individual variability in the whole-brain results using the Miller approach. We conclude that the variability in specific functional networks gives rise to the overall pattern of inter-individual differences present in fMRI results.

D14

LARGE-SCALE AUTOMATED DECODING OF HUMAN BRAIN ACTIVITY Tal Yarkoni[1], Russell Poldrack[2], Thomas Nichols[3], David Van Essen[4], Tor Wager[1]; [1]University of Colorado at Boulder, [2]University of Texas at Austin, [3]University of Warwick, [4]Washington University School of Medicine — A central goal of human neuroimaging research is to map relationships between mind and brain, enabling decoding of cognitive states from brain activity. Previous decoding approaches have focused on discriminating between narrow sets of alternative states, overlooking the vast range of cognitive states human beings can experience. Here we introduce a novel brain mapping approach that uses text mining and meta-analysis to produce accurate mappings between brain activity and a large number of cognitive states. Using automated coordinate extraction software, we generated a database of 122,627 activation foci drawn from 3,617 published neuroimaging studies. Validation analyses verified the accuracy of this approach, with 84% sensitivity and 97% specificity compared to a manually-coded reference database. We used the resulting database to (a) automatically produce whole-brain meta-analysis maps for over 200 distinct psychological concepts; (b) generate 'reverse inference' maps quantifying the likelihood of specific psychological processes given observed activation patterns; and (c) accurately decode cognitive states in individual subjects based purely on prior literature and without any training on subject-level data. Collectively, these results validate a novel approach to the long-standing problem of reverse inference in brain imaging and represent a substantial step towards open-ended decoding of human brain activity.

D15

USING RESTING STATE FUNCTIONAL CONNECTIVITY TO EXPLORE THE HIERARCHICAL ORGANIZATION OF PREFRONTAL CORTEX Lisa Ankeny[1], Jeremy Reynolds[1], Jessica Andrews-Hanna[2]; [1]University of Denver, [2]University of Colorado — Experimental data suggest that a network of areas within prefrontal cortex (PFC) underlie behavior on complex tasks (Badre & D'Esposito, 2007). Specifically, these areas correspond to dorsal premotor cortex (PMd), anterior dorsal premotor cortex (prePMd), inferior frontal sulcus (IFS) and anterior prefrontal cortex (aPFC). Previous approaches have argued for hierarchical interactions among these regions whereby anterior areas of PFC influence more posterior areas. However, there have been limited attempts to directly investigate this pattern of connectivity in human subjects. The current study used resting-state functional connectivity MRI (rs-fcMRI) to investigate this proposed pattern. First, we explored whether the network of areas above is spontaneously correlated at rest. Results indicated that 1) the prePMd, IFS, and aPFC were significantly positively correlated with each other and 2) none of these regions were strongly associated with the PMd. Second, we investigated whether the correlations between areas could be characterized as direct or indirect using statistical mediation techniques. Correlation patterns indicated both direct and indirect relationships, such that the area of IFS partially mediated the correlation between areas of aPFC and prePMd, consistent with work examining the anatomic connectivity among areas within PFC in macaque monkeys (Petrides & Pandya, 2007). These data suggest that even in the absence of a goal-directed motor task, three anterior PFC areas interact in a systematic manner. However, consistent with some prior results (Vincent et al., 2008), these areas appear to be distinct from a posterior network including the PMd.

D16

THE NEUROIMAGING INFORMATICS TOOLS AND RESOURCES CLEARINGHOUSE (NITRC) David Kennedy[1], Christian Haselgrove[1,2], Jeff Grethe[3], Nina Preuss[4], Robert Buccigrossi[4]; [1]University of Massachusetts Medical School, [2]Neuromorphometrics, Inc., [3]UCSD, [4]TCG, Inc. — We report on the use of a neuroimaging informatics knowledge environment for functional and structural neuroimaging tools and resources entitled: Neuroimaging Informatics Tools and Resources Clearinghouse (NITRC). Initiated in October 2006 through the NIH Blueprint for Neuroscience Research, NITRC's mission is to foster a user-friendly knowledge environment for the functional and structural neuroimaging community. By continuing to identify existing software tools and resources valuable to this community, NITRC's goal is to support its researchers dedicated to enhancing, adopting, distributing, and contributing to the evolution of neuroimaging analysis tools and resources. Located on the web at www.nitrc.org, this site promotes software tools and resources, vocabularies, test data, and databases, thereby extending the impact of previously funded, neuroimaging informatics contributions to a broader community. NITRC gives researchers greater and more efficient access to the tools and resources they need, better categorizing and organizing existing tools and resources, facilitating interactions between researchers and developers, and promoting better use through enhanced documentation and tutorials—all while directing the most recent upgrades, forums, and updates. In Summary, NITRC facilitates access to an ever growing number of functional and structural neuroimaging tools and resources (315 to date). We encourage the community to continue providing design and content feedback. Averaging monthly 525,000 hits and 9,000 unique visitors, NITRC is now an established knowledge environment for the functional and structural neuroimaging community where tools and resources are presented in a coherent and synergistic environment for the advancement of functional and structural neuroimaging research.

D17

EYE TRACKING EVIDENCE FOR ACTION SIMULATION Lauren Marsh[1], Moritz Daum[2], Anne Springer[2], Wolfgang Prinz[2], Antonia Hamilton[1]; [1]University of Nottingham, Nottingham, [2]Max Planck Institute for Cognitive and Brain Sciences, Leipzig — Action simulation is believed to be a core function of the human mirror system, allowing us to predict actions and possibly learn new actions. However, direct measures of ongoing action simulation are hard to obtain. The present study explores the role of eye movements as an implicit and online measure of action simulation. Participants viewed predictable sequences of natural, goal-directed actions which were occluded for a two second period. Following occlusion, the action sequence reappeared at three levels of temporal asynchrony. Participants were instructed to imagine the continuation of the action during the occlusion period and to make a judgement about the temporal coherence of the sequence. During natural viewing and occlusion, eye movements were recorded. Significant correlations between eye movements during natural viewing and during occlusion are reported. This suggests that eye movements continue to track an action during occlusion, indicating ongoing action simulation in this period. Moreover, initial results indicate that stronger eye movement correlations across participants predicted better behavioural performance. Further work should assess the functional role of these eye movements for accurate action prediction.

D18

INFORMATIONAL CONNECTIVITY: A NOVEL FMRI ANALYSIS METHOD FOR IDENTIFYING BRAIN AREAS THAT SHARE DISTRIBUTED ENCODING PRINCIPLES Marc N. Coutanche[1], Sharon L. Thompson-Schill[1]; [1]University of Pennsylvania — The past decade of fMRI data analyses has led to the advent of two new classes of analytic tools for understanding the functional architecture of the brain. One such method, multi-voxel pattern

analysis (MVPA), has been utilized to decode distributed patterns at the across-voxel level. Another, functional connectivity, measures activation synchrony between anatomically-distant regions to detect functional networks. Here, we describe a novel technique that combines both methods to discover networks of regions that share related approaches to representing classes of stimuli or cognitions. We have developed a metric that quantifies the distance between the patterns of class-confusability found for different regions. By incorporating this measure into a roaming searchlight procedure, we are able to map the groups of brain areas that share information-processing principles. We have applied this technique to an existing fMRI dataset recorded during presentations of images of exemplars from eight semantic categories. The results identify a selective set of regions that differs from groupings obtained with existing functional connectivity techniques. The regions detected with the method vary based on the location of the seed region, suggesting sensitivity to information processing differences in regions of interest. By selecting a hypothesis-driven seed region, this technique can be used to move beyond the question of which areas are concurrently functionally active, to which areas process stimuli, or engage in cognitive processes, in a related manner.

D19

TRANSCRANIAL DIRECT CURRENT STIMULATION TO PREFRONTAL CORTEX ALTERS BLOOD FLOW AND FUNCTIONAL CONNECTIVITY IN REWARD NETWORKS Matthew Weber[1], Samuel Messing[1], Hengyi Rao[1], David Wolk[1], John Detre[1], Sharon Thompson-Schill[1]; [1]University of Pennsylvania — Transcranial direct current stimulation (tDCS) is a method of noninvasive brain stimulation that has grown much more popular in recent years, but little is known about its effects on human neurophysiology, especially at sites distal to the stimulated tissue. Additionally, almost all imaging work to date has focused on stimulation of primary motor cortex. To examine the effects of tDCS to prefrontal cortex, we scanned subjects with conventional BOLD fMRI and arterial spin-labeling (ASL) perfusion fMRI before and after tDCS over dorsolateral prefrontal cortex (DLPFC). ASL scans measured resting cerebral blood flow (CBF); BOLD scans measured activity during the Balloon Analog Risk Task, which activates DLPFC (Rao et al., 2008) and is responsive to tDCS over DLPFC, with stimulated subjects showing greater risk aversion (Fecteau et al., 2007). We observed post-tDCS reductions of CBF in DLPFC and orbitofrontal cortex, as well as reductions of task-related BOLD activity in insula and striatum. TDCS also altered functional connectivity between the stimulation sites and several other reward-related regions including insula, striatum, and cingulate cortices. This work elucidates the neurophysiological changes caused by prefrontal tDCS and strongly suggests that stimulation to DLPFC alters the subject's assessment of risk and reward through its effect on downstream sites.

D20

HIGH RESOLUTION FIBER TRACTOGRAPHY OF CORPUS CALLOSUM FIBER PATHWAYS Kevin Jarbo[1], Verstynen Timothy[2], Schneider Walter[3]; [1]University of Pittsburgh — Histological studies on nonhuman primate and postmortem human brains have shown a highly detailed topography of commissural fibers that has yet to be fully visualized in vivo. This is due to the inability of current diffusion imaging methods to navigate regions where callosal fibers cross with other major cortical tracts, causing whole brain tracking approaches to fail at detecting lateral projections to areas of the parietal and temporal lobes where fibers are known to exist. To this end, we used generalized Q-ball imaging (GQI) reconstruction on high angular resolution diffusion spectrum imaging (DSI) data (257 direction, TR = 9916 ms, TE = 157 ms, voxel size = 2.4 x 2.4 x 2.4 mm3, FoV = 231 x 231 mm, b-max = 7000 s/mm2) to model the detailed directional information in white matter pathways. By combining whole brain and local region-of-interest based seeding and then applying deterministic tractography methods, we were able to render a complete map of callosal projections to specific cortical and subcortical targets where commissural fibers are expected to terminate. This approach yielded a well-defined topography of parietal and temporal cortical endpoints that was not visualized strictly using a whole brain tractography method through the corpus callosum. Furthermore, connectivity analysis across 8 subjects revealed enhanced connectivity structure of caudal cortical regions using this combined method. These results indicate that GQI combined with local seeding compensates for the loss in detection of fiber projections to specific cortical regions due to intricate fiber crossings.

D21

VOXEL-BASED MORPHOMETRY IDENTIFIES SMALLER GRAY MATTER VOLUMES IN ADOLESCENT DRINKERS Jessica Pommy[1], Mollie Monnig[1], Per Lysne[1], Ronald Yeo[1], Michael Bogenschutz[1], Robert Thoma[1]; [1]University of New Mexico — Chronic alcohol use disorders (AUD) in adults are associated with smaller gray matter (GM) volumes in the frontal cortex, hippocampus, and cerebellum. The neurodegenerative effects of ethanol on the developing brain, however, are not as well understood. It was hypothesized that regional cortical abnormalities in adolescents with an AUD could be identified relative to healthy, normal controls. GM volumes were assessed in 7 adolescents diagnosed with an AUD and 12 healthy, non-drinking adolescents. Voxel-based morphometry (VBM), a neuroimaging analysis technique, was used to provide a comprehensive, unbiased comparison of gray matter (GM) volumes between the two groups at baseline and at a one year follow-up. A VBM multiple regression analysis identified associations between an AUD diagnosis and GM volume. Preliminary results indicate regions of smaller GM volume in the AUD group relative to controls, at both time points. At baseline, the neocortical effects were greatest in the right inferior temporal gyrus, left and right superior occipital gyrus, right superior temporal gyrus, left precuneus, and right middle gyrus. At a one year follow-up, the greatest effects were identified in the right inferior temporal gyrus, left inferior frontal gyrus, left superior occipital gyrus, right cerebellum, and right inferior occipital gyrus. These results, though preliminary, indicate smaller GM volumes in adolescents diagnosed with an AUD at both time points, and potentially suggest different patterns of cortical development in adolescents with AUD.

Methods: Other

D22

THE WESTERN PENNSYLVANIA PATIENT REGISTRY: A NEW RESOURCE FOR NEUROPSYCHOLOGICAL RESEARCH Julie Fiez[1], Denise Balason[1], Rupa Ramaswamy[1], Fissell Catherine[1], Behrmann Marlene[2]; [1]Dept. of Psychology, University of Pittsburgh, [2]Dept. of Psychology, Carnegie Mellon University — The Western Pennsylvania Patient Registry (WPPR) is a joint effort involving the Departments of Psychology and the Center for the Neural Basis of Cognition at the University of Pittsburgh and Carnegie Mellon University. The intent is to foster clinical research, specifically human neuropsychological investigations, as a convergent method within cognitive neuroscience. WPPR is a HIPAA-compliant clinical registry of over 800 individuals with focal brain injury who are interested in participating in research studies. The WPPR database contains, with participants' consent, de-identified profiles offering complete pictures of their brain injury status, including medical reports, demographic information, clinical diagnoses, basic neuropsychological assessments, radiological reports of lesions/location, as well as actual images. The de-identified profile information is stored in a MySQL database and is accessible to registered users through a web-based graphical interface. WPPR was designed to serve the needs of local researchers but it has potential value at the national level. The database tools and data management strategies that have been developed are available for other researchers engaged in neuropsychological research. For instance, specialized software has been developed to automatically upload, reformat, and display representative slices from medical images acquired using a variety of formats and naming conventions. The accumulated data has value for investigators interested in the effects of focal brain injury, or computational approaches for automated brain registration and lesion

identification. Finally, WPPR may serve as a tool to recruit participants for research programs, depending upon the investigator's ability to travel to Pittsburgh and/or the need for face-to-face contact.

Other

D23

WHITE MATTER DIFFUSIVITY: CHANGES BETWEEN SELECT DEMENTIA GROUPS Jeremy F. Strain[1], John Hart[1], Ramon Diaz-Arrastia[2], Kyle B. Womack[2]; [1]The University of Texas at Dallas, [2]University of Texas Southwestern Medical Center — Alzheimer disease (AD) and frontotemporal dementia (FTD) are neurodegenerative disorders that differ in their histopathology. Protein inclusions in the oligodendrocytes of white matter are present in many forms of FTD, but not in AD. Diffusion Tensor Imaging (DTI) is an MRI technique that measures the directional diffusivity of water and is sensitive to changes in white matter integrity. Analyses may utilize diffusivity measures, directly or use derived values such as fractional anisotropy (FA). Subjects: 28 patients with AD, 19 patients with FTD, and 28 normal controls (NC) Methods: Images were collected from a 3T scanner and processed using the brain-imaging program FSL. Global voxel-wise analyses of mean diffusivity (MD), axial diffusivity (AxD), radial diffusivity (RD) and FA were conducted in FSL with the tract based spatial statistics (TBSS) and Randomize modules (?=0.05, corrected for multiple comparisons). Results: While robust differences in FA were seen comparing dementia groups and controls, differences in FA were not seen between FTD and AD. Significant voxels were found for AxD but MD and RD differences were trending towards significance (p=0.06 and p=0.08 respectively). Conclusions: As predicted from histopathology, white matter integrity was more disrupted in FTD than in AD. Diffusivity measures were more sensitive than FA for demonstrating this difference. Our data shows that the increased diffusivity seen in FTD, as compared to AD, is relatively proportional in the axial and radial directions creating a situation in which the FA remains relatively stable in the face of increasing diffusivity.

D24

A COMPUTATIONAL MODEL OF THE EFFECTS OF SCHIZOPHRENIA AND ANTIPSYCHOTICS ON COGNITION Ahmed Moustafa[1], Szabolcs Keri[2], Mark Gluck[1]; [1]Rutgers University-Newark, [2]University of Szeged, Hungary — Prior computational models of schizophrenia simulate either prefrontal or hippocampal dysfunction in these patients, and most of these models did not simulate the effects of antipsychotics on cognition. However, empirical results have shown that schizophrenia is associated with disruption to the prefrontal cortex, basal ganglia, and the hippocampus, as well as to dopaminergic projections to these brain regions. Empirical studies have also shown that antipsychotics enhance performance in latent inhibition and acquired equivalence, but have no effect on working memory tasks. We present here a neural network model of prefrontal-striatal-hippocampal interactions which simulates cognitive dysfunction in schizophrenia. According to our model, positive symptoms of schizophrenia are associated with hippocampal dysfunction, while the occurrence of negative symptoms is associated with frontostriatal deficits in a subset of patients. Accordingly, our simulation results show that the severity of negative symptoms in schizophrenia correlates with impaired feedback learning, as found empirically. In our model, latent inhibition and acquired equivalence deficits in schizophrenia are associated with hippocampal dysfunction, while working memory deficits are associated with prefrontal dysfunction. In agreement with empirical results, our simulation results show that antipsychotics enhance performance in latent inhibition and acquired equivalence, but not in working memory tasks. In sum, our new computational model (a) provides a systems-level analysis of cognitive dysfunction in different subtypes of schizophrenia patients, and (b) simulates the enhancing and deleterious effects of antipsychotics on cognition.

D25

IMPROVING BEHAVIOR, COGNITION AND NEURAL MECHANISMS OF ATTENTION IN AT-RISK CHILDREN Helen J. Neville[1], Courtney Stevens[1,2], Scott Klein[1], Jessica Fanning[1], Ted Bell[1], Elif Cakir[1], Eric Pakulak[1]; [1]University of Oregon, [2]Willamette University — The impact of lower socioeconomic status (SES) on the cognitive skills and brain function of children and adults has been well documented (Hackman et al., 2010). Additionally, the considerable personal costs to individuals and the economic costs to society of such achievement gaps have been well documented. Recent meta-analyses of costly studies initiated in the 1960s have shown that programs that target low-SES preschoolers and their parents can ameliorate such problems (Heckman, 2010). Different systems of the brain display different degrees and timeperiods of neuroplasticity. Relevant here are studies showing that selective attention is a highly malleable system that is both enhanced in remaining modalities following sensory deprivation, shows deficits in developmental disorders and in typically developing low SES children and that selective attention can be increased in both typically and non-typically developing children following computerized training (Stevens and Neville, 2010). Here we targeted highly plastic attention systems in a randomized, pre/post training study with 104 Head Start (HS) preschoolers (at risk for school failure because of their low SES) and their parents. It included a parenting program and attention training for children that we show boosts mechanisms of attention. After eight weeks of such training, parenting practices improved, stress decreased, and children's behavior, social skills, cognition and neural mechanisms of attention improved significantly when compared to children and parents randomly assigned to HS without training. These results carry implications for ongoing discussions concerning evidence-based early education programs that could impact at-risk children and reduce achievement gaps.

D26

OBJECT INDIVIDUATION IN CHICKS: USE OF PROPERTY/KIND INFORMATION Laura Fontanari[1], Rosa Rugani[2], Lucia Regolin[2], Giorgio Vallortigara[1]; [1]Center for Mind/Brain Sciences, University of Trento, [2]Department of General Psychology, University of Padua — Object individuation is the process by which organisms establish the number of distinct objects present in an event. Previous research demonstrated that chicks are able to use spatiotemporal and property information for object individuation. The ability to use property/kind information is assessed employing imprinting objects and food items (i.e. mealworms). Newborn chicks were reared with 5 identical imprinting objects. On day 2 each chick underwent a free choice test in which 2 groups of events were shown: a group comprised two stimuli i.e. an imprinting object and a food item; the second group was composed by a single stimulus (i.e. either imprinting object or food item) presented twice (Exp.1). Each stimulus in each group of events was sequentially presented and concealed in the same spatial location; each group of events took place in a different spatial location and the number of events was equalized. Chicks (N=24) spontaneously approached the two different stimuli rather than the single stimulus seen twice. A possible preference for the more varied set of stimuli was excluded by testing chicks (N=12) in a simultaneous presentation of two imprinting objects Vs. two food items (Exp.2).

D27

THE POWER OF SUGGESTION EXTENDS BEYOND ILLNESS. EXPECTATION-INDUCED MODULATION OF TOUCH Mirta Fiorio[1], Serena Recchia[1], Federica Corrà[1], Michele Tinazzi[1]; [1]University of Verona, Italy — Evolutionary theories explain the analgesic placebo effect as a process of interpersonal healing, having a survival value for individuals. Being the placebo effect deeply rooted in humans, it is conceivable that it exerts its power even in unnecessary circumstances, beyond illness and pain. In the current study we aimed at inducing enhancement of tactile perception, by influencing expectation. A group of subjects, attending to a stimulated body side, has been verbally suggested and surreptitiously conditioned about the effect of an inert cream in enhancing tactile perception, while a control

group was informed about the real inefficacy of the cream. The placebo group referred higher tactile sensation after treatment than before, although the intensity of stimulation was identical in the two conditions. In order to unveil whether the neurophysiological underpinnings of this effect should be ascribed to early or late stimulus processing, we measured the amplitude of early-middle and late somatosensory evoked potentials (SEP), before and after treatment. Results showed that the placebo manipulation has no effect on low level tactile processing, as the amplitude of the early and middle SEPs. Conversely, we found modifications in the late SEPs, suggesting that the placebo effect might be related to late cognitive processing of tactile information, probably due to expectation and attention. Our study is the first demonstration that manipulating subjects' expectation has reflections in the processing of tactile information, without obvious protective or survival value for the individual, thus extending the power of human suggestion beyond illness.

D28

MATERNAL MULTIPLE MICRONUTRIENT SUPPLEMENTATION IMPROVES MATERNAL AND CHILD COGNITION IN UNDERNOURISHED MOTHERS IN INDONESIA Elizabeth Prado[1,2], Michael Ullman[3], Katie Alcock[4], Husni Muadz[5], Anuraj Shankar[1,6], The SUMMIT Study Group[1]; [1]SUMMIT Institute of Development, Indonesia, [2]University of California at Davis, [3]Georgetown University, [4]Lancaster University, UK, [5]Mataram University, Indonesia, [6]Harvard University — Brain development and function throughout the lifespan depend on adequate nutrition, including micronutrients (vitamins and minerals). For example, during fetal and infant development micronutrients play a role in neuron proliferation and myelination, while in adulthood, micronutrients are essential for neurotransmitter synthesis. Acute micronutrient deficiencies can lead to severe effects on the central nervous system in utero (e.g., maternal folic acid deficiency can cause spina bifida) and throughout adulthood (e.g., thiamine deficiency can cause memory loss). The extent to which non-clinical micronutrient deficiencies during pregnancy impair maternal and child cognition is not yet clear. We assessed participants in a randomized trial in Indonesia, comparing maternal multiple micronutrient (MMN) supplementation to iron and folic acid supplementation provided during pregnancy until three months postpartum. We evaluated 640 mothers on eight tests of mood and cognition (e.g., working memory, declarative memory, reading, motor function) after an average of 25 weeks of supplementation. We followed up by assessing 487 of their children at age 3.5 years on eight tests of socio-emotional and cognitive development (e.g., picture vocabulary, visual attention/spatial ability, motor function). For undernourished mothers (mid-upper arm circumference < 23.5 cm), MMN improved cognition both in the mothers at the time of supplementation (especially reading), and in the children 3.5 years later (especially motor function and visual attention/spatial ability). These findings suggest that undernourishment during pregnancy is associated with cognitive impairments both in pregnant mothers and in their children several years later, and that both impairments can be corrected with maternal MMN supplementation during pregnancy.

Emotion & Social: Person Perception

D29

DYNAMIC FACIAL EXPRESSIONS EVOKE DISTINCT ACTIVATION IN THE FACE PERCEPTION NETWORK AS REVEALED BY PARALLEL FMRI AND MEG ANALYSIS Elaine Foley[1], Gina Rippon[1], Carl Senior[1]; [1]Aston University, Birmingham, UK — The neural structures involved in the perception of dynamic facial expressions of emotion were investigated using both functional Magnetic Resonance Imaging (fMRI) and Magnetoencephalography (MEG). A unique set of naturalistic dynamic facial expressions was specifically created and in both procedures participants viewed video clips and static images of angry, happy and speech face stimuli. Through fMRI (n=14) a dynamic face perception network was identified, including early visual regions, such as the Inferior Occipital Gyrus (IOG), insensitive to motion or affect but sensitive to the visual stimulus; the superior temporal sulcus (STS), specifically sensitive to motion, and the amygdala, recruited to process affect, particularly dynamic angry facial expressions. MEG (n=12) and Synthetic Aperture Magnetometry (SAM) were then used to examine the spatiotemporal profile of neurophysiological activity within this dynamic face perception network. This analysis revealed an early decrease in the beta frequency (15-35 Hz) band in the right IOG at 200ms post stimulus onset for dynamic relative to static expressions, and a slightly later decrease in the left IOG at 400ms post stimulus onset, across the group of participants. Bilateral STS also showed a decrease in power in the beta frequency (15-35 Hz) band at 750ms in response to dynamic faces, across the group. These findings support the presence of a dedicated network of cortical regions that mediate the perception of dynamic facial expressions, with the fMRI data providing information on the spatial co-ordinates paralleled by the MEG data which indicate the temporal dynamics within this network.

D30

INDIVIDUAL VARIATION IN AMYGDALA INVOLVEMENT IN THEORY OF MIND: AN FMRI STUDY Karen Lythe[1], Andrew Lawrence[1]; [1]Cardiff University, UK — A key component of social cognition is "theory of mind" (ToM) or the ability to infer others' mental states. A network of core regions, including temporoparietal junction (TPJ), dorsomedial prefrontal cortex (dmPFC) and precuneus is thought to underpin ToM abilities. Lesion, functional imaging and electrophysiological studies in humans and nonhuman animals have demonstrated a role for the amygdala in processing stimuli with emotional and social significance. However, there is some debate as to the extent to which the amygdala forms part of the core ToM network. One reason for this is that there may be considerable individual variation in amygdala reactivity during ToM processing. To examine this, we examined the influence of individual differences in performance on advanced ToM tests (Reading the Mind in the Eyes, faux pas recognition) and dispositional empathy (Toronto Empathy Questionnaire) on BOLD signal response in the amygdala when people reasoned about the contents of another person's mind, relative to a control physical condition. fMRI data were collected from 40 female participants using a 3T GE scanner. Across participants, activity was seen in core ToM regions (including TPJ, precuneus, dmPFC). Importantly, individual differences in Mind in the Eyes test accuracy, but not self-reported empathy, significantly predicted left and right amygdala response during the ToM task. These results suggest that variation in amygdala response during ToM tasks is importantly related to social cognitive abilities, and have important implications for understanding the role of the amygdala in social cognition and its disorders.

D31

A CORTICAL NETWORK FOR PLEASANT AND UNPLEASANT FACIAL EXPRESSIONS PROCESSING: VALIDATION ANALYSES OF THE LATERALITY HYPOTHESES BY DYNAMIC CAUSAL MODELLING Hiroaki Itoh[1], Midori Shibata[1], Hiroki Motoyama[1], Jun-ichi Abe[1]; [1]Hokkaido University — There are two competing hypotheses for the lateralized processing of facial expressions. On the one hand, the right-hemisphere dominance hypothesis (RHH) suggests that the right hemisphere is dominant for processing all facial expressions regardless of their affective valence. On the other hand, the valence-specific hypothesis (VSH) suggests that the left hemisphere is specialized for processing pleasant facial expressions, while the right hemisphere is specialized for processing unpleasant facial expressions. In this study, we examined the validity of the two hypotheses using Dynamic Causal Modelling (DCM) and Bayesian Model Selection (BMS). Eleven participants performed a blocked fMRI paradigm, viewing pleasant, unpleasant, and neutral facial expressions. We constructed two DCM models: The RHH model assumes that pleasant and unpleasant facial expressions modulate forward connections from the bilateral fusiform gyrus (FG) to the right orbitofrontal cortex (OFC), whereas the VSH model assumes that pleasant facial expressions modulate forward connections from the bilateral FG to

the left OFC, while unpleasant facial expressions modulate forward connections from the bilateral FG to the right OFC. BMS revealed that the RHH model fitted marginally better than the VSH model. Regarding the activating patterns, pleasant facial expressions enhanced forward connections from the bilateral FG to the right OFC, while unpleasant facial expressions did not enhance any connections. Taken together, the present results supported neither hypothesis, suggesting that processing of pleasant facial expressions enhanced activation of the right frontal cortex, while processing of unpleasant facial expressions did not enhance activation of either cortex.

D32

NEURONAL ACTIVITY OF PRIMARY SOMATOSENSORY CORTEX DURING OBSERVED HAND TOUCH OF SELF AND OTHER – A 7-TESLA FMRI STUDY Esther Kuehn[1], Robert Trampel[1], Karsten Mueller[1], Robert Turner[1], Simone Schuetz-Bosbach[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences — Neuronal activity of the primary somatosensory cortex (S1) has been linked to both felt touch and observed touch. This has led to the assumption that S1 forms a key part of a system for mirroring observed touch. Moreover, recent findings have suggested social sensitivity in S1 in the sense that its anterior parts are preferably recruited during observation of self-related touch, and its posterior parts showing stronger responsitivity during observation of other-related touch. Here, we aimed to explore this hypothesis further by conducting a functional magnetic resonance imaging (fMRI) study at high-field (7 Tesla). We presented short video sequences of hands being either touched or non-touched to healthy participants. Importantly, self-attribution of observed touch and non-touch was modulated by varying hand perspective (egocentric versus allocentric) and hand identity (self versus other) in a 2x2x2-factorial design. Our results clearly relate activity increase of S1 to observed touch versus non-touch conditions. S1 activity, however, did not show any systematic modulatory shifts during observed touch with respect to differences in hand perspective, or hand identity. Instead, on a group level, similar areas within S1 were recruited irrespectively of whose hand was being touched, or in which perspective the hand was shown. Our findings therefore contradict previous results and do not support the assumption that directed activity shifts within subregions of S1 may reflect the degree of self-attribution during observed touch.

D33

EARLY PERCEPTION OF FACIAL EMOTION IN POSTTRAUMATIC STRESS DISORDER: AN MAGNETO-ENCEPHALOGRAM STUDY Heather Dodge[1], Pilar M. Sanjuan[1,2], Per Lysne[2], Flannery Merideth[1], Bobby Sena[2], Jason Long[2], Robert Thoma[2]; [1]The Mind Research Network, [2]The University of New Mexico — Posttraumatic stress disorder (PTSD) is a debilitating and persistent condition with a significant affective component that can disrupt the social relationships of those afflicted. Facial affect recognition is an important component of social cognition, and this pilot study aimed to evaluate the impact of PTSD on the early stages of visual processing of facial emotion in the calcarine fissure and fusiform gyrus in combat veterans. We hypothesized that magnetoencephalographic (MEG) activation would reveal group differences in the processing of facial emotion as seen in the amplitude and latency of the M100 visual peak in the calcarine fissure and the M160 face-specific peak in the fusiform gyrus. MEG data were collected while five combat veterans with PTSD and five combat-exposed controls without PTSD were presented repeatedly with faces of happy, fearful, and neutral affect, as well as a swirled face control condition. Across groups the effect of facial versus swirled stimulus was significant on both amplitude and latency in the bilateral fusiform gyrus, with swirls eliciting lesser amplitude and longer latency than faces. Group differences were found such that PTSD subjects showed lesser activation and longer latencies versus controls. A group effect on the response differential between happy and fearful faces was found on right hemisphere amplitude and left fusiform latency. An effect of age on fusiform amplitude was also found. The data suggest that the processing of facial affect is altered in people who suffer from PTSD.

D34

BDNF POLYMORPHISM-DEPENDENT OFC AND DLPFC PLASTICITY DIFFERENTIALLY MODERATES IMPLICIT AND EXPLICIT BIAS Chad Forbes[1,2], Joshua Poore[2], Aron Barbey[2], Frank Krueger[2,3], Jeffrey Solomon[4], Robert Lipsky[5], Colin Hodgkinson[6], David Goldman[6], Jordan Grafman[2]; [1]Imaging Sciences Training Program, Radiology and Imaging Sciences, Clinical Center and National Institute of Biomedical Imaging and Bioengineering, [2]Cognitive Neuroscience Section, National Institute of Neurological Disorders and Stroke, National Institutes of Health, [3]Department of Molecular Neuroscience, George Mason University, Fairfax, VA, [4]Medical Numerics, Germantown, Maryland, [5]Department of Neurosciences, Inova Fairfax Hospital, Falls Church, VA, [6]Laboratory of Neurogenetics, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, Bethesda, MD — This study examined the role of orbitofrontal cortex (OFC) and dorsolateral prefrontal cortex (DLPFC) plasticity in the inhibition of implicit and explicit bias. Specifically, normal controls and patients with varied OFC and DLPFC lesion size and single nucleotide polymorphisms (SNPs) in the brain-derived neurotrophic factor (BDNF) gene, a gene known to either promote (Met/Val SNP) or stifle (Val/Val SNP) neural plasticity in damaged prefrontal cortex regions, completed measures of implicit and explicit gender bias. Patients demonstrated comparable levels of implicit bias compared to controls, but patients' implicit bias was moderated by lesion size and BDNF SNP. Patients with Met/Val SNPs exhibited greater stereotype inhibition to the extent they had smaller OFC lesions compared to their Val/Val counterparts and patients with large OFC lesions. Both patients and controls demonstrated patterns of explicit bias consistent with hypotheses. Furthermore, patients with Met/Val SNPs exhibited less explicit bias to the extent they had smaller DLPFC lesions sizes compared to their Val/Val counterparts and those with large DLPFC lesions. Findings highlight the integral role of OFC and DLPFC in the expression of implicit and explicit bias respectively and suggest that neural plasticity within these regions moderates their efficaciousness in executing inhibitory and control processes.

D35

BRAIN POTENTIALS REVEAL A FEATURAL/CONFIGURAL BIAS IN FACE MEMORY DUE TO EMOTIONAL CONTEXT AT ENCODING Donna J. Bridge[1], Ken A. Paller[1]; [1]Northwestern University — Memory encoding often necessitates a bias whereby some details of an experience are prioritized in memory while others are discarded. What factors determine what will be remembered later? Learning context can play an important role, as demonstrated in our prior study of memory for faces with neutral expressions (Bridge et al., 2010). In that study, memory was systematically modulated according to whether faces were learned in a happy or sad encoding context (HEC or SEC). Memory for HEC faces was superior when tested in an upright orientation; memory for SEC faces was superior when tested in an inverted orientation. We inferred that the HEC promoted holistic encoding, whereas the SEC promoted feature-oriented encoding. In the present study, we analyzed event-related potentials to determine whether right-occipito-temporal N170 potentials might reveal evidence for a global or local emphasis due to encoding context. Generally, face-sensitive N170 potentials do not vary as a function of memory. Nevertheless, we found that N170 amplitudes to remembered faces (hits during recognition testing) were greater for HEC faces than for SEC faces. Additionally, N170 potentials during recognition testing were significantly right-lateralized for HEC faces but not for SEC faces or new faces. Configural information may have been under-weighted or featural information preferentially accessed when SEC faces were successfully recognized. In sum, encoding context can have an influence extending well beyond encoding, in that happiness versus sadness engenders a memory bias for configural versus featural facial information, respectively, with repercussions evident in subsequent memory.

D36

A GUESS MAKES A DIFFERENCE: FACIAL ATTRACTIVENESS ANTICIPATION MODULATES FACIAL ATTRACTIVENESS EVALUATION Hongbo Yu[1], Xiangming Jiang[1], Lihui Wang[2], Zhiheng Zhou[1], Xiaolin Zhou[1]; [1]Center for Brain and Cognitive Sciences and Department of Psychology, Peking University, [2]Center for Studies of Psychological Application, South China Normal University — Introduction: The neural underpinnings of social reward (e.g. attractive face) anticipation, evaluation and their relationship investigated in the current fMRI study are crucial in understanding human decision-making in social realm and are largely unknown to date. Method: Participants were presented in each trial with a Gaussian-blurred picture of female face and were asked to make an attractive/unattractive force-choice. Then a picture of clear face was presented as feedback (Fig. 1). Result: 1) upon guessing: compared with the "unattractive" judgment, the "attractive" judgment activated right amygdala and left insula activation (Fig. 2a); 2) upon feedback: attractive faces activated ventral striatum and bilateral fusiform comparing with unattractive faces (Fig. 2b); predicted outcomes elicited greater activation in ventromedial orbital frontal cortex (vmOFC) than unpredicted ones (Fig. 3); 3) correlation between guess and feedback phases: right amygdala activity following the "attractive" judgment correlated with the activation difference, in both vmOFC and ventral striatum, between attractive and unattractive faces in the feedback phase (Figs. 2c and 2d). Conclusion: 1) differential neural activity in the limbic structure in the guess phase reflects anticipation towards the affective nature of the outcome; and 2) affective anticipation modulates the process of outcome evaluation in OFC and ventral striatum.

D37

PRIMING AFFECTIVE INCONGRUITY IN BICULTURAL INDIVIDUALS USING THE N400 Michelle Fong[1], Colleen Moore[2], Tracy Zhao[2], Zach Schudson[2], Sharon Goto[2], Richard Lewis[2]; [1]Harvey Mudd College, [2]Pomona College — The effect of priming cultural schemas on the neural mechanisms underlying attention is not yet well understood. Individuals in multicultural environments often switch between cultural schemas according to the immediate sociocultural context (Hong et al., 2000). Across several behavioral, electrophysiological and neural measures, individuals from collectivist cultures (e.g., East Asians) have been shown to allocate greater attention to background objects and context relative to individuals from individualistic cultures (e.g., European Americans) (Masuda et al., 2008). We sought to examine whether or not priming of independent and interdependent self-construal affects neural activity underlying attention to social contexts in bicultural individuals (i.e., East Asian Americans). Using a modified N400 event-related potential design (Goto et al., 2010), we measured the degree to which 37 monoracial East Asian American participants, undergraduates aged 18-22 years, responded to semantic incongruity in the emotional expression of a central figure relative to the surrounding figures. The priming procedure consisted of two tasks, the Sumerian Warrior Story task and the Similarities and Differences with Friends and Family task, both of which have been shown to reliably impact self-construal (Trafimow et al., 1991). All subjects were given both independent and interdependent primes, with the order of the primes alternating between subjects. As predicted, when participants were primed with interdependent values they displayed greater N400s when viewing incongruent affective stimuli than when primed with independent values. This finding suggests that frame switching in bicultural individuals affects the affective processing of social relationships.

D38

THE NEURAL BASES OF UPDATING IMPRESSIONS Peter Mende-Siedlecki[1], Yang Cai[1], Alexander Todorov[1]; [1]Princeton University — Person perception is a dynamic, evolving process. Since other people are an endless source of social information, quite often we find ourselves in situations where new information we learn about an individual is not consistent with previously learned information. Thus, the capacity to update our impressions of those around us is critical. We devised an fMRI study designed to identify brain regions involved in the process of updating impressions. Subjects saw neutral male faces with either positive or negative behavioral information printed below them, and were asked to form impressions of these individuals. Each face was seen five times in a row, each time with a different piece of behavioral information. For half of the faces, the valence of the information was kept consistent—on all five trials, the face was paired with either positive or negative information. Critically, for the rest of the faces, the valence of the information changed on the fourth trial—making the fourth and fifth trials inconsistent with information previously learned about that person. We ran a contrast of all face+behavior trials against control trials (faces alone) to identify regions involved for impression formation. Consistent with prior work, this contrast yielded activity in dmPFC, PCC, and amygdala. Activity in the dmPFC ROI increased significantly from trial 3 to trial 4 in the inconsistent condition, but remained stable from trial 3 to trial four in the consistent condition. This condition-specific increase in dmPFC activity paralleled changes subjects' ratings of trustworthiness from trial 3 to trial 4.

D39

MU RHYTHM MIRRORING RESPONSE TO EMOTIONAL FACES: COMPARISON OF BLIND SOURCE SEPARATION AND CHANNEL-BASED EEG ANALYSIS TECHNIQUES Adrienne Moore[1], Irina Gorodnitsky[1], Jaime Pineda[1]; [1]University of California, San Diego — The goal of this study was to determine whether the electroencephalographic (EEG) mu rhythm is modulated by observation of emotional faces, and whether the mu response to emotional faces can be studied with a blind source separation (BSS) based approach applied to data collected with an array of 17 scalp electrodes. The mu rhythm is typically considered an 8-13 Hz sensorimotor cortex rhythm and is believed to reflect the activity of a "mirroring system" for comprehending the actions of others by simulating them. Observation of emotional facial expressions activates the mirror neuron system, pointing to the hypothesis that the mu rhythm also responds to emotional face observation. However because EEG signals recorded from scalp electrodes are often a mixture of several source signals with imprecisely known locations in the brain, the optimal means of addressing the mu face observation hypothesis is not obvious. The results of this study show that the mu response to emotional faces, if measured as the signals from individual EEG electrodes, is a mixture of source signals from various parts of the brain. The Second-Order Blind Identification (SOBI) algorithm successfully unmixes these signals into dipolar source components with only a 17 electrode array. There are important differences between the emotional face mu response derived from SOBI components and the traditionally derived mu face response. SOBI based analysis confirms that the mu rhythm is modulated by observation of emotional faces, consistent with the view that face perception involves mirroring, or motor cortical simulation of an observed expression.

D40

RACE MODULATES THE NEURAL UNDERPINNINGS OF IMITATION: SELF-SIMILARITY VS FAMILIARITY Elizabeth Reynolds Losin[1], Marco Iacoboni[1], Mirella Dapretto[1]; [1]University of California, Los Angeles — We aimed to disentangle the effects of model-observer similarity and familiarity on the neural mechanics of imitation. Both factors can bias individuals to learn from certain models, thereby increasing the adaptive value (e.g., self-relevance) of learned information. In prior studies of action observation, however, model similarity and familiarity have often been confounded. Here we compared the neural encoding of race during imitation between participants from a racial majority, European American (EA), and a racial minority, African American (AA). In a novel fMRI paradigm, participants imitated videos of EA and AA models performing unfamiliar meaningless hand actions. All participants reported feeling most similar to ingroup models. However, EA participants reported less experience with AAs than their racial ingroup whereas AA participants reported comparable levels of racial experience with ingroup and EA individuals. At the neural level, EA and AA participants exhibited opposite patterns

of activity. AA participants exhibited more activity in visual and motor regions when imitating ingroup compared to outgroup individuals. EA participants exhibited more activity in a similar suite of visual and motor regions when imitating outgroup compared to ingroup members. In other words, both EA and AA participants exhibited greater activity in imitation-related regions while imitating AA than EA models. Furthermore, almost no differences resulted from a between-group comparison on the [imitate AA > EA] contrast. These findings suggest that racial similarity alone cannot explain the neural encoding of race during imitation and that racial experience may also play a significant role.

D41

THE ROLE OF MIRRORING IN DECEPTION: A MU SUPPRESSION STUDY Arnold Noriega[1,3], Daniel Chun[2,3], Jamie A. Pineda[2,3]; [1]Department of Psychology, [2]Department of Cognitive Science, [3]University of California, San Diego — Deception is based in part on having a theory of mind (TOM), that is, being able to infer what beliefs, thoughts, and knowledge others might have (Spence 2004). One proposed neural mechanism for gaining such insight is the human mirror neuron system (MNS), which is assumed to involve a significant amount of similar neural activity as a "common coding between perceived and generated action" in an observer and an observed individual (Pineda 2009). Thus, it stands to reason that the process of deception might be associated with changes in activity in the human MNS (Gallese et al., 1998). The present study was designed to test if MNS activity depends on whether an individual is engaged in truth-telling or deception. Suppression of EEG mu rhythms (8-13Hz oscillations with sources in sensorimotor cortex) was used as an index of mirroring activity. A within-subjects design was utilized in which subjects were asked to either tell the truth or lie for each block of 15 autobiographical questions. EEG data collected from fifteen subjects (10 females) were analyzed using a repeated measures analysis of variance. Significance was found in the Frontal, Central and Midline sites. Constant with previous research, such as Zuckerman et al. 1981, telling a lie is more demanding than truth telling reflected by the most engagement of the mirror neuron system. Cognitive complexity only partially explains deception due lack of differences in mu suppression between truth and deception conditions. Regional variation in mu suppression suggests a variety of mechanisms involved.

D42

INDIVIDUAL DIFFERENCES IN TRAIT EMPATHY AND SEX INFLUENCE NEURAL RESPONSE TO MENTALIZING IN THE GENERAL POPULATION Michael Lombardo[1], Meng-Chuan Lai[1], Amber Ruigrok[1], Renate van de Ven[1], Bhismadev Chakrabarti[2], Ed Bullmore[3], John Suckling[3], MRC AIMS Consortium[4], Simon Baron-Cohen[1]; [1]Autism Research Centre, University of Cambridge, [2]School of Psychology and Clinical Language Sciences, University of Reading, [3]Brain Mapping Unit, University of Cambridge, [4]University of Cambridge; Institute of Psychiatry, Kings College London; University of Oxford — Prior research suggests that there are subtle differences between males and females in mentalizing. Females also tend to self-report more trait empathy than males. However, although the neural circuits generally involved in mentalizing are well characterized, little is known about how individual differences in trait empathy as well as one's sex influences the recruitment of such circuits. Here we show on a relatively large sample of healthy males and females (n = 66), that some of the neural systems integral for mentalizing respond in a sexually dimorphic fashion and are related to individual differences in trait empathy. Participants were scanned with fMRI at 3T while making reflective mentalizing or physical judgments about either themselves or familiar but non-close other (e.g., the British Queen). Despite near identical behavioral responses between males and females during scanning, females scored higher on trait empathy than males. Whole-brain FDR-corrected analyses highlighted more pronounced Mentalizing>Physical response in males compared to females in right temporo-parietal junction (TPJ) and posterior cingulate cortex (PCC). RTPJ response was also negatively correlated with trait empathy. In a subset of males and females matched for level of trait empathy (n=50), the negative correlation and sex difference in neural response were still apparent. These results demonstrate that neural mentalizing response is influenced by both trait empathy and sex. The characterization of normative patterns reported here has important implications for neurodevelopmental conditions such as autism, where skewed sex ratios and deficits in mentalizing and empathy are paramount.

D43

BRAD CLOONEY AND ANGELINA HILTON? EXTRACTING MEAN IDENTITY FROM FAMOUS FACE SETS Markus F. Neumann[1], Stefan R. Schweinberger[1,2]; [1]Friedrich Schiller University Jena, [2]DFG Research Unit Person Perception — When confronted with arrays of simultaneously presented objects, statistical mean representations may serve as an efficient way of coding information. Accordingly, participants precisely extracted mean size information from sets of circles varying in size, while information about individual exemplars was nearly absent (Ariely, 2001, Psychological Science). Similarly, mean emotion and mean gender (Haberman & Whitney, 2007, Current Biology), and mean identity (de Fockert & Wolfenstein, 2009, Quarterly Journal of Experimental Psychology) can be extracted from sets of unfamiliar faces. In the present study, participants saw sets of four faces from different, well-known celebrities. They indicated whether or not a subsequent probe face was an image (Exp.1a) or identity (Exp.1b) previously seen in the set. Probes were either exemplars (real face photographs) or averages across images of four different identities. Furthermore, probes either corresponded to the set (i.e., included set images), or were new images from the same set identities, or were images from different famous identities. We hypothesized that famous identities should activate distinct representations (face recognition units) and expected mean identity representations not to be formed. Unexpectedly, participants produced large proportions of "present" responses to both the corresponding exemplar and, to a lesser extent, the corresponding average conditions. During identity matching a similar pattern additionally emerged for averages across four new images from set identities, suggesting high-level identity averaging. Control experiments ruled out alternative explanation such as participant's response biases. We concluded that in addition to strong exemplar face representations mean identity representations were extracted from famous face sets.

D44

THE INFLUENCE OF FACIAL AGE ON GENDER PERCEPTION: AN ERP STUDY ON FACE CATEGORIZATION Nadine Kloth[1,2], Stefan R. Schweinberger[1,2], Holger Wiese[1,2]; [1]Department of General Psychology and Cognitive Neuroscience, University of Jena, Germany, [2]DFG Person Perception Research Unit, University of Jena, Germany — Whereas familiar face processing is usually characterized by individual identification, efficient perception of unfamiliar faces typically involves their categorization (e.g., into male vs. female faces). Aiming at a deeper understanding of these processes, the present ERP study examined the effect of facial age on gender categorization. We presented participants with male and female adult faces of three age groups and asked them to categorize each face according to its gender. Examining the potential contributions of featural and configural information, we presented each face in both an unfiltered and low-pass filtered (blurred) version as well as in upright and inverted orientation. Behavioral results revealed a pronounced effect of facial age on gender classification: Participants were faster to categorize female than male faces when these were young, but were faster to categorize male than female faces when these were middle-aged or old. The additional finding that blurring speeded up gender categorization for old female faces while slowing down the categorization of old male faces suggests that the influence of facial age on gender categorization might be moderated by the smoothness of the skin texture. Analysis of electrophysiological data revealed a strong effect of age on the N170 for which increasing facial age evoked increasing amplitudes. Interestingly, this effect was restricted to the unfiltered versions of the stimuli, suggesting its related-

ness to high spatial frequency information in faces. Finally, N170 inversion effects were larger for young than middle-aged and old faces, possibly reflecting enhanced configural processing of young faces in young participants.

D45

BRAIN REGIONS INVOLVED IN PROCESSING OTHERS' PAIN ARE MODULATED BY SOCIAL GROUP MEMBERSHIP Glenn R. Fox[1,2,3], Mona Sobhani[1,2,3], Lisa Aziz-Zadeh[1,2,3]; [1]Brain and Creativity Institute, [2]Neuroscience Graduate Program, [3]University of Southern California — Investigations focusing on the neural substrates of empathy have primarily focused on physical or tangible cues to invoke an empathic response. For instance, neuroimaging studies on empathy for physical pain have identified a set of regions, including the cingulate and insula, known as the "pain matrix" (Jackson et. al., 2006). Activity in the matrix can be modulated by factors such as perceived fairness, (Singer, 2006), facial expression, (Xu & Han, 2009) and race, (Xu & Han, 2008). Less is known of how these empathic responses can be modulated by non-physical cues to group membership, such as religion. In this study, 19 neurologically normal Jewish subjects were familiarized, outside the scanner, with stories of eight individuals (targets). Half of the targets belonged to neo-Nazi groups, whereas the other half did not. Next, while undergoing fMRI, subjects viewed video clips of the targets receiving a painful stimulation (injection in the hand) or a non-painful stimulation as control (Q-tip touch). Our results showed a strong modulation in the pain matrix, as well as in reward regions and regions associated with top-down cognitive function while perceiving dislikable people in pain. To investigate how regions modulated by group membership may be "functionally" connected to other regions, we performed an analysis using psychophysiological interaction (PPI). This analysis showed connections between limbic cortices and those associated with top-down cognition. Our results support the notion that social group membership and likability modulate activity in regions involved in processing others in pain.

D46

THE P2 ERP COMPONENT DISTINGUISHES AMONG ATTRACTIVE, AVERAGED, AND UNATTRACTIVE FACES Logan Trujillo[1], Jessica M. Jankowitsch[1], Connor Principe[1], Judith H. Langlois[1]; [1]University of Texas at Austin — Many studies have shown that adults, children, and infants judge people differently based on facial attractiveness and that faces are perceived as attractive when their facial configuration approximates the average facial configuration of the population. Conversely, faces that deviate from this average configuration are perceived as unattractive. There is minimal neurocognitive evidence, however, showing that attractive and average faces are processed similarly and in a manner distinct from the processing of unattractive faces. To address this issue, we recorded event-related potentials (ERPs) and reaction time from 27 adult human participants while they discriminated between human and monkey faces. Participants viewed three kinds of human faces: high attractive (faces independently rated at the high end of a 7-point attractiveness scale), low attractive (faces independently rated at the low end of a 7-point attractiveness scale), and morphed faces (32-face mathematical composites of high and low attractive faces that are typically judged to be highly attractive). Participants were significantly faster to categorize morphed vs. low attractive faces, and marginally faster to categorize high vs. low attractive faces, as human. The posterior P2 ERP component (200 – 300 ms post-stimulus onset) was significantly larger in response to high attractive and morphed faces vs. low attractive faces. As the P2 is thought to reflect a generalized cognitive matching process, these P2 differences may indicate a correspondence between stored facial representations and the attractive/morphed faces. Overall, the present findings provide further evidence that faces are perceived as attractive when they approximate an average facial configuration.

D47

COMPETITION EFFECTS OF SOCIAL THREAT CUES IN A CHANGE DETECTION TASK- EVIDENCE FROM STEADY-STATE VEPS Matthias J. Wieser[1,2], Lisa M. McTeague[2], Andreas Keil[2]; [1]University of Würzburg, [2]Center for the Study of Emotion and Attention, University of Florida — Numerous studies have shown that emotional stimuli attract attention and enhance perception. This is especially true if the stimuli hold a special relevance for the observer like phobic stimuli. In addition to conventional ERP research, steady-state visual evoked potentials (ssVEPs), which are defined by a resonant oscillatory response of visual cortex to repetitive stimulation, offer an avenue to observing electro-cortical facilitation as an index of enhanced attentional engagement. Using frequency tagging (i.e. simultaneously flickering multiple stimuli at multiple frequencies), it is possible to separate visual cortical activity to spatially overlapping stimuli. Thus, attentional selection and competition can be tested in conditions in which multiple stimuli compete for attention resources. In the present study, a change detection task array was spatially overlaid over a facial expression (angry, happy, neutral), each flickering at a different frequency (15 vs. 20 Hz), while high-density EEG was recorded from 256 sensors in 17 low and 17 high socially anxious participants. Socially anxious participants showed only slightly enhanced ssVEP amplitudes to angry faces. However, the signal amplitude of the concurrent task array was reduced when competing with angry faces, which demonstrates cost effects, potentially caused by attention capture by angry faces. No impairments were observed regarding change detection accuracy. It is suggested that phobia-relevant stimuli draw attentional resources when competing for attention resources and that such competition is most easily observed when stimulating the same population of neurons by using spatially overlapping stimuli.

D48

MODULATION OF THE MIRROR NEURON SYSTEM BY SOCIAL GROUP MEMBERSHIP Mona Sobhani[1,2], Glenn Fox[1,2], Lisa Aziz-Zadeh[1,3]; [1]Brain and Creativity Institute, [2]The Neuroscience Graduate Program, [3]Division of Occupational Science and Occupational Therapy — Social group membership is an intrinsic and powerful component of human social behavior. Social group membership can be manipulated quickly, at a level outside direct cognitive control (e.g. Tajfel, 1971; Aronson and Linder, 1965). Here we examined how social group membership may modulate the mirror neuron system. Eighteen Jewish subjects were familiarized with stories of eight individuals, half of which belonged to Neo-Nazi groups and half of which did not. While undergoing fMRI, the subjects then viewed clips of actors depicting individuals in the stories performing simple motor actions (e.g. grasping a water bottle and raising it to their lips) or a still image of the actor and water bottle as a control. We predicted that the mirror system would be more active for individuals more similar to the self; thus viewing individuals from the out-group perform actions would generate less activity in the mirror neuron system. However, we found a trend directly opposite to our predictions; the left inferior frontal gyrus (IFG) was more active for members of the out-group as compared to the in-group. These data provide a novel understanding of how we process individuals that we dislike and dissociate from the self.

Emotion & Social: Emotion-Cognition Interactions

D49

EMOTIONAL RESPONSE IS ATTENUATED AFTER CONFLICT RESOLUTION PROCESSES ARE ACTIVATED - EVIDENCE FROM PAPILLARY DILATION MEASURES Noga Cohen[1], Avishai Henik[1]; [1]Department of Psychology, Ben-Gurion University of the Negev, Beer-Sheva, Israel — Recently, there has been growing empirical data showing that the appearance of emotional response following emotional stimuli is not automatic as previously thought. For example, studies that assessed emotional influence on attentional tasks found that emotional interference was reduced under

high attentional load or under conflict situations. The current research was designed to examine if a conflicting task could attenuate papillary response for emotional pictures. Participants first responded to a flanker task and then saw a picture that could be emotionally negative or neutral. Pupil diameter was measured during the experiment. We found that emotional interference, as assessed by larger pupil dilatation for the emotional pictures, was modulated by the flanker task. More specifically, the difference in pupil dilatation for emotional pictures and neutral pictures was smaller after incongruent flanker trials compared with after congruent flanker trials. We suggest that after conflict resolution processes are activated, our emotional system is down-regulated. From an evolutionary perspective, the ability to inhibit emotion under conflicting situations is crucial for our survival.

D50

REGULATING NEGATIVE EMOTIONS IN SOCIAL INTERACTIONS: NEURAL AND PSYCHOPHYSIOLOGICAL RESPONSES TO REAPPRAISAL AND VERBALIZING ONE'S FEELINGS AFTER BEING TREATED UNFAIR

Mascha van 't Wout[1], Steven Rasmussen[1]; [1]Brown University — Although emotion regulation is considered to be essential in every day life and in social interactions in particular, no studies directly examine the neural and psychophyiological effects of different emotion regulatory techniques in a social context. The Ultimatum Game provides a way to elicit negative feelings, i.e. unfairness in a social setting. We examined neural and skin conductance responses to two regulatory mechanisms: reappraisal and verbalizing one's own emotions after people were treated unfairly while being scanned with fMRI. Data of seven participants shows that regulation resulted in increased acceptance rates of unfair offers. However, only reappraisal was effective in increasing acceptance rates of very unfair offers. Unfair offers elicited greater right insula activation compared to fair offers. Regarding the regulation of unfair offers specifically we observed increased caudate and dorsolateral prefrontal cortex activation in the reappraisal condition and increased activation in Brodmann Area 44/45 in the verbalizing condition. Reappraisal compared to no regulation resulted in a greater left insula response for reappraisal. Verbalizing compared to no regulation resulted in increased subgenual anterior cingulate extending into the putamen for no regulation. Regarding skin conductance, responses were reduced in the reappraisal versus no regulation and verbalizing condition (during verbalizing three participants even showed increased responses). These data not only extend our current knowledge on emotion regulation to social interactions, it suggests that different regulatory techniques are associated with specific neural and psychophyiological responses and that some may be more beneficial than others when dealing with adverse events in social settings.

D51

DIFFERENT LEVELS OF DICTATOR GAME ALTRUISM REVEAL DISTINCT NEURAL SYSTEMS AND MOTIVES FOR GIVING

Cendri Hutcherson[1], Benjamin Bushong[1], Matthew Rabin[2], Antonio Rangel[1]; [1]California Institute of Technology, [2]University of California, Berkeley — The existence of costly altruism has long been a puzzle to economists, psychologists and philosophers alike. In order to identify the neural correlates of other-regarding preferences, we used fMRI to scan participants as they chose between proposed payments to themselves and an anonymous partner. All choices involved a tradeoff between selfish and generous outcomes. Our results revealed two distinct neural systems supporting generous behavior. One network was characterized by sensitivity to one's partner's payoff in social cognition regions like the temporoparietal junction (TPJ). Activation in this network correlated with greater generosity. A second system was characterized by less generosity overall, longer reaction times when choosing generously, and greater activation when choosing generously in a region of right inferior frontal gyrus (IFG) previously associated with self-control (Hare et al., 2009). IFG showed negative connectivity with regions involved in valuation, such as the vmPFC, further supporting its role in exerting control over reward computations in order to yield generous behavior. To examine whether these systems were associated with different underlying preferences, we randomly vetoed participants' choices on 40% of trials. Reward-related responses in the vmPFC when generous choices were vetoed (resulting in the unchosen but selfish outcome) were higher in participants activating the IFG during generous choice, and lower in participants representing their partner's outcome in TPJ. These results suggest that participants choose generously for different reasons: they may genuinely care about their partner's outcomes, or they may exert self-control in order to override selfish impulses and make the "virtuous" choice.

D52

MAGNETOENCEPHALOGRAPHIC EVIDENCE FOR EARLY INTERACTION BETWEEN GAZE AND FEARFUL EMOTION DURING ATTENTION ORIENTING

Fanny Lachat[1,2,3], sara benetti, teresa farroni[3,4], nathalie george[1,2,3]; [1]Université Pierre et Marie Curie-Paris 6, Centre de Recherche de l'Institut du Cerveau et de la Moelle épinière, UMR-S975, Paris, France, [2]Cnrs, UMR 7225, CRICM, Paris, France, [3]Inserm, U 975, CRICM, Paris, France, [4]Centre for Brain and Cognitive Development, Birkbeck College, University of London, London, UK, [5]Dipartimento di Psicologia dello Sviluppo e della Socializzazione, University of Padua, Padua, Italy — Gaze and emotional expressions are two main cues in our social life. Together they convey invaluable information about the direction of others' attention, hence about potentially relevant surrounding events and the affective value of these events. In particular, it may be predicted that fearful (relative to happy) gaze give rise to selective early effect of attention orienting as it signals a potential threat in the environment. We tested this hypothesis in 15 subjects with magnetoencephalography (MEG) (whole-head CTF Omega 151 system). In each trial, a central face turned its gaze to the right or the left and displayed a fearful or happy expression. After a random time interval (300-450ms), a target checkerboard appeared either at the gazed-at (valid) or at the uncued (invalid) location. Attention orienting effect was defined as the difference in evoked magnetic responses to valid versus invalid targets. The results showed a selective attention orienting effect induced by fearful gaze between 55 and 70ms. This effect involved the left superior parietal lobule and lateral occipital cortex. This is the first time that gaze cueing was combined with emotional faces in an MEG study. The precocity of the attention orienting effect induced by fearful gaze might subtend rapid detection and enhanced early processing of potential danger in the environment. This early effect involved parietal regions which are well known to play an important role in attention as well as extrastriate regions likely to reflect the amplification of the sensory processing of potentially relevant targets.

D53

EXAMINING THE TEMPORAL DYNAMICS OF EMOTION REGULATION: EVIDENCE FROM LONGITUDINAL REAPPRAISAL PRACTICE IN BORDERLINE PERSONALITY DISORDER PATIENTS

Bryan T. Denny[1], Harold W. Koenigsberg[2], Kevin N. Ochsner[1]; [1]Columbia University, [2]Mount Sinai School of Medicine — A fundamental question involving emotion regulation is whether one can improve with practice. This question is particularly important for certain clinical populations, such as those with Borderline Personality Disorder (BPD), which exhibit difficulty in regulating emotion. We assessed whether training in cognitive reappraisal (specifically, psychological distancing, where participants are instructed to decrease their personal connection to a stimulus) would modulate self-reports of negative emotion, psychophysiological arousal (via skin conductance response), and brain activity (via fMRI) within an image-based reappraisal task. We designed a reappraisal training paradigm in which participants practiced implementing reappraisal strategies with an experimenter and then performed a variant of an image-based reappraisal task (Ochsner et al., 2002, 2004) during five daily experimental sessions. In the task, for each trial, participants saw one of two cues (DISTANCE or LOOK), followed by an image (negative or neutral) and then a negative affect rating screen. On look trials participants were asked to respond naturally. Trials were presented in a randomized order and unique images were presented for all sessions. Results from 10 BPD par-

ticipants indicated that distancing training yielded reductions in negative affect ratings for Look-negative image trials over time and reductions in skin conductance response for both Look-negative and Reapp-negative trials. Preliminary fMRI results indicate that training is associated with increased ventrolateral prefrontal activity at Session 5 relative to Session 1 when engaging in regulation relative to responding naturally. Thus, distancing training has been shown to hold promise for improving regulation in individuals with BPD.

D54

DIFFUSE ATTENTION IS ELICITED BY FEARFUL, BUT NOT ANGRY FACIAL EXPRESSIONS F. Caroline Davis[1], Erika J. Ruberry[2], Paul J. Whalen[1]; [1]Dartmouth College, [2]Cornell Medical School — Previous research has focused on dimensions of valence (e.g., negativity) and emotional arousal to delineate the effects of emotional cues on behavior. Here, we explore the hypothesis that threat related facial expressions differentially influence environmental monitoring. Fearful and angry facial expressions can be equated on valence and emotional arousal, but they differ in the predictive information that they provide to viewers. Fearful faces indicate the presence of a proximal, but unknown, threat, whereas angry expressions embody a certain and direct threat. Thus, fearful faces should facilitate processing of the environment to disambiguate the threat, while angry faces should direct attention to the individual displaying the expression. Using a dot-probe paradigm, we presented pairs of faces containing either a fearful and neutral face (FN), an angry and neutral face (AN), or two neutral faces (NN). A dot-probe immediately followed the faces, and reaction time to detect the probe was measured. Consistent with previous research, participants were faster to detect probes behind angry compared to neutral faces. In contrast, participants displayed no reaction time bias toward the fearful compared to neutral faces, consistent with the notion that fearful faces elicit a broadening of attention that includes the fearful face and other environmental information. Across all three conditions, participants were fastest to detect probes following Neutral faces in the FN trials compared to AN and NN pairs. These data suggest that fearful faces uniquely diffuse attention for all information in the experimental context, compared to angry facial expressions, which capture and hold attention.

D55

CONTRIBUTIONS OF THE VENTROMEDIAL PREFRONTAL CORTEX TO EMOTION REGULATION Amy Winecoff[1], John Clithero[1], Sara Bergman[1], Yizheng He[1], McKell Carter[1], Lihong Wang[1], Scott Huettel[1]; [1]Duke University — The neural mechanisms of cognitive reappraisal, defined as the implementation of a cognitive strategy to regulate the emotional impact of a stimulus, have been well characterized. The key success has been identifying the role of prefrontal cortex (PFC) in modulating amygdalar responses during reappraisal of negative stimuli. Here, we investigated the mechanisms of emotion regulation of positive and negative stimuli in a functional magnetic resonance imaging (fMRI) experiment. On half the trials, participants (N =25) experienced their emotions naturally (Experience Condition), while on the other half they attempted to emotionally detach themselves from their emotions (Reappraise Condition). Participants rated the valence of each stimulus on each trial. When reappraising, participants activated the PFC and parietal regions. When experiencing positively-rated stimuli, participants activated the ventromedial PFC (vmPFC), a region implicated in integrating reward value signals. Furthermore, reappraisal of positive stimuli led to decreased vmPFC activation. Psychophysiological interaction analyses were used to investigate functional connectivity of the vmPFC during emotion regulation. These analyses revealed that, during reappraisal, the vmPFC was inversely connected to the superior frontal sulcus and the anterior cingulate. These results indicate that a similar functional relationship exists for modulation of the vmPFC during the regulation of positive emotions as has been demonstrated for modulation of the amygdala during the regulation of negative emotions. Thus, the vmPFC may integrate information about reappraisal by modulating value signals derived from the experience of positive emotions.

D56

ATTENTIONAL BIAS FOR TRAUMA-RELATED WORDS: EXAGGERATED EMOTIONAL STROOP EFFECT IN IRAQ AND AFGHANISTAN WAR VETERANS WITH PTSD AND TBI Victoria Ashley[1], Nikki Pratt[1], Jary Larson[1], Timothy Justus[1], Diane Swick[1,2]; [1]VA Northern California Health Care System, Martinez, CA, [2]UC Davis — The emotional Stroop effect has been studied extensively in patients with anxiety disorders and depression (Williams et al., 1996), but less so in those with combat-related Post Traumatic Stress Disorder (PTSD) (Constans et al., 2004). In PTSD, attention is biased toward threat-related information relative to general emotional or neutral information. To examine the role of threat-related information in Iraq and Afghanistan war veterans with PTSD, we measured accuracy and reaction times to color naming of combat-related words on an emotional Stroop task and administered the Beck Depression Inventory (BDI) and the PTSD Checklist (PCL). Twelve of the 20 PTSD patients also had mild Traumatic Brain Injury (TBI), a common occurrence for recent combat veterans. Groups included 20 PTSD/TBI patients (mean age: 32.1 yrs), 20 military controls (mean age: 33.5 yrs), and 20 civilian controls (mean age: 32.1 yrs). The emotional Stroop task used 5 different blocks (neutral, positive, negative, combat-related, and combat-matched neutral) of 84 unique words in a Latin-square counterbalanced order. Results showed a clear emotional Stroop effect (slowing of RTs) for combat-related words in PTSD/TBI veterans (115 msec), but not in military (21 msec) or civilian controls (34 msec), and more errors to combat-related words in PTSD/TBI veterans than controls. Higher scores on the PCL and BDI were also strongly correlated with slower RTs in the Stroop task. The emotional Stroop test may show promise as an objective behavioral measure to distinguish between combat veterans with a PTSD diagnosis, and those without.

D57

ATYPICAL AMYGDALA CONNECTIVITY DURING INVOLUNTARY EYE-GAZE PROCESSING IN EMOTIONAL FACES IN AUTISM SPECTRUM DISORDERS (ASD) Eric Murphy[1], Anila D'Mello[1], Adam Fine[1], Jennifer Foss-Feig[1], Xiaozhen You[1], Lauren Kenworthy[2], William Gaillard[1,2], Chandan Vaidya[1,2]; [1]Georgetown University, [2]Children's National Medical Center — Children with ASD show atypical functional activation when processing emotional expressions and eye gaze. One locus of atypicality is the amygdala, which often shows increased response to emotional faces in ASD. It is unknown whether amygdala functional connectivity with regions involved in cognitive control (anterior cingulate) and encoding of socio-emotional cues (superior temporal sulcus) is atypical in ASD. We examined this in a Stroop-like task in which 7-13 year-old ASD and control children viewed negative faces with eyes gazing congruently, incongruently, or centrally (neutral) with words "RIGHT or LEFT" on their foreheads. Subjects classified word direction, ignoring eye gaze. Involuntary attention to eye gaze is beneficial on congruent trials (relative to Neutral) but interfering on incongruent (relative to Congruent) trials; behavioral results confirmed this and groups did not differ. Psycho-physiological interaction analysis was conducted to identify connectivity with an amygdala seed region (based upon neutral>fixation contrast activation) during Congruent>Neutral and Incongruent>Congruent contrasts. Two-sample t-tests at $p<0.01$ (corrected) showed that during the Congruent>Neutral contrast (task-beneficial gaze processing), control subjects showed greater amygdala connectivity with the right STS, a region previously implicated in gaze processing, while ASD subjects showed greater amygdala connectivity with the ACC, a region previously implicated in interference control. During Incongruent>Congruent contrast (task-distracting gaze processing), amygdala connectivity with ACC was greater than controls; no regions showed greater connectivity in controls relative to ASD. Thus, amygdala connectivity was reduced with a region important for gaze-processing and increased with regions important for cognitive control in ASD children.

D58

THE INTERPLAY OF MOOD AND THE PROCESSING OF PSEUDOHOMOPHONES: EVIDENCE FROM N400 Constance Th.W.M. Vissers[1], Jos I. M. Egger[1,2,3], Dorothee J. Chwilla[2]; [1]Centre of Excellence for Neuropsychiatry, Vincent van Gogh Institute for Psychiatry, Venray, The Netherlands, [2]Donders Institute for Brain, Cognition and Behaviour, Centre for Cognition, Radboud Univeristy Nijmegen, The Netherlands, [3]Behavioural Science Institute, Radboud University Nijmegen, The Netherlands — Chwilla, Virgillito, and Vissers (in press) demonstrated that mood affects how we process meaning. In particular, we showed that the N400 cloze probability effect was reduced in a sad mood compared to a happy mood. In the present study we investigated the effects of mood on the processing of nonwords, in particular, of pseudohomophones. EEG was recorded while female participants read high-cloze sentences and low-cloze sentences in which the highly expected or unexpected word was substituted by a pseudohomophone which was phonologically identical to the (un)expected word ("In that library the pupils borrow bouks ..." vs. "The pillows are stuffed with bouks …'). Mood was manipulated by presenting short film clips that displayed fragments from a happy movie or a sad movie. The mood induction was succesful: Participants were happier after watching the happy film clips than after watching the sad film clips ($p < .01$). Mean N400 amplitude was significantly larger for the high-cloze than for the low-cloze sentences, indicating that an N400 cloze probability effect for the pseudohomophones was obtained. The cloze effect was widely distributed across the midline and the left and right hemisphere. Crucially, the N400 cloze effect for pseudohomophones was not modulated by mood. Separate analyses for the two mood conditions revealed an N400 cloze effect both for the happy and for the sad mood ($ps < .01$). Thus, while pseudohomophones elicit an N400 cloze effect the influence of a participant's mood is restricted to real words and does not occur for pseudohomophones.

D59

COGNITIVE REAPPRAISAL MODULATES EVENT-RELATED POTENTIALS AND EMOTIONAL MEMORY IN HEALTHY MEN AND WOMEN Hyeon Miin An[1], In Jae Hwang[1], Ji woon Jung[1], Kyung Hun Han[1], Hyun Taek Kim[1], Sang Hee Kim[1]; [1]Korea University — Cognitively reinterpreting emotional information has been known to modulate psychological and neural measures of emotional arousal and have effects on episodic memory. We attempted to investigate how cognitive emotion regulation would influence temporal unfolding of emotional processes using event- related potential (ERP) techniques and change subsequent emotional memory. Healthy men and women were recruited and completed an emotion regulation task which included reinterpreting emotional scenes to increase or decrease emotional responses while the electroencephalogram (EEG) was recorded from 14 cortical sites. Online changes of subjective feelings of emotional intensity and valence upon emotion regulation were recorded. Episodic memory for the pictures was measured using free recall and recognition tests with retention delay of 10 minutes and one week. The early posterior negativity (EPN) and late posterior potential (LPP) of ERP components were defined as the average ERP responses in the time windows of 200-300ms at O1 and O2, and 500-900ms at Pz, post-stimulus, respectively. Online ratings showed that, overall, reappraising to increase or decrease emotional reactions increased and decreased subjective feelings of arousal and valence. Overall, recall and recognition was enhanced for pictures presented during the increase condition than those presented during the decrease condition. Preliminary analyses on ERP data showed that both EPN and LPP were greater for pictures presented during the regulation conditions than those during the watch condition. Our results indicate that cognitive reappraisal of emotion influences both early and later stage of emotion processing and has modulatory effect on successful retrieval of emotional events.

D60

ASSESSING THE WAY PEOPLE LOOK TO JUDGE THEIR INTENTIONS J. Bruno Debruille[1], Mathieu Brodeur[1], Ursulla Hess[2]; [1]McGill University, [2]Humboldt University — Faces of unknown persons are processed to infer the intentions of these persons not only when they depict full-blown emotions, but also at rest, or when these faces do no signal any strong feelings. We explored the brain processes involved in these inferences to test whether they are similar to those found when judging full-blown emotions. We recorded the event-related brain potentials (ERPs) elicited by faces of unknown persons who, when they were photographed, were not asked to adopt any particular expression. During the ERP recording, participants had to decide whether each face appeared to be that of a positively, negatively, ambiguously or neutrally intentioned person. The early posterior negativity, the EPN, was found smaller for neutrally categorized faces than for the other faces, suggesting that the automatic processes it indexes are similar to those evoked by full-blown expressions and thus that these processes might be involved in the decoding of intentions. In contrast, in the same 200-400 ms time window, ERPs were not more negative at anterior sites for neutral faces. Second, the peaks of the late positive potentials (LPPs) maximal at parietal sites around 700 ms post-onset, were not significantly smaller for neutral faces. Third, the slow positive waves that followed the LPP were larger for faces that took more time to categorize, that is, for ambiguous faces. These three series of unexpected results may indicate processes similar to those triggered by full-blown emotions studies, but they question the characteristics of these processes.

D61

DEPRESSION IS ASSOCIATED WITH WEAK RIGHT AMYGDALA MODULATION DURING EMOTIONAL REAPPRAISAL Daniel Dillon[1,2], Randy Buckner[2,3,4], Sunny Dutra[5], Diego Pizzagalli[1,2]; [1]McLean Hospital, [2]Harvard Medical School, [3]Harvard University, [4]Athinoula A. Martinos Center, Massachusetts General Hospital, [5]Yale University — Major Depressive Disorder (MDD) is a significant public health problem, but the neurocognitive mechanisms implicated in MDD remain poorly understood. One hypothesis is that MDD attenuates emotional flexibility, truncating the range of emotional experience. This study investigated whether MDD compromises top-down control of emotions via reappraisal, and also examined effects of MDD on memory. During functional magnetic resonance imaging, depressed adults (n = 13) and controls (n = 24) reappraised their responses to negative and neutral pictures by using mental imagery to increase and decrease the pictures' personal relevance. Two weeks later, recognition memory was tested. Trial-by-trial valence ratings revealed that increasing and decreasing the personal relevance of negative pictures intensified and reduced negative emotional experience, respectively. Moreover, a [negative/increase – negative/decrease] contrast recruited brain regions associated with emotion regulation, self-referential processing, and mental imagery—namely, the rostral cingulate, medial prefrontal cortex, and bilateral parietal lobes. Negative emotion enhanced memory accuracy for pictures recognized with high confidence, but reappraisal did not affect memory. Surprisingly, depression did not influence these findings. However, there was a group difference in amygdala modulation by reappraisal. In controls, the [negative/increase – negative/decrease] comparison revealed right amygdala activation, but this effect was absent in the MDD group. Region-of-interest analyses revealed that this difference was restricted to negative trials, and was not observed when neutral pictures were reappraised. Finally, self-reported depressive symptoms correlated negatively with the degree of right amygdala modulation by reappraisal. These results suggest weak top-down amygdala modulation in MDD, which could contribute to emotional inflexibility.

D62

THE MODULATION OF EMOTIONAL CONTEXT ON THE ITEM-METHOD DIRECTED FORGETTING EFFECT: AN ERP STUDY Tzuling Liu[1], Daisy L. Hung[1], Ovid J.-L. Tzeng[1,2], Shih-kuen Cheng[1]; [1]Institute of Cognitive

Neuroscience, National Central University, Taiwan, [2]Institute of Linguistics, Academia Sinica, Taiwan — Emotionally valenced materials are in general better remembered and more resistant to intentional forgetting than neutral ones. It is however not clear whether emotional context modulates the mnemonic and intentional forgetting processes in the same way as emotional contents. The current study addressed this issue by examining the item-method directed forgetting effect for neutral words embedded in an emotional context. At study, a neutral or negative picture was presented and then a neutral word was superposed on the picture. Participants first made connections between the word and the picture. An R/F cue then appeared to designate the neutral word to be remembered or forgotten. At test, participants discriminated all studied words from unstudied new words. A reduced directed forgetting effect was found for items initially embedded in a negative context. The ERPs recorded at study showed a late positive complex for negative pictures. A P3b-like positivity was found for ERPs elicited by the R cues and this effect was reduced when the preceding study item was embedded in a negative context. In addition, a frontally distributed positivity was observed for F cues in a later time window. This frontally distributed positivity was also greater when the preceding study item was embedded in a negative context. These results suggest that a greater attentional resource might have been allocated to the negative context such that less effective mnemonic and intentional forgetting processes were engaged for items embedded in negative context.

D63

BRIEF MOTOR EXPERIENCE REVERSES VISUAL HEMIFIELD EFFECTS Geoffrey Brookshire[1], Daniel Casasanto[1,2,3]; [1]Max Planck Institute for Psycholinguistics, Nijmegen, [2]Donders Institute for Brain, Cognition, & Behaviour, Nijmegen, [3]The New School for Social Research, New York — For decades, visual hemifield (VHF) experiments have served as a behavioral window into hemispheric specialization. According to VHF studies of emotion in right-handers, the left hemisphere is specialized for positive and approach emotions, and the right hemisphere for negative and withdrawal emotions. VHF effects reverse in left-handers, suggesting a reversed hemispheric organization of emotion. However, recent studies reveal implicit associations between left-right space and emotional valence, calling these conclusions about hemispheric specialization into question. In right-handers, positive emotions are implicitly associated with the right side, the side on which they can act more fluently with their dominant hand, and negative emotions with the left side. In left-handers, associations between space and valence are reversed. Since VHF studies rely on lateralized stimulus presentation, emotional VHF effects could arise due to fluency-based space-valence associations: not to hemispheric specialization. Here we tested competing accounts of emotional VHF effects by training natural right-handers to be transiently left-handed. Participants categorized faces presented in the right or left VHF as positive or negative. In Experiment 1, untrained right-handers tended to judge neutral faces presented on the right as positive and on the left as negative. Untrained left-handers showed the opposite pattern. In Experiment 2, changes in motor fluency induced changes in right-handers' VHF effects. After motor training, right-handers categorized faces like natural left-handers. In light of these results, emotional VHF effects can no longer be interpreted as evidence for hemispheric specialization of emotions. Asymmetries in motor fluency can determine space-valence associations and reverse emotional VHF effects.

D64

RACIAL IDENTIFICATION MODULATES DEFAULT NETWORK ACTIVITY FOR SAME- AND OTHER-RACES Vani Mathur[1], Tokiko Harrada[2], Joan Chiao[1]; [1]Northwestern University, [2]Nagoya University — Racial identification shapes self-concept and how people interact with and interpret the social world around them. Prior neuroimaging studies have demonstrated the role of the neural default network in self-referential processing. However, how racial identification affects neural processing of social information remains unknown. Here we examined the effect of racial identification on neural response related to social perception among African American and Caucasian American individuals using functional magnetic resonance imaging. Our results demonstrate that degree of racial identification predicts activity within cortical midline structures of the default network in response to viewing racial ingroup, relative to outgroup members, and activity within the medial temporal lobe subsystem of the default network in response to viewing racial outgroup, relative to ingroup members. Broadly, our findings suggest that strength of racial identification is associated with differential recruitment of neural and cognitive processes to understand and respond to other people within and outside of one's racial group.

D65

THE ROLE OF INTRAPARIETAL SULCUS IN THE EMOTIONAL COST OF TEMPORAL ATTENTION Emma Ferneyhough[1], Caroline H. McClave[1], Elizabeth A. Phelps[1]; [1]New York University — The attentional blink (AB) task assesses the temporal limitations of attention. In a rapid visual serial presentation, identifying a target stimulus impairs identification of a second target stimulus that follows soon after (early lag), but not later (late lag). Emotion has been shown to influence temporal attention in two ways: 1) an emotional second target facilitates attention, and 2) an emotional first target impairs attention. Previous research has explored the neural systems of emotion's facilitation of temporal attention. The goal of the present study was to explore the neural systems linked to the emotional cost of temporal attention. While the intraparietal sulcus (IPS) has been implicated in spatial attention costs observed with emotion, the present task explores the role of IPS in emotional costs of temporal attention. We recruited 15 participants for an AB task in which emotional or neutral distracter words appeared 3, 4, 7 or 8 lags prior to a single neutral target. Lags 3 and 4 were within the AB window (270, 360ms respectively) whereas lags 7 and 8 appeared outside (630, 720ms respectively). Participants provided self-report trait anxiety measures. Consistent with prior research, trait anxiety correlated with fronto-parietal networks implicated in attention capture by emotion, indicating that high-trait anxious individuals may be more susceptible to emotional costs. Moreover, we observed differential activation in the IPS for early lags in the emotion compared to neutral condition. Thus, IPS may play a role in attentional costs with emotion, not only in spatial, but also temporal domains.

D66

EFFECTS OF COGNITIVE APPRAISAL AND ACTION MODALITY ON EMOTIONAL PROCESSING OF INFORMATION: AN ERP STUDY IN VIDEO GAME PLAYERS Aurélie Campagne[1], Nicolas Mathieu[1], Benoit Fradcourt[1]; [1]Psychology and Neurocognition Laboratory, CNRS, Université Pierre Mendès France, Grenoble, France — Our study aimed to determinate the evoked response potentials (ERP) underlying the influence of cognitive appraisal and action modality on emotional processing of information in video game players. Thirteen video games players and eleven non-players visualized emotionally positive and negative natural scenes and carried out six tasks in which modalities of the following variables were crossed: cognitive appraisal (perception / affective categorisation), motor emotional categorisation (random / emotional motor categorization) and action modality (button / joystick). Our study revealed higher amplitudes of visual components P1 and N1, a higher latency of N1 and a lower amplitude and a shorter latency of the P2 component during cognitive appraisal of negative situations essentially. These results suggest that categorisation tasks involve an increased attentional cost, selective attention, effortful processing and increased attentiveness. Players showed lower amplitudes of N70, N1 and P2 and a shorter latency of N1 comparatively to non-players. The attenuation of N70 and N1 latency may reflect structural encoding and broader and coarser processing of images in players. However, an early effect of action modality was observed with a higher N70 for the joystick, particularly in players. The reduction of N1 and P2 suggest an increased and shared attentiveness which will be equivalent between the perception task and categorisation in players as evidenced by the N1 delay observed between these tasks.

D68

INTENSITY OF NEGATIVE EMOTION PREDICTS SELF-REGULATORY SKILLS IN DREAMING (BUT NOT WAKING) Tracey Kahan[1], Kelly Bulkeley[2], Nader Kawadri[1]; [1]Santa Clara University, [2]Graduate Theological Union — Some theorists claim that dreaming serves to regulate emotion (e.g., Kramer, 1991). We tested two hypotheses derived from this claim. First, dream experiences should be rated as more emotionally intense than comparably sampled waking experiences (Hyp 1). Second, the relationship between emotion, self-monitoring, and self-regulation should be stronger for dreaming than for waking experiences)(Hyp 2). Parallel samples of dreaming and waking were obtained via experimental interruptions of late-night sleep and ongoing waking experience. Participants rated the subjective qualities of these experiences via two questionnaires used in prior research (Kahan, 1994; Kahan & LaBerge, 1996; 2010). Contrary to Hyp 1, M ratings of emotional intensity for dreaming and waking experiences did not differ statistically. Further, participants gave higher ratings to positive emotions than negative emotions. However, a statistically significant interaction revealed that dreaming experiences were rated as less positive and more negative than waking experiences, $F(1, 169) = 74.61$, $MSE = .66$, $p < .001$. To test Hyp 2, we computed the correlations (Pearson's r) between participants' ratings of positive and negative emotions and self-regulation (reported monitoring of one's reactions, monitoring of the external environment, and self-regulation of thought or behavior). Consistent with Hyp 2, the reported intensity of negative emotion in dreaming was strongly related to all three self-regulatory activities; no such relationship was observed for waking experiences. Thus, although dreaming may not involve generally heightened emotional activation, there may be a stronger relationship between (negative) affect and the cognitive skills involved in self-regulation in dreaming than in waking.

D69

MUSIC, AROUSAL, AND SPATIAL MEMORY: AN INVESTIGATION USING EEG Branden Kolarik[1], Geisler Mark[1], Propper Ruth[2], Lester Ken[1]; [1]San Francisco State University, [2]Montclair State University — Previous research suggests that music can be effective in influencing arousal levels (Rickard, 2004; Lundqvist et al., 2009). In addition, Brunye et al., 2009; Gable & Harmon-Jones, 2010 have shown that arousal levels can modulate spatial memory. This study investigates the role arousal plays in the construction and maintenance of spatial memory using music as a means of arousal manipulation while recording Electroencephalography (EEG) from front right (F4) and front left (F3) recording sites as well as recording Skin Conductance Responses (SCR) and Heart Rate (HR). 15 participants listened to two 2-minute music clips, one rated high and one rated low arousing before memorizing a rudimentary map. Participants later responded to questions about the relative locations of landmarks on the map. The question types were either short, medium, or long inter-landmark distances. EEG (Global, Alpha and Beta Power), SCR, and HR were recorded throughout. Given the previous findings, we hypothesized that music type would influence the amount of short or long distance questions answered correctly, in that following high arousal, more long distance questions would be answered correctly. Conversely, following the low arousal song, more short distance relations should be remembered. Preliminary analyses show an effect of music type on the number of long and short distance questions answered correctly, as well as a main effect of music type on EEG Power. We also show that increases in the differences in hemispheric EEG Power and increases in SCR and HR were positively correlated with participants subjective ratings of arousal level.

D70

CONTROL OF NUCLEUS ACCUMBENS ACTIVITY WITH NEUROFEEDBACK Andrew Trujillo[1], Stephanie Greer[2], Brian Knutson; [1]Stanford University, [2]University of California, Berkeley, [3]Stanford University — Functional magnetic resonance imaging (FMRI) not only allows investigators to visualize neural activity on the temporal scale of seconds and a spatial scale of milliseconds, but also allows presentation of this information to subjects. FMRI studies have implicated the nucleus accumbens (NAcc) in the anticipation of diverse rewards and the experience of positive and aroused affect (Knutson et al., 2001). We sought to determine whether subjects (n=24) could use affect-based mental strategies in the context of neurofeedback to modulate their NAcc activity. In the task, subjects were asked to develop mental strategies to increase and decrease positive arousal. During FMRI scanning, subjects were then cued to either increase or decrease their NAcc activation. On-line algorithms presented the dynamic NAcc signal to the subjects as they implemented their strategies. Subjects were able to use neurofeedback to significantly increase and decrease NAcc activation. Additional analyses suggested that control diminished in the absence of feedback, and that the most robust modulation occurred during the first few seconds of cue presentation. Functional connectivity analyses suggested that medial prefrontal cortex recruitment correlated with successful NAcc neurofeedback-based modulation. In addition to supporting an anticipatory affect account of NAcc activity, these findings suggest that humans can use FMRI-based neurofeedback to control NAcc activity.

D71

ACUTE STRESS AND ERP CORRELATES OF ATTENTION TO ALCOHOL IMAGES IN SOCIAL DRINKERS Reiko Graham[1], Ryan Giuliano[2], Laura Kaufman[1], Nicole Wicha[2], Natalie Ceballos[1]; [1]Texas State University, [2]University of Texas – San Antonio — This study examined the effects of acute stress on event-related potentials (ERPs) to images of alcohol and objects using a 3-stimulus oddball paradigm. Seventy-five participants were assigned to either an alcohol- or object-target condition while ERPs were measured before and after an acute stressor or control task. Separate analyses were conducted on the peak latencies and amplitudes of the P2, N2 and P3. Results indicated that stress significantly decreased the latencies of the N2 and P3, whereas P2 latency was not moderated by stress. Notably, stress related decreases in P3 latency were observed for both object and alcohol targets, as well as alcohol non-targets. Amplitudes of the P2 were larger for alcohol images and were enhanced for all image types after the stressor. P2/N2 amplitude changes were not sensitive to image type, but were enhanced after the stressor. N2/P3 amplitudes were not sensitive to stress, but were enhanced to alcohol images, especially after repetition. In summary, P2 amplitudes were enhanced by stress and motivational significance independently, whereas changes in N2 latencies and amplitudes were primarily stress-related. P3 latencies were shorter to targets and nontarget alcohol images after stress; amplitudes of the P3 were not sensitive to stress, but were enhanced by alcohol images and object targets. These findings suggest that stress may influence the early stages of alcohol-related processing, an effect that may be particularly apparent in ERP latencies. P3 amplitude, associated with controlled processing, was resistant to stress and may represent a trait response to addiction-related stimuli.

D72

EMOTION REGULATION OF TOP-DOWN AND BOTTOM-UP GENERATED EMOTIONS Kateri McRae[1], Supriya Misra[2], Aditya K. Prasad[2], Sean C. Pereira[2], James J. Gross[2]; [1]The University of Denver, [2]Stanford University — Current theories of emotion suggest that emotions may be generated by the perception of low-level features of the stimulus itself (e.g., properties of the eyes in an emotional face) or the appraisal of the meaning of a stimulus considering the larger context within which an individual is operating (e.g., knowledge that a neutral face hides disappointment). The present study examined the effects of cognitive reappraisal when performed upon emotions generated in these two ways. Twenty-four women were scanned on a 3-Tesla GE magnet while viewing top-down and bottom-up emotional stimuli under instructions to respond naturally or to use cognitive reappraisal to decrease negative affect. Previously reported self-report and amygdala data indicate that reappraisal is more effective for top-down generated emotions, and may result in paradoxical increases in amygdala activation for bottom-up generated emotions. During reappraisal, medial prefrontal regions showed greater activation during natural responding to top-down generated emotions

and during reappraisal of both top-down and bottom-up generated emotions, but were not recruited during bottom-up emotion generation. In addition, the reappraisal of top-down generated emotions resulted in greater activation in the left lateral prefrontal cortex and the caudate/ventral striatum than the reappraisal of bottom-up generated emotions. Reappraisal of bottom-up generated emotions recruited more right lateral prefrontal cortex activation and resulted in greater down-regulation of the insula and visual cortex than the reappraisal of top-down generated emotions. Taken together, this implies that the different cognitive processes (and potentially specific strategies) are engaged during the reappraisal of top-down and bottom-up generated emotions.

D73

NEUROBIOLOGIC CORRELATES OF HYPERAROUSAL IN PATIENTS WITH GULF WAR ILLNESSES Gail Tillman[1], Clifford Calley[1], Timothy Green[1], Virginia Buhl[1], Melanie Biggs[2], Jeffrey Spence[2], Richard Briggs[2], Robert Haley[2], John Hart[1,2], Michael Kraut[1,3]; [1]University of Texas at Dallas, [2]University of Texas Southwestern Medical Center, [3]Johns Hopkins School of Medicine — Many veterans returned from the 1991 Persian Gulf War with symptom complexes that have been referred to as Gulf War Illness. While many have attributed these symptoms to postwar stress, other studies have attributed the psychological, somatic, and cognitive symptoms to the results of deployment-related exposures. An exaggerated response to emotional stimuli is widely reported by returning Gulf War Veterans. Such hyperarousability is not only a principal marker of PTSD but is also observed among individuals with disorders such as obsessive-compulsive disorder, schizophrenia, and depression, as well as among those with traumatic brain injuries. In order to assess the hyperarousal symptom of Gulf War Illness, we analyzed event-related potential data of 30 Gulf War veterans, some of whom met Haley criteria for syndromes of Gulf War Illness, collected during their performance of visual and auditory three-condition oddball tasks where threatening stimuli were the novel probes. Reported hyperarousal of the ill veterans was significantly greater than that of the control veterans, but different ERP profiles emerged to explain hyperarousability in the different syndromes. Relative to controls, Syndromes 2 and 3 showed significantly higher early components, purported to indicate compromised inhibitory gating, and Syndromes 1 and 2 showed higher responses to task-irrelevant novel threatening stimuli (P3a) than to the task-relevant target stimuli (P3b), purported to indicate dysfunctional attentional control.

D74

IT'S ALL ABOUT YOU: AN ERP STUDY OF THE INTERACTION OF SELF-RELEVANCE AND EMOTIONAL VALENCE IN DISCOURSE Eric C. Fields[1,2], Wonja M. Fairbrother[1], Gina R. Kuperberg[1,2]; [1]Tufts University, [2]Massachusetts General Hospital — Accurately communicating self-relevant and emotional information is a vital function of language. Despite this, we have little idea about how these factors impact normal discourse comprehension, either independently or in combination. In an event related potential (ERP) study, we fully crossed self-relevance and emotional valence in a discourse context. Two-sentence scenarios were either in 3rd or 2nd person (previous work has shown grammatical person modulates the perspective from which mental models are built; Brunyé et al., 2009). A critical word toward the end of the second sentence was pleasant, neutral, or unpleasant, e.g., "A man knocks on Sandra's/your hotel room door. She/You see that he has a gift/tray/gun in his hand". ERPs recorded on this critical word showed a larger P2 in self-relevant than non-self-relevant scenarios, suggesting that, regardless of emotional valence, self-relevant discourse can enhance attention to words during early stages of processing. In addition, unpleasant words evoked a larger Late Positivity than pleasant or neutral words, indicating that, regardless of self-relevance, negatively valenced words can capture attention and trigger additional analysis at post-lexical stages of processing. Finally, self-relevance and valence interacted on the Late Positivity: whereas a larger Late Positivity was evoked by neutral words in self-relevant than non-self-relevant scenarios, no such effect of self-relevance was seen on pleasant or unpleasant words. This suggests that self-relevance can lead to further attentional allocation and additional analysis at post-lexical stages of processing, but only when such resources have not already been captured by emotional valence.

D75

PROSODIC EMOTION RECOGNITION DEFICITS AND DECREASED FUNCTIONAL CONNECTIVITY IN PARKINSON'S DISEASE Maria Ventura[1], Sarah Acklin[1], Masih Qawam[1], Kim Russo[1], Karen Sigvardt[1], Heidi Kirsch[2], Elizabeth Disbrow[1,2]; [1]University of California, Davis, [2]University of California, San Francisco — While Parkinson's disease (PD) is traditionally described as a movement disorder, there is increasing evidence of social cognitive dysfunction in PD. We studied facial and prosodic emotion recognition in PD, administering the Comprehensive Affect Testing System (CATS) to 16 medicated PD subjects (9M, 7F) and 18 age-matched controls (7M, 11F). CATS is a computer based button press task with eight subtests. In prosodic subtests, participants hear a series of sentences and identify the emotion conveyed in the tone of voice (i.e. happy, sad, angry, frightened, neutral). Magnetoencephalography (MEG) resting state data was also collected from 15 PD subjects and 14 controls to assess alpha band (8-12Hz) coherence. CATS data revealed that PD subjects had specific impairment in prosodic emotion recognition. When divided into left-side (of body) (N=8) vs. right-side (N=8) disease severity dominant, subjects with left-side dominant PD showed deficits in subtests Name Emotional Prosody (p=.05) and Conflicting Prosody and Meaning (p=.03). MEG data revealed that PD subjects had significantly decreased functional connectivity compared to controls in regions involved with emotion processing: anterior insula, Brodmann area (BA) 13 (p=.04), anterior cingulate BA 24 & 25 (p=.001), and BA 32 (p=3.1E-07). Furthermore, when divided into left vs. right-side dominant PD, subjects with left-side dominant PD (N=7) showed significantly decreased functional connectivity in superior temporal gyrus BA22 (p=.04), BA13 (p=.02), and BA 24 & 25 (p=.03) compared to right-side dominant PD (N=8). Our findings suggest that disruption of BG-thalamocortical loops results in changes in perception of emotional prosody.

D76

PRIMING AND PROSODY: INTERACTIONS BETWEEN VISUAL PRIMING, SYMPATHETIC NERVOUS SYSTEM AROUSAL AND INTERPRETATION OF SPEECH SOUNDS Joshua Downer[1]; [1]University of California, Davis — Is the interpretation of emotional prosody modified by differences in one's visual environment? And, if so, to what extent are these modifications related to the activity of the autonomic nervous system? The present study examines the dynamic nature of this modality of nonverbal communication. University undergraduates (n = 30) were asked to interpret the intended meanings of hundreds of nonsense utterances based on the inflection and intonation of the speaker's voice. The utterances expressed 12 intended meanings - anger, disgust, empathy, fear, forgiveness, happiness, pride, questioning, relief, sadness, shame and surprise. Participants were exposed to and interviewed about these utterances in both of two priming conditions - one in which the visual presentation of a neutral face (33ms) directly preceded the utterance and one in which a fearful face preceded the utterance (also 33ms). Recordings were made of the participants' physiological responses during testing. Significant main effects were found for intended meaning and visual stimulus condition; there was also an interaction between the two factors. Physiological data was used to calculate sympathovagal balance (SVB), and was then correlated with the data from the interpretation task; significant associations were found between measures of SVB and response behavior.

D77

NEURAL PROCESSING ASSOCIATED WITH COGNITIVE AND AFFECTIVE THEORY OF MIND IN ADOLESCENTS AND ADULTS Catherine Sebastian[1], Nathalie Fontaine[2], Geoffrey Bird[1,3], Sarah-Jayne Blakemore[1], Stephane De

Brito[1], Eamon McCrory[1], Essi Viding[1]; [1]University College London, [2]Indiana University, [3]Birkbeck College — Theory of Mind (ToM) is the ability to attribute thoughts, intentions and beliefs to others. This involves component processes, including cognitive perspective taking (cognitive ToM) and understanding emotions (affective ToM). This study assessed the distinction and overlap of neural processes involved in these respective components, and also investigated their development between adolescence and adulthood. While data suggest that ToM develops between adolescence and adulthood, these populations have not been compared on cognitive and affective ToM domains. Using fMRI with 15 adolescent (aged 11-16) and 15 adult (aged 24-40) males, we assessed neural responses during cartoon vignettes requiring cognitive ToM, affective ToM, or physical causality comprehension (control). An additional aim was to explore relationships between fMRI data and self-reported empathy. Both cognitive and affective ToM conditions were associated with neural responses in the classic ToM network across both groups, although only affective ToM recruited medial/ventromedial PFC (mPFC/vmPFC). Adolescents additionally activated vmPFC more than did adults during affective ToM. The specificity of the mPFC/vmPFC response during affective ToM supports evidence from lesion studies suggesting that vmPFC may integrate affective information during ToM. Furthermore, the differential neural response in vmPFC between adult and adolescent groups indicates developmental changes in affective ToM processing.

D78

EXPECTED REWARD MODULATES PRESTIMULUS ENCODING-RELATED THETA ACTIVITY Matthias Gruber[1], Andrew Watrous[2], Charan Ranganath[2], Arne Ekstrom[2], Leun Otten[1]; [1]University College London, [2]University of California, Davis — Oscillatory brain activity in the theta frequency range (4-8 Hz) is thought to play a pivotal role in memory encoding. Recent findings indicate that theta activity before the onset of an item can influence the likelihood of successful encoding. Here, we used electroencephalography (EEG) to test whether theta activity can be engaged dynamically to promote verbal memory encoding. Two experiments were performed in which participants intentionally encoded a series of words. Each word was preceded by a cue that indicated the amount of money that would be earned if the word were successfully remembered in a later recognition test. Each word also required an alphabetic judgment to ensure equal attention to all words during encoding. Low and high reward cues were intermixed in Experiment 1, while only high reward cues were presented in Experiment 2. In Experiment 1, prestimulus theta activity at frontal scalp sites was sensitive to reward amount, predicting later memory performance only in the high reward condition. In Experiment 2, theta activity was related to the extent to which participants allocated sufficient cognitive resources toward encoding of the items. Encoding-related prestimulus activity was inversely related to accuracy on the concurrent alphabetic task. These findings are consistent with the idea that theta activity plays a dynamic, voluntary role in memory encoding. Engaging such activity may depend on the degree to which encoding is emphasized.

D79

FUNCTIONAL PARCELLATION OF THE HUMAN RIGHT INSULA USING RESTING STATE FMRI Luke Chang[1], Mel Win Khaw[2], Alan Sanfe[1,3]; [1]University of Arizona, [2]Duke University, [3]Donders Institute for Brain, Cognition and Behavior, Radboud University — While the insula has been implicated in a number of disparate functions including interoception, affect, pain, empathy, and error processing, there have been only a handful of meta-analyses examining whether these functions localize to specific insular subregions. We predicted that these subregions should be differentially connected with the rest of the brain based on their purported functions. Importantly, we hypothesized that these functional networks should be evident even when the specific function is not being directly experimentally induced. To test this hypothesis, we used an unsupervised clustering algorithm to anatomically parcellate the insula based on shared patterns of connectivity across the brain while participants were at "rest". We then used a multi-level multiple regression approach to isolate the networks that were independently functionally coupled to each subregion and spatially consistent across participants. Our data-driven procedure revealed three distinct regions that were spatially consistent with the cytoarchitectural divisions and anatomical tracings reported in primates as well as recent meta-analyses of the function of the insula. Moreover, these subregions were coupled to networks that are consistent with their purported function. For example, the ventroanterior insula was functionally connected to limbic areas, the dorsoanterior insula was connected to cognitive regions, and the posterior insula was connected to somatosensory/motor areas. These results suggest that the insula is indeed functionally subdivided into at least three distinct regions and plays an integral role in the integration of emotional, sensory, and cognitive information.

D80

WHITE AND GREY MATTER VOLUMES CORRELATE WITH DELAY DISCOUNTING: A VOXEL-BASED MORPHOMETRY STUDY Rongjun Yu[1], Dean Mobbs[1], Elisabeth A. H. von dem Hagen[1], Andrew J Calder[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK — A preference for immediate gratification or inability to delay reward is a central feature in addictive processes. However, the neural structures underlying reward delay tolerance are still unclear. Healthy participants (n=121) completed a delay discounting questionnaire assessing the extent to which they prefer smaller immediate rewards to larger delayed reward after undergoing magnetic resonance imaging (MRI) scanning. Whole brain voxel-based morphometry analysis shows that delay discounting rates were negatively correlated with white matter volume in frontal cortex and positively correlated with white matter volume in hippocampus. Our study provides further evidence that individual differences in delay discounting are associated with the volume of specific brain structures. It highlights the possibility that our ability to tolerant reward delay may be associated with brain regions implicated in executive control and temporal estimation. This study might better our understanding of the neural basis of impulsivity and addiction.

D81

ERP EVIDENCE FOR VERY EARLY GATING OF FACIAL EXPRESSION PROCESSING BY SUSTAINED ATTENTION David J Acunzo[1], Graham MacKenzie[1], Mark van Rossum[1]; [1]University of Edinburgh — The first visual event-related potential (ERP) component C1 (50-100 ms post-stimulus onset) has recently been reported to be sensitive to emotional stimuli as well as sustained attention. In particular, some results suggest that emotional faces generate an increase in the amplitude of C1, compared with neutral faces. Here we present two ERP studies investigating the effects of fearful faces on C1 amplitude. In both experiments, participants stared at a fixation point while faces were presented in the upper left or right hemifield. In experiment 1, a central cue pointing left or right preceded the display of fearful, neutral and happy faces; participants were instructed to detect happy faces at the cued location (valid trials) by a button-press. In experiment 2, participants had to detect a change of colour of the fixation point while neutral and fearful faces were presented upright or inverted. In experiment 1, we found a significant main effect of emotion ($p < 0.01$) on C1 amplitude, but no effect of validity; however, we found a significant modulation by emotion for valid, but not for invalid trials. In experiment 2, no modulation of C1 amplitude by emotion was found for either upright or inverted faces. Our results confirm that facial expression can modulate C1 amplitude, but suggest that if attention is drawn away from the facial stimuli, this modulation disappears. This study provides evidence for a very early gating of facial expression processing by sustained attention.

D82

EFFECTS OF STRESS INDUCTION ON FUNCTIONAL BRAIN CONNECTIVITY IN OBSESSIVE-COMPULSIVE DISORDER ASSESSED BY WAVELET-BASED CORRELATIONS Hamdi Eryilmaz[1,4], Martin Desseilles[1,2,3], Pierre Maquet[2], Dimitri Van De Ville[1,4], Sophie Schwartz[1,4]; [1]Department of Neuroscience, University of Geneva, Geneva, Switzerland, [2]Cyclotron Research Centre, University of Liège, Belgium, [3]Depression Clinical and Research Program, Massachusetts General Hospital, Harvard Medical School, [4]Geneva Neuroscience Center, University of Geneva, Switzerland — Spontaneous patterns of functional brain connectivity during resting are altered in neurological and psychiatric diseases. Here we studied how resting network connectivity differs between obsessive-compulsive disorder (OCD) patients and healthy controls, and how it is modulated by stress induction. We acquired functional MRI (fMRI) data during a 'classical' resting state condition and when resting state was associated with stress induction. First we determined regions of interest (ROIs) using independent component analysis (ICA). We then used wavelet-based correlations to assess functional connectivity between these regions for slow and fast frequency ranges of fMRI signal. Bootstrapping statistics revealed distinct networks between groups (OCD vs controls) and conditions (resting state vs induction). During resting state, OCD patients (vs controls) showed increased connectivity between striatum, ventro-medial prefrontal cortex (VMPFC), and insular regions, selectively for fast oscillations (0.14-0.28 Hz). By contrast, at slow oscillations (0.02-0.04 Hz), controls (vs patients) showed increased connectivity in the default-mode network. Stress induction enhanced connectivity between the caudate, insula and ACC in OCD patients, while connectivity within a network encompassing VMPFC and nucleus accumbens was strengthened in the controls. These effects were found for fast oscillations of fMRI signal. This pattern of results suggests that the pathophysiology of OCD may involve disturbances across multilayered neural networks oscillating at different frequencies that are related to motivation and the regulation of internal states (providing an increased emotional vulnerability to patients). Such disturbances were partially mimicked by a stress induction procedure in the controls, providing neural evidence for increased stress-eliciting thoughts in OCD.

D83

NATURE, DEPRESSION AND WORRY Marc Berman[1], Mary K. Askren[1], Aleah Burson[1], Ethan Kross[1], Stephen Kaplan[1], Alexa Erickson[1], Catherine Cherny[1], Patricia J. Deldin[1], Lindsey Sherdell[2], Ian H. Gotlib[2], John Jonides[1]; [1]The University of Michigan, [2]Stanford University — Depression is characterized by rumination and worry about one's symptoms and life distress. Although there have been important advances in the treatment of depression, e.g., cognitive behavioral therapy (CBT), many depressed individuals do not have the resources to obtain treatment. Investigators have begun to examine how interacting with nature (e.g., walking in a park) can improve cognitive functioning. In the present study we explored whether interacting with nature may benefit participants diagnosed with Major Depressive Disorder (MDD). Ten healthy control (HC) participants and ten participants experiencing MDD participated in our study. We assessed participants' mood and working memory spans, and they then recalled a negative memory. Participants then walked for 50 minutes either in the Ann Arbor Arboretum (a natural setting) or in downtown Ann Arbor (an urban setting). Participants returned from their walk and we assessed their mood and working memory spans again. Participants returned to the lab one week later and repeated the same procedure, but walked in the other location. Both groups improved their memory spans more when walking in nature vs. in the urban setting, but the effect was stronger for the MDD participants. In addition, although both groups showed reductions in worry when walking MDDs showed larger decreases in worry especially when walking in the nature setting vs. the urban setting. Moreover, improvement in working memory span was correlated with decreases in worry. These results indicate that interacting with nature may be a therapeutic intervention for individuals suffering from MDD.

D84

EFFECT OF STRESS AND GENETICS ON FUNCTIONAL CONNECTIVITY IN FMRI John P. Hegarty II[1], Brad Ferguson[1], Ana Hartman[1], Jesse R. Day[1], Karen L. Jones[1], Shawn Christ[1], Michael Tilley[2], Stephen Kanne[1], David Q. Beversdorf[1]; [1]University of Missouri, Columbia, [2]Central Methodist University — Psychological stress has a significant impact on health, and stress also affects cognitive performance, which appears to be mediated by the noradrenergic system. Our previous work demonstrated that drugs affecting the noradrenergic system influence functional connectivity, and we wish to determine how stress may affect these networks and how this influence may be altered based on genetics. The first step in this line of research is to determine how stress affects these networks. Functional magnetic resonance imaging (fMRI) was utilized, and functional connectivity was assessed during tasks with and without stressors. Testing consisted of administration of semantic categorization tasks across two separate scan sessions: one in which subjects were given the Montreal Imaging Stress Task (MIST) and another scan that served as a control. Preliminary results reveal a main effect of decreased functional connectivity across all language network system ROI pairs during stress as compared to no stress. Regions of interest were localized to the fusiform gyrus, middle temporal gyrus, inferior frontal gyrus, and parietal cortex. These findings begin to reveal how stress impacts cognitive performance on tasks involving the language networks, and show that stress influences the activity pattern of functionally associated brain regions. Further study of the interaction between this finding and genes that influence stress reactivity, such as the SLC6A4 gene which is involved with the expression and function of the serotonin transporter (5-HTT), is warranted.

D85

DEVELOPMENT OF A NOVEL EXECUTIVE CONTROL TASK TO INVESTIGATE COGNITIVE CONTROL OVER WORRY Lauren Hallion[1], Amishi Jha[2]; [1]University of Pennsylvania, [2]University of Miami — Uncontrollable anxious thought is a central feature of many anxiety disorders. However, little is known about the prefrontal executive control processes (ECPs) that underlie the ability to control worry and other anxious thoughts. Identifying the cognitive underpinnings of control over worry is an important step toward explaining why some individuals suffer from uncontrollable worry. The aims of the present study were to: 1) develop the Working memory, Inhibition, and Switching Task (WIST), a continuous performance task that simultaneously assesses these three ECPs hypothesized to be involved in emotion regulation; 2) investigate the role of these ECPs in control over worry; and 3) explore the relationship between trait worry and ECP use. In the WIST, participants must maintain and update representations of recently presented stimuli (WM); inhibit prepotent responses (Inhibition); and periodically change the stimuli to which they respond (Switching). Each ECP is assessed under high and low demand conditions. Healthy undergraduates (N=47) completed the WIST while controlling worry and neutral thought (counterbalanced). Patterns of performance on the WIST were comparable to established assessments of each ECP, with higher demands associated with lower accuracy. The accuracy efficiencies for each ECP were uncorrelated, suggesting independence. Worry was associated with slower reaction times (RTs). Higher levels of trait worry were unrelated to WM and Switching but were associated with slower RTs during high Inhibition demand. These findings suggest that the WIST is a viable method of simultaneously assessing these ECPs, and that induced and high trait worry place a substantial demand on ECPs.

D86

THE EFFECTS OF PHYSICAL DISTINCTIVENESS AND EMOTIONAL DISTINCTIVENESS ON RECALL – A SUBSEQUENT MEMORY STUDY Siri-Maria Kamp[1], Ashley Gruber[1], Nasreen Sadeq[1], Glen Forester[1], Emanuel Donchin[1]; [1]University of South Florida — Von Restorff (1933) showed that physically distinct words ("isolates") are better recalled. Isolates also elicit a P300. It has been demonstrated (Karis et al. 1984) that the amplitude of the P300 is correlated with subsequent recall when the participant uses rote memory, rather than elaborative memorization strategies. We investigated whether isolation due to emotional content will display a similar "subsequent memory effect". In experiment 1, participants studied lists of positive words, lists of negative words, and neutral word lists. In different neutral lists we embedded physical, positive, or negative isolates. Recall was tested immediately after the presentation of each list. For physical isolates and negative emotional isolates, recall was enhanced. Furthermore, physical isolates and negative isolates both elicited a P300. In experiment 2, study lists included only neutral words and one negative isolate. For a cluster of participants who better recalled the negative isolates, the isolates elicited a centro-parietal P300. For these participants, negative isolates that elicited a larger P300 were less likely to be recalled than isolates eliciting a smaller P300. This pattern is the reverse of the previously reported P300 subsequent memory effect for physically isolated items. Across participants, the amplitude of an additional, parieto-occipital positivity elicited by negative isolates was negatively correlated with subsequent recall of all words in the middle serial positions of the same list. Based on these results, the cognitive mechanisms that lead to the enhancing effects of physical isolation and isolation due to negative emotional content on recall appear to be different.

D87

WINNERS TAKE MORE, LOSERS TAKE LESS: EMOTIONALLY AROUSING SOUNDS AMPLIFY DIFFERENCES IN PERCEPTUAL SALIENCE AMONG COMPETING VISUAL STIMULI Matthew Sutherland[1], Mara Mather[1,2]; [1]University of Southern California, Department of Psychology, [2]The USC Davis School of Gerontology — In two experiments, 150 participants (ages 18-30) performed a visual identification task to test the hypothesis that emotional arousal increases attention to high priority visual stimuli and inhibits attention to low priority visual stimuli. In each trial a circular array of letters was briefly presented following exposure to negative arousing or neutral sounds. Contrast level was manipulated to make some letters higher in priority. Emotionally arousing sounds increased identification rates for high contrast (dark grey) letters and decreased identification rates for low contrast (light grey) letters. Manipulating the time between a sound and the subsequent letter display revealed that arousal increased the salience of high contrast letters and decreased the salience of low contrast letters in the first 3000 milliseconds after the sound, but not after that critical period. These findings support our arousal-biased competition hypothesis (Mather & Sutherland, in press), which predicts that emotional arousal acts to amplify biased competition processes in selective attention, producing a "winner-take-more loser-take-less" effect when processing competing stimuli.

D88

GENDER DIFFERENCES IN THE ALLOCATION OF ATTENTION TO NEGATIVE STIMULI ARE NOT ANXIETY DRIVEN - ELECTROPHYSIOLOGICAL EVIDENCE Johanna Simpson[1], Stephen M. Lawrie[2], Jeremy Hall[2], David I. Donaldson[1]; [1]Psychological Imaging Laboratory, University of Stirling, Stirling, United Kingdom, [2]Division of Psychiatry, University of Edinburgh, Edinburgh, United Kingdom — There is considerable behavioural and brain imaging evidence for a difference in affective processing between the genders. Females are, compared to males, more accurate at labeling negative facial expressions and show more anterior and medial cingulated gyrus activation in response to negative pictures. We have previously demonstrated gender differences in the neural correlates of affective picture processing using ERPs (Event-Related Potentials). Specifically, women (but not men) exhibit greater sustained attention to negative than positive stimuli, as indexed by the LPP (Late-Positive Potential; a long lasting centro-parietal positivity starting at 400ms post stimulus onset). , This pattern of 'attending to the negative' is also seen in participants with higher levels of trait anxiety however, suggesting that putative gender differences could simply reflect underlying differences in anxiety between the genders. To rule out this potential confound we assessed anxiety in 24 participants (12 female), allowing us to examine gender differences whilst matching for anxiety. EEG was recorded while participants viewed 222 pictures from the International Affective Picture System (IAPS), including 74 highly arousing negative, 74 highly arousing positive and 74 low arousing neutral according to IAPS standard ratings. As previously demonstrated, we found that negative images elicited significantly larger LPPs in females than males, while LPP amplitudes did not differ between the genders for neutral or positive images. Importantly, because the genders did not differ in anxiety, our results suggest a genuine gender difference in affective picture processing beyond simple differences in anxiety.

D89

LOOK AWAY: THE RELATIONSHIP BETWEEN THE CATECHOL-O-METHYLTRANSFERASE VAL158MET GENOTYPE AND VALENCE IN SPATIAL DISENGAGEMENT PROCESSES Kathrin Gschwendtner[1], Andreas Reif[1], Andreas Mühlberger[2], Andrea Kübler[2], Claudia Sommer[1], Martin J. Herrmann[1]; [1]University Hospital of Wuerzburg, [2]University of Wuerzburg — Catechol-O-Methyltransferase (COMT) is an enzyme, which degrades dopamine, epinephrine and norepinephrine. A single nucleotide polymorphism in the COMT gene leads to a substitution of methionine for valine at the codon 158 which results in a more thermolabile enzyme. An ERP-study showed that methionine carriers have a higher Early Posterior Negativity (EPN) for negative pictures. Since this EPN indexes an attentional bias we hypothesized that methionine carriers disengage slower from negative pictures using spatial disengagement as behavioural operationalisation of the attentional bias. In a forced disengagement eye-tracking task emotional pictures were shown to 43 participants stratified for the COMT-Val158Met-Polymorphism. The time period until the subjects had to disengage was varied. Contrary to the postulated hypothesis an u-shaped relation between the polymorphism and the latency of the disengagement movement was found. While heterozygote participants showed no difference in disengaging from positive compared to negative pictures, homozygote participants disengaged slower from negative pictures. The results also revealed that participants needed longer to disengage from negative pictures compared to positive pictures when the disengagement movement had to be conducted shortly after the onset of the picture. If this time period was extended, this difference disappeared. The mid-level dopamine concentration of the heterozygote participants seems to result in an optimal functioning to conduct the task – irrelevant of the valence of the presented picture. We speculate that if participants had more time to prepare the movement they were able to use regulation strategies to disengage as fast from negative as from positive pictures.

D90

USING GRAPH THEORY TO CHARACTERIZE AN AFFECTIVE PROSODIC PROCESSING NETWORK David I. Leitman[1], Theodore D Satterthwaite[1], Ruben C Gur[1,2], Daniel H Wolf[1]; [1]Deaprtment of Psychiatry, University of Pennsylvania, [2]Deaprtment of Radiology, University of Pennsylvania — A prominent model of affective prosodic evaluation posits that subcortical and primary auditory regions feed the raw acoustic signal to secondary acoustic regions including posterior portions of superior and middle temporal gyri (pSTG/MTG). PSTG/MTG, together with amygdala input, extract and integrate acoustic features that have emotional salience, which are subsequently evaluated for goal relevance in the inferior frontal gyrus (IFG). We developed an event-related fMRI prosody identification paradigm (four emotions: happiness fear, anger or no emotion), parametrically varying the presence of salient acoustic cues that typify particular emotions. Using this paradigm in 28 healthy individu-

als, we previously described this temporo-frontal circuit in its most basic form, and observed that auditory regions along with amygdala activated reciprocally with IFG as a function of affective cue salience and correlated identification accuracy. However, our analysis indicated that parametric changes in cue saliency also modulated activity in cingulate, caudate, nucleus accumbens (NA), and ventromedial prefrontal cortex (vmPFC), suggesting a need for more complex and comprehensive models. Here we employed graph theory (Sporns and Rubinov, NeuroImage 2009) to characterize the functional configuration of this network and how this configuration changes as cue-based signal ambiguity leads to emotion identification ambiguity. We characterized the efficiency and modularity of the overall network, and the degree and betweenness-centrality of individual nodes (regions). Preliminary results indicate that during correctly-identified high cue salience stimuli (vs. incorrectly-identified low cue salience stimuli), overall network integration and connectivity of NA and vmPFC was higher, while the connectivity between cingulate and IFG was reduced.

D91

DIFFERENTIAL NEURAL ACTIVITY DURING EMOTIONAL VS. NON-EMOTIONAL REVERSAL LEARNING Kaoru Nashiro[1], Lin Nga[1], Mara Mather[1]; [1]University of Southern California — Reversal learning refers to the ability to change an established pattern of behavior based on feedback. In a typical reversal learning experiment, one learns a stimulus-reward association (e.g., selecting a particular object yields a monetary reward) and when the association changes, one needs to alter their response. The orbitofrontal cortex (OFC) has been identified as a critical region for reversal learning. However, little is known about how the emotional salience of outcomes affects brain activity during reversal learning. The current study examined whether emotional vs. non-emotional outcomes would activate different regions of the brain during reversal learning. To test this, on each trial we asked participants to select which of two neutral faces would change. In some blocks, the change was emotional; one of the faces would smile or frown if selected, whereas the other face would not change. In other blocks, the change was not emotional; one of the faces would appear with eyeglasses if selected, whereas the other face would not change. We contrasted activity during the decision-making phase of trials immediately after reversals in the emotion vs. non-emotion blocks - when participants viewed two neutral faces whose associated outcomes had just switched. Thus, there were no perceptual differences between the conditions for this contrast. However, several brain regions including the OFC showed greater activity after emotional than after non-emotional reversals. The results indicate that the brain processes emotional reversals differently than non-emotional reversals.

D92

THE INFLUENCE OF AMYGDALA LESIONS ON EMOTIONAL STROOP INTERFERENCE Maureen McHugo[1], Richard Piech[2], Stephen Smith[3], Mildred Dukic[1], Joost Van Der Meer[1], Bassel Abou-Khalil[1], David Zald[1]; [1]Vanderbilt University, [2]Trinity College Dublin, [3]University of Winnipeg — Previous work has shown that task-irrelevant affective stimulus qualities can facilitate or interfere with attention depending on variables such as stimulus type and timing. The predominant model for emotion-facilitated attention holds that the amygdala modulates sensory cortices to bias processing in favor of emotional stimuli. Although one highly influential study found that patients with left amygdala damage failed to show enhanced identification of emotional words in an attentional blink task (Anderson & Phelps, Nature, 2001), recent studies from our lab and others have found no evidence for emotion-facilitated detection of threat-relevant stimuli in patients with unilateral (Piech et al., Neuropsychologia, 2010) or bilateral amygdala lesions (Tsuchiya et al., Nature Neuroscience, 2009). Because these studies examined only task conditions in which emotion facilitated attention, it remains unclear whether the amygdala is necessary for cases in which emotion interferes with attention. We therefore investigated whether unilateral amygdala lesions attenuate affective distraction using a Stroop task variant. We measured the latency to name word color for negative, positive, neutral and color words in adult patients with unilateral amygdala damage (n=26) and demographically matched healthy controls (n=30). In contrast to healthy controls, patients with amygdala lesions did not show emotional Stroop interference from negative words. However, negative Stroop effect magnitude was unrelated to amygdala volume loss in patients. All groups exhibited an intact color Stroop effect. These results suggest that although patients with unilateral amygdala damage may be less distracted by negative emotional words, this effect may be due to extra-amygdalar temporal lobe damage.

Perception & Action: Other

D93

THE EFFECTS OF EXPERIENCE ON THE OBSERVATION OF NOVEL EFFECTORS Sook-Lei Liew[1,2], Mustafa Seckin[1,3], Lisa Aziz-Zadeh[1,2]; [1]Brain and Creativity Institute, University of Southern California, Los Angeles, CA, [2]Division of Occupational Science & Occupational Therapy, USC, Los Angeles, CA, [3]Ataturk Training and Research Hospital, Clinic of Neurology, I.zmir, Turkey — How do we understand the actions of those unlike us? Several studies suggest that actions performed by body parts or effectors (e.g., robotic claws) that we do not have activate sensorimotor regions, such as in the premotor and parietal nodes of the mirror neuron system. However, in many cases, the effector of interest is visually familiar, even if the observer does not possess that body part (e.g., a hand observed by an individual without hands). In this study, we examined the neural response to a visually novel biological effector (an amputated limb) and a familiar biological effector (a hand), during both the initial viewing of each as well as after prolonged visual exposure. Using fMRI, we first scanned typically-developed participants with little to no prior experience with amputatees as they watched short video clips of identical actions performed by an amputated upper extremity and a hand. We then showed extended clips of each effector to provide increased visual experience with each effector, and rescanned participants. Our preliminary results reveal a greater sensorimotor response to the novel effector compared to the familiar effector during the initial viewing of the actions, but similar responses to both effectors after visual exposure. We suggest that these results provide new information on the role of experience in understanding and representing novel effectors in the brain and hold implications for how different types of experiences may affect the way that we represent others' actions.

Monday, April 4, 8:00 - 10:00 am, Pacific Concourse

Emotion & Social: Emotional Responding

E1

HEMISPHERIC BLOOD FLOW DURING EMOTIONAL PROCESSING: A TRANSCRANIAL DOPPLER STUDY Daniel Horton[1], Natalie Ceballos[1], Reiko Graham[1]; [1]Department of Psychology, Texas State University — Transcranial Doppler (TCD) is a noninvasive and portable method of assessing changes in cerebral blood flow velocity (CBFV) in the basal cerebral arteries. The objective of this study was to assess the utility of TCD in examining changes in CBFV in the middle cerebral arteries (MCA) in response to viewing emotional pictures. MCA CBFV was monitored bilaterally in 23 normotensive adults (17 female, 6 male; aged 20-31 years, M=23.3 years) during a blocked viewing task (positive, negative, neutral – 30 images in each block, each presented for 2 seconds), alternating with 2 minute rest periods. Results revealed that mean and peak CBFV were faster in the left hemisphere during picture viewing, and that the CBFV changes in the MCA in response to viewing pictures were larger in men relative to women. Significant heart rate deceleration was also observed during picture viewing relative to baseline periods. Resistance (estimated with Pourcelot's index) was moderated by emotional pictures and also varied as a function of hemisphere. Specifically, while viewing all picture types resulted in decreases in MCA resistivity in the right hemisphere, decreases in resistivity in the left hemisphere were only observed for positive pictures. Given that CBFV did not change and that heart rate deceleration was consistent across all conditions, we speculate that resistivity decreases were due to higher diastolic flow. These results are consistent with models of emotional processing, which postulate a general role for the right hemisphere in processing emotions, and left hemisphere involvement in processing positive emotional content.

E2

TOP-DOWN AND BOTTOM-UP PROCESSES IN EMOTION RECOGNITION Ming Peng[1], Lin Yuan[1], REnlai Zhou[1,2]; [1]Beijing Normal University, [2]Southeast University — This research investigated how emotional information identification was affected by bottom-up and top-down processing by using a priming paradigm. The experiment is a 2 (target facial expressions: neutral face, fearful face)× 2 (relationships between cues and targets: consistent, inconsistent)×2 (probabilities of inconsistency between cues and targets: 50%, 75%) within-subject design. In the bottom-up processing, the probability that the priming words were inconsistent with the target facial expressions was 50%; while in the top-down processing, the probability that the priming words were inconsistent with the target words was 75%. Behavioral results revealed that in the 50% conditions, the reaction time of fearful faces in the consistent trails is shorter than that of the inconsistent ones. The reaction time of neutral faces in the inconsistent trials is shorter than that of the inconsistent ones. ERPs results showed that, the emotional effects happened in medium(P2)and late periods(P3)in the 50% conditions, while in the 75% conditions, the amplitudes of the N1 components after the appearance of fearful faces were larger than those of neutral ones in left-hemisphere, and the emotional effects disappeared in medium period but reappeared in the late period(P3). The results demonstrated that the processing of fearful faces was more affected by the bottom-up processing, while neutral faces were more affected by the top-down processing.

E3

PROCESSING OF CIGARETTE AND FOOD STIMULI IN INSULA FOR CIGARETTE SMOKERS AND NON-SMOKING CONTROLS Richard Lopez[1], Hedy Kober[2], Peter Mende-Siedlecki[3], Ethan Kross[4], Walter Mischel[1], Carl Hart[1], Kevin Ochsner[1]; [1]Columbia University, [2]Yale University, [3]Princeton University, [4]University of Michigan — It has been suggested that the insula plays a significant role in craving for cigarettes. For example, insula damage is associated with reduced craving and increased quitting. However, other lines of research also have implicated the insula in processing the somatosensory aspects of tasting food stimuli rather than in food craving. We scanned twenty-one cigarette smokers using Functional Magnetic Resonance Imaging (fMRI) as they viewed photographs of cigarettes and tasty foods. Participants were instructed to focus on the immediate sensory experience of food and cigarettes ("NOW" strategy), or on the long-term health consequences associated with them ("LATER" strategy). Participants reported significantly greater craving in the NOW compared to LATER condition for both food and cigarettes. While separate subsections of insula showed significantly greater activation for food vs. cigarette stimuli, there was no difference in insula activity for NOW vs. LATER trials, and insula activity did not correlate with craving for either stimulus. Instead, activity in bilateral insula positively correlated with number of cigarettes smoked per day (CPD), such that those who reported greater CPD showed greater activation for food compared to cigarettes. These data are consistent with the hypothesis that the insula plays a significant role in the processing somatosensory aspects of both cigarette and gustatory stimuli, above and beyond the experience of craving.

E4

ALE META-ANALYSIS REVEALS SEX DIFFERENCES IN THE NEURAL CORRELATES OF EMOTION PROCESSING IN THE AMYGDALA AND RELATED REGIONS Jennifer Strafford Wilson[1], Stephan Hamann[1]; [1]Emory University — A small number of functional neuroimaging studies have examined sex differences in emotional neural processing, making it difficult to characterize patterns of sex differences without combining findings quantitatively across studies. Here we used quantitative meta-analysis to combine data from the largest set of neuroimaging studies examined to date, supplementing the small number of studies directly examining sex differences in emotion with the much larger set of studies that have examined men only, or women only. We used activation likelihood estimation (ALE 2.0) to combine peak activation coordinates from studies that contrasted emotion elicitation with a neutral or baseline condition (45 studies of women; 44 of men). Sex differences in emotional responses were examined separately for positive and negative emotions, and in a combined analysis of all emotions regardless of valence. For negative emotion, women showed greater activation likelihood than men in left amygdala whereas men showed greater activation likelihood

in right amygdala. Additional regions preferentially activated during negative emotion in women included left thalamus, mammillary bodies, left caudate, and medial prefrontal cortex. For positive emotion, men showed greater activation likelihood than women in left amygdala. Men preferentially activated bilateral inferior frontal gyrus, left insula, left posterior cingulate, and right fusiform. Results indicate that sex differences can be consistently observed in the amygdala and other areas closely associated with emotion processing. Our findings demonstrate that sex differences in the context of positive vs. negative emotion differ substantially, and parallel previously reported sex differences in emotional responsivity and vulnerability to affective disorders.

E5

DECONSTRUCTING EMOTION EXPERIENCE: NEURAL EVIDENCE FOR CORE AFFECT Christine Wilson-Mendenhall[1,2], Lisa Barrett[2,3], Lawrence Barsalou[1]; [1]Emory University, [2]Northeastern University, [3]Massachussetts General Hospital, Harvard Medical School — Basic emotion theories propose that non-reducible affect programs in the brain produce a small number of discrete emotions such as fear or happiness. An alternative view is that core affect is a basic ingredient of emotion experience, and that neural systems underlie core affect properties of valence and arousal. To test the core affect hypothesis, we developed fear, happiness, and sadness scenarios that varied in valence and arousal. During an fMRI session, participants imagined these scenarios from a first-person perspective, and then focused on and rated the valence or arousal of the induced emotion. The core affect view predicts that the brain regions correlating with valence or arousal ratings should be the same across experiences of all three emotions. Based on previous literature, we predicted that valence ratings would correlate with activity in orbitofrontal cortex (OFC) and that arousal ratings would correlate with activity in the amygdala. As predicted, across all three emotion categories, activity in medial OFC increased as rated unpleasantness decreased and rated pleasantness increased, whereas activity in left amygdala increased as rated arousal increased. Interestingly, a gradient in medial OFC was also observed in which voxels most sensitive to unpleasantness were more inferior to those most sensitive to pleasantness. The findings support the view that valence and arousal are basic properties of core affect that contribute to emotional experience.

E6

AMYGDALA ACTIVATION IS LINKED TO PATTERNS OF EMOTIONAL DECISION MAKING IN PSYCHOPATHY Abigail Marsh[1], Elise Cardinale[1], Caitlin Taylor[1]; [1]Georgetown University — Psychopathy is a personality variable associated with antisocial behavior and deficient empathy and remorse. Prior research demonstrates that psychopathy is also associated with deficits in recognizing and responding to distress cues such as fearful facial expressions. This impairment has been linked to deficits in amygdala function and may be associated with prevalent antisocial behavior in psychopathy. Theories of psychopathy specify that amygdala dysfunction may prevent psychopathic individuals from making appropriate decisions about behaviors that cause others fear or distress. The present study demonstrates that, relative to controls, highly psychopathic individuals judge behaviors that cause others fear to be more acceptable, and that this response pattern is associated with reduced amygdala activation in highly psychopathic subjects. A community sample of 19 participants underwent fMRI scanning while viewing statements that elicit various emotions (e.g., anger, disgust, fear). Participants decided whether making each statement to another person would ever be appropriate and indicated their decisions using button presses. As has been previously demonstrated, higher psychopathy scores were associated with judgments that frightening others is more acceptable. FMRI data indicated that this response pattern is associated with reduced amygdala activation when psychopathic subjects judged frightening statements. Differential patterns of amygdala activation were not associated with judgments of other types of emotional statements. This study links fear processing deficits in psychopathy to judgments about antisocial behavior. These data are the first to show that amygdala dysfunction in psychopathy is associated with judgments about the acceptability of causing others fear.

E7

IS THE FRUSTRATION EFFECT FRUSTRATING? A TASK TO LOCALIZE REGIONS INVOLVED IN FRUSTRATION Steven Green[1], Sharlene Newman[1]; [1]Indiana University — According to Abram Amsel, frustration is experienced when an expected reward is omitted. He further states that when frustrated, responding becomes more vigorous; which he calls the frustration effect. Thus, the frustration effect provides a behavioral measure for frustration which could be used to identify the neural network that underlies frustration. However, no studies have confirmed that the subjective experience of frustration corresponds to the frustration effect in humans. The current study tested a task that may be used as a functional localizer that elicits the frustration effect. Here subject's self reports of frustration were compared with the behavioral frustration effect in order to verify the connection. To manipulate frustration levels, the outcomes of reward and reward omission were occasionally repeated either twice or three times. The frustration effect was demonstrated in the significant difference in reaction time between reward omission and reward trials. However, the repetition of outcome did not interact with the frustration effect. There was a significant effect of outcome on self reports of frustration. Reward omission trials were reported as being more frustrating than non reward trials. In contrast to the frustration effect, there was a significant effect of outcome repetition on reports of frustration. Subjects reported higher levels of frustration when reward omission trials were repeated and decreasing levels of frustration when reward trials were repeated. These results suggest the task may be used broadly to localize regions associated with frustration.

E8

DOPAMINE RECEPTOR AVAILABILITY IS ASSOCIATED WITH PERSONALITY TRAITS RELATED TO BEHAVIORAL DISINHIBITION Sanghyun Baik[1], Su Jin Kim[2], Hyeon Min An[1], Sang Eun Kim[2], Sang Hee Kim[1]; [1]Korea University, [2]Department of Nucear Medicine, Seoul National University Bundang Hospital — Behavioral disinhibition has been implicated in various neuropsychiatric disorders such as substance abuse disorders. Recent neuroimaging and genetic studies have suggested that dopaminergic activity in the brain plays an important role in individual differences in personality traits characterized by behavioral disinhibition such as impulsivity, novelty seeking and extraversion. We designed positron emission tomography (PET) study to investigate the contribution of dopaminergic receptor availability in personalty traits related to behavioral disinhibition. Seventeen healthy, right-handed volunteers (10 men and 7 women, mean age 24.24±2.68 years) participated in the study. T1-weighted magnetic resonance images (MRI) and [18F]fallypride PET data were acquired from each participant and questionnaires measuring related personality characteristics were completed. PET images were spatially realigned to correct motion, and coregistered to individual MRIs using SPM 5 and PMOD 3.13. Regions of interest included the bilateral ventral striatum, caudate nucleus, and putamen. We found a positive correlation between extraversion scores and the BP values of the right caudate nucleus and left putamen. Significant negative correlations between the imlsivity scores on Eysenk questionnaires and the BP values of the right cigulate was observed {p<0.005(unc.), and extend threshold k=10 voxels}. In this study we found that dopamine receptor availability in the striatum was associated with individual differences in impulsiveness and extraversion. Given that behavioral disinhibition has been consistently reported in neuropsychiatric disorders such as addiction, our results contribute to the understanding of neurochemical mechanisms of such disorders.

E9

NEURAL CORRELATES OF ATTENTIONAL BIAS TO CONDITIONED FACIAL STIMULI: AN ERP STUDY OF AN EMOTIONAL STROOP TASK SoJeong Yoon[1], JiWoon Jeong[1], InJae Hwang[1], Hyun Taek Kim[1]; [1]Korea University — The present study investigated the neural correlates of attentional bias to

conditioned facial stimuli. We examined the neural processing of fear-conditioned stimulus using a classical fear conditioning procedure with event-related potentials (ERPs). Twenty-one healthy college students (5 men and 16 women; age range = 20-24 years) participated in the experiment. The stimuli consisted of four pictures of two female faces (angry and neutral). During the conditioning session, one angry face of the two female faces (conditioned stimulus: CS+) was paired with a mild electric shock (unconditioned stimulus: US) on fingers, and the other angry face was unpaired (CS-). In a subsequent emotional Stroop task, the participants were tasked to identify the color of the facial stimuli (red, green, blue, or yellow). Early posterior negativity (EPN) was significantly greater in the conditioned face and the neutral face of the same visage (CS+ type) over temporo-occipital sites. Late positive potential (LPP) also significantly increased with the angry faces (emotion type) over centro-parietal sites. The level of state-anxiety was positively correlated with attentional bias score and the mean amplitude of the CS+ type of LPP component. These findings provide stimulus type (CS+ type and emotion type) - specific components in ERPs for attentional bias to conditioned emotional face stimuli and demonstrate a correlation between anxiety and acquired attentional bias.

E10

DIFFERING NETWORKS ASSOCIATED WITH RATING VALENCE VS. AROUSAL WHILE VIEWING EMOTIONAL IMAGES Joseph Andreano[1,2], Rebecca Dautoff[1,2], Brad Dickerson[1,2], Christopher Wright[1], Lisa Feldman Barrett[1,2,3]; [1]Massachusetts General Hospital, [2]Athinoula A. Martinos Center for Biomedical Imaging, [3]Northeastern University — In prevailing models, emotion is generally divided into two separate measures of valence and arousal, and neuroimaging studies of emotion typically use subjective emotional ratings based on one of these two measures. As valence and arousal are believed to be psychologically distinct, rating either of these features likely involves intentionally shifting attention to focus on one or the other aspect of emotional experience. The process of subjective rating, therefore, may involve a form of top-down modulation of the brain's affective circuitry. To address this question, 34 participants between the ages of 60 and 86 were scanned by fMRI while viewing a sequence of International Affective Picture System (IAPS) images selected to vary by both valence and arousal. During viewing, 22 participants provided an arousal rating for each image, while 17 participants rated valence. Whole-brain analysis was then used to identify the networks associated with rating either valence or arousal. Additionally, the timecourse of the BOLD response to IAPS images was compared between valence and arousal raters in several affective ROIs, including amygdala, anterior cingulate, and insula. The results indicated differences in valence and arousal rating networks, with several frontal and temporal regions of activation unique to the arousal rating group. Significant differences in the response of affective ROIs were also detected. These findings suggest that the neural response to emotion differs depending upon the aspect of emotion that is emphasized.

E11

DYNAMIC CROSS-MODAL PRIMING OF EMOTION INVESTIGATED WITH EVENT-RELATED POTENTIALS Patricia Garrido-Vásquez[1], Silke Paulmann[2], Marc D. Pell[3], Sonja A. Kotz[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]University of Essex, Colchester, UK, [3]McGill University, Montreal, Canada — Emotional expressions from face and voice are inherently dynamic. However, the processing of emotional facial expressions is often tested with static images. Also, we do not know much about how these two communication channels interact. In the present study, we set out to investigate how dynamic facial expressions influence the processing of emotional speech and vice versa in a priming paradigm. We used videos of four actors interpreting emotional sentences, cut to 520 ms length and without sound. Voice stimuli were sentences in pseudo-speech, unintelligible to listeners, but conveying different emotional tones, with a duration of approximately 3 seconds. Event-related potential responses were recorded from 64 scalp electrodes. Thirty-two participants were presented with angry, happy or emotionally-neutral stimuli as primes, immediately followed by an angry or happy target. Thus, there was a congruent, an incongruent, and a neutral prime condition. A gender decision was performed to keep subjects unaware of study purposes. For the video-as-prime condition, we observed a congruency effect as early as 100 ms post sentence-onset, with an enhanced N100 in response to incongruent trials. Furthermore, incongruency elicited an N400-like component. In the speech-as-prime condition, incongruency effects emerged later, in an enhanced negativity for congruent trials peaking approximately 200 ms after target onset. These data suggest that dynamic audiovisual emotional priming works in both priming directions and under implicit processing conditions. Due to different prime durations, depending on whether a video or a sentence served as prime, different processing steps may have been tapped by prime-target congruency manipulations.

E12

IMPLICIT EFFECTS OF EMOTIONAL PROSODY ON VISUAL BEHAVIOR Simon Rigoulot[1], Marc Pell[1]; [1]McGill University — During a conversation, listeners encounter linguistic and extra-linguistic information that can guide visual behavior, including vocal cues about a speaker's emotion (emotional prosody). Here, we investigated whether the implicit processing of emotional prosody influences gaze behavior to facial expressions of emotion in a visual search task. Thirty-one participants viewed five-second visual arrays composed of four faces portraying happiness, anger, fear and neutrality, while concurrently listening to a pseudo-utterance (Someone migged the pazing) uttered with a happy, angry, fearful or neutral prosody played during the first 1250 millisecond of the array. We recorded the eye movements of the participants as they scanned the visual array and analyzed the frequency and duration of first saccades and of total looks in three temporal windows ([0-1250 ms], [1250-2500 ms], [2500-5000 ms]) according to the emotional content of faces and voices. We observed that participants looked more frequently and longer at faces that matched the prosody, and that this effect persisted after the auditory information was no longer present (i.e., in the 1250-2500 time window). As well, the specific emotional content of the voice influenced the congruency effect, which was more prominent in response to fearful and happy voices than to the other emotions. These data confirm the importance of emotional auditory information which guides visual scanning behavior to facial cues during social communication, in an automatic and emotion-congruent manner even after the auditory stimulus has been processed.

E13

DIFFERENTIAL ACTIVATION OF THE CALCARINE FISSURE AND FUSIFORM GYRUS BY EMOTION OF VIEWED FACES Kaitlyn DePlonty[1], Per Lynse[1,2], Pilar Sanjuan[1,2], Robert Thoma[1], Jeffrey Lewine[1]; [1]Mind Research Network, [2]University of New Mexico — The ability to recognize facial expressions is critical to social interactions between humans. Behavioral studies demonstrate impairments in face processing in several conditions characterized by abnormal socialization. In trying to elucidate the neurobiology of face processing, most models and neuroimaging studies have focused on the role of brain regions beyond core visual cortex; the fusiform face region and the amygdala. Of particular interest has been the right fusiform cortex, with multiple types of imaging studies providing converging data that the activity of this region is modulated by the specific emotional characteristics of faces. Using MEG, Lewis et al. (2003) found differential activation of the right fusiform when viewing happy, versus disgusted versus neutral versus swirled faces. The current work sought to extend these findings by, 1) expanding the stimulus set to all six basic emotions and an additional non-face control condition, 2) investigating the primary visual response of the calcarine fissure for an emotion-dependent component, and 3) investigating effects of subject gender and age. As expected, the latency and peak-amplitude of activity in the fusiform was modulated by emotional characteristics of faces. However, our data also showed a very early, and different pattern of emotion-related modulation of responses from the calcarine cortex. In the calcarine,

happy faces were seen to elicit the greatest amplitude of response, whereas, in the fusiform, fearful and surprised faces resulted in the largest responses. Additional results were a main effect for gender, with women displaying greater amplitude, and an effect of age towards greater amplitude.

E14

THE EYE MOVEMENT PATTERNS IN VIEWING CHINESE AFFECTIVE PICTURES Tsung-Han Yang[1], Nai-Shing Yen[1,2], Yuan-Yi Chang[1], Pei-Chi Tseng[1], Chieh-Ning Lee[1], Ching-Hui Chueh[1]; [1]Department of Psychology, National Chengchi University, Taipei, Taiwan, [2]Research Center for Mind, Brain, and Learning, National Chengchi University, Taipei, Taiwan — Pictures from the International Affective Pictures System (IAPS, Lang, Bradley, & Cuthbert, 2005) are usually used to elicit different emotion responses. But the results of using IAPS in Taiwan showed some cultural differences. A Chinese-IAPS has been developed and the subjective ratings of Taiwanese were collected. It was found that the erotic pictures were rated as neutral stimuli, which is different from the results of IAPS. For understanding how Taiwanese attend to the affective pictures, we used eye-tracker to record the fixation numbers and gaze durations in the emotional area of the pictures from 9 Taiwanese. Ninety-six pictures were selected from Chinese-IAPS and assigned evenly into positive (mean=7.84), neutral (mean=5.05), and negative (mean=2.06) categories, and the erotic pictures were in the neutral category. In number of fixations, there was no significant difference between 3 categories. However, the gaze duration of positive pictures were significantly longer than those of neutral and negative pictures. The 96 pictures were further divided into 5 subcategories: positive, erotic, other neutral, mutilation, and other negative. The gaze duration of the erotic pictures was significantly shorter than those of other categories. In number of fixations, although there was no significant difference between the subcategories, the fixation numbers of erotic pictures were the highest. The results suggested that when Taiwanese saw these erotic pictures, although the emotional area attracted attention many times, but every gaze time was short. This is consistent with the social expectation in Taiwan that the erotic material are often associated with impoliteness and shame.

E15

FEAR CONDITIONING WITHOUT AWARENESS USING CONTINUOUS FLASH SUPPRESSION Candace Raio[1], David Carmel[1], Marisa Carrasco[1], Elizabeth Phelps[1]; [1]New York University — Learning what to fear is essential for adaptive functioning. While threatening stimuli can be detected—and the fear they elicit physiologically expressed—outside of awareness, it remains unclear whether new fear associations can be learned without awareness. Here, we investigated this issue using a Pavlovian fear conditioning paradigm while suppressing long-duration conditioned stimuli (CSs) from awareness using continuous flash suppression (CFS). During CFS, stimuli presented to one eye are rendered invisible by salient dynamic stimulation of the other eye. One suppressed stimulus (CS+) was occasionally paired with a shock, whereas the other (CS-) was not. Importantly, the temporal parameters of CFS allowed for the measurement of participants' fear–evoked skin conductance responses (SCRs) during acquisition, rather than the expression of fear afterwards. Two groups of participants were conditioned with identical CSs, either with CFS (unaware group) or without it (aware group). We found significantly greater responding to the CS+ in both groups, but the temporal pattern of this learning differed. Robust differential SCRs were observed only during early acquisition (1st half of session) for unaware participants, and only during late acquisition (2nd half of session) for aware participants. Conditioning magnitude was negatively correlated with state anxiety in both groups, but only during the stage in which differential learning occurred. Our data suggest that fear conditioning without awareness recruits a rapid, automatic form of learning that also dissipates swiftly, perhaps because it is preserved for identifying immediate threats, while fear conditioning with awareness may employ cognitive mechanisms that allow associations to develop over time.

E16

GENETIC MODULATION OF EXTINCTION RETENTION, ANXIETY, AND DEPRESSIVE SYMPTOMS IN HUMANS Catherine Hartley[1], Elizabeth Phelps[1], B.J. Casey[2], Charles Glatt[2]; [1]New York University, [2]Weill Cornell Medical College — Serotonin has long been implicated in the etiology of depression and anxiety, however there is no clear mechanistic account of its function in these disorders. A recent report (Wellman et al., 2007) that serotonin transporter (5-HTT) knockout mice show heightened spontaneous fear recovery following extinction, as well as anxiety and depression-like behavior suggests that serotonin may contribute to anxiety and depression by modulating extinction retention. Genetic variation in 5-HTT expression may function similarly in humans. Here, we explored whether two 5-HTT gene polymorphisms, 5-HTTLPR and a serotonin transporter polyadenylation polymorphism (STPP/rs3813034), were associated with extinction retention and self-reported anxiety and depressive symptoms. Subjects took part in a two-day fear conditioning paradigm consisting of acquisition and extinction, followed 24 hours later by a test of extinction retention. Participants' degree of extinction retention and self-reported anxiety were inversely correlated. Furthermore, STPP genotype had a dose-dependent association with spontaneous fear recovery, while 5-HTTLPR had none. Trait anxiety and depressive symptoms were strongly associated with STPP genotype, and weakly associated with 5-HTTLPR genotype. However, participants' number of low-expressing STPP and 5-HTTLPR alleles were correlated within our sample, and path analysis demonstrates that the apparent association of 5-HTTLPR with both measures is entirely explained by its correlation with STPP. These data suggest that the little-studied STPP may be an important risk factor for depression and anxiety, and that the controversial inconsistent 5-HTTLPR associations with these phenotypes may be due to variable correlation with STPP in experimental samples.

E17

DYNAMIC CULTURAL INFLUENCES ON EFFECTIVE CONNECTIVITY OF NEURAL SUBSTRATES UNDERLYING EMOTIONAL RESPONSE Lisa Hechtman[1], Ahmad Hariri[2], Tokiko Harada[3], Yoko Mano[4], Norihiro Sadato[5], Todd Parrish[1], Tetsuya Iidaka[3], Joan Chiao[1]; [1]Northwestern University, [2]Duke University, [3]Nagoya University, [4]Tohoku University, [5]National Institute for Physiological Sciences — Mood and anxiety disorders have been linked to a number of biological mechanisms, including variations in the serotonin transporter gene, increased amygdala response to emotional stimuli, and decreased functional connectivity between amygdala and regulatory prefrontal cortex regions (Pezawas et al., 2005). Most of this work, however, focuses mainly on outcomes in Western, individualistic contexts, and treats heightened emotional sensitivity as maladaptive. One theory holds that living according to collectivistic norms requires particular sensitivity to negative information in one's surroundings, due to increased emphasis on group membership and hierarchy (Chiao & Blizinsky, 2010). Here we examine the neural mechanisms by which cultural values specifically influence emotional response and regulation. Bicultural Asian Americans completed an individualistic or collectivistic essay prime, and subsequently matched a series of emotional scenes and geometric shapes during fMRI scanning. Measures of effective connectivity between right lateral orbitofrontal cortex (LOFC) and bilateral amygdala--estimated by dynamic causal modeling— differed between the collectivistic and individualistic prime groups, such that collectivists showed greater top-down LOFC influence on amygdala response. Behavioral results further indicate that collectivistic priming increased task accuracy without a reaction time tradeoff. Taken together, these findings demonstrate that even temporarily heightening awareness of collectivistic cultural values enhances emotional vigilance. These neural and behavioral findings highlight the importance of considering cultural context in neurobiological models of psychopathology.

E18

EFFECTS OF SUBJECTIVE PREFERENCE FOR COLOR ON ATTENTION-RELATED OCCIPITAL THETA ACTIVITY Masahiro Kawasaki[1], Yoko Yamaguchi[1,2]; [1]Rhythm-based Brain Computation Unit, RIKEN BSI-TOYOTA Collaboration Center, Japan, [2]Laboratory for Dynamics of Emergent Intelligence, RIKEN Brain Science Institute, Japan — Our daily behaviors are often affected by the subjective preferences. Previous studies have shown that the unconscious physical responses would surface prior to the conscious decision making for subjective preference. If so, it might be hypothesized that the neural activity for visual attention is influenced by the subjective preferences. However, there are little neurological findings about the relationships between visual attention and subjective preferences. Here, to address the issue, we have focused on the laterality for the visual attention and investigated the effects of the subjective preferences on the neural activities. We measured the electroencephalogram (EEG) during a preference judgment task which required 19 participants to choice a preferred one from two simultaneously right and left presented colors. In addition, to indentify the oscillatory activity for visual attention, we conducted a control condition where subjects were asked to merely attend either right or left color. EEG results showed that theta (4-6Hz) activity was enhanced in the right and left occipital electrodes during attending color in the opposite hemi-field. The contralateral occipital theta activity was also increased to the direction that the preferred color was presented. The duration of the activity was longer than that of the ipsilateral occipital activity. These results indicated that the attention-related brain activity would be affected by the subjective preference. Moreover, the frontal beta activity for the preferred color was increased rather that for the attended color, suggesting that the activity is associated with the subjective preference itself.

E19

BRAIN ACTIVATION PREDICTS TREATMENT IMPROVEMENT IN PATIENTS WITH MAJOR DEPRESSIVE DISORDER Andrea Samson[1], Eva Meisenzahl[2], Johanna Scheuerecker[2], Emma Rose[3], Veronika Schoepf[2], Martin Wiesmann[2], Thomas Frodl[3]; [1]Stanford University, [2]Ludwig-Maximilian University, Munich, Germany, [3]Department of Psychiatry, School of Medicine & Trinity College Institute of Neuroscience, Integrated Neuroimaging, The Adelaide and Meath Hospital incorporating the National Children's Hospital (AMNCH), & St. James's Hospital, Trinity College, Dublin, Ireland — Major depressive disorder (MDD) is associated with alterations in brain function that might be useful for therapy evaluation. The current study aimed to identify predictors for therapy improvement and to track functional brain changes during therapy. Twenty-one drug-free patients with MDD underwent functional MRI twice during performance of an emotional perception task: once before and once after 4 weeks of antidepressant treatment (mirtazapine or venlafaxine). Twelve healthy controls were investigated once with the same methods. A significant difference between groups was a relative greater activation of the right dorsolateral prefrontal cortex in the patients vs. controls. Before treatment, patients responding better to pharmacological treatment showed greater activation in the dorsomedial prefrontal cortex during viewing of negative emotional pictures. Activations in the caudate nucleus, subgenual anterior cingulated cortex (sgACC) and insula decreased after successful treatment. The distinction in brain activity between responders and non-responders might be related to altered self-referential processes and a differential response to external emotional stimuli, suggesting differences in the processing of emotionally salient stimuli between those who are likely to respond to pharmacological treatment and those who will not. In accordance with previous studies, the present investigation suggests the insula, caudate nucleus and sgACC may have a key role as a biological marker for treatment response and predictor for therapeutic success.

E20

DURING REWARD PROCESSING VENTRAL STRIATAL AND MEDIAL PREFRONTAL FMRI ACTIVATION IS CORRELATED WITH THE FEEDBACK NEGATIVITY ERP Josh Carlson[1], Dan Foti[1], Lilianne Mujica-Parodi[1], Eddie Harmon-Jones[2], Greg Hajcak[1]; [1]Stony Brook University, [2]Texas A&M University — Localization research utilizing functional magnetic resonance imaging (fMRI) suggests that the ventral striatum (VS), medial prefrontal cortex (mPFC), and other structures of the mesocorticolimbic dopamine system underlie aspects of reward processing from expectation and craving of reward to the pleasurable states experienced upon reward attainment. At the same time, research assessing the temporal characteristics of reward processing with event-related potentials (ERP) indicates that the feedback negativity (FN) is sensitive to reward vs. non-reward feedback and outcome expectation. Source localization techniques indentify the mPFC and VS as likely neural generators of the FN. Yet, to the best of our knowledge, research has not directly explored the relationship between ERP and fMRI measures of reward processing within the same sample. Given the complementary strengths and weaknesses of ERP and fMRI, collecting both measures in a single sample can provide unique insight into the neural processing of reward. Therefore, our primary aim was to assess the relationship between fMRI (i.e., VS and mPFC) and ERP (i.e., FN) measures of reward processing. Counterbalanced fMRI and ERP sessions of a monetary gambling task were completed by 45 individuals. We found a positive correlation between fMRI activation in the mesocorticolimbic reward circuit including the VS and mPFC and the FN for the Win > Loss comparison. In sum, we provide evidence that monetary gains activate the VS, mPFC, amygdala, and orbital frontal cortex, amplify the FN ERP component at approximately 300ms post feedback, and that these fMRI and ERP measures of reward processing are related.

E21

INSULA REACTIVITY TRACES CONDITIONED FEAR GRADIENTS WITH RESPECT TO THREAT-SALIENCE Tsafrir Greenberg[1], Joshua M. Carlson[1], Greg Hajcak[1], Lilianne R. Mujica-Parodi[1]; [1]Stony Brook University — Fear generalization is the transfer of conditioned fear to perceptually similar stimuli. This process is thought to contribute to the maintenance of anxiety symptoms by extending a learned fear response to potentially innocuous cues. Recent studies have demonstrated that fear-potentiated startle and skin conductance responses to a conditioned stimulus (CS) generalize to similar stimuli, with the strength of fear generalization linked to perceptual similarity with the CS. The aim of the present study was to extend this work by examining whether neural reactivity shows a similar response pattern to that reported with peripheral measures of fear. An initial study (N=8) revealed that insula reactivity tracks the conditioned fear gradient. Here, we attempt to validate this effect in an independent sample (N=8) using a fear generalization task optimized for functional neuroimaging. The CS was a medium sized rectangle and co-terminated with an electric shock 50% of the time. Six rectangles differing by ±20%, ±40% or ±60% in width from the CS served as the generalization stimuli. Parameter estimates extracted from a 10×10×10 mm cube surrounding the maximum activated voxel in the left and right insula (for each stimulus versus baseline contrast), showed a significant quadratic trend with highest reactivity to the CS and decreased response amplitude with increasing perceptual dissimilarity. This response pattern was consistent with participants' post-task ratings of perceived shock likelihood for each of the rectangles. These findings provide a first step in elucidating the neurocircuitry of an important learning mechanism that may contribute to increased anxiety in patients.

E22

EMOTIONS AFFECT MOTOR RESPONSES AND THE NEURAL PROCESSES Jie Yu[1], Jin Yan[1]; [1]The Chinese University of Hong Kong — Human emotions affect judgments and responses. The purpose of this study was to examine the impacts of three emotional states (positive, neutral, or negative) on the speed and accuracy of a conflict motor task.

The neural mechanisms of the emotional effects in motor judgments were also explored. After viewing an emotional picture of a sport event, each participant performed the Simon task while reaction time (RT), response accuracy (RA), and event-related potentials (ERPs) were recorded. Behavioral findings indicate that the emotional states resulted in significant differences in RT, but not in RA. Delta RT analyses suggest that subjects performed better in conflict control under positive conditions than under neutral and negative conditions. ERPs results showed marked emotion-related gaps in P1, N1, P2, and N2 in selected brain regions. In frontal and left occipital regions, negative emotions produced shorter P1 peak latencies than positive and neutral stimuli. Positive stimuli activated P1 and resulted in shorter N2 latencies while triggering higher N2 activation levels in left hemisphere. Negative stimuli, however, caused shorter N2 latencies and higher N2 activation levels in right hemisphere. Overall, positive stimuli generated longer N1 and P2 latencies and higher N1 and P2 activation levels in frontal and occipital lobes than neutral and negative stimuli. The results support the broaden-and-build hypothesis that positive emotions facilitate conflict control by expanding the scope of attention and the thought-actions repertory.

E23

OVERNIGHT THERAPY? SLEEP DE-POTENTIATES EMOTIONAL BRAIN REACTIVITY Els van der Helm[1], Justin Yao[1], Vikram Rao[1], Shubir Dutt[1], Matthew Walker[1]; [1]University of California Berkeley — While the benefit of sleep on various neurocognitive processes has been established, a role for sleep in emotional brain regulation remains largely uncharacterized. This is surprising considering that nearly all clinical mood disorders express co-occurring abnormalities of sleep, most commonly in the amount and timing of rapid eye movement (REM) sleep. Using fMRI in combination with EEG sleep physiology, here we test the hypothesis that sleep, and specific aspects of REM sleep, de-potentiates the behavioral and neural reactivity associated with prior affective experiences. Thirty-three healthy young adults performed two fMRI sessions, separated by a 12hr period containing either a full night of physiologically recorded sleep (Sleep-group), or a normal waking day (Wake-group). At each session, participants rated affective picture-stimuli on a 1-5 scale (corresponding to increasing emotional intensity). In contrast to equivalent time awake, sleep resulted in a selective and significant palliative overnight reduction in extreme emotion intensity ratings (P?0.04). This behavioral de-potentiation was further associated with an interaction effect in the amygdala, showing overnight decreases in reactivity in the Sleep-group (P=0.004), while no such decrease was observed in the Wake-group. Additionally, this sleep-dependent reduction in amygdala reactivity was associated with enhanced ventromedial prefrontal cortex (vmPFC) functional connectivity (P=0.005). Moreover, the overnight increase in amygdala-vmPFC connectivity correlated significantly with the speed of entry into REM sleep (R=0.53, P=0.025). Taken together, these findings support a homeostatic role for sleep, and especially REM sleep, in the optimal regulation of limbic brain networks, de-potentiating next-day emotional reactivity and re-establishing vmPFC top-down control.

E24

THE NEURAL CORRELATES OF EMPATHY: EXPERIENCE, AUTOMATICITY, AND PROSOCIAL BEHAVIOR Sylvia A. Morelli[1], Lian T. Rameson[1], Matthew D. Lieberman[1]; [1]University of California, Los Angeles — Empathy is a critical aspect of human emotional experience that influences the behavior of individuals as well as the functioning of society as a whole. Although empathy is first and foremost a subjective experience, no studies have yet examined the neural correlates of the self-reported experience of empathy. Furthermore, although interest in empathy can be traced to its role in promoting prosocial behavior, no work has yet linked empathy-related neural activity to real-world behavior. Lastly, the assumption that empathy is an automatic experience remains a largely untested supposition. It is also unknown whether individual differences in trait empathy reflect either variability in the automaticity of empathic responses or the capacity to feel empathy. In this study, 32 participants completed a two-week diary study measuring daily helping behavior. Participants later underwent an fMRI task assessing empathic responses to naturalistic stimuli. Participants viewed images of sad events under three conditions: watching naturally, under cognitive load, and while instructed to empathize. Across conditions, higher levels of self-reported experienced empathy were associated with greater activity in medial prefrontal cortex (MPFC). Activity in MPFC was also correlated with daily helping, and this activity predicted daily friend helping even controlling for trait empathy. Additionally, high trait empathy participants displayed greater self-reported empathy and stronger MPFC responses than low trait empathy individuals under cognitive load, suggesting that empathy is more automatic for individuals high in trait empathy. Taken together, these results suggest that MPFC plays a critical role in the instantiation of empathic experience and behavior.

E25

CHILDREN'S NEURAL RESPONSE TO MOTHER'S FACE: EFFECTS OF EARLY CAREGIVING EXPERIENCES Nim Tottenham[1], Mor Shapiro[1], Eva Telzer[1]; [1]University of California, Los Angeles — A mother's face is a highly meaningful stimulus to a child, one which is discriminated both perceptually and affectively within the first year of life. The intimate mother-infant relationship provides opportunities for the child to learn to distinguish this face as an emotionally meaningful stimulus. Maternally-deprived children exhibit behaviors towards adults that suggest weaker affective discrimination between caregivers and other adults. The current study used functional magnetic resonance imaging to examine neural responses to mothers' and strangers' faces in typically-reared and orphanage-reared children (who were later adopted). Typically-reared children exhibited greater amygdala response to their mother's face over a stranger's face, suggesting that the mother's face is a unique stimulus signaling a rich emotional contingency history. In contrast, children with a history of early maternal-deprivation did not show an amygdala response that differentiated mother's from a stranger's face, and this lack of differentiation resulted from hyperreactive amygdala responses to both individuals. Children who received the lowest quality of caregiving were least likely to differentiate mother from stranger at the level of the amygdala. These findings suggest that early maternal deprivation interferes with the typical process whereby a mother accrues special meaning for the child and may, in part, explain why children with a history of disrupted caregiving are at risk for showing odd affiliative behaviors, such as poor emotional attachments to adoptive parents and indiscriminate friendliness towards strangers. These data also provide insight into the nature of early learned emotional representations and suggest a sensitive period such emotional learning.

E26

EMOTIONAL PROCESSING IN ALZHEIMER'S DISEASE: A META-ANALYSIS Yanica Klein Koerkamp[1,4], Marine Beaudoin[2,4], Monica Baciu[3], Pascal Hot[1,4]; [1]Laboratoire de Psychologie et Neurocognition (CNRS UMR-5105), Grenoble, France, [2]Laboratoire Inter-Universitaire de Psychologie / Personnalité, Cognition, Changement Social, Chambéry, France., [3]Université Pierre Mendès France, [4]Université de Savoie, Chambéry Cedex, France — Deficits in emotion processing in Alzheimer's disease (AD) compared with healthy aging have been inconsistently reported. This meta-analysis aims to identify factors that might explain this inconsistency. We analyzed 23 studies published between 1996 and 2009 (databases: MEDLINE, PsycINFO, PubMed). Emotion processing abilities of Mild Cognitive Impairment (MCI, N = 112) and AD (N = 504) patients have been compared with those of healthy older adults (HOA, N = 519) using varying methodologies (type of emotion task, stimuli modality and kind of emotion) that can moderate the presence of a deficit. Weighted Cohen's d effect sizes and confidence intervals have been calculated to assess differences in emotional processing abilities between patients (MCI and AD) and HOA. Compared to HOA, the MCI and AD patients were impaired for emotional recognition when tasks (i.e., emotional discrimination, naming, matching, selection and rating), modality of stimu-

lus (i.e., visual, audio, audiovisual) and kind of emotions (e.g., happy, fear, anger) have been collapsed. Interestingly the presence of impairment was found to depend on the methodology used in the studies. AD patients were not impaired in the emotional rating task, suggesting an intact emotion experiencing. Moreover, a relative preserved recognition of happy emotions was present in AD while surprise and specifically fear were impaired. These selective impairments in emotional processing could reflect progressive degree of brain structures degeneration, such as amygdala and other limbic structures. Through a better understanding of mechanisms underlying emotional processing, this study could help to clarify the diagnosis at earliest stage of AD.

E27

DIFFERENTIAL RESPONSES TO IMAGES OF THREAT AND HUMAN SUFFERING AFTER INTENSIVE MEDITATION TRAINING Brandon G. King[1], Anthony P. Zanesco[1], Erika L. Rosenberg[1], David A. Bridwell[2], Tonya L. Jacobs[1], Stephen R. Aichele[1], Katherine A. MacLean[3], Phillip R. Shaver[1], Baljinder K. Sahdra[1], Emilio Ferrer[1], B. Alan Wallace[4], Clifford D. Saron[1]; [1]University of California, Davis, [2]University of California, Irvine, [3]Johns Hopkins University, [4]Santa Barbara Institute for Consciousness Studies — We investigated training-related changes in psychophysiological responses to aversive emotional images in an intensive meditation retreat. Startle eyeblink magnitude and cardiac deceleration were assessed in response to images depicting scenes of human suffering (e.g., illness, loss, starvation, injury) or threat (e.g., human violence, threatening animals). Matched participants were assigned to training (N=23) and wait-list control (N=22) groups and tested onsite at a remote meditation center at the beginning and end of training. Training consisted of three months of practice in meditative techniques designed to foster increases in attention, vigilance, and emotional balance. Participants viewed counterbalanced sets of positive and negative images from the International Affective Picture System. Images were accompanied by bursts of white noise (50ms, 100dB peak SPL) occurring at 1500ms, 4500ms, and 7000ms following picture onset. Startle magnitude (50ms baseline to 20-120ms post-probe peak rectified EMG amplitude) and cardiac deceleration (2s baseline to 0-4500ms post-picture maximum estimated interbeat interval) were quantified for each trial and averaged across picture content. Repeated measures ANOVAs revealed training-related decreases in startle magnitude and cardiac deceleration to scenes depicting threat. Additionally, at post-test the training group showed significantly greater cardiac deceleration to scenes of human suffering. Consistent with the goals of contemplative practice, these results suggest a decreased emotional reactivity to threatening stimuli as a function of training, as well as greater engagement with images of human suffering. Furthermore, responsivity to human suffering was related to time spent practicing loving-kindness meditation, a technique aimed at promoting benevolent aspirations towards oneself and others.

E28

A CAUSAL FRONTO-TEMPORAL NETWORK FOR THE DECODING OF EMOTIONAL PROSODY. Sascha Fruehholz[1,2], Leonardo Ceravolo[1,2], Didier Grandjean[1,2]; [1]Neuroscience of Emotion and Affective Dynamics Lab, Department of Psychology, University of Geneva, Geneva, Switzerland, [2]Swiss Center for Affective Sciences, University of Geneva, Geneva, Switzerland — We used angry and neutral human utterances to reveal brain activations during implicit (gender decision) and explicit processing (prosodic discriminations) of vocal emotional tones during high resolution functional magnetic resonance imaging (fMRI) brain scans covering the superior temporal, inferior frontal and medial limbic cortices. We found significant brain activations related to angry compared to neutral voices independent of the task in right middle (mSTG) and posterior superior temporal gyrus (pSTG) and in left inferior frontal cortex (IFC). Left mSTG and pSTG as well as right IFC were only active during implicit processing, whereas bilateral amygdalae were only active during explicit processing. Furthermore, we found specific activation in subgenual anterior cingulate cortex (sgACC) during explicit processing in bilateral basal ganglia during implicit processing. A psycho-physiological interaction (PPI) analysis revealed bi-directional connectivities in a fronto-temporo-limbic prosody network. Finally, a sequential approach using dynamic caudal modeling (DCM) and Bayesian model selection (BMS) revealed a right hemispheric network where feed-forward signals in the STG network mainly converge in pSTG. The amygdala sends feed-forward signals to this STG network during explicit processing, but there is a bi-directional information flow between the IFC and the STG network during implicit processing. Together, these data suggest (1) common as well as distinct brain regions during explicit and implicit processing of emotional prosody, (2) a high interconnectivity in this brain network, and (3) a causal network with the pSTG as central voice sensitive regions receiving and exchanging information with limbic and IFC regions depending on the task requirements.

E29

DIFFERENTIAL RESPONSE TO FOOD IMAGES PREDICTS DIET OUTCOME: AN FMRI STUDY Trisha M. Patrician[1,2], Florence J. Breslin[1], Laura E. Martin[1], Rebecca J. Lepping[1,2], Anthony M. Lynch[2], Rebecca Hughey[1], Amanda S. Bruce[3], Joseph E. Donnelly[2], Cary R. Savage[1]; [1]University of Kansas Medical Center, [2]University of Kansas, [3]University of Missouri-Kansas City — One third of the United States population is obese (body mass index [BMI] ? 30 kg/m2), and many individuals regain lost weight within one year. Previous neuroimaging studies have shown that obese and healthy weight individuals respond differently to food cues and hunger states, as do successful dieters compared with individuals who are not dieting. The current study sought to extend the present literature by using functional magnetic resonance imaging (fMRI) to investigate baseline brain function in a group of dieters, then identifying those who lost weight (successful) and those who did not (unsuccessful). Prior to beginning a diet intervention, 66 obese participants were scanned while viewing food and nonfood images before and after eating a standardized meal. Participants who had lost ? 7% of their pre-diet body weight at the conclusion of the 12-week intervention were considered successful. Results showed a cluster of differential responding in the left orbitofrontal cortex (OFC). In this region, unsuccessful dieters responded more to meal state and stimulus type than did successful dieters. Specifically, unsuccessful dieters showed greater OFC activation (food versus nonfood) than successful dieters, a pattern that was most pronounced post-meal compared with pre-meal. In contrast, successful dieters did not show differential responding to meal state or stimulus type in the OFC. Increased OFC activation pre-diet may predict an individual's ability to lose weight. It is possible that unsuccessful dieters continue to experience food stimuli as highly rewarding even after eating, contributing to chronic overeating and difficulty losing weight.

E30

DISTRACTOR PROCESSING IN HEALTHY YOUNG AND OLDER ADULTS: AN ERP STUDY Ana Ramchurn[1], D. Bunce[1]; [1]University of London & Brunel University, UK — Research into the global precedence effect suggests that visual processing of the "whole" (e.g., a large letter H) takes place before processing of its constituent parts (e.g., little letter Fs). In the context of age, older adults produce disproportionately slower RTs responding to local targets when the global letter is incongruent with local letters (i.e., interference), suggesting a reduced ability in older adults to inhibit salient information. Although several behavioural studies have demonstrated the global precedence effect and interference in older adults, less work has explored the role of inhibition using electrophysiological methods. In the present study, healthy young (M = 25 years) and older (M = 74 years) adults performed a Global-Local task with simultaneous recording of their electrophysiological activity. Event-related potentials were extracted, and analyses focused on the N2 component. Analyses of behavioural RTs indicated that while older adults were significantly slower than younger adults overall, global interference in local responding was similar for both age groups. Larger N2 for incongruent (vs. congruent) stimuli suggested that N2-related processing is greater when successfully responding to targets simultaneously presented with con-

flicting distractor information. While there was no age difference in N2 for local-responding, older adults exhibited smaller N2 than young adults for global-responding, suggesting that the source of the slower RTs in older adults was due to greater distractor processing. Discussion focuses on the implications of these findings for age differences in the processing of salient distractor information.

E31

GREATER AUTOMATIC FACIAL MIMICRY FOR MORE SOCIALLY REWARDING FACES: EVIDENCE FROM A FACIAL ELECTROMYOGRAPHY (EMG) STUDY Thomas Sims[1], Carien M. van Reekum[1], Tom Johnstone[1], Bhismadev Chakrabarti[1,2]; [1]Centre for Integrative Neuroscience and Neurodynamics, School of Psychology and Clinical Language Science, University of Reading, [2]Autism Research Centre, Department of Psychiatry, University of Cambridge — Facial mimicry, which occurs both unconsciously and spontaneously during social interaction, represents a rudimentary form of empathy. Social psychological studies have shown that people tend to mimic those who they like more. This has led to the proposal that more rewarding social stimuli elicit greater automatic mimicry. To test this, Thirty-two participants (26 females) took part in an implicit reward conditioning paradigm which was used to manipulate the reward value associated with four neutral target faces. The participants subsequently viewed short video clips of the same target faces making happy and angry emotional expressions, while facial EMG was recorded from the Corrugator Supercilii (CS) and the Zygomaticus Major (ZM) muscles as a measure of automatic facial mimicry. While watching the happy expressions, participants showed significantly higher activation in the congruent muscle (ZM) to faces associated with high rewards, than in response to those associated with low rewards (all $p<0.05$). No difference was observed for the incongruent muscle (CS) response to the happy faces. No significant differences were observed for angry faces associated with different reward values. These results suggest that reward value of a socially rewarding stimulus (e.g. a happy face) can modulate the extent of automatic facial mimicry. Given the central role of facial mimicry in mediating emotion understanding, this result has a crucial implication for conditions such as Autism Spectrum Disorders, where a deficit in automatic facial mimicry has been observed.

E32

GENDER DIFFERENCES IN RESPONSE TO A COMMON NOISE DISTRACTION Veronica Galvan[1], Mat Golley[1], Maddie Lenard[1], Ankita Dhar[1], Ross Kendall[1], Kandice Ocheltree[1], Cynthia Gutierrez[1]; [1]University of San Diego — Psychosocial stressors reliably elicit a stress response in both males and females. However, there are gender differences that depend on the type of stressor: males are more likely to be stressed by achievement stressors, while females are more likely to be stressed by social rejection. Our study sought to examine the effects of a common, 'everyday' distractor, overheard conversations. Subjects were pre-screened via a telephone interview for stress-related diseases, recent surgery, etc; females both on and off oral contraceptives were asked to participate during days 16-24 of their menstrual cycle. Subjects believed they were participating in a study examining school performance. While they were doing an SAT task, they were exposed to different types of conversation carried on by a confederate(s). Saliva was sampled two times before (baseline) and four times after the exposure (post-immediate, post-twenty, post-forty, and post-sixty). Survey results indicated that both males and females were irritated by the conversation distractor. Hormone analysis revealed a cortisol peak eight minutes after conversation initiation and declined thereafter. Analysis by gender revealed that males and females were affected by different types of conversation. Although the type of conversation may have caused these differences, the situation surrounding saliva sampling may also have been a factor. Males had higher cortisol levels when surrounded by two female confederates (a possible achievement stressor), while females had higher cortisol responses when accompanied by a single female confederate.

E33

CONTEXTUALLY EVOKED EMOTION RESPONSES IN FUSIFORM FACE AREA AND EXTRASTRIATE BODY AREA Charlotte Sinke[1,2], Jan Van den Stock[1], Rainer Goebel[2], Beatrice de Gelder[1,3]; [1]Cognitive and Affective Neurosciences Laboratory, University of Tilburg, Tilburg, the Netherlands, [2]Department of Cognitive Neuroscience, University of Maastricht, Maastricht, the Netherlands, [3]Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Harvard Medical School, Charlestown, MA — Humans rapidly recognize and understand facial expressions of others, as shown by numerous behavioral and neuroimaging studies. An important factor that may influence this recognition process is the context in which the face is perceived. Affective scenes have already shown to influence an ERP component (the N170) of facial expressions, indicating that the face is already at an early stage encoded differently in an affective context. Using functional magnetic resonance imaging, we tried to investigate the influence of an emotional scene on the neuronal processing of fearful and neutral faces. Fourteen participants were being scanned while they were shown photographs (248 trials) of either a fearful, neutral or no face in a fearful, neutral or scrambled scene. To stay focused, they had to respond to an oddball. The experiment consisted of four runs of 31 blocks. Eight stimuli were presented per block for 800 ms with an interval of 350 ms. Also, a functional localizer for the perception of faces, bodies, houses and tools was used. As predicted, we found that activity for fearful faces in right fusiform gyrus increases when they are embedded in a fearful scene. In addition, parahippocampal place area and retrosplenial complex show less activation for a scene when it is fearful. Most interestingly, extrastriate body area is highly responsive to a fearful facial expression embedded in a threatening scene, even though there is no body visible. Moreover, this area responds to the threatening scene when there is a neutral face and even without face.

E34

NEURAL BASIS OF SELF-TRANSCENDENT EMOTIONS DEMONSTRATED THROUGH INTER-SUBJECT SYNCRONI-ZATION OF CORTICAL ACTIVITY DURING FREE-VIEWING James Morris[1], Jonathan Haidt[1], Zoe Englander[1]; [1]University of Virginia — To date, most research investigating the neural basis of moral emotions has been dedicated to emotions that give rise to negative evaluations of others (e.g. anger, disgust). Emotions triggered by the virtues and excellences of others have been almost completely ignored. Using fMRI, we investigated the neural basis of two self-transcendent emotions – Admiration for Physical Skill (AD), and Moral Elevation (EL) caused by witnessing acts of moral beauty. Ten participants viewed the same nine video clips, three belonging to the AD condition, three belonging to the EL condition and three belonging to a neutral condition. We then performed pair-wise voxel-by-voxel correlations of the BOLD signal between individuals for each video clip and a separate resting-state run. Replicating prior work, we found a high degree of inter-subject synchronization, regardless of stimulus condition, across several brain regions during free-viewing of videos. EL videos evoked significant inter-subject synchronization in brain regions previously implicated in self-referential and interoceptive processes, including medial prefrontal cortex, precuneus and insula. The degree of synchronization was highly variable over the course of the videos, with the highest amount of synchronization occurring during portions of the videos that were rated by later judges to be most emotionally arousing. These same brain regions did not show high synchronization for either neutral or AD videos. Results suggest that inter-subject synchronization may provide a new and useful tool for understanding moral emotions.

E35

DOES THE ISOLATION OF CRITICAL FACIAL FEATURES MODULATE ACTIVITY IN EMPATHY-RELATED BRAIN REGIONS IN INDIVIDUALS WITH PSYCHOPATHIC TRAITS? Thida Han[1], Gésine L. Alders[1], Steven G. Greening[1], Richard W. J. Neufeld[1], Derek G. V. Mitchell[1]; [1]The University of Western Ontario — The ability to accurately interpret the emotions of others is crucial for effective social functioning. Psychopathy, a develop-

mental disorder characterized by a manipulative interpersonal style and increased risk for violent offending, is also associated with an impaired ability to recognize fearful facial expressions. Previous literature has demonstrated that this impairment can be remedied when attention is redirected to critical cues, specifically the eye region of fearful faces. However, it is unclear whether this improvement elicits genuine empathy or reflects a compensatory mechanism that may be less likely to facilitate prosocial behaviours ('pseudo-empathy'). In the current study, fMRI was used to examine the activity of empathy-related brain regions in a community sample of individuals with high versus low psychopathic traits (N=28) while completing an emotion recognition task involving fearful, happy, angry, disgusted, and neutral faces. Facial features were isolated systematically so that participants were exposed to intact faces as well as partial face stimuli consisting of only the most or least diagnostic features. We then contrasted activity between the most diagnostic (eyes only) and the least diagnostic condition (eyes removed) of fearful faces. Preliminary results of these analyses reveal that when viewing the least diagnostic features of fearful faces, participants with high psychopathic traits show reduced activity in neural regions associated with emotion (amygdala and medial prefrontal cortex), and attention (fronto-parietal network), relative to their low psychopathic trait peers. These findings suggest that neurocognitive systems responsible for orienting attention to salient facial features functions abnormally in individuals with high psychopathic traits.

E36

DO ALL THREATS WORK THE SAME WAY? EVIDENCE FOR EARLY DIVERGENCE AND LATER CONVERGENCE IN FEAR AND DISGUST PROCESSING Elizabeth Krusemark[1], Wen Li[1]; [1]University of Wisconsin — The literature on threat processing has been dominated by an almost exclusive focus on fear, resulting in limited knowledge about other meaningful threat emotions (e.g., disgust). In two studies, we compared analysis of fear versus disgust emotions at early and later stages of the cognitive stream. The first study (N=43) examined early visual event-related potentials (VERPs) to images eliciting disgust, fear or neutral emotion in combination with a basic visual search task presented immediately after the image. Visual ERPs indicated enhanced response to fear images and suppressed activity to disgust images, relative to neutral images (p's<.001). Tracking this profile, fear facilitated and disgust delayed visual search performance (p's<.001). These findings thus suggest that fear and disgust instigate opposite sensory and attentional processes at an early stage. The second study (N=40) concentrated on later processing by examining how these threat images modulated responses to a neutral object (a greeble) that followed about 425 ms (jittered) later. We replicated differential VERPs to fear and disgust images shown in Study 1. Strikingly, N170 to greebles (emerging about 600 ms post image onset) was comparable when preceded by disgust or fear images (nevertheless, more pronounced than that subsequent to neutral images; p's=.001). In parallel, distance estimation of greebles (as a measure of social avoidance) was equivalent between fear and disgust trials (but more proximal than neutral trials; p's<.01). Together, these results highlight the dynamic temporal course of threat processing, evolving from relatively mandatory sensory discrimination to later functional convergence to motivate adaptive behavior.

Emotion & Social: Development & Aging

E37

ANXIETY, SLEEP EFFICIENCY, AND 5-HTTLPR GENOTYPE IN OLDER ADULTS John Flournoy[1], Taryn Weinkam[1], Joachim Hallmayer[1], Ruth O'Hara[1]; [1]Stanford University School of Medicine — Anxiety and insomnia co-occur in older adults (Magee & Carmin, 2010). More specifically, anxiety and poor sleep efficiency (SE) are associated in older women (Spira et al., 2009). Also, recent evidence suggests that serotonin transporter gene promoter region (5-HTTLPR) genotype moderates the relationship between stress and subjective sleep quality (Brummett et al., 2007). We investigated whether any association of anxiety and sleep efficiency is similarly moderated by 5-HTTLPR genotype. 102 community-dwelling older adults (43 males, 59 females, mean age 71.18) completed the Beck Anxiety Inventory (BAI) and Spielberger State-Trait Anxiety Inventory (STAI). Participants were genotyped using Polymerase chain reaction amplification, and assessed with in-home full ambulatory polysomnography for SE. We measured self-report of sleep quality with the Pittsburgh Sleep Quality Index (PSQI). We found no significant associations when regressing BAI scores on age, SE, presence of the 5-HTTLPR short (s) allele, and the interaction of 5-HTTLPR and SE. In secondary analysis, PSQI scores were significantly associated with the interaction of 5-HTTLPR genotype and SE (p=.03). Contrary to our expectations, we did not find any relationship between SE and anxiety, nor between SE, 5-HTTLPR genotype and anxiety. However, our results do indicate that 5-HTTLPR genotype moderates the impact of inefficient sleep on subjective sleep quality and suggest that individuals with the s allele may be more emotionally or cognitively affected by sleep disturbances. This differential sensitivity may help explain discrepancies observed in studies relating objective to subjective sleep quality.

E38

CHILDREN'S UNDERSTANDING OF SOCIALLY-RELEVANT CATEGORIES: THE ROLE OF THE AMYGDALA IN RACIAL/ETHNIC CATEGORIZATION Eva Telzer[1], Mor Shapiro[1], Kate Humphreys[1], Nim Tottenham[1]; [1]University of California, Los Angeles — Successful social development depends on identification of context-relevant social categories. A salient social category is race/ethnicity, which develops early. Three-month-old infants show preferences for own-race faces, and 3-year-old children often show a bias in favor for European-Americans and a prejudice for ethnic minorities. Developmental psychologists have been attempting to understand whether racial biases are rooted in ingroup favoritism, outgroup derogation, or culturally learned associations. The current study uses neuroimaging techniques to examine how children construct an understanding of socially-relevant categories. Children, 4-17 years (40% European-American, 23% Asian-American, 15% African-American) completed a functional MRI scan during which they matched faces (European-American, African-American, and Asian-American) based on emotion. Additionally, we measured children's self-reported attitudes towards African-Americans and their neighborhood ethnic diversity. Results indicate that children do not report negative, prejudicial biases towards African-Americans but report that the majority of African-Americans have good characteristics such as friendly, smart, not ugly, and not bad. In addition, the more ethnically diverse children's neighborhoods, the more positive their attitudes are towards African-Americans. Finally, the more positive children's attitudes towards African-Americans, the greater bilateral amygdala activity they show to African-American relative to European-American faces. This finding suggests that the developing amygdala is not signaling threat or negative valence to these facial images but is signaling previously learned social associations for these stimuli. Together, these findings suggest that racial biases may reflect culturally learned associations shaped through one's neighborhood context, and these biases do not necessarily reflect derogation of traditionally stigmatized groups, but may be positive in nature.

E39

NEURAL CORRELATES OF RISK-TAKING IN RISK-AVERSE ADOLESCENTS Adriana Galván[1], Tara Peris[1], Kristine McGlennen[1]; [1]University of California, Los Angeles — Adolescents are typically characterized as risk-takers. Relative to children and adults, they show heightened risky behavior and exaggerated neural activation in dopamine-rich circuitry during reward processing and risky choice. However, not all adolescents are risk-takers. Anxious youth in particular show greater risk aversion than their non-anxious counterparts and display decreased risk-taking behavior. In this study, our goal was to examine neural correlates of risk-taking in these risk-averse youth to determine whether risk-aversion in adolescence is associated with decreased ventral striatal recruitment (contrary to age-typical patterns of activation) or whether

exaggerated ventral striatal activation characteristically observed in non-anxious adolescents is observed in the absence of heightened risk-taking phenotypes. While undergoing functional magnetic resonance imaging (fMRI), anxious and non-anxious adolescents (ages 13-17) performed a modified version of the Cups Task, which is designed to assess risky choices under positive and negative contexts. Behaviorally, anxious youth made less risky choices than non-anxious youth. This behavioral difference was associated with less ventral striatal activation in anxious versus non-anxious youth. However, both groups showed similar patterns of activation in the lateral orbitofrontal cortex and parietal regions. These data suggest that while cortical circuitry may be conserved across adolescence regardless of risky behavior, ventral striatal regions may specifically influence risky behavior. Further, this study shows that we can gain traction in the neural correlates of risky behavior in adolescence by examining age-matched adolescents who differ on risk-taking phenotypes.

E40

POSTNATAL ADVERSITY IS ASSOCIATED WITH IMPAIRED EMOTIONAL LEARNING DURING CHILDHOOD Kathryn L. Humphreys[1], Nim Tottenham[1]; [1]UCLA — Learning about the emotional contingencies of environmental stimuli is a fundamental means of navigating the world independently. Rodent studies show that these processes are dramatically impaired by postnatal maternal deprivation (Sullivan et al., 2006). We examined emotional learning using a simple associative learning task in a sample of children with typical and atypical early life experience. We hypothesized that, consistent with the rodent literature, the ability to learn about emotional contingencies would be impaired following postnatal maternal deprivation in the form of institutionalized care. Previously institutionalized (PI) and comparison children were administered a task in which balloons could be pumped for an initially unknown number of times to collect reward (if balloon exploded from too much pumping, reward was lost). Three different balloon colors were associated with either a high, low, or variable number of pumps to explosion. A significant interaction was found by caregiving condition and balloon contingency ($F=2.41$, $p<.05$), where comparison children showed evidence of learning these associations by the end of the task and PI children did not show such evidence. This failure to learn the contingencies by the PI group was associated with the PI group making fewer pumps in total ($F=4.48$,$p<0.05$). Thus, the impaired ability to recognize response contingencies was associated with more inhibited behavior by the PI group. These findings suggest emotional learning is impaired following early caregiver deprivation and are consistent with our previous work showing atypical development of neural circuitry involved in emotional learning (e.g., the amygdala; Tottenham et al., 2010a, 2010b).

E41

DEVELOPMENT OF BRAIN RESPONSES TO VALENCED STIMULI IN A COGNITIVE CONTROL CONTEXT James Porter[1,2,3], Paul Collins[1,2], Ryan Muetzel[1,4], Monica Luciana[1,2,3]; [1]University of Minnesota, [2]Center for Neurobehavioral Development, [3]Center for Cognitive Sciences, [4]Center for Magnetic Resonance Research — The neural mechanisms of reward processing are of particular interest to the study of adolescent risk-taking. FMRI studies show the striatum, especially nucleus accumbens (NAcc), and the orbitofrontal cortex (OFC) to be reliable neural correlates of reward anticipation. The NAcc is associated with the presence of rewards and the absence of punishments, though recent studies indicate NAcc may be equally responsive to the onset of both aversive and appetitive stimuli. Additionally, there is evidence that adolescents show greater NAcc response to rewards compared to children and adults, and that adults show greater prefrontal cortical (PFC) activity. The current study examined brain responses to the onset and offset of appetitive and aversive visual stimuli in a healthy developmental sample (ages 11–24, N=31). Participants performed a novel fMRI task designed to elicit cognitive control over emotional reactivity. Participants experienced discrete time intervals via visual displays, and then had to accurately reproduce the intervals in order to win money. The image content on each trial varied by valence: positive/appetitive, negative/aversive, or neutral. Robust fMRI activation was seen in hippocampus, amygdala, caudate, putamen, NAcc, OFC, and dorsolateral (DL) PFC. Image onset activated OFC, DLPFC, and primary visual cortex. Image offset engaged these areas, as well as hippocampus, amygdala, insula, ventrolateral PFC, middle temporal gyrus, precentral gyrus, and secondary visual areas. Positive images elicited significantly greater NAcc response to image onset and offset, compared to negative images. Developmental effects within these regions, and implications for risk-taking behavior, will be discussed.

E42

AGE DIFFERENCES IN AMYGDALA FUNCTIONAL CONNEC-TIVITY DURING REST Michiko Sakaki[1], Matthew Sutherland[1], Lin Nga[1], Mara Mather[1]; [1]University of Southern California — Cognitive decline in normal aging has been associated with gray matter loss and anatomical disconnection across brain regions that ordinarily function together. In line with this idea, past studies revealed that healthy older adults show decreased activity of the "default-mode network" and reduced correlations among brain regions involved in this network (Damoiseaux et al., 2008). While many cortical regions in the default mode network decline with increasing age, the gray matter volume of the amygdala is relatively preserved in older adults (Grieve et al., 2005). This suggests the possibility that the functional connectivity of the amygdala is not disrupted among older adults. To examine this, we compared functional connectivity during rest in older people (N = 20; age range 61-78) with younger people (N = 20; age range 19-37). Consistent with previous findings, we observed greater involvement of posterior cingulate in the default-mode network of younger adults than of older adults. However, using the amygdala as a seed region revealed stronger functional connectivity in older people: Both the left and right amygdala had greater positive connectivity with the occipital and temporal lobes in older people than in younger people. Similar age-related increases in amygdala functional connectivity were found during fixation periods during a task in the same participants and during rest in another independent group of participants. These results indicate that aging is not always accompanied with reductions in the functional connectivity across brain regions, and that the amygdala has stronger functional connectivity during rest as people get older.

E43

STRUCTURAL BRAIN CORRELATES OF SUCCESSFUL STRESS REGULATION IN CHILDREN Jamie Hanson[1], Moo Chung[1], Brian Avants[2], Elizabeth Shirtcliff[3], James Gee[2], Seth Pollak[1], Richard Davidson[1]; [1]University of Wisconsin-Madison, [2]University of Pennsylvania, [3]University of New Orleans — The ability to regulate one's behavior in stressful conditions is an essential component of successful human adaptation. Such regulatory processes are likely subserved by a complex constellation of interconnected brain regions. One outstanding question is whether particular brain regions important for regulation operate in a domain-general manner, and are predictive regulatory behavior across a variety of contexts. In this study, we examined the neurobiological correlates of stress regulation in a sample of typically developing children (n=61; mean age=11.8 years) using a tensor-based morphometry analytic framework to analyze structural MRI. Intensive interviews were conducted with parents and children about functioning of the child participant at school, at home, with friends, and within the family. We hypothesized that successful regulation of stress would be related orbitofrontal morphometry as research in non-human animals and humans have implicated this region in adaptive control of behavior in changing environments. Using Logical AND conjunctions that combined four correlations between voxel-wise Jacobian determinants (a metric of volumetric contraction or expansion) and interview ratings of stress regulation in different contexts, we found a significant association between successful stress regulation across multiple life domains and larger volumes in the orbitofrontal cortex (minimum correlation $r>.436$;$p=\sim0.00000001$ uncorrected). In addition to the oFC, volumetric properties of the cuneus were related to functioning across multiple domains of behavior (minimum correlation

r>.374;p=~0.00000001 uncorrected). For both regions, smaller volumes were related to poorer functioning across all domains. These findings suggest regulatory (oFC) and attentional (cuneus) regions may be involved with domain-general stress regulation and functioning.

Emotion & Social: Other

E44

TASK GOALS AND ACHIEVEMENT MINDSET INFLUENCE ATTENTION TO FEEDBACK AND LEARNING SUCCESS IN A CHALLENGING MEMORY TASK Sylvia Rodriguez[1], Belen Guerra[2], Tory Higgins[1], Jennifer Mangels[2]; [1]Columbia University, [2]Baruch College, City University of New York — Achievement goals have an important influence on learning success, in part by directing how attention is oriented toward task-relevant information. Particularly in challenging task situations, a focus on mastery of the material (mastery focus) is considered to be more adaptive than a focus on proving ability relative to others (performance focus) because it keeps attention oriented toward learning rather than toward cues of potential failure. Other research suggests, however, that task engagement benefits most from congruence or "fit" between the individual's mindset and the goals emphasized by the environment, even if both are performance oriented. The current study investigated how both task goals and participant mindset influence attention toward, and the ability to learn from, feedback in a difficult memory retrieval task. One task block was framed to emphasize performance; the other to emphasize learning. Event-related potentials (ERPs) were recorded to performance (accuracy) and learning (correct answer) feedback after each trial. Performance framing biased attention toward negative accuracy feedback, as evidenced by an enhanced late positive potential (LPP; 400-600 ms), with endorsement of performance goals additionally predicting the extent to which this LPP was sustained (800-1000 ms). Mastery framing biased attention toward learning-relevant feedback, as evidenced by an enhanced inferior temporal negativity (200-600 ms) that also predicted successful encoding of this information. Although a mastery mindset was most predictive of learning success in the mastery frame, a performance mindset was most beneficial in the performance frame. This "fit" effect suggests that attention to performance feedback does not necessarily undermine learning.

E45

NEURAL CORRELATES OF INDIVIDUAL DIFFERENCES IN THE E-I PERSONALITY DIMENSION UNDER STRESS In Jae Hwang[1], Kyung Hun Han[1], Sang Eun Chi[1], Eung Suk Kim[1], HyunTaek Kim[1]; [1]Korea University — Humans have different coping strategies to deal with stress in same stressful situations, according to individual differences in personality. The present study investigated the differences of the underlying neural mechanisms between Extroversion and Introversion by using event-related potentials (ERPs) and electroencephalogram (EEG). In the experiment, 40 subjects (age range 19-28 years; 16 males & 24 females) were assigned to two groups (20 E-extroversion, 20 I-introversion) according to the Korean version of the Eysenck Personality Scales. Subjects performed a visual cognition task, both without a stressor (No-stress condition) and with a stressor (Stress condition) during the ERP recording. Subsequently, EEG was recorded in two different conditions (eyes-open and -closed) in each experimental condition (Stress and No-stress). The behavior measure was obtained from State-Trait Anxiety Inventory in each session. The present study showed: (1) In the ERP response, N1, P2, and P3 peak amplitudes decreased significantly in E-group in Stress condition; and (2) The Alpha band (8-13Hz) in I-group increased significantly at Fz, Cz, and Pz sites (in the eyes-closed condition) after removing the stressor. In addition, the Beta and gamma bands (13-30Hz, 30-50Hz) increased significantly in E-Group. The main findings were that the E-I personality trait can manifest itself by the characteristics of ERP and EEG in Stress and No-stress conditions. These results suggest that the introversion group tends to be able to relieve tension and to be relaxed, whereas the extroversion group tends to turn their attention to other stimuli and/or to seek other interests in No-stress condition.

E46

THEORY OF MIND BRAIN REGIONS ARE SENSITIVE TO THE CONTENT, NOT THE STRUCTURAL COMPLEXITY, OF BELIEF ATTRIBUTIONS Jorie Koster-Hale[1], Rebecca Saxe[1]; [1]Massachusetts Institute of Technology — Previous work has found that a distinct group of brain regions, the 'Theory of Mind network', responds to reading or thinking about other people's thoughts, beliefs and desires. We investigated whether ToM regions are sensitive to two dimensions along which mental state attributions can vary: (1) structural (syntactic) complexity and (2) content of belief. Our stimuli consisted of vignettes describing someone's belief . The content of the belief was mundane or socially-relevant (thoughts about e.g. housework and haircuts or scandal and sexual relations). The form the belief description was either first-order ('John thinks that …') or higher-order ('John thinks that Mary believes that he thinks that…'). In each participant, we defined functional regions of interest (ROIs) for regions implicated in ToM (contrasting False belief > False photograph stories) and in language processing (False Photograph stories > lists of Non-Words). Most ToM regions - temporo-parietal junction bilaterally, precuneus and medial prefrontal cortex - show significantly higher response to beliefs with socially-relevant content, compared to mundane content; none showed a higher response to embedded than to first-order belief attributions. By contrast, most language regions were sensitive to syntactic embedding - left inferior frontal gyrus and left temporal lobe show a higher response during higher-order than first-order belief attributions, while left angular gyrus and left superior frontal gyrus show a higher response during first-order attributions. We conclude that ToM regions are sensitive to the content, but not structural complexity, of belief attributions, while many language regions are sensitive to the structural complexity.

E47

ATYPICAL EEG AND TMS ACTIVITY DURING PAIN OBSERVATION IN AMPUTEES WHO EXPERIENCE SYNAESTHETIC PAIN Bernadette M Fitzgibbon[1], Peter G Enticott[1], Melita J Giummarra[1], Richard Thomson[1], Nellie Georgiou-Karistianis[1], John L Bradshaw[1]; [1]Monash University — For some people, observing pain in another person causes the sensation of pain to oneself; 'synaesthetic pain'. Early reports indicate that this experience is not uncommon among amputees with phantom pain. We used electroencephalography (EEG) to determine if amputees who experience synaesthetic pain process observed pain differently to controls. While observing pain-related images, we compared the EEG response of amputees who experience phantom pain and synaesthetic pain, to that of amputees who experience phantom pain but not synaesthetic pain, and to healthy controls. We found that the pain synaesthete group showed reduced event-related potentials (ERPs) components at certain electrode sites, and reduced theta and alpha band power at a central electrode over the sensorimotor cortex compared to controls. We speculate that the observed reduction in ERP amplitude and theta band power may reflect inhibition of the processing of observed pain, perhaps as a protective strategy, and that the reduced alpha band power may indicate a disinhibition of processes that may result in synaesthetic pain. Complimenting this finding is preliminary transcranial magnetic stimulation data implicating increased pain-related inhibition in pain synaesthetes compared with controls. These findings demonstrate the first documentation of atypical neurophysiological activity in pain synaesthetes when observing pain in another person.

E48

THE ROLE OF CULTURE ON THE AUTOMATICITY OF EMPATHY: THE MODULATING INFLUENCE OF INTERDEPENDENCE Bobby Cheon[1], Dongmi Im[2], Tokiko Harada[3], Ji-Sook Park[2], Vani Mathur[1], Jason Scimeca[1], HyunWook Park[2], Joan Chiao[1]; [1]Northwestern University, [2]Korea Advanced Institute of Science and Technology, [3]Nagoya University — The social neuroscience of empathy has demonstrated that social and interpersonal processes may modulate the mechanisms underlying empathy. Limited attention has been devoted to understanding the influence that culture

may exert on empathic processes. Here we sought to examine how a dimension of interdependent self-construal style reflecting how readily one engages in processing the internal states of others may modulate the automaticity of empathic processing among participants from individualistic (i.e., United States) and collectivistic (i.e. Korea) cultures. Using cross-cultural fMRI, we examined how an index of 'other-focusedness' modulated neural activity when Caucasian-Americans and Koreans viewed scenes of others in emotional distress without being required to engage in empathic processes. Whole-brain regression revealed that greater levels of 'other-focusedness' was associated with greater reactivity in regions that process pain and empathy such as the anterior cingulate cortex (ACC) and right anterior insula (AI). Cross-cultural comparisons revealed that this relationship between activity in the ACC and right AI with 'other-focusedness' was stronger among Korean relative to Caucasian-American participants. Furthermore, whole-brain regressions conducted independently among the members of the two cultures revealed that greater levels of 'other-focusedness' among Koreans, but not Caucasian-Americans, corresponded with greater reactivity in the ACC, bilateral AI, and medial prefrontal cortex. These findings suggest that interdependent social processing styles may have different consequences for empathy within collectivistic and individualistic cultural contexts, and that culture and interdependence may interact to determine how automatically empathic processes are engaged.

E49

SEARCHING FOR THE HUB VOXELS OF FMRI DATA WITH THE HYPERGRAPH MODEL Joon Shik Kim[1], Eun-Sol Kim[1], Byoung-Kwon Lim[1], Byoung-Tak Zhang[1]; [1]Seoul National Univeristy — Traditional functional magnetic resonance (fMRI) studies focus on the activation contrast between different tasks during an imaging. Hub voxels of emotion are brain regions which are in common over many categories of emotion. We used a hypergraph model to endow each voxel with a centrality, i.e., importance rating. The Pittsburgh brain activity interpretation contest (PBAIC) 2007 fMRI data were used with 7 emotion categories. Seven emotional categories include "annoyed angry", "arousal", "body", "dog visible", "dog", "faces", and "fearful anxious". We extracted the voxels whose correlation values were larger than 75% of the maximum correlation value between each emotional rating and blood oxygen level dependent (BOLD) signal. A hypergraph is a collection of hyperedges, which contain a number of vertexes. In our study, hyperedges are emotional categories, and the vertexes are the voxels correlated with each emotional state. A hypergraph can be described with an incidence matrix (E). An adjacency matrix (A) can be obtained by the operation E(transpose)E, where (i, j) element of A is the number of hyperedges which contain i-th and j-th voxels. The eigenvector of the largest eigenvalue of an adjacency matrix was selected where each of its elements represents the centrality of each voxel. In our analysis, voxels in occipital lobe, precuneus and precentral gyrus were observed to have high centrality. Visual, visuospatial, and motor areas seem to play an important role in emotion processing during a video game experiment.

E50

VIVID: A FULLY CROSSED ERP INVESTIGATION OF VALENCE, AROUSAL, CONCRETENESS, AND FREQUENCY Nathaniel Delaney-Busch[1], Vivian Haime[1], Gianna Wilkie[1], Gina Kuperberg[1,2]; [1]Tufts University, [2]Martinos Center for Biomedical Imaging, Mass General Hospital — Volcano. Samurai. Spicy. Immense. Rouse. Surprise. There seems to exist a small class of words that are highly salient, but neutral or ambiguous in their emotional valence. These words, though often omitted in studies of emotional language, are required for a full evaluation of the impacts of valence, arousal, and their interactions on word processing. We used event-related potentials (ERPs) to investigate the time-course of processing positive, negative, and neutral words that were either high or low in arousal, by presenting 468 self-paced single words to participants as they responded to randomly inserted probe words (animals). In addition, the influences of concreteness (high, low) and frequency (high, medium, low) on emotional word processing were evaluated. Word groups were matched such that any one-way or two-way analysis could be performed without confounds by collapsing across variables (valence, arousal, concreteness, or frequency) not being assessed in that analysis. Using this robustly matched and expansive word set, the amplitude of the late positivity was the same to positive, negative and neutral words, once effects of arousal were controlled. Instead, arousing words evoked a larger positivity than non-arousing words. This effect was most pronounced for emotional words, but it was also elicited by neutral stimuli. These results suggest that the late positive component often elicited with emotional stimuli is more a marker of arousal than either emotion per se or emotional valence. Important considerations for past and future experiments of emotional language are also discussed.

E51

PERCEIVING EMOTIONAL VALENCE OF PICTURES: RELATIVE HEMISPHERIC COMPETENCE AND THE ROLE OF HEMISPHERIC INTERACTION Andrew Hughes[1], Barbara Rutherford[1]; [1]UBC Okanagan — Two hypotheses of relative hemispheric competence for emotional processing were tested: The emotional valence hypothesis predicts a right hemisphere advantage for processing negative emotions and a left hemisphere advantage for positive emotions, while the right hemisphere hypothesis predicts a right hemisphere advantage for emotion, regardless of valence. Also tested were predictions that hemispheric interaction reduces efficiency of processing simple stimuli and benefits the processing of complex stimuli. Two experiments presented pictures at fixation, with a distractor to the left visual field or right visual field or with no distractor at all. Experiment two also included a double distractor condition. Response time and accuracy to classify the picture as pleasant or unpleasant were recorded. Results revealed faster and more accurate responses to positive than negative pictures, suggesting positive pictures are more simple to process than negative. Positively-valenced pictures also were more efficiently processed by the left than the right hemisphere and hemispheric interaction reduced efficiency. Negatively-valanced pictures were better processed by the right than the left hemisphere, but were were most efficiently processed using the combined hemispheres. Taken together, the results support the valence hypothesis and suggest that task complexity impacts the outcome of hemispheric interaction.

E52

IS BEING FEMALE PROTECTIVE AGAINST AUTISM SPECTRUM DISORDERS? OXYTOCIN AND VASOPRESSIN LEVELS IN CHILDREN AND ADOLESCENTS Meghan Miller[1,2], Marjorie Solomon[1,3], Karen Bales[3], Sandra L. Taylor[3], Jong Yoon[3], Michael Minzenberg[3], Cameron S. Carter[3]; [1]MIND Institute, [2]UC Berkeley, [3]UC Davis — Male predominance of autism spectrum disorders (ASD) is estimated at 4 to 1. It has been theorized that processes mediated by oxytocin (OT), and lack of reliance on arginine vasopressin (AVP), make being female protective against autistic-like behavior (Carter, 2007). This study (1) examined blood plasma levels of OT and AVP in girls and boys with ASD and typical development, and (2) related OT and AVP levels to autism and internalizing symptom measures. Plasma OT and AVP levels and symptom measures were obtained from 72 children ages 8-18: 39 with high-functioning ASD (18 girls, 21 boys) and 33 typically developing children (15 girls, 18 boys). OT and AVP levels were modeled as a function of time of blood draw, age, gender, and diagnosis. There were significant effects of gender on OT levels (girls higher, Cohen's d = .47) and blood draw time on AVP levels (p = .013), and marginally significant effects of diagnosis on OT (ASD higher, Cohen's d = .43) and gender on AVP (boys higher, Cohen's d = .44). Higher OT values were associated with higher anxiety in girls and worse pragmatic language in boys and girls. OT and AVP levels were positively associated with restricted and repetitive behaviors in girls with ASD, while AVP levels were negatively associated with these behaviors in boys with ASD. Results are inconsistent with the suggestion that OT levels are lower in individuals with ASD and are suggestive of common and distinct roles of OT and AVP in boys and girls.

E53

PERSONALITY IN THE CORTEX: ASSOCIATING THE BIG FIVE TRAITS WITH REGIONAL CORTICAL THICKNESS Rachael Grazioplene[1], Matthew Russell[1], Michael Kostolnik[1], Jeremy R Gray[2], Colin G DeYoung[1]; [1]University of Minnesota, [2]Yale University — Identifying associations between personality traits and brain structure is an important step in constructing a systematic understanding of how biology subserves individual differences in behavior. DeYoung et al (2010) identified distinct regions where brain volume correlated significantly with four of the Big Five personality traits in gray and white matter. The present study sought to replicate and refine DeYoung et al.'s findings using Freesurfer's cortical reconstruction software. Analysis of the relation of Big Five traits to cortical thickness was performed in a group of 98 healthy male adults aged 20-40 years. Results indicated multiple distinct regions associated with each personality trait. Areas overlapping with DeYoung et al.'s (2010) results were identified for Extraversion (orbitofrontal cortex; related to reward sensitivity), Agreeableness (superior temporal sulcus; related to action interpretation), and Neuroticism (dorsomedial prefrontal cortex; involved in emotion regulation). Additionally, we identified a large area of the cingulate cortex related inversely to Openness/Intellect, the one trait not previously linked to regional volume. The cingulate is thought to monitor conflict during simultaneously active mental representations, a complex process which involves the dorsolateral prefrontal cortex and which may relate to the role of Openness/Intellect in cognitive flexibility and perceptual inclusiveness (DeYoung et al., 2005). These results indicate that certain brain regions appear robust in their relation to individual traits; observed differences between the current results and those of DeYoung et al. (2010) suggest that the structural morphology of gray versus white matter has both independent and interaction effects associated with individual differences in behavior.

E54

DOPAMINERGIC CONTROL OF HUMAN EMOTIONS Rajendra Badgaiyan[1]; [1]SUNY at Buffalo, [2]Harvard Medical School — Animal experiments have suggested that dopamine neurotransmission is involved at various stages of emotional processing. Its role in the processing of human emotions however is unclear. We used a dynamic molecular imaging technique to detect, map, and measure dopamine released during emotional processing in healthy young volunteers. The technique exploited the competition between endogenous dopamine and its ligand for receptor occupancy. To exploit this competition, we intravenously injected radiolabeled dopamine receptor ligand (either 11C-raclopride for detection of dopamine released inside the striatum or 18F-fallypride for detection outside the striatum) and asked the volunteers to perform a task that elicited negative emotion. The task consisted of a control and a test condition. In the control, volunteers were shown emotionally neutral words and in the test condition emotional words were presented. Each stimulus was presented for 4500 msec (ISI 5 sec) and volunteers were asked to rate the intensity of emotion elicited by each word in a scale of 1-3. During the experiment, we measured the ligand concentration using a PET camera. Based on the concentration, the rate at which the ligand displaced from the receptor sites was estimated using a receptor kinetic model. We observed that the rate increased significantly (indicating endogenous release of dopamine) in the caudate, putamen, amygdala, medial temporal lobe and the frontal cortex during presentation of emotional words (test condition). The results indicate that human emotions are processed by dopamine and that the dynamic molecular imaging technique can be used to study neurochemical control of human cognition.

E55

FOOD MOTIVATION AND IMPULSIVITY IN OBESITY: AN FMRI STUDY Laura Martin[1], Florence Breslin[1], Rebecca Lepping[1,2], Trisha Patrician[1,2], Anthony Lynch[2], Rebecca Hughey[1], Joseph Donnelly[2], Cary Savage[1]; [1]University of Kansas Medical Center, [2]University of Kansas — One third of the United States population is obese (body mass index [BMI]?30 kg/m2). In obesity, the neural systems of reward are hyperresponsive to food rewards. Behavioral studies find increased levels of impulsivity among obese individuals. The current study used functional magnetic resonance imaging (fMRI) to examine the neural systems of reward in response to food cues before and after eating among individuals beginning a 3-month diet. Twenty-three high impulsive and 19 low impulsive participants were selected from an ongoing study based on scores from the Barratt Impulsiveness Scale (BIS-11). Participants were scanned while viewing images of food and animals before and after eating a standardized meal. Results showed differential activation of the orbitofrontal cortex (OFC) between high and low impulsive obese participants in that before eating both high and low impulsive participants responded more to food than non-food cues. On the other hand, after eating high impulsive participants continued to show increased activation to food cues. However, there was no significant difference in weight loss following the 3-month diet between high and low impulsive participants. The observed activation of the OFC indicates that high impulsive participants continue to evaluate food as rewarding even after eating which in turn may make it more difficult for them to control their eating behaviors, yet this difference at the beginning of the diet does not impact their ability to lose weight while on a strict 3-month diet.

E56

ACUTE STRESS ENHANCES DEFAULT MODE NETWORK ACTIVITY 15-25 MINUTES LATER David Clewett[1], Andrej Schoeke[1], Zara Abrams[1], Mara Mather[1]; [1]University of Southern California — While stress-induced impairment of cognitive function has been observed in goal-directed paradigms, little is known about the influence of acute stress on resting state network activity. One possibility is that enhanced default mode network (DMN) activity after stress contributes to executive deficits in learning and memory. In the present study, we used pulsed arterial spin labeling (PASL) to measure differences in healthy male adults' resting state changes in regional cerebral blood flow (CBF) following a cold pressor stress induction task versus a control task, with the stress and control conditions conducted on different days. Salivary cortisol was measured before and after each scanning session as a hormonal indicator of the autonomic stress response. Following stress induction, there was an interval filled with instructions and preparations for entering a 3T MRI scanner. During the period of peak cortisol response to acute stress (fifteen to twenty-five minutes after stress induction), participants were asked to rest for six minutes with their eyes closed during a PASL scanning sequence. There was enhanced activity in the precuneus cortex, anterior cingulate cortex, secondary somatosensory cortex, fusiform cortex and left caudate in the post-stress condition compared with the control. Non-stress (control condition) resting activity was marked by significantly higher activation in the cerebellum and primary somatosensory cortex. Our results support the notion that stress biases resource allocation towards nodes in the DMN. Stress-induced DMN activity may reflect increased self-referential processes and global vigilance, representing a prioritization of vital life functions over cognitive demands.

E57

RELIABLY QUANTIFYING THE VALUE AN INDIVIDUAL ASSIGNS TO GIVING A STRANGER MONEY Andrew S Fox[1], Nathan J Vack[1], Elizabeth Vanderwerff[1], Richard J Davidson[1]; [1]University of Wisconsin-Madison — Most individuals recognize the value of both selfish and other-oriented motivations, and it is clear that there are large individual differences in these motivations between individuals. Although quantifying and increasing other-oriented behavior is of great societal interest, little is known about how to reliably measure other-oriented preferences. In order to address this question we developed a novel economic game to quantitatively measure individual differences in willingness to give to others. Specifically, we gave 72 subjects 200 forced choice monetary decisions between money for themselves ($0-$10) and money for a stranger ($0-$10). To precisely quantify the amount of money an individual was willing to sacrifice to give a dollar to a stranger (i.e. their indifference point or "IP"), we adaptively altered the ratio of the two offers. Results demon-

strated substantial variability in IP across subjects (μ=.85, ?2=1.91), suggesting that the majority of individuals do not behave purely selfishly or altruistically. Additionally, we observed that IPs were significantly correlated with related constructs such as self-reported willingness to donate to a stranger (r=-.23, p=.05). We further demonstrated the reliability of self-other IP as a measure of individual differences by re-testing 45 subjects between 2 and 14 weeks after their original test, in the same task. We observed significant correlations between IPs across time, (r=.48, p=.0008) suggesting that individual differences in IP are reliable.

E58

WHITE MATTER TRACT INVOLVEMENT AS A PREDICTOR OF POST-STROKE DEPRESSIVE SYMPTOMS Ana Soper[1], Nina Dronkers[1,2], Juliana Baldo[1], And Turken[1]; [1]VA Northern California Healthcare System, [2]University of California, Davis — Depressive symptoms are common sequelae of stroke within the chronic phase of recovery (?1 year post-CVA). While there is debate about association between lesion location and depression, the contribution of white matter tract involvement is unknown. We examined whether white matter involvement differed between individuals reporting at least mild depressive symptoms ("depressed"; n=13) and those below cutoff for mild depressive symptoms (WNL; n=16). Twenty-nine left hemisphere stroke patients were assessed with the Geriatric Depression Scale at least one year post-CVA. To examine white matter tract involvement, we overlaid tracts (from JHU and Juelich probabilistic tract mapping) onto each individual patient's digitized lesion reconstruction, and then coded degree of each lesion's involvement in the tract on a 4-point scale, ranging from 0 (no involvement) to 3 (lesion fully bisected the tract). Aphasia severity was assessed with the Western Aphasia Battery, which did not distinguish the two groups. Among 9 tracts tested, logistic regression showed that the greater the degree of cingulate gyrus (CG) involvement, the greater the probability of being classified into the depressed group (?2 (1) = 4.99, p = .03). Illustratively, individuals with at least moderate CG involvement (2 on our scale) had over 90% probability of being in the depressed group. The single predictor of CG involvement accounted for 25% of total variance in depressive symptoms. CG involvement accurately classified 69% of the people into depressed vs. WNL categories. This is the first study to implicate specific white matter tract involvement with chronic depressive symptoms in stroke patients.

E59

FAILURE OF RAPID AMYGDALA HABITUATION IN INDIVIDUALS WITH AN INHIBITED TEMPERAMENT Jennifer Blackford[1], Amil Allen[1], Suzanne Avery[1], Ronald Cowan[1]; [1]Vanderbilt University School of Medicine — Inhibited temperament is a trait that represents differences in behavioral responses to novelty. Inhibited individuals typically avoid new people, places or objects whereas uninhibited individuals approach novelty. Individuals with an inhibited temperament are at increased risk for social difficulties, including social anxiety disorder. We recently discovered that individuals with an inhibited temperament show a sustained amygdala response to newly familiar faces, in contrast to the reduced amygdala response seen in individuals with an uninhibited temperament. It is unknown whether a failure in amygdala habituation underlies the sustained amygdala response in inhibited temperament. In the present functional magnetic resonance imaging (fMRI) study we examined rapid amygdala habituation to novel faces in young adults with an inhibited (n = 19) or uninhibited temperament (n = 20). Participants viewed 6 novel, neutral faces randomly presented twice within each of four 18-s blocks. Habituation was defined as a decrease in amygdala activation between the first and last blocks. Across all subjects, both the left and right amygdala showed significant habituation. An area in the right amygdala (15 voxels, 405mL) showed a significant difference in habituation between the two groups ($p < .05$, corrected). In the uninhibited individuals, the right amygdala habituated over time, as expected. However, in individuals with an inhibited temperament, the right amygdala failed to habituate. Therefore, avoidance of novelty in inhibited temperament may be mediated by a failure of the amygdala to habituate rapidly.

E60

EMOTION REGULATION AND ANTERIOR INSULA VOLUME Nicole Giuliani[1], Roshni Bhatnagar[1], Emily Drabant[1], Kateri McRae[1,2], James Gross[1]; [1]Stanford University, [2]University of Denver — A common emotion regulation strategy, expressive suppression, involves the minimization of the outward expression of emotion. This requires an individual to constantly monitor both emotional and bodily states. The anterior insula is theorized to play a crucial role in both of these tasks: emotional awareness (Craig, 2003) and the perception of autonomic and bodily changes (Craig, 2003; Pollatos, et al., 2007). A separate literature has established the causal relationship between engaging in regular cognitive or physical behaviors and the volume of brain regions associated with those behaviors (May, 2008). Therefore, we hypothesized that frequency of suppression usage, as measured by the Emotion Regulation Questionnaire (Gross & John, 2003), would be positively associated with anterior insula volume, as measured by manual volumetric region of interest (ROI) measurement. Indeed, suppression usage positively correlated with bilateral anterior insula volume in two separate samples of healthy adults (Sample 1: r = 0.32, p = 0.02, N = 51; Sample 2: r = 0.66, p = 0.005, N = 16). A control regulation strategy, cognitive reappraisal, was not related to insula volume in either sample (all p-values > 0.75). A complementary voxel-based morphometry (VBM) approach yielded comparable findings. These results are consistent with the idea that expressive suppression engages prolonged interoceptive monitoring of autonomic states and facial expression.

E61

ACTIVITY IN STRIATAL DOPAMINERGIC CIRCUITRY DURING MUSICAL REWARD CONSUMPTION PREDICTS SUBSEQUENT PURCHASES Valorie N Salimpoor[1,2,3], Iris van den Bosch[4], Alain Dagher[1], Robert J Zatorre[1,2,3]; [1]Montreal Neurological Institute, McGill University, [2]International Laboratory for Brain, Music, and Sound Research (BRAMS), [3]Centre for Interdisciplinary Research in Music, Media, and Technology, McGill University, [4]Utrecht University — In a previous [11C]raclopride PET study, we demonstrated that dopamine is released in response to music. Few can pinpoint exactly why they like a piece of music, yet the desire to achieve specific musical experiences is highly potent, reflected by tremendous amounts of money spent on music in our society. Using fMRI, we examined whether activity in the dopaminergic reward circuit during the experience of a musical reward (consumption phase) could predict its subsequent purchase. An auction paradigm was applied to determine how much individuals were willing to pay for musical excerpts heard inside the scanner. Newly released music that was geared towards participant preferences but unfamiliar was used to rule out any specific episodic associations. Contrasting items that participants subsequently spent the maximum amount on with those not purchased revealed robust activity bilaterally in the nucleus accumbens and the right caudate, similar to those that were found to release dopamine during peak moments of emotional arousal in the previous study with familiar music. What is notable is that here we used entirely novel musical stimuli without any prior associations or episodic memory traces that could activate the striatal dopaminergic system; any responses observed are exclusively due to the music. Importantly, BOLD increases were also found in the ventral tegmental area, the primary source of dopaminergic input to the striatum while participants were listening to excerpts subsequently purchased, compared to those that were not. These findings demonstrate that activity in the dopaminergic circuit during reward consumption predicts subsequent music purchases.

Emotion & Social: Self Perception

E62

BRAIN BIOCHEMISTRY AND THE BIG FIVE: THE DEFAULT HYPOTHESIS Sephira Ryman[1], Alison Marshall[1,2], Ranee Flores[1,2], Stephen Zamora[1,2], Veena Patel[1,2]; [1]Mind Research Network, [2]University of New Mexico — To investigate the neural correlates of personality, we utilized the Big Five

scale to explore hypotheses regarding relationships between brain biochemistry and core personality traits(Costa Jr and McCrae 1995). Specifically, we examined regions within the Default Mode Network (DMN) including the posterior cingulate cortex (PCC) and the precuneus. The DMN is implicated in internally focused tasks, likely to be important to stable personality functioning, such as autobiographical memory retrieval and perspective taking (Raichle, MacLeod et al. 2001). We hypothesized that brain biochemistry within the PCC and precuneus would predict scores on the Big Five. We obtained proton magnetic resonance spectroscopic imaging (1H-MRSI) and personality functioning (NEO-FFI) from 60 healthy participants (27 Females). Subjects did not differ significantly in terms of age (mean = 23.4; S.D.=3.7), sex, or intelligence (IQ=115; S.D.=8). We found that lower concentrations of Creatine in the PCC predicted higher levels of Neuroticism ($F=5.5$, $p<.05$, $r2=.09$). In contrast, subjects with higher levels of Creatine in the PCC exhibited higher levels of Conscientiousness ($F=9.04$, $p=.004$, $r2=.14$). Finally, lower Creatine within the white matter underlying the precuneus predicted higher Extraversion ($F=5.6$, $p<.05$, $r2=.09$) and Agreeableness ($F=8.3$, $p=.006$, $r2=.13$). Creatine's role in the storage and transmission of phosphate-bound energy serves as an indicator of increased energy use within neurons that have higher Creatine concentrations. Thus, our results suggest that variation in the energetic functioning of neurons in the Default Mode Network is related to four of the Big Five personality traits, Neuroticism, Conscientiousness, Extraversion, and Agreeableness.

E63

MY BETTER SELF IS VIRTUAL: HOW AVATARS CAN COMPENSATE FOR A LOW SELF-ESTEEM Shanti Ganesh[1], Hein T. Van Schie[1], Floris P. De Lange[1], Daniël H. J. Wigboldus[1]; [1]Radboud University Nijmegen, Nijmegen, The Netherlands — Goal: Previous studies suggest that players of online role-playing games tend to view their virtual alter-ego, or avatar, as more positive than they view themselves. Players' level of self-esteem may mediate this trend. The aim of this study is to investigate the cognitive neural processes that subserve this compensation effect. Methods: Using functional magnetic resonance imaging, we scanned 22 players of World of Warcraft and 21 matched non-gaming controls, while they rated the applicability of positive and negative personality traits to themselves, avatar, close other and distant other on a five-point Likert scale. Controls rated their favorite cartoon character instead of avatar. Results: Preliminary results indicated that players rate themselves as more negative than controls do. Players did not rate avatars as more positive than self. A negative correlation between player's self-esteem and positive avatar-ratings confirmed the compensation effect in players. Conversely, controls showed a projection effect, as self-esteem positively co-varied with positive ratings for cartoon and familiar other. Data also indicated greater neural reactivity to positive and negative traits of self and avatar in players, relative to controls. Within players, we observed this reactivity only for self and avatar, but not for familiar others. Stronger motor activations were associated with more positive ratings of self and avatar. Interestingly, avatar-related activity in the visual cortex showed positive correlations with both higher self-esteem and unfavorable avatar ratings. Conclusions: These results illuminate the cognitive neural processes subserving the compensation effect, and extend our knowledge about inclusion of avatars in the human self-concept.

E64

THE MIRROR VIEW: HEMISPHERIC SPECIALIZATION OF SELF-FACE RECOGNITION Yuan Hang Li[1], Eran Zaidel[1,2]; [1]Department of Psychology, UCLA, [2]Brain Research Institute, UCLA — Self-faces are seen more in the mirror view than in the camera view. We examined the effect of mirror reversal on recognition of faces of self or of a friend in the left or right visual hemifields. Results showed a significant interaction of face-type (self, friend) x image reversal (camera, mirror) x visual field of presentation (left, right). Self-faces, but not faces of friends, in the right visual hemifield, were recognized more accurately in the mirror view than the camera view. However, both views were recognized equally well in the left visual hemifield. This was true when faces were presented at different angles (left profile, left 45?, right 45?, and right profile), but not when presented as head-on views. We conclude that face recognition is qualitatively different in the two visual hemifields (hemispheres) and that self-faces are processed differently than faces of friends, but only in the unspecialized left hemisphere. We suggest that in the left hemisphere head-on views can be identified using relatively fast neurons that are invariant to left/right asymmetry (Freiwald & Taso, 2010) and are subcallosally mediated (Zaidel, 1994). Profile views must be identified using face recognition units that are view-invariant (e.g., Quiroga et al., 2005). We further argue that the view-invariant system is sufficiently efficient in the right hemisphere to be insensitive to the familiarity effect of mirror reversal. By contrast, the view-invariant system in the left hemisphere is less efficient and therefore sensitive to the familiarity effects "offered" by (mirror) non-reversed stimuli.

E65

A ROSE BY ANOTHER NAME?: MOTIVATION ENGAGES UNIQUE NEURAL SUBSTRATES OF BIASED SOCIAL COMPARISON Brent Hughes[1], Jennifer Beer[1]; [1]University of Texas at Austin — People may cope with self-esteem threat by exaggerating how positively they compare to peers. Yet exaggerated positivity has been associated with information-processing limitations that, in some circumstances, generate exaggerated negativity which could threaten self-esteem. This raises the possibility that self-esteem threat elicits exaggerated positivity through a distinct mechanism. Previous neural research associates exaggerated positivity with reduced frontal lobe activation but has not manipulated threat. Is exaggerated positivity elicited by threat associated with the reduced frontal lobe activation identified in previous research? The current study tested the neural associations of the effect of self-esteem threat on social comparative judgments (rather than the effect of information-processing limitations manipulated in previous neural research). Exaggerated positivity elicited by threat increased activation in orbitofrontal cortex (OFC), medial prefrontal cortex (MPFC), amygdala, and insula. Individual differences in exaggerated positivity correlated with medial OFC and MPFC activity. The findings suggest that although exaggerated positivity may appear similar at a behavioral level, it may be that unique mechanisms underlie exaggerated positivity when it is a response to self-esteem threat.

E66

MEDIAL PREFRONTAL ACTIVITY DURING SELF- AND OTHER- DIRECTED AFFECT JUDGMENTS IN CHILDREN AND ADOLESCENTS IS RELATED TO AGE AND SOCIAL RESPONSIVENESS Brent Vander Wyk[1], Kevin Pelphrey[1]; [1]Yale University — Adapting a task by Ochsner and colleagues (Ochsner et al., 2004), children and adolescents were scanned using fMRI, while they made judgments about their own feelings about emotional pictures (Self), the feelings of people depicted in the pictures (Other), or the location of where the picture was taken (Location). Processing during the Self judgment condition relative to Location judgments engaged a broad network of regions including the medial prefrontal cortex, bilateral temporal poles, bilateral superior temporal sulci, and the precuneus. These regions were also active during Other judgments, but less robustly. In particular, activation during Self judgments was significantly larger than during Other judgments in a dorsal region of the medial prefrontal cortex (mPFC). To investigate the relative cortical activation of each condition within the mPFC we constructed two regions. The first region was defined by an activation likelihood analysis from previous literature on affective judgments. The second region was defined from a functional connectivity analysis during rest using a precuneus seed. Within these independently delineated regions within the mPFC, we observed that Self > Other > Location. Additionally, we observed a positive correlation between the degree of selectivity of activation to Self within an individual and their age, and a negative correlation between this selectivity and deficits in social responsiveness, as measured by the Social Responsiveness Scale (Constantino et al., 2003). We argue that these data are consistent with the view that the mPFC region is dedicated to self-directed modes of mentalizing

Executive Processes: Development & Aging

E67

DEVELOPMENTAL DIFFERENCES IN HIERARCHICAL COGNITIVE CONTROL Lauren M. McShane[1], Sara Haas[1], Dima Amso[1], David Badre[1]; [1]Brown University — It is established that the prefrontal cortex (PFC) undergoes a protracted developmental course that continues through late adolescence (Gogtay et al., 2004). Notably, the maturation of PFC is accompanied by an increased capacity for cognitive control of thought and action (Diamond, 2002). However, subregions of PFC display considerable heterogeneity both in their developmental time course and in their functional contribution to cognitive control (Bunge et al., 2002). Recent evidence in adults has suggested that subregions of PFC are organized in a hierarchical manner (Badre and D'Esposito, 2009). In this functional hierarchy, more abstract cognitive representations in rostral PFC guide selection of less abstract action representations, in caudal PFC, that are more closely tied to motor actions. However, to date, little is know about the relationship between PFC maturation and the development of this hierarchical organization. To begin to address this question, we tested children (8-12 years) and adolescents (13-15 years) on two tasks previously associated with cognitive control (Badre and D'Esposito, 2007). To manipulate the level of abstraction, the Response experiment required choosing a manual response based on the color of a cue (1st order selection), while the Feature experiment required choosing a set of feature-to-response mapping rules based on a colored cue (2nd order selection). Preliminary results indicate age related differences in overcoming competition at these different levels of abstraction. The results have important implications for our understanding of both the development of cognitive control function and the way that cognitive control is organized in the brain.

E68

WHEN COMPENSATION FAILS: PERCEPTUAL DEFICITS IN HIGHER AGE CAUSED BY VISUAL DISTRACTION Edmund Wascher[1]; [1]Leibniz Research Centre for Working Environment and Human Factors — Cognitive changes associated with normal aging are widespread, including attention, working memory and episodic memory. The most influential explanation of these deficits is the assumption of "general slowing", and the "inhibitory deficit hypothesis", which proposes that the impairments in cognitive abilities are due to an inability to control interference of task-irrelevant information. In a recent study, Gazzaley (2008) investigated possible interactions between general slowing and inhibitory deficits in a working memory task. They found evidence for a direct interaction between alterations in neural processing speed and the ability to suppress irrelevant information. Based on this thesis, aged people are able to perform as accurate as young participants in various tasks if they have sufficient time. Following this approach the present study investigated the ability to process relevant signals that were simultaneously accompanied by salient irrelevant stimuli. Older adults showed severe deficits in processing such competing stimuli. Early asymmetries in the EEG indicated that they were unable to sufficiently control the distracting information. However, they showed reliable latency effects both on early sensory components of the EEG and the fronto-central N2 that can be assigned to executive control. Moreover, the latency of the latter component reliably correlated with detection accuracy. Thus, general slowing might determine the control of distracting information. However, if, interference on a sensory level distorts the early representations of incoming signals, compensatory mechanisms cannot restore distracted information.

E69

COMPARISONS IN THE MEMORY FOR INTENTIONS SCREENING TEST FOR YOUTH: THE IMPORTANCE OF GENDER, TIME-DELAY, AND CUE TYPE Julianne Garbarino[1], Ginger Mills[1], Sarah Raskin[1]; [1]Trinity College — Age development has become an important question in prospective memory (PM) research in children. In the current study 116 healthy children ages 5-14 were administered the Memory for Intentions Screening Test for Youth (MISTY). The MISTY is a paper-and-pencil test that requires children to perform simple tasks such as "When I show you a book, turn it to page nine" while completing a word search. Performance on this task demonstrates the necessity of considering time delay and cue type when interpreting results of PM studies in children. Also important are potential interactions between gender and both time delay and cue type. Results show that older children's performance does not differ significantly depending on whether the time delay is two-minute vs. ten-minute or whether the cue is time-based vs. event-based. However, younger children perform significantly better on two-minute than on ten-minute cues and on event-based than on time-based cues. There are no overall gender differences. Interestingly, results suggest that there may be earlier development of short term PM (two-minute delay) in females than in males, and also earlier development of event-based PM in females than in males. The percent of errors that resulted from complete absence of response (prospective failures), declined greatly in females between ages of 5-6 and 7-8. In males, the decline was not as large. This is another indicator that gender may be a factor in the rate of development of PM in children.

E70

NEURAL INDICES OF IMPROVED ATTENTIONAL MODULATION OVER MIDDLE CHILDHOOD Carter Wendelken[1], Carol Baym[2], Adam Gazzaley[3], Silvia Bunge[1]; [1]University of California at Berkeley, [2]University of Illinois at Urbana-Champaign, [3]University of California at San Francisco — The ability to control the focus of attention relies on top-down modulation of cortical activity in areas involved in stimulus processing, and this ability is critical for maintaining items in working memory in the presence of distraction. Prior research demonstrates that children are less capable of focusing attention, relative to adults, and that this ability develops significantly during middle childhood. Here, using fMRI and a face/scene working memory task adapted from Gazzaley and colleagues (Gazzaley et al. 2005), we compared top-down modulation in fifteen children (aged 8-13) and fifteen young adults (aged 19-26). Replicating prior results, in young adults, attention to scenes modulated activity in the parahippocampal place area (PPA). Modulation of PPA activity increased as a function of age in children, and PPA activity was related to performance in this group, on the working memory task as well on a test of subsequent memory. Dorsolateral PFC also demonstrated increasing task-specific activation, as a function of age, in children. The present findings support the idea that children's reduced ability to maintain items in working memory, especially in the presence of distraction, is driven by weaker top-down modulation of activity in areas involved in stimulus processing.

E71

WHEN DO WE GET LOST? EXAMINING THE EFFECTS OF AGING ON A VARIETY OF TOPOGRAPHICAL ORIENTATION STRATEGIES Irene Liu[1,2], Giuseppe Iaria[1,2]; [1]Neurolab, University of Calgary, [2]Hotchkiss Brain Institute — Individuals orient successfully in large-scale surroundings by relying on a variety of cognitive strategies such as the use of environmental landmarks, the sequence of body turns, or the acquisition and use of a mental representation of the environment (i.e. a cognitive map). Although these strategies require similar cognitive processes such as attention, perception, memory and decision-making skills, they also rely on different spatial information such as environmental landmarks or body-centered information. Here, we investigated the effects of aging on the use of different strategies useful for orientation. The sample included 620 healthy individuals who performed, through the internet (www.gettinglost.ca), a comprehensive battery of tests assessing the use of different orientation strategies in virtual environments. We found that older participants (46-88 years of age) performed worse than younger participants (Group 1: 31-45 years of age; Group 2: 18-30 years of age) in tests assessing the ability to (1) form and make use of cognitive maps, (2) to integrating body-centered information, and (3) to form associations between environmental landmarks and body turns. No differences were

found between participants in the two younger groups (31-45 and 18-30 years of age) in our orientation tests, except for a path integration task. These findings suggest that aging affects a variety of orientation strategies, the effects of which may start to become evident in the late forties.

E72

METACOGNITION IN THE BEHAVIORAL VARIANT OF FRONTOTEMPORAL DEMENTIA Jessica Zakrzewski[1,2], Howard Rosen[1,2], Oscar Alcantar[1,2], Arthur P. Shimamura[3], John Neuhaus[1], Bruce Miller[1,2]; [1]University of California San Francisco, [2]USCF Memory and Aging Center, [3]University of California Berkeley — Frontotemporal dementia (FTD) is a neurodegenerative disorder that is characteristically associated with very poor self-awareness. The cognitive basis of this deficit is poorly understood but impairment in metacognition, the process by which we understand and alter our own thinking, may underlie these deficits. Many different measures can be used to assess metacognition and thus far only a few studies using a limited set of measures have examined FTD. Furthermore, metacognition is often assessed without feedback about task performance, yet feedback may be a major contributor to metacognition. We used a 20 item-paired associate word paradigm to examine aspects of metacognition in patients with the behavioral variant of frontotemporal dementia (bvFTD, n=12), as well as patients with Alzheimer's disease (AD, n=14) and age-matched controls (n=35). BvFTD patients showed an aberrant pattern of feeling of knowing ratings, limiting themselves to highly confident or guessing ratings. AD patients did show impaired feeling of knowing; however they were less impaired than bvFTD patients. Most strikingly, patients with bvFTD failed to appropriately adjust their predictions about future memory performance even after receiving explicit feedback that they had performed worse than expected. These findings reinforce previous research indicating that feeling of knowing is the metacognitive task most specifically impaired with frontal lobe dysfunction, and they highlight the effects of frontal lobe disease in preventing adjustment of metacognitive knowledge in response to feedback. In addition, they provide additional insight about the profound lack of self-awareness in bvFTD.

E73

AN ELECTROENCEPHALOGRAPHIC EXAMINATION OF THE ORIGIN OF COGNITIVE DECLINE IN AGING ADULTS DURING THE COLOUR WORD STROOP TASK Clare Killikelly[1], Denes Szucs[1]; [1]University of Cambridge — It is consistently found that aging adults are limited in their ability to ignore distracting information while performing a cognitive task. The loci of this cognitive limitation may be responsible for serious cognitive deficits in older adulthood (Mager et al, 2007). We are therefore in the process of identifying the specific neural correlates that underlie this limitation. Using electroencephalography (EEG), the brain activity of young adults (aged 20-30) and older adults (aged 45-65) was examined as they performed a manual version of the colour word Stroop task. This task was designed to isolate the point in stimulus and/or response level processing when task irrelevant distracting information (ie word reading as opposed to colour naming) induces interference in the brain (De Houwer, 2003). Young adults and older adults showed the same pattern reaction time and accuracy however, the underlying brain activity was significantly different in older adults. It was found that older adults had larger amplitudes and longer latencies for all the early stimulus related components including P1, N1, P3a and P3b. Specifically the P3a component was significantly larger and delayed in older adults indicating additional processing was required for reorienting attention. Additionally between 420-480ms after stimulus presentation there was a negative depression (N450) which is related to response conflict. This was significantly enhanced in older adults. Overall these results indicate that with age additional processing is required however there not a general compensatory process but compensatory mechanisms that are engaged to serve specific stimulus or response related functions.

E74

VISUAL WORKING MEMORY IN CHILDHOOD AND EARLY ADOLESCENCE: AN EVENT-RELATED POTENTIAL STUDY Benjamin Freer[1], John Curtis[1], Richard Milich[1], Elizabeth Lorch[1]; [1]University of Kentucky — A long latency, negative-going ERP component is manifested during the retention period in visual working memory (VWM) paradigms, increasing in amplitude with the number of items held in VWM (e.g., McCollough et al., 2007). The current study examined age differences in this component, hypothesizing that younger children would exhibit greater amplitude compared to older children at all levels of VWM load, reflecting greater effort to hold representations in VWM. Participants were divided into two groups: a young age group of eleven 8-9 year olds, and an older age group of fifteen 12 year olds. The VWM paradigm (Vogel et al., 2001) presented a 100ms memory array of 2, 4, or 6 colored squares, followed by a 900 ms delay (retention period). Participants then indicated whether a test array was identical to the memory array or differed by one color. There were no group differences on accuracy for any memory load. ERPs were averaged across four parietal-occipital electrode sites where the retention-related component was maximal. Mean amplitude during the retention period was calculated for trials with the correct response, and was greater in young children than in the older children for the 4-object condition ($F(1, 24) = 4.90$, $p = 0.037$), and marginally greater for 2 objects ($F(1, 24) = 3.55$, $p = 0.072$). As hypothesized, differences in patterns of brain activity between older and younger children, despite a lack of difference in accuracy, suggest younger children require greater cognitive resources than older children to perform the VWM task.

E75

INHIBITORY CONTROL AND WORKING MEMORY IN YOUNG AND ELDERLY ADULTS Liana Machado[1], Natalie Wyatt[1], Hayley Guiney[1]; [1]University of Otago — Debate persists regarding the nature of age-related deficits in inhibitory control, and whether inhibitory control depends on the working memory system. The current research aimed to characterize age-related changes in inhibitory control, and assess interrelationships between inhibitory functions and working memory performance. To this end, we measured performance in 60 young adults (18-30 years) and 60 elderly adults (60-88 years) on a range of established relevant tasks. The results support age-related decrements in strategic inhibitory control (demonstrated across several tasks: anti-saccade, Stroop, flanker, Simon), and an age-related increase in reflexive inhibition (based on inhibition of return elicited by an uninformative peripheral flash). This combination of weaker strategic inhibition and stronger reflexive inhibition suggests age-related deterioration of cortical structures may allow subcortical structures to operate hyperactively. In young adults, none of the inhibitory measures correlated. In contrast, elderly adults showed positive correlations between anti-saccade error rates, the flanker effect, and the Simon effect. The emergence of correlations between inhibitory measures in elderly adults may indicate that as the brain deteriorates and capabilities decline, a common mechanism is recruited to compensate. Regarding working memory scores, age-related decrements occurred, but few correlations between working memory and inhibitory control measures arose in either age group. This indicates that inhibitory control and working memory operate independently, and working memory impairment cannot account for declines in inhibitory control. Overall, the results suggest that aging promotes hyperactive subcortical inhibitory control, hypoactive cortical inhibitory control that shifts toward reliance on a unitary mechanism, and independent working memory deficits.

E76

TRANSIENT AND SUSTAINED FUNCTIONAL ACTIVATION IN ADOLESCENTS WITH AND WITHOUT CHILDHOOD HISTORIES OF ADHD: LINKS TO ADHD SYMPTOMATOLOGY AND IMPAIRMENT Katerina Velanova[1], Brooke S. G. Molina[1], Beatriz Luna[1]; [1]University of Pittsburgh — Attention deficit hyperactivity disorder (ADHD) is a childhood-onset disorder having high rates of persistence into adolescence and adulthood. ADHD is characterized

by excessive, chronic, and age-inappropriate hyperactivity, inattention and impulsivity, either alone or in combination, and may be regarded as an extreme variant along a psychopathologic continuum. Here we used mixed-block/event-related fMRI to examine the relationship between symptom severity and impairment, and sustained and trial-related functional activation elicited during the performance of oculomotor tasks requiring inhibitory control. Participants were adolescents (13-17 years-of-age) with and without childhood histories of ADHD-Combined subtype who, as adolescents, showed a wide range of symptom severity and impairment. During fMRI, subjects alternated between performance of antisaccade (AS), prosaccade (PS), and mixed (AS and PS) tasks, and extended periods of fixation. The design permitted estimation of trial-related activation separately from sustained activation maintained throughout periods of task performance (i.e., during AS, PS and mixed blocks). Magnitudes of BOLD activation were correlated with symptom and impairment scores obtained using standardized parent/teacher rating scales. Initial results from 42 subjects (including 21 typically-developing controls) implicate regions in dorsolateral prefrontal cortex, lateral parietal cortex, and basal ganglia in the pathophysiology of ADHD, with these regions showing reliable correlations between AS trial-related activation and specific symptom and impairment scores. Sustained activation in superior medial frontal cortex during mixed blocks varied consistently with all ADHD-related symptom and impairment variables, but not with age, performance or IQ. These results accord with dimensional views of ADHD and highlight the centrality of disruptions in sustained processing.

E77

AGE-RELATED CHANGES IN CONFLICT AND ERROR PROCESSING Jessica Strozyk[1], Ines Jentzsch[1]; [1]University of St Andrews — According to the conflict monitoring theory of cognitive control, people monitor for the occurrence of conflict in information processing in order to evaluate the need for control adjustments. Conflict monitoring has previously been shown to be impaired in older adults. In this study we investigated this effect in a middle-aged group using an adaptation of the flanker task in which conflict was additionally manipulated by independently varying the contrast of target and flanker letters. Effects of this manipulation on both behavioural and electrophysiological measures were analyzed. A significant effect of contrast on the compatibility effect confirmed that the conflict manipulation was successful. Control adjustments in form of the post-error slowing effect were also affected. Despite a general slowing for middle-aged adults, neither conflict size nor post-error slowing was affected by age. However, both the error-related negativity (ERN) and the error positivity (Pe), two components of the event-related potential that have shown to be reduced in amplitude in older adults and that have previously been linked to post-error slowing, were reduced in amplitude in the middle-aged group. These findings challenge previous interpretations of these components.

E78

A SILVER LINING: HOW AGE DIFFERENCES IN EMOTION REGULATION CAN BE USED TO ATTENUATE DEFICITS IN LEARNING Marissa A. Gorlick[1], Brian D. Glass[1], Brittany N. Nix[1], Mara Mather[2], W. Todd Maddox[1]; [1]University of Texas, Austin, [2]University of Southern California — Toward the end of life, goals shift from acquiring knowledge to developing social relationships (Carstensen, 2006). This manifests itself as a "positivity bias"; an increase in processing positive emotional experiences (Mather & Carstensen, 2005). However, this positivity bias requires cognitive control processes and it reverses when cognitive control resources are taxed (Mather & Knight 2005; Knight et al., 2007; Isaacowitz et al. 2009). Present research asks whether these processing biases can be used to attenuate cognitive deficits associated with normal aging. Under low cognitive control demands, we predict that learning will be better for positively-valenced feedback. However, under high cognitive control demands, we predict that learning will be better for negatively-valenced feedback. We also predict larger effects for emotional feedback (e.g., happy and angry faces) than for logical feedback (e.g., gains or losses in points). In line with our prediction, Nashiro et al. (2010) found better learning for positively-valenced emotional feedback in older adults in a low cognitive control demanding task. The current study examined learning in a task that loaded heavily on cognitive control processes (a modified Wisconsin Card Sort Task). In line with our prediction, we found better learning for negatively-valenced emotional feedback in older adults, and no effect of valence for logical feedback. Computational models were applied to the data (Bishara et al., 2010) that provide some important insights onto the locus of the learning effect in older adults. Analysis of potential dopamine and serotonin genetic predictors of performance are ongoing.

E79

DEVELOPMENTAL CHANGES IN BRAIN ACTIVITY SUPPORTING WORKING MEMORY Laura Dewey[1,2], Michael A. Motes[1,2]; [1]University of Texas Southwestern Medical Center, Psychiatry, [2]University of Texas at Dallas, Center for BrainHealth & School of Behavioral & Brain Sciences — Goals: Previous research shows that several regions of the human brain follow a quadratic developmental trajectory (Geidd et al., 1999). The gray matter volume of the prefrontal cortex (PFC) is believed to peak around 13 years of age before decreasing, possibly as a function of pruning. However, few studies exploring the corresponding developmental trajectories in functional activation have been conducted. Previous functional magnetic resonance imaging (fMRI) research in adults shows the involvement of PFC in supporting working memory (WM). Thus, this study sought to explore the relationship between PFC activity during a working memory (WM) task and age in a group of adolescents. Methods: Twenty-six healthy adolescents (aged 11 to 17) participated in the study. The participants completed a delayed-response WM task while fMRI data were collected. On each trial, participants studied either six or one letter (4 s encoding phase), remembered the items over a (4 s) delay, and then judged (within 3 s) whether a single probe letter was in the studied set. An fMRI blocked design was used: four blocks per set-size and three trials per block (Philips Achieva 3T scanner: EPI volumes=147, TR=2 s; TE=30 ms; slices=36 trans. 3.5x3.5x4mm; matrix=64x64). Results: Multiple regression was used to evaluate linear and quadratic relationships between task-related BOLD signal-change per voxel and age. Quadratic relationships were found for voxels within PFC (in addition to linear relationships). Conclusion: These analyses provide evidence of a functional link between PFC gray matter volume changes occurring with development and PFC functional activity supporting WM.

E80

STRATEGIC MEMORY & REASONING TRAINING BENEFITS FRONTAL-MEDIATED EXECUTIVE FUNCTION IN ADOLESCENTS Monique Salinas[1], Tiffani Jantz[1], Neena Rao[1], Mandy Maguire[1,2], Matthew Brier[1], John Hart Jr.[1,3], Sandra Chapman[1], Jacquelyn Gamino[1], Michael Motes[1,3]; [1]Center for BrainHealth,University of Texas at Dallas, [2]Callier Center for Communications Disorders, University of Texas at Dallas, [3]University of Texas Southwestern Medical Center — The present study investigated effects of strategic memory and reasoning training (SMART) on executive function, particularly inhibition and frontal activity among adolescents. SMART teaches hierarchical cognitive strategies that support higher-order reasoning, promoting the identification of deeper meaning in information and fostering comprehension. Both before and after SMART (N=18) or an equivalent waiting period (N=18), adolescents (aged 12-15) completed a response inhibition task in which the required depth of semantic processing was manipulated. The lowest level of semantic processing required only relatively simple feature-based discrimination (i.e., respond to a picture of a single car [80% Go] but not a single dog [20% No-Go]); the next level required more complex feature-based discrimination (i.e., respond to multiple types of cars but not multiple types of dogs); and the highest level required conceptual-based discrimination (i.e., respond to objects but not animals). EEGs, response times, and accuracies were recorded. For SMART participants, frontal (Fz) evoked potential amplitudes 300 ms (P3) increased across sessions for repeated exemplars and multiple

exemplars on Go trials. For controls, there were no Fz P3 differences across sessions for Go trials for the different semantic processing conditions. For both groups, Fz P3 amplitudes increased across sessions for all semantic processing conditions on No-Go trials, particularly concept selection. Although SMART did not include the direct training of response inhibition, SMART affected frontal-mediated executive processing used in response inhibition. SMART produced frontal changes consistent with deeper semantic processing on concept selection trials (i.e., Go trials) even when only simple feature-based discrimination was required.

E81

NEURAL CORRELATES OF PROCESSING SPEED: A COMBINED DTI-FMRI STUDY IN HEALTHY AGING Ilana Bennett[1,2], Meghana Karnic-Henry[1,2], Amanda Colby[1,2], Bart Rypma[1,2,3]; [1]Center for Brain Health, University of Texas at Dallas, [2]School of Behavioral and Brain Sciences, University of Texas at Dallas, [3]Department of Psychiatry, University of Texas Southwestern Medical Center — Processing speed (PS) is a fundamental cognitive ability that accounts for individual- and age group-differences in performance across a wide range of cognitive tasks (e.g., Salthouse, 1996). However, the neural substrates of PS are only recently being explored. In the present study, we used functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) to examine the functional and structural correlates of PS in 21 younger and 19 older adults. During fMRI acquisition, participants performed a modified digit-symbol substitution task (DSST). PS was measured with the DSST as the time to indicate whether a probe digit-symbol pair matched a pair from a simultaneously presented array of nine digit-symbol pairings. Behavioral results revealed that older adults were significantly slower, but not less accurate, than younger adults. Imaging results revealed that PS correlated with both neural measures, with age group differences and similarities in these relationships. That is, faster PS was associated with reduced DSST-related neural activity in younger adults but increased activity in older adults (e.g., L frontal pole), indicative of reduced neural efficiency in aging. Faster PS was also associated with increased white matter tract integrity across both age groups (e.g., genu of the corpus callosum), indicative of monotonic age-related declines in structural efficiency. Neural activity and white matter integrity from these interconnected regions were not related to each other, suggesting that they make independent contributions to PS.

E82

AMPLITUDE MODULATIONS AND PHASE-STABILITY OF ALPHA OSCILLATIONS DIFFERENTIALLY REFLECT LIFESPAN DIFFERENCES IN WORKING MEMORY CONSTRAINTS Myriam C. Sander[1], Markus Werkle-Bergner[1], Ulman Lindenberger[1]; [1]Max Planck Institute for Human Development, Berlin — The capacity of visual working memory (WM) shows an increase across childhood, a peak in young adulthood and a marked decline with advancing age. Top-down control via a fronto-parietal network is thought to support selection and maintenance of information in WM and undergoes strong age related changes. Recently, amplitude modulations of alpha oscillations (7-13 Hz) were suggested to reflect interindividual differences in WM capacity and selectivity (Sauseng et al., 2005). Therefore, in the present study, children (CH, 11-13 years), younger (YA, 20-25 years) and older adults (OA, 70-75 years) performed a cued change detection task (Vogel et al., 2004). OA showed lowest performance, followed by CH and then YA. Individual alpha frequencies (IAF) were determined to investigate the effect of WM-load on lateralized alpha power changes over posterior regions during retention. In line with previous reports, hemispheric alpha power differences increased with WM demands in YA. However, in CH and OA, lateralized alpha oscillations increased only until WM limits were reached and decreases thereafter, following an inverted u-shaped function. Those results are interpreted to reflect decreased inhibitory control when WM limits were overtaxed. Additionally, phase-stability after stimulus presentation was stronger in OA compared to CH and YA. The strong entrainment of neuronal processing by external stimulation in OA may imply less selective information uptake in OA. We conclude that differences in top-down guidance and information uptake as reflected in amplitude modulations and phase-stability of alpha rhythms interactively determine WM constraints across the lifespan.

E83

WHEN LESS IS REALLY LESS: AGING AND THE SPREAD OF INHIBITION Brian Gordon[1,2], Chun-Yu Tse[2,3], Gabriele Gratton[2], Monica Fabiani[2]; [1]Washington University in St Louis, [2]University of Illinois, [3]National University of Singapore — Behaviorally even healthy aging is couple with a host of cognitive declines (Park & Reuter-Lorenz et al., 2009). Functionally older adults activate additional tissue compared to their younger counterparts (Grady et al., 1999; Reuter-Lorenz et al., 2000, Cabeza 2002). As opposed to their activations, older adults have reduced deactivation of the default mode network (Lustig et al., 2003, Grady et al., 2006; Persson et al. 2007, Braski et al., 2010). The current experiment investigated both cortical activation and deactivation during a Sternberg working memory task. The resulting whole brain analysis replicated previous work with older adults recruiting more cortical areas while possessing less deactivation. A novel region-of-interest (ROI) approach was taken to assess the consistency of blood flow around indentified functional peaks. This was done utilizing spherical ROIs of increasing size from 3-13mm normalized by the initial 3mm sphere. This transformed the data to represent a proportion of the peak activation or deactivation. The rate at which this value declines with increasing sphere size represents homogeneity around the peak. For each subject the values were obtained from a series of masks representing the two anti-correlated networks and entered into an ANOVA. The results from indicated that older adults had significantly more homogenous spread of activation at larger sphere sizes. The spread of deactivation was greatly impaired in the older adults suggesting a particularly strong inability to spread inhibit these regions. These results indicate both changes in the intensity as well as the spread of neuronal activity with age.

Executive Processes: Other

E84

A BIAS TO APPLY HIERARCHICAL STRUCTURE IN LEARNING: A COMPUTATIONAL AND BEHAVIORAL STUDY Anne G.E. Collins[1], Michael J. Frank[1]; [1]Cognitive, Linguistic & Psychological Sciences Department, Brown University — Growing evidence suggests that cognitive control is implemented hierarchically in human prefrontal cortex, but how this structure is acquired without instructions is poorly understood. Previous studies have shown that people can learn hierachical structure when there is incentive to do so (e.g., when it confers an advantage in terms of reducing memory load and interference, or when rules are temporally separated). However, it is unknown whether people naturally apply hierarchical structure while learning in the absence of such incentives. Participants performed a reinforcement learning task in which acquisition of stimulus-action associations could not benefit from a hierarchical task representation. Nevertheless, a subsequent transfer phase assessed whether participants had incidentally acquired the task with hierarchical structure. Results showed a significant transfer effect, indicating use of hierarchical representation of learned rules. Pre-transfer switch costs further allowed us to characterize individual hierarchical structures, and predicted subsequent transfer effects as well as error types repartition. We developed a novel learning and decision model based on a non-parametric hidden Markov model capable of learning hierarchical structure, allowing us to make predictions on behavior and individual differences. This model was pitted against full flat or mixture of flat experts learning models. Only the proposed hierachical model accounted for all observed effects, including individual differences. This study shows that subjects have a propensity to build hierarchical structure regardless of its immediate utility (or even potential cost) for learning. Our model proposes an

approximate optimal inference framework that accounts for this hierarchical structure learning.

E85

THE EFFECT OF A CONCURRENT EXECUTIVE WORKING MEMORY TASK ON PAIN AND PLACEBO Jason Buhle[1], Bradford L. Stevens[1], Jonathan J. Friedman[1], Tor D. Wager[2]; [1]Columbia University, [2]University of Colorado, Boulder — Previous research has argued that executive processes may play a role in placebo analgesia (Wager et. al, 2004; Atlas et al., 2009; Krummenacher et al., 2010). However, recent neuroimaging work by Wager and colleagues (in press) has challenged this claim. To test these competing hypotheses, we designed a novel paradigm that combined transient thermal pain, performance of a difficult, 3-back, working memory task, and placebo drug treatment. An interaction between the task and placebo conditions would provide evidence for the involvement of executive processes in placebo analgesia. In the first of three sessions, task difficulty and nociceptive stimulus intensity were individually calibrated for each participant (n = 26). Sessions 2 and 3 consisted of placebo and control sessions, the order of which was counterbalanced across participants and controlled for in analyses. Participants rated each stimulus immediately after it occurred on a continuous rating scale. Participants reported less pain during the working memory task than during the no task condition, $F(1, 99) = 79.75$, $p < .001$, and less pain during the placebo and control sessions, $F(1, 99) = 17.48$, $p < .001$, but there was no interaction between the task and placebo conditions, $F(1, 99) = .37$, $p = .54$. There was no difference in working memory performance between the placebo and control sessions, $F(1, 49) = .027$, $p = .87$. Taken together, these data suggest that the cognitive processes that support placebo analgesia may be independent from those supporting executive function.

E86

THE IMPACT OF FEEDBACK SCHEDULE ON ERROR EVALUATION WITHIN MEDIAL-FRONTAL CORTEX Olave Krigolson[1]; [1]Dalhousie University — The frequency with which feedback is provided during skill acquisition has a profound impact on learning. Contrary to intuition, research suggests that learning is facilitated when feedback is provided on a reduced schedule, i.e., not every trial (Winstein & Schmidt, 1990). While the behavioral impact of a reduced feedback schedule appears to be quite robust, the neural mechanisms that underlie the benefits of a reduced feedback schedule remain unclear. To address this question, we had two groups of participants perform a precision line drawing task while event-related brain potential (ERP) data was recorded. One group of participants was provided with feedback after every attempt to reproduce a target line length (full feedback). Conversely, the other group of participants was provided with feedback on every other experimental trial (reduced feedback). An analysis of our behavioral data revealed a pattern of results consistent with previous behavioral findings – both feedback groups performed equally well during the acquisition phase of the experiment. However, in a delayed transfer test of line drawing accuracy, the reduced feedback group outperformed the full feedback group. Interestingly, our ERP data revealed that feedback on a reduced schedule elicited a larger feedback error-related negativity than on a full schedule. Given recent theoretical accounts of the feedback error-related negativity (i.e., Holroyd & Coles, 2002), our data suggest that the behavioral benefits of a reduced feedback schedule may result from increased activation of a reinforcement learning system within medial-frontal cortex during skill acquisition.

E87

A GENE-BRAIN-COGNITION PATHWAY FOR THE EFFECT OF COMT ON EXECUTIVE ATTENTION AND IQ Adam Green[1], David Kraemer[2], Colin DeYoung[3], John Fossella[4], Michael Cohen[5], Joseph Kim[6], Kathleen Muller[7], Jeremy Gray[7]; [1]Georgetown University, [2]University of Pennsylvania, [3]University of Minnesota, [4]Mount Sinai School of Medicine, [5]UCLA, [6]Vanderbilt University, [7]Yale University — A central prediction of emerging cognitive neurogenetic research is that genetic effects on cognition are mediated by brain function. However, while pair-wise correlations are now abundant, neural mediation has not been demonstrated. Here, in 160 genotyped fMRI participants, we tested whether activity in four frontal brain regions statistically mediated the effect of COMT Val158Met genotype on cognitive performance. We constructed a path-analytic gene-to-brain-to-cognition model to predict performance on an executive attention task (MSIT) performed during fMRI, and an abbreviated full-scale IQ test performed outside the scanner. The model included four mediator variables representing activity in four brain regions previously reported in brain-imaging of MSIT. Results indicated that brain activity in these regions during MSIT executive conflict mediated the effect of COMT genotype on MSIT performance and the effect of COMT genotype on IQ. This finding provides proof of concept for gene-to-brain-to-cognition path analysis to test neural mediation, and informs the molecular-biological genesis of intelligent cognition.

E88

THERE IS MORE THAN ONE WAY LEADING TO THE CORRECT RESPONSE: ERP EVIDENCE FOR REACTIVE AND PROACTIVE COGNITIVE CONTROL Daniela Czernochowski[1]; [1]Heinrich-Heine University, Düsseldorf — A longstanding debate surrounds the question how cognitive control is fine-tuned to flexibly meet changing task requirements. According to the dual mechanisms of control framework (Braver et al., 2007), two alternate routes may lead to correct response selection when faced with increased task demands. When response conflict is detected, reactive control processes can be recruited immediately before the response. However, this type of response selection will require additional time. If advance preparation is feasible, control processes can be recruited proactively to allow for both rapid and correct response selection. In the present investigation, informative or uninformative cues were presented in a cued task-switch paradigm, making advance preparation either feasible or not. Event-related potentials (ERPs) were recorded to identify dissociable neural correlates for both control processes. Following informative cues, participants responded about 300 ms faster relative to uninformative cues, suggesting that participants successfully recruited proactive control. In the corresponding ERPs, a sustained (predominantly right-) frontal positivity was observed between 200-500 ms post-cue onset following informative, but not uninformative cues. By contrast, accuracy was comparable across conditions, suggesting that reactive control processes were recruited successfully in the aid of accurate performance at the expense of longer RTs following uninformative cues. Starting around 200 ms prior to the response, the corresponding ERPs revealed an additional (left-) frontal activity (pre-response negativity) following uninformative relative to informative cues. Both components and performance differences were evident only during mixed-task blocks, consistent with the notion that control processes are recruited selectively to meet higher task demands.

E89

BEYOND THE FLANKER TASK: INTERFERENCE FROM INCENTIVIZED DISTRACTERS, ANTICIPATED ACTION-EFFECTS, AND REFRESHED REPRESENTATIONS Pareezad Zarolia[3], Tiffany Jantz[1], Jason Hubbard[1], Ezequiel Morsella[1,2]; [1]San Francisco State University, [2]University of California, San Francisco, [3]University of Denver — The classic flanker task has been used to illuminate the behavioral, subjective, and neural aspects of different kinds of interference in action production. For example, 'response interference' (RI; when distracters and targets indicate different responses) leads to stronger behavioral and subjective effects than 'perceptual interference' (PI; when distracters look different from targets but lead to the same response). RI is the condition that activates most the anterior cingulate cortex (van Veen et al., 2001). We introduce three variants of the flanker task that extend these findings that, like previous variants, are amenable psychophysiological and neuroimaging technologies. One variant (n = 21) yields flanker-like interference in a 'response-effect compatibility' paradigm, where interference stems from anticipated action-effects. In this variant, RI trials elicited longer response times (RTs) than PI trials, $F(1, 19) = 5.90$, $p < .05$. Another variant (n = 28) exam-

ined interference involving 'composite' stimuli, which participants created by combining perceptual features of externally-presented stimuli with 'refreshed' stimuli in working memory. RTs were greater for PI (M = 1571.31, SEM = 86.21) than a condition in which targets and distracters were identical (M = 1503.06, SEM =85.37). Extending the flanker task into motivation-based interference, another variant (n = 41) employed distracters that were previously paired with incentivized stimuli that elicited approach tendencies (e.g., interesting images). Subjective measures (e.g., 'urges to err') were lower for this 'incentive interference' than for RI, $t(81) = -3.07$, $p < .01$. These successful variants were designed to be integrated with the technologies of neuroscience.

E90

AN FMRI STUDY OF THE EFFECTS OF A CATHECOL-O-METHYLTRANSFERASE INHIBITOR ON IMPULSIVITY Ana Navarro-Cebrian[1,2], Daicia C. Allen[1,2], Andrew S. Kayser[1,2], Jennifer M. Mitchell[1,2], Howard L. Fields[1,2]; [1]Ernest Gallo Clinic and Research Center, [2]University of California, San Francisco — Impulsivity is a known risk factor for substance use disorders, rendering its understanding and remediation a high priority for vulnerable populations. Delay discounting tasks (DDT), in which subjects are offered the choice between a smaller-sooner and a larger-later reward, have been used to quantify impulsivity: more impulsive subjects tend to choose smaller-sooner rewards, reflected in higher impulsive choice ratios (ICRs). Recently it has been shown that (1) a greater ICR was correlated with greater blood-oxygen level dependent (BOLD) activity in the dorsal prefrontal cortex (PFC) and lesser BOLD activity in the ventrolateral PFC, and (2) variation in the ICR was associated with variation in the Val-158-Met polymorphism in the catechol-O-methyltransferase (COMT) gene, whose protein product degrades synaptically-released dopamine in PFC. Specifically, the Val-Val genotype, linked to greater COMT activity and therefore to lower levels of prefrontal dopamine, was associated with greater ICR. These findings raise the intriguing possibility that an inhibitor of COMT (tolcapone) may reduce impulsive behavior. In the current study we attempted to confirm this hypothesis via a functional MRI study in which subjects were screened for COMT genotype and administered tolcapone or placebo in randomized, double-blind, counterbalanced fashion across two sessions as they performed the DDT. Our preliminary results demonstrate significant variability in ICR across subjects, are supportive of the previous BOLD results in PFC, and suggest differences in previously implicated brain regions, such as the parahippocampal gyri, across drug sessions. Ongoing work will further quantify these findings and link them to COMT genotype.

E91

IMPROVING THE DEFINITION OF MULTIPLE DEMAND CORTEX Ben Crittenden[1,2], Russell Thompson[1], John Duncan[1]; [1]Medical Research Council, Cognition and Brain Sciences Unit, [2]University of Cambridge — Several discrete regions of the prefrontal cortex (PFC) and the parietal lobe have been shown to be consistently and reliably activated by a wide variety of executive tasks, regardless of the specific cognitive operations required by each task. It is argued that these regions, termed multiple demand (MD) cortex, flexibly adapt to code information that is relevant to ongoing behavior, thus playing a important role in guiding our behavior. Our aim was to better classify which PFC and parietal regions are MD using fMRI. We employed a mixed block/event-related design to identify common regions of activation during the performance of a visual matching-to-sample task, an auditory discrimination task and a motor-dexterity task, each of which was presented in either an 'easy' or 'hard' form. We found significant activations around the region of insula/frontal operculum and intraparietal sulcus as well as robust activations of pre-SMA and inferior frontal sulcus, when compared to baseline, which was consistent across all three tasks. Interestingly, while behavioral results showed a successful difficulty manipulation, this effect was not present in the imaging data. Previous studies have suggested that a simple perceptual difficulty contrast should provide a reliable MD activity pattern. The current data, however, suggests that perceptual difficulty alone may not be sufficient or sensitive enough to elicit strong MD activity. The long-term aim of this work is the development of a short task that will act as a functional localizer for defining the MD pattern in individual subjects across experiments and labs.

E92

TRANSCRANIAL DIRECT CURRENT STIMULATION OVER THE LEFT PREFRONTAL CORTEX FACILITATES COGNITIVE FLEXIBILITY IN TOOL USE Evangelia G. Chrysikou[1], Roy H. Hamilton[1], H. Branch Coslett[1], Sharon L. Thompson-Schill[1]; [1]University of Pennsylvania — The left ventrolateral prefrontal cortex has been implicated in higher-order cognitive tasks, in which one has to exert cognitive control over available information to achieve optimal performance (e.g., working memory, rule switching, resolving interference from unwanted information). Recent neuroscience evidence, however, has offered support for the hypothesis that certain cognitive tasks may benefit from a tradeoff between brain regions involved in rule-based processing (i.e., prefrontal cortex, PFC) and regions involved in object processing, particularly of object attributes or features (i.e., visual cortex). Guided by recent neuroimaging findings from our lab, in the present study we explored the hypothesis that inhibitory transcranial direct current stimulation (tDCS) will facilitate performance in a flexible use generation task. Participants were randomly assigned to one of six conditions: they were shown pictures of common artifacts and were asked to generate aloud either the object's common use (e.g., belt: to keep one's pants up) or an uncommon use for it (e.g., belt: to use as a tourniquet), while receiving cathodal tDCS (1.5 mA) either over the left PFC (F7 on the 10-20 system), or over the right PFC (F8 on the 10-20 system), or sham stimulation. Participants were also administered a control task (forward digit span). Analysis of voice-onset reaction times showed facilitative effects of left PFC stimulation for the uncommon, but not the common, use generation task. There were no effects of stimulation on the control task. The results support the hypothesis that certain tasks may benefit from tradeoff between PFC and other brain regions.

E93

EVENT-RELATED POTENTIAL VARIABILITY RELATED TO PERSONALITY TRAITS ON A CONTINUOUS PERFORMANCE TASK Kazufumi Omura[1], Eriko Suzuki[1], Katsuhito Yamaguchi[1], Kenji Kusumoto[1]; [1]Yamagata University — It is suggested that the amplitude and latency of the N2 and P3 components of event-related potentials (ERPs) have been related to several personality traits. In addition, behavioral inhibition (impulsivity) in patients with attention-deficit/hyperactivity disorder (ADHD) is also associated with these ERP components. This study evaluated how individual differences in N2 and P3 components on a continuous performance task (CPT) with the personality traits, including impulsiveness measured by self-reported questionnaires. On a trial basis, ten healthy participants completed self-reported impulsivity measure, Barratt Impulsiveness Scale, version 11 (BIS-11), Behavioral Inhibition/Behavioral Activation Scales (BIS/BAS), and Temperament and Character Inventory (TCI). Afterwards, they were asked to perform an AX-type CPT with EEG recording. In the CPT, participants were instructed to press a button as fast and accurate as possible, whenever the letter "X" was preceded by the letter "O" (Go condition). For all other letters following the letter "O", the prepared motor response had to be suppressed (Nogo condition). The results showed the tendency that P3 amplitude in the Nogo condition was positively correlated with the novelty seeking, and was negatively correlated with impulsiveness. In contrast, the other ratings of personal traits were not related to N2 and P3 amplitude in the Nogo condition at this sample size. The results suggest the plausible relationship between personality traits and N2 and P3 components. Future research needs to increase number of participants for the detailed investigation of this relationship and its strong statistical significance.

E94

AN EARLY NEURAL MARKER OF TOP-DOWN ATTENTIONAL CONTROL PREDICTS LATER SELECTIVE ATTENTION OPERATIONS AND TASK PERFORMANCE Elise C. Tarbi[1], Anna E. Haring[1], Tatyana Y. Zhuravleva[1], Xue Sun[1], Phillip J. Holcomb[2], Dorene M. Rentz[1], Kirk R. Daffner[1]; [1]Center for Brain/Mind Medicine, Division of Cognitive and Behavioral Neurology, Department of Neurology, Brigham and Women's Hospital, Harvard Medical School, [2]Department of Psychology, Tufts University — Neural mechanisms underlying individual differences in executive control remain to be established. In the current study, event-related potentials (ERPs) were recorded from 28 young subjects while they performed a task requiring selective attention to color. Although traditional investigations of selective attention have compared the electrophysiological response to stimuli under attend vs. ignore conditions, the current study added an attentionally "neutral" condition with respect to color. This novel approach led to the identification of the Early Attentional Control Positivity (EACP), an anteriorly-distributed endogenous ERP component elicited in response to stimuli in a to-be-ignored color, which we hypothesize orchestrates subsequent selective attention operations. Here, differences in this neural index of top-down control activity were examined across individuals varying in executive function capacity (defined by neuropsychological test performance). Executive capacity strongly predicted the size of the EACP and the level of performance on the task. The EACP likely mediates the influence of executive capacity over RT performance, as the association disappeared after controlling for it. Consistent with the hypothesized role of the EACP, its activity strongly predicted the amplitude of the subsequent posterior selection negativity (SN), a component believed to represent the modulation of sensory-perceptual processing in extrastriate cortex based on stimulus feature relevance. After accounting for the SN, the association between the EACP and task performance also vanished. Our findings suggest that individual differences in executive capacity are tightly linked to the EACP, which impacts performance on the experimental task through its controlling influence over selective attention operations indexed by the SN.

E95

NEURAL ACTIVATION DYNAMICS OF CONFLICT DETECTION AND COGNITIVE CONTROL IN AN AUDITORY STROOP TASK Sarah E. Donohue[1], Mario Liotti[2], Rick Perez III[3], Marty G. Woldorff[1]; [1]Duke University, [2]Simon Fraser University, [3]University of Texas Health Science Center at San Antonio — The electrophysiological correlates of stimulus conflict processing have been well characterized for the visual modality in paradigms such as the Stroop task and the Eriksen Flanker task. Much less is known about conflict monitoring and associated cognitive control processes in response to conflicting auditory input. In the present study, high-density electrical recordings of brain activity were obtained during an auditory version of the Stroop task, using three modalities of response (Overt verbal, Covert verbal and Manual) as we had done previously in the visual modality (Liotti et al., 2000). As expected, participants were less accurate and slower to respond to incongruent compared to congruent trials. The evoked response to incongruent trials showed an enhanced negative-polarity wave relative to congruent trials over superior scalp sites, similar to the N450 in the traditional visual Stroop task but peaking about 100 ms earlier. In addition, this negative-polarity neural activity showed a response-related posterior shift in distribution, from fronto-central for covert and overt verbal responses to more central-parietal for manual responses, also similar to the pattern seen in the visual Stroop. The conflict-related negative wave was followed by an enhanced posterior positivity for incongruent trials, similar to the late SP reported for the visual Stroop task (500-800 ms post-stimulus). In addition, sequential effects were also observed that supported the conflict-monitoring and cognitive adjustment hypothesis. These data demonstrate that while the precise timing of conflict detection is very dependent on the modality of input, the general mechanisms appear to be similar across modalities.

E96

EVIDENCE FOR DECOUPLING OF ATTENTION FROM PERCEPTUAL INPUT DURING OFFLINE THOUGHT Kevin Brown[1], Jonathan Smallwood[1], Ben Baird[1], Joyce Sato-Reinhold[1], Jonathan W Schooler[1], Jean M Carlson[1]; [1]UC Santa Barbara — Accumulating evidence suggests that the mind is not only proficient at processing external events but also adept at disengaging from the stream of sensory input to process internally generated thoughts and feelings. This "offline" cognitive mode has been hypothesized to require both spontaneously generated mental activity and a decoupling of attention from perception in order to separate competing streams of internal and external information. Here, we use measurements of pupil diameter (PD) and surface electroencephalography (EEG) to provide evidence for the role of decoupling during spontaneous cognitive activity. We employ two tasks that differed in the degree of online processing for good task performance in order to focus particularly on task periods: (i) conducive to offline thought, (ii) requiring external task focus, (iii) prior to errors, or (iv) prior to slow behavioral responses. We find spontaneous activity decoupled from task events during periods conducive to offline thought, and (as expected) large task-evoked changes during periods requiring task focus. We also find high levels of spontaneous activity prior to task errors, as opposed to correct reponses. Finally, high levels of spontaneous activity occurred prior to only the slowest 20% of correct responses, suggesting a binary switch in cognitive functioning. Taken together, these data are consistent with the decoupling hypothesis, which suggests that the capacity for spontaneous cognitive activity depends upon minimizing disruptions from the external world.

Monday, April 4, 1:00 - 3:00 pm, Pacific Concourse

Executive Processes: Goal Maintenance & Switching

F1

A BAYESIAN MODEL OF HUMAN SENSORIMOTOR CONTROL DURING TASK SWITCHING Francisco Barceló[1], Xavier Porte[1], Laura Prada[1]; [1]University of the Balearic Islands, Palma de Mallorca, Spain — Modern models in Cognitive Neuroscience explain the behavioral and brain responses obtained in task-switching paradigms through a variety of mechanisms whose neurocognitive substrates are not well understood yet. Few studies have attempted to model cognitive control in terms of the probabilistic associations among task events using formal computational tools based on Information theory and Bayesian probability theory. In this study we employed a Bayesian model of surprise (Is) to estimate the amount of information conveyed by sensory, motor and sensorimotor representations in three different task contexts (Switch, NoGo and Oddball), conveying identical visual information but distinct response demands each. The model allowed us to explore trial-by-trial changes in the amount of stimulus-response surprise over the course of the experiment. The behavioral and brain responses measured in each task supported the modeling work and resulted in three distinct information processing profiles, which can be summarized into two major properties. First, there was greater variability in trial-by-trial surprise during the initial 100 trials of each task compared to the remaining trials in the block. Second, contextually informative cues that did not demand any overt response actually conveyed a larger amount of surprise than to-be-responded targets. The modeling of sensorimotor –rather than only sensory or only motor– representations achieved the best fit with the reaction times and other brain indicators of cognitive control. These analyses suggest that task-switching performance could be accounted for through probabilistic sensorimotor associations among stimulus and response representations. Supported by the Spanish Ministerio de Innovación y Ciencia (PSI2010-17419/PSIC).

F2

SELF-REGULATION OF TASKS UNDER DYNAMIC CONDITIONS David Wisniewski[1,2,3], Carlo Reverberi[1,4], John-Dylan Haynes[1,2,3]; [1]Bernstein Center for Computational Neuroscience Berlin, Charité Universitätsmedizin Berlin, Germany, [2]Graduate School of Mind and Brain, Humboldt-Universität zu Berlin, Germany, [3]Max-Planck-Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [4]Università Milano - Bicocca, Milano, Italy — In changing environments we need to dynamically re-organize our behavior in order to reach desired goals. This requires strategic switches between different tasks. However, little is known about the neural basis of such adaptation processes. We developed a novel, motivated choice paradigm and used multivariate pattern analysis of fMRI data (MVPA) to investigate this. Subjects chose between three different tasks on a trial-by-trial basis. Task difficulty varied independently for all three tasks, increasing for the chosen task set and decreasing for the non-chosen task sets. This created an exploration-exploitation dilemma for which subjects needed to find a solution. To keep difficulty and error rates low, they had to produce a motivated decision on which task to perform next, based on their estimation of the changing environmental variables. Using MVPA, we were able to predict subjects' choices from medial PFC, and parietal cortex. Furthermore, we could predict the current difficulty level – the motivational factor driving choices – from reward related areas. Interestingly, the ventro-medial PFC (vmPFC) encoded both the choices and the difficulty. This area was previously associated with the processing of stimulus-values. Our results suggest that vmPFC is also involved in encoding motivated choices. Further planned analyses will investigate the interaction between areas encoding choices and areas encoding motivational factors in more detail. This should provide important clues on how humans endogenously adapt their behavior to cope with changing environments.

F3

THE EFFECTS OF CONTEXT, EPISODIC AND STIMULUS-RESPONSE COMPATIBILITY DEMANDS ON EXECUTIVE PROCESSING IN THE YOUNG AND ELDERLY Brian C. Rakitin[1], Yaakov Stern[1]; [1]Columbia University — Twenty-two healthy elderly (age = 65 ± 5.5) and twenty healthy young (age = 26 ± 6.8) participated in a version of Etienne Koechlin's test of executive function. This task combines contextual demands (i.e. single task versus task-switching conditions) with episodic demands (i.e. the number of conditions indicated by a color cue across all task conditions within participants) to vary executive function difficulty and drive prefrontal cortex. As anticipated, both speed and accuracy was impaired in dual-task conditions relative to single task conditions, in high episodic demand conditions versus low-episodic demand conditions, and all effect were proportionately larger in the elderly compared to young participants. An unexpected effect was the disproportionate impairment in the elderly participants when a stimulus indicated two different responses in the two different tasks. That is stimulus-response incompatibility was a major determinant of accuracy and RT in the elderly. This finding is not predicted by, nor is it commensurate with the information theory framework put forward by Koechlin to provide a common metric of difficulty for different aspects of executive function and to explain shifts in neural support along the lateral frontal axis in response to executive demands.

F4

REWARD EXPECTATION IN THE HUMAN PREFRONTAL CORTEX Sven Collette[1,2,4], Etienne Koechlin[3,4,5]; [1]Université Pierre Marie Curie, Paris, [2]Ecole de Neurosciences Paris/Ile de France, [3]INSERM, Paris, France, [4]Ecole Normale Supérieure, Paris, France, [5]CENIR, Paris, France — The ability to associate actions and outcome values and to flexibility adapt our current intentions to external contingencies is fundamentally engaged in human decision-making. Recent fMRI studies based on models of reinforcement learning (RL) showed that choice values and prediction errors were associated with activations in striatum and anterior medial prefrontal regions (amPFC). However, these studies focused on learning single actions. Little is known whether similar mechanisms operate for value-

based learning and deciding between superordinate task-sets, which we investigated in this study. Furthermore we want to elucidate the functional specificity of distinct brain regions in such a learning mechanisms. Subjects were scanned with functional magnetic resonance imaging while choosing freely between two tasks respectively two motor responses, which where differently and variably rewarded in a stochastic manner. Using an extended reinforcement-learning model, we show that frontopolar regions only track the value of the unchosen task, but not the unchosen motor response, whereas activity in dorsal ACC correlates with both unchosen values. Furthermore amPFC integrates the value of the chosen task and motor response. At a glance, these findings provide new insights into prefrontal neural circuits responding distinctly to reward expectations.

F5

SPATIOTEMPORAL DYNAMICS OF LOW FREQUENCY BOLD FLUCTUATIONS IN THE DEFAULT NETWORK MAY PREDICT PSYCHOMOTOR VIGILANCE TASK PERFORMANCE Hillary Schwarb[1], Garth Thompson[1], Waqaas Majeed[1], Andy McKinley[2], Michael D. Merritt[1], Eric H. Schumacher[1], Shella D. Keilholz[1]; [1]Georgia Institute of Psychology, [2]Air Force Research Laboratory — In recent years, researchers have begun mapping functional connectivity in the resting brain by identifying spontaneous low frequency fluctuations in the blood oxygen level dependent (BOLD) signal. Using this technique, researchers have identified many brain networks. Two such networks often associated with attention are the "default mode" and "task-positive" networks. Standard techniques measure activity in these networks across scans. However, it is possible that a wealth of information exists in the dynamic fluctuations of the BOLD signal which are not measured with current analysis techniques. In this study, high temporal resolution functional magnetic resonance imaging (fMRI) data were collected from human subjects performing a psychomotor vigilance task (PVT). A novel pattern finding algorithm was developed and applied to examine the spatiotemporal patterns in BOLD fluctuations. The most common pattern detected was an alternation between those areas associated with the default mode network (e.g., posterior cingulate and anterior medial prefrontal cortices) and those associated with the task-positive network (e.g., superior parietal and premotor cortices). Differences in the signal between default mode and task positive mode activations surrounding PVT task onset were then identified. Preliminary results indicate that successful PVT performance was associated with an anti-correlation between the two modes while failure on the PVT task was associated with correlated mode signals. These data indicate that patterns of relative dominance in the BOLD signal of the default mode network may predict performance on attentional tasks.

F6

THE NEURAL BASIS OF TOP-DOWN AND BOTTOM-UP INFLUENCES IN VOLUNTARY TASK CHOICE Jelle Demanet[1], Wouter De Baene[1], Catherine M. Arrington[2], Marcel Brass[1]; [1]Ghent University, [2]Lehigh University — The present fMRI study investigates the neural correlates of top-down and bottom-up influences on voluntary task choice. Recent studies have shown that voluntary task choice is biased by elements in the environment. The likelihood to choose a specific task in a given trial depends for example on whether the stimulus has been associated with the same or a different task in a preceding learning phase (Arrington et al., 2010; Demanet et al., 2010). In the present study we used such bottom-up influences on task choice to manipulate the degree of intentional involvement in task selection. We argue that trials in which the task choice is primed by the stimulus are less intentional than trials where participants overrule the stimulus bias to select a task. This assumption was supported by the finding that participants, during mind wandering episodes, were biased more often by a stimulus in their task choice. The brain imaging data revealed that a top-down driven (unbiased) task choice was related to activity in the anterior cingulate cortex, inferior frontal gyrus, anterior insular cortex and intra-parietal sulcus, areas that all can be related to intentional choice and cognitive control. A bottom-up driven (biased) task choice led to stronger activity in the posterior cingulate cortex, the precuneus, the angular gyrus and the medial prefrontal cortex. These areas are typically considered as part of the default network (e.g. Mason et al., 2007). Our results reveal how brain activation related to the free selection of task sets is affected by bottom-up influences.

F7

EFFECTS OF HEMISPHERIC ASYMMETRIES ON TASK SWITCHING Sebastian Ocklenburg[1], Onur Gunturkun[1], Christian Beste[1]; [1]Ruhr University Bochum — Functional hemispheric asymmetries have been observed in different cognitive domains, but it is still largely unclear how they modulate the efficacy of specific executive functions. In the present study, we used a lateralized version of the task switching paradigm to investigate the relevance of hemispheric asymmetries for cognitive flexibility. Words were tachistoscopically presented in the left (LVF) and right visual half field (RVF) and participants had to perform one out of two discrete tasks on each trial: In first task, participants had to categorize the words based on their initial letters, whereas in the second task the words had to be categorized according to their word class. On half of the trials the task changed (change trials) whereas on the other half it stayed the same (repeat trials). ERPs were recorded using a 64-channel EEG, and the neural sources of the ERPs were reconstructed using standardized low resolution brain electromagnetic tomography (sLORETA). On the behavioral level, we observed an interaction between task type and visual field. In the initial letter task, switch costs were higher for LVF trials than for RVF trials, whereas the opposite pattern was observed in the word class task. On the electrophysiological level, we observed visual half-field dependent differences in the amplitude of the P3. For both tasks, stimulus presentation in the LVF induced a weaker P3 compared to presentation in the RVF. In conclusion the results suggest that modulating influences of hemispheric asymmetries should be taken into account when examining executive functions.

F8

BETTER TASK-SWITCHING PERFORMANCE IN EXPERT VIDEO GAME PLAYERS: SUPERIOR PREPARATION? Meredith Minear[1], Mark Thacker[1]; [1]The College of Idaho — Recent studies have reported improved performance on several attention tasks by experienced video game players (VGPs) compared to non-gamers (NVGPs). There has been growing research into whether VGPs are also superior on measures of executive function. Several studies have examined differences in task-switching performance, one putative executive function, with mixed results. Task-switching itself is thought to consist of several different processes, some executive and others not. These processes can be teased apart by manipulating different variables such as the extent to which a switch is predictable, the degree of task overlap between stimuli and response sets and the amount of time to prepare for a switch. Previous studies of expert VGPs have used different types of switching paradigms making comparisons across studies difficult. The goal of the present study was to systematically manipulate the type of switch as well as the amount of time given to prepare for a switch in order to better understand whether VGPs do show better switching performance than NVGPs and why. We compared the switching performance of experienced VGPs (individuals who reported playing first person shooter and real time strategy games at least 10 hours a week for at least 2 years) to NVGPs. We found that while VGPs had smaller switch costs in most conditions, their performance did not differ from NVGPs when there was no opportunity to prepare for a switch. This suggests that superior switching performance in VGPs may be due to strategic or motivational differences in preparation.

F9

SWITCHING ABILITY PREDICTS TRAINING-BASED IMPROVEMENT IN MOVEMENT INITIATION IN PARKINSON'S DISEASE Rebecca Stein[1,3], Karen Sigvardt[1,3,5], Kim Russo[1,2], Christopher Higginson[4], Edward Yund[3], Lin

Zhang[5], Norika Malhado-Chang[5], David Woods[3,5], Elizabeth Disbrow[1,2,3,5]; [1]UC Davis, [2]UC San Francisco, [3]VA Northern California Health Care System, [4]Loyola University Maryland, [5]UC Davis School of Medicine — Motor planning is a fundamental component of motor behavior that is disrupted in Parkinson's disease (PD). Movements can be internally generated (IG) or externally cued (EQ), and motor deficits in PD are typically linked to IG movements. However, treatment has focused primarily on motor execution. We evaluated the efficacy of neurocognitive rehabilitation to improve performance of IG movement initiation in PD. PD and control subjects performed a PC-based adaptive training paradigm. Trials consisted of typing a response to a visually presented sequence of 1-4 digits (EQ movement) then reproducing the sequence in response to an uninformative cue (IG movement). A 5:1 adaptive staircase with per-trial performance of 87% correct was used over 12 days of training with a fixed length pre- and post-test. Subjects also completed neuropsychological measures of cognitive flexibility and measures of timed instrumental activities of daily living (TIADLs). PD participants were assigned to a group who benefited from training and a group who did not. All groups showed decreased RT after training, and improvement was similar across groups for cued responses. However, the PD improvement group showed significantly greater reduction in RT and error rate, as expected based on group formation criteria. Specific measures of cognitive flexibility (Switch time Trails B) and TIADLs (change making subscore) predicted improved performance. Results suggest that cognitive rehabilitation can be used to improve movement initiation in PD, and a neuropsychological test battery can be used to identify candidates for training.

F10

TOWARDS NEURAL NETWORK MODELS LINKING GENETICS TO INDIVIDUAL DIFFERENCES IN EXECUTIVE FUNCTIONS Seth Herd[1], Naomi Friedman[1], Christopher Chatham[1], Thomas Hazy[1], Angela Brant[1], Randall O'Reilly[1]; [1]University of Colorado — We report preliminary results of a project that seeks to provide mechanistic explanations linking genetics to cognition through detailed models of brain function. We have created neural network models that learn an array of executive function tasks that have previously been used to derive components of executive function based on individual differences (Friedman et al., 2008). The models use the Prefrontal cortex Basal ganglia Working Memory (PBWM) framework (Hazy, Frank, & O'Reilly 2006) and extend it to task control. This framework proposes learning mechanisms in the prefrontal cortex (PFC) and basal ganglia (BG) consistent with extensive low-level biological data. Changes in key parameters of these models sensibly correspond to two of the three components of executive function found in empirical work: updating working memory, and switching task sets. Changes in parameters in the basal ganglia affect learning when to store information in PFC, and therefore the updating component, while parameters affecting the tendency of PFC neurons to automatically retain information negatively affect the switching component. Some of these parameters correspond to genetic variation related to dopamine receptors in striatum and PFC. This preliminary testing represents a small subset of the predictions and tests of theory that can be performed with these models. These models offer a rich explanatory framework that links low and high level data through the intermediate level addressed by cognitive neuroscience. As such, this new approach may bypass some of the problems (e.g., massive multiple comparisons) inherent in a purely empirical mapping between genetics and cognition.

F11

NEURAL CORRELATES OF TASK SWITCHING WITH AND WITHOUT CROSSTALK Emre Demiralp[1], Mary Askren[1], Lacey Steven[1], Wager Tor[2], Sylvester Ching-Yune[1], Jonides John[1]; [1]University of Michigan, [2]University of Colorado — It is well known that mental functioning in our daily activities have multiple concurrent demands which require reconfiguration and utilization of mental resources. The present study investigated the role and neural underpinnings of crosstalk in dual-task interference. Participants were shown a display with two symbols each of which was a letter, a number or a non-alphanumeric symbol and were asked to make a consonant/vowel or an odd/even judgment. The judgment type or task was cued by the color of the stimuli. Switching was event-related, unpredictable and self-paced. There were blocks of crosstalk and neutral switching trials. Overall participants spent more time performing crosstalk trials compared to neutral trials in addition to reliable overall switching costs. Dorsolateral prefrontal regions were found to respond to crosstalk and this response was larger when there was task switching implicating interference resolution and or inhibition. Left lateral frontopolar cortex was responsive to task switching with and without crosstalk. Overall, more time was spent performing crosstalk trials than neutral trials and to investigate the role of time on task, switch costs were entered into a second level random effects analysis as a covariate. This analysis did not degrade the dissociation between dorsolateral prefrontal cortex and frontopolar cortex observed in the previous analysis.

F12

SUCCUMBING TO BOTTOM-UP BIASES DURING VOLUNTARY TASK CHOICE PREDICTS INCREASED SWITCH COSTS Joseph M. Orr[1], Sean E. Masters[1], Daniel H. Weissman[1]; [1]University of Michigan — Bottom-up biases are widely thought to influence task choice in the voluntary task switching paradigm. Definitive support for this hypothesis is lacking, however, because task choice and task performance are usually confounded. We therefore revisited this hypothesis using a task switching paradigm in which task choice and task performance were registered at different times in each trial. Fifty-four healthy undergraduates participated in the study. In the choice phase of each trial, they were (a) explicitly cued to choose one of two possible tasks or (b) prompted by a question mark to randomly choose a task. Critically, each question mark was flanked by an irrelevant stimulus that often served as a cue to perform a specific task in other trials. As predicted, participants tended to choose the task primed by the irrelevant stimulus. Moreover, such choices were linked to increased switch costs during subsequent task performance. These findings provide compelling evidence that bottom-up biases influence voluntary task choice. They also suggest that succumbing to such biases reflects a reduction of top-down control that persists to influence upcoming task performance.

F13

THE ABILITY TO ADAPT TO SHIFTING REWARD CONTINGENCIES IS DIFFERENTIALLY IMPAIRED IN COCAINE ADDICTION AND BINGE EATING DISORDER Edward Patzelt[1,2], Kelvin Lim[1,2], Nancy Raymond[1], Sheila Specker[1], Angus MacDonald III[1,2]; [1]University of Minnesota, [2]VA Medical Center — Impulsive disorders such as cocaine addiction, and perhaps binge eating disorder, have been associated with maladaptive behaviors that continue despite increasingly deleterious consequences. However, the underlying mechanism of an inability to learn as a result of negative reinforcement remains unclear because of the psychopharmacological effects of cocaine. Using a probabilistic reversal learning task we investigated the ability of binge eating disordered participants (n=25), normal weight controls (n=22), overweight controls (n=24), cocaine users (n=37), and non-using controls (n=37) to adapt to changing reward contingencies. Participants performed a reversal learning task in which they choose between two stimuli, receiving feedback as to the whether their choice was "correct" or "incorrect". During 20% of the trials participants received false feedback indicating their choice was incorrect when it was actually correct. Following 10 consecutive correct responses the patterns (and corresponding feedback) reversed. Data were analyzed using a repeated measures mixed effects hierarchical linear model for each disorder (binge eating & cocaine addiction). In the cocaine group there was a significant interaction between group membership and reversal when comparing the sum of trials to obtain the 1st reversal vs subsequent reversals. This pattern was not observed in the binge eating group, suggesting a possible difference in the mechanism underlying the two disorders, potentially mediated by the pharmacological effect of cocaine use. These findings imply that the nature of impulsivity in cocaine addiction

may correspond to a failure to integrate reward feedback, whereas this mechanism does not characterize the impulsivity associated with binge eating disorder.

F14

INVESTIGATING CUE-RELATED BRAIN ACTIVITY DURING TASK-SWITCHING Andrea Weinstein[1], Rachel Milgrom[1], Marlena Casey[1], Destiny Miller[1], Sarah Banducci[1], Stephanie Akl[1], Kirk Erickson[1]; [1]University of Pittsburgh — The ability to rapidly switch between multiple tasks decreases with age, prompting research on attenuating losses in switching ability. In this fMRI-based pilot study, we examined the effect of cueing during a task switching paradigm on 19 healthy, young adults (Mean age = 24.60 years; SD = 3.30 years). We employed an event-related paradigm in which repeat and switch trials were presented pseudo-randomly. During each trial, a letter was presented surrounded by a box with a cue indicating the task to perform. The two tasks were a consonant/vowel judgment (marked by a red CV) and an uppercase/lowercase judgment (marked by a blue UL). Cues appeared simultaneously with or prior to (2000 or 4000 ms) stimulus onset. We predicted that cueing the task before stimulus onset would reduce switch costs and reduce brain activity in prefrontal and parietal regions associated with task-switching. Further, we hypothesized that cue-related brain activity would predict decreases in activity during switching. Consistent with our predictions, we found that performance during switch trials were slower than repeat trials ($t = 8.607$; $p < .001$). Importantly, cueing successfully reduced switch costs by 52.70 ms ($t = -2.520$; $p = .022$). Additionally, brain activity during switching was reduced after cue presentation in several regions, including precuneus and anterior cingulate cortex. Our results indicate that cues and associated brain activity predict subsequent decreased cortical resource allocation during task-switching. Future analyses will include data from healthy and impaired older adults to investigate whether cueing can reduce switch costs in these populations.

F15

IMPAIRED TASK SWITCHING IS RELATED TO WORKING MEMORY ABILITY AND INHIBITORY CONTROL IN CHILDREN WITH ADHD Natasha Matthews[1], Kelly Garner[1], Joe Wagner[1], Emma Collier-Baker[1], Alasdair Vance[2], Mark. A Bellgrove[1]; [1]University of Queensland, [2]University of Melbourne — This study investigated the relationship between task switching performance and both working memory ability and inhibitory control in children with attention-deficit-hyperactitivy-disorder (ADHD). Thirty-five children with ADHD and 30 aged-matched control children performed a task-switching task in which they alternated between judging the colour or the shape of a target stimulus. Both children with ADHD and control participants displayed the predicted task-switching cost, with longer reaction times and great error rates on trials that required switching between the colour- and shape-tasks relative to trials in which tasks were repeated. The switch costs were greater for children with ADHD compared with controls. Post error slowing (calculated as the mean of reaction time following an error response minus mean reaction time following a correct response) did not differ between groups. Successful task switching ability requires both the maintenance of the current task set in working memory and the inhibition of previous task sets. To explore the relationship between these two processes and switching performance we correlated switch costs with performance on a 2-back spatial working memory task and a stop signal inhibition task. Both working memory accuracy and stop signal reaction time were correlated with task switching performance in children with ADHD, but not in control children. The present results provide further evidence for impaired task switching performance in ADHD and suggest that this impairment may be closely related to underlying impairments in working memory and inhibition.

F16

STRATEGIC ORIENTATION OF ATTENTION REDUCES TEMPORALLY PREDICTABLE STIMULUS CONFLICT Lawrence Appelbaum[1], Carsten Boehler[1], Robert Won[1], Lauren Davis[1], Marty Woldorff[1]; [1]Duke University — Humans are able to continuously monitor environmental situations and adjust their behavioral strategies to optimize performance. Here we investigate the behavioral and brain adjustments that occur when conflicting stimulus elements are, or are not, temporally predictable. Event-related potentials (ERPs) were collected while two different variants of the color-naming Stroop task were performed in which the stimulus onset asynchronies (SOAs) between the relevant color and irrelevant word stimulus components were varied, with the SOAs (-200ms, -100ms, 0ms/simultaneous, 100ms, 200ms) being either randomly intermixed or held constant within each experimental run. Results indicated that the size of both the neural and behavioral effects of stimulus incongruency varied with the temporal arrangement of the stimulus components, such that the random-SOA arrangements produced the greatest incongruency effects at the earliest irrelevant-dimension first SOA (-200 ms) and the constant-SOA arrangements produced the greatest effects with simultaneous presentation. These differences in conflict processing were accompanied by rapid (~150 ms) modulations of the sensory evoked components of the irrelevant distracter components when they consistently occurred first. These effects suggest that individuals are able to strategically allocate attention in time to mitigate interference of a temporally predictable distracter. In that these adjustments were instantiated by the subjects without instruction, they reveal a form of rapid strategic learning for facilitating performance when there is temporally predictable stimulus incongruency.

F17

THE EVENT-RELATED OPTICAL SIGNAL (EROS) REVEALS COMMON AND TASK-SPECIFIC MECHANISMS OF RESPONSE MODE PREPARATION Pauline Baniqued[1], Kathy Low[1], Monica Fabiani[1], Gabriele Gratton[1]; [1]Beckman Institute and Psychology Department, University of Illinois at Urbana-Champaign — Redirecting attention from previously relevant tasks to deal with new demands is an important everyday skill. Whereas previous studies show the importance of fronto-parietal regions in controlling attention, little is known about the spatio-temporal dynamics of this network. Using the event-related optical signal (EROS), we investigate activity related to task-switching in networks of brain regions. EROS measures changes in optical scattering due to activity in neural tissue and offers good spatial and temporal resolution. We manipulated the response mode on each trial in a choice-response task. Subjects received an auditory-visual precue indicating whether to respond vocally or manually. After 2000 ms, participants saw or heard an "L" or "R", indicating a "left" or "right" response to be implemented with the appropriate response modality. There were no reliable switch costs for reaction time or accuracy, although vocal responses were slower overall than manual responses. Consistent with previous findings, we found common task-switching activity in fronto-parietal regions beginning around 200 ms post-precue. We also found prolonged task-specific effects in the final second before the reaction stimulus, where switching to a vocal response mode showed activity in dorsomedial prefrontal cortex, and switching to manual elicited a response in more ventral parietal-occipital regions. Concurrently recorded ERPs show a similar pattern reversal at the Pz electrode during the later preparatory period. Switching to manual was associated with greater negativity, and switching to vocal was associated with greater positivity. These results expand on models of task preparation by revealing the interplay of common and specific processes.

Executive Processes: Monitoring & Inhibitory Control

F18

VARIATIONS IN DISCOUNT RATES ARE ASSOCIATED WITH DIFFERENCES IN THE ABILITY TO IMAGINE FUTURE REWARDS Shabnam Hakimi[1], Todd Hare[1], Antonio Rangel[1]; [1]Caltech — Behavioral studies have shown that there is considerable variation across individuals on their ability to postpone gratification in order to obtain larger delayed rewards. It has been hypothesized that some of this variation might be due to differences on the ability to represent the value of future rewards. We tested this hypothesis using human functional neuroimaging while participants performed two different tasks: an intertemporal monetary choice (ITC) task where they made binary choices between a small immediate amount of money and larger delayed payments, and a visualization task in which they consumed or imagined consuming appetitive liquid rewards. Consistent with previous studies, we found that the subjective value of the monetary offers was encoded in ventral medial prefrontal cortex (vmPFC) during the ITC task. We also found a common area of left ventrolateral prefrontal cortex (vlPFC) that exhibited a pattern of activity consistent with the main hypothesis. During ITC, this region exhibited stronger activation in more difficult trials (where there is a conflict between the immediate and delayed values of the rewards), as well as increased functional connectivity with the area of vmPFC involved in valuation. During the visualization task, the same region showed stronger activation during imagining than consumption trials, and it also exhibited increased functional connectivity with vmPFC. Moreover, more patient participants exhibited enhanced responses in vmPFC during the imagination component of the visualization task. Together, these data suggest that the left vlPFC plays a critical role in computing the value of delayed rewards during decision-making.

F19

FURTHER EVIDENCE OF A DISSOCIATION BETWEEN ACTION PREVENTION AND CANCELLATION Chelan Weaver[1,2], Courtney Clark[3], Michael C. Anderson[2]; [1]Cambridge University, [2]MRC Cognition and Brain Sciences Unit, [3]University of California, Los Angeles — The ability to stop prepotent motor responses is widely thought to rely on inhibitory control. Two of the most commonly used motor-stopping tasks are the stop-signal and go/no-go paradigms. These are similar but distinct tasks that have been used extensively (and often interchangeably), to measure the ability to stop movements across many and varied populations. Although both tasks quantify aspects of stopping performance, there is increasing doubt that they share common computational processes or neural substrates. Further, it has not previously been shown that either task necessitates inhibitory control as narrowly defined by cognitive psychologists, in which stopping is accomplished by attenuating the response itself. To ascertain the involvement of inhibition in these paradigms, each task was adapted to incorporate the independent probe method, a technique developed to isolate the after-effects of inhibition from other sources of memory impairment. In the current work, novel stimuli were used to elicit recently-stopped motor responses, enabling the measurement of performance decrements localized to responses. This revealed a dissociation between two types of motor stopping. Across a series of between-subject and within-subject experiments, robust after-effects of inhibition were found in the adapted stop-signal task, but no evidence of inhibition was found in the adapted go/no-go task. This suggests that inhibitory control is recruited for cancelling actions, but might not be utilized to prevent movements.

F20

SPATIO-TEMPORAL BRAIN DYNAMICS MEDIATING POST-ERROR BEHAVIORAL ADJUSTMENTS Aurélie Manuel[1,2], Fosco Bernasconi[1,2], Micah Murray[1,2,3,4], Jeremy Grivel[2], Lucas Spierer[1]; [1]Chuv, [2]University of Lausanne, [3]Cibm, Lausanne, Switzerland, [4]Vanderbilt University Medical Center, Nashville, TN — Optimal behavior relies on rapid and flexible adaptation to environmental requirements, notably based on the detection of errors. The impact of error-detection on subsequent behavior typically manifests as a slowing down of response time following errors. This effect has been attributed to shifts to more cautious response mode or to distraction induced by the infrequent error trials. However, how errors impact the processing of subsequent stimuli and in turn shapes behavior remains unresolved. To address these questions, we used a speeded auditory spatial Go/NoGo task and contrasted auditory evoked potentials (AEPs) to left-lateralized "Go" and right "NoGo" stimuli as a function of performance on the preceding Go stimuli, generating a 2x2 design with "Preceding Performance" (accurate; inaccurate) and Stimulus type (Go; NoGo) as within-subjects factors. Behaviorally, we replicated post-error slowing effects. Electrophysiologically, AEPs modulated topographically as a function of preceding performance 80-110ms post-stimulus onset and then as a function of stimulus type 110-140ms, indicative of changes in the underlying brain networks. Source estimations of these effects revealed a stronger activity of prefrontal regions to stimuli after successful than error trials, followed by a stronger response of parietal areas to the NoGo than Go stimulus. We interpret these results in terms of a shift from a fast-automatic to a slow-controlled form of inhibitory control induced by the detection of errors, manifesting during low-level integration of subsequent stimuli, which in turn influences response speed.

F21

WHEN THE PRESENCE OF ANOTHER AGENT ALTERS MY OWN ACTION: AN ELECTROMYOGRAPHIC STUDY OF THE SOCIAL SIMON EFFECT Karen Davranche[1], Pascal Huguet[1], Clément Belletier[1,2], Boris Burle[1], Franck Vidal[1], Thierry Hasbroucq[1]; [1]Université de Provence et CNRS, Marseille, France, [2]Direction Générale de l'Armement — The purpose of this study was to investigate whether sharing a task with another agent alters our own cognitive performances. We combined reaction time (RT) methods and electromyographic (EMG) recordings to assess the nature of information processing implemented by each co-actor. Sixteen participants performed an individual Simon task and a Go/Nogo task completed alone and alongside with a friend. In the joint Go/Nogo task, each participant was responsible to only one response (left or right hand) associated to the colour of the stimulus (red or green). Each actor can be seen as performing a Go/Nogo task, or from another point of view, that the pair performed a Simon task. In the individual Simon task, RT was shorter when spatial locations of stimulus and response corresponded than when they did not correspond (+29ms). An analogous interference effect, albeit of smaller magnitude, was observed both in the individual Go/Nogo task and in the joint Go/Nogo task. Importantly, the effect was smaller in the former (+6ms) than in the latter task condition (+11ms). This suggests that co-acting alters the nature and number of operations of information processing. Nevertheless, analysis of EMG patterns reveals that the motor component of cognitive processes implemented by each co-actor differs from those implemented in the individual Simon task. In particular, the number of incorrect EMG activations was unaffected by the correspondence between the stimulus and response locations. The results further show that co-acting with another agent speeds up response execution.

F22

INFORMATION-BASED BRAIN MAPPING OF STIMULUS- VERSUS RESPONSE-BASED INTERFERENCE CONTROL PROCESSES Tobias Egner[1], Jiefeng Jiang[1]; [1]Duke University — Interference control, the resolution of conflict from task-irrelevant stimuli in the selection of goal-directed responses, is held to be a key executive function. A basic distinction can be drawn between two major forms of conflict: stimulus-based conflict interferes with response selection as a consequence of perceptual ambiguity in the imperative stimulus (e.g., in a manual Stroop task), whereas response-based conflict interferes with response selection via a

response-affordance of a task-irrelevant stimulus attribute (e.g. in the Simon task). It is currently debated whether the resolution of these different conflicts is served by domain-general or domain-specific mechanisms. To address this question, we conducted an fMRI study (n = 21) that orthogonally combined stimulus- (Stroop) and response-based (Simon) conflicts in a face-gender discrimination task. Behavioral results documented additive costs of these conflicts. We analyzed the fMRI data with information-based pattern analysis techniques. Specifically, using a recursive voxel selection/elimination scheme, we trained one classifier to distinguish between congruent and incongruent Simon features, and another classifier to distinguish between congruent and incongruent Stroop features. Cross-validation analysis showed that the classifiers achieved ~75% performance accuracy. Preliminary additional analyses suggest that the Stroop classifier performs poorly at predicting Simon congruency, and vice versa. Furthermore, the two classifiers draw on distinct sets of voxels, with the Simon classifier relying predominantly on voxels in premotor cortex, and the Stroop classifier on voxels in visual cortex, including the fusiform face area. These preliminary results support the assumption of a modular (domain-specific) organization of interference control processes.

F23

NEURAL MECHANISMS OF CONTEXT-SPECIFIC COGNITIVE CONTROL Joseph A. King[1], Franziska M. Korb[1], Tobias Egner[1]; [1]Duke University — Recent behavioral research has shown improved interference resolution for stimuli in contexts (e.g. locations) associated with a high proportion of incongruent items and vice versa-even though subjects are unaware of conflict frequency manipulations. These findings suggest that contextual cues trigger an online retrieval of attentional control associated with that context ("priming of control"). An alternative possibility is that the effect is mediated by sustained attention to the context with higher probability of conflict. Here, we employed event-related functional magnetic resonance imaging (fMRI) to adjudicate between these two possibilities. We manipulated the proportion of incongruent-to-congruent trials presented in each visual hemifield in a face-gaze version of the Eriksen flanker task (n = 27). Crucially, we used only trial-unique stimuli and thus controlled for possible influences of lower-level associative mechanisms. Nevertheless, participants showed a robust context-specific adaptation effect with reduced interference at the high-conflict location. Our fMRI analyses focus on activation in the fusiform face area (FFA), which we defined with an independent localizer scan. Specifically, activity in the left/right FFA are analyzed as a function of whether the stimulus on a given trial was in the ipsi- or contra-lateral hemifield, and whether the contra-lateral field was the low or high conflict location. The sustained attention account predicts generally enhanced FFA activation contra-lateral to the high-conflict hemifield, whereas the priming-of-control account predicts enhanced FFA activity only when a stimulus is present in contra-lateral, high-conflict field. Preliminary results uncovered a hemifield by context interaction in the FFA, concordant with the priming-of-control account.

F24

IS IMITATION RELATED TO THE ACTIVATION OF THE MOTOR CORTICES DURING ACTION OBSERVATION? Elena Núñez Castellar[1], Clémence Roger[1], Wim Fias[1]; [1]Ghent University, Belgium — Recent research has shown that during action observation activity in the motor cortices is influenced by the observed action. Observer's lateralized activity in motor cortices is thought to reflect what the observer would have done if he/she had actively done the task him/herself (Van Schie et al., 2004) consistent with studies of imitation. In the present study we further investigated this lateralization during action observation. EEG was recorded when participants executed and observed other participant's performance in a flanker task. Opposite to previous studies, the other's actions were not monitored by observing the other's hand movements but instead a red light indicated the side in which the other participant's response was given. The data were analyzed using Laplacian transform (Babiloni et al., 2001), which improves the spatial and temporal resolution of the EEG. Our results showed that even in the absence of hand-movement observation, there was lateralized activity maximal over the observer's premotor cortex. We did not find this activity maximal over the motor cortices. The finding of lateralized activity in the pre-motor areas when the motor acts cannot be observed put in doubt the idea that increased activity at the motor level is related with imitation, which can be defined as the copying of body movements that we observe (Brass & Heyes, 2005). Instead, we hypothesize that the lateralized activity is driven by the representation of the other's expected response.

F25

AROUSAL IN COGNITIVE CONTROL Marlies van Bochove[1], Lise Van der Hagen[1], Wim Notebaert[1], Tom Verguts[1]; [1]Ghent University — Emotional stimuli lead to enhanced processing and subsequent improved memory (e.g., McGaugh, 1990). Verguts and Notebaert (2009) proposed that a similar process is responsible for increased cognitive control in congruency tasks after incongruent stimuli. For example, after an incongruent flanker trial, it is assumed that an arousal signal is sent throughout the cortex which strengthens active task-relevant associations. This arousal-induced learning leads to a reduced congruency effect on the next trial (i.e., Gratton effect). The current study therefore investigated arousal in the flanker by measuring pupil dilation, an index of arousal (possibly related to LC activation (Jepma & Nieuwenhuis, in press)). We asked participants (N = 13) to perform a flanker task and collected both reaction times and pupil width. We found that pupil width is larger during incongruent than congruent trials. This is consistent with the hypothesis that conflict leads to arousal and more generally, in line with the hypothesis that learning might play a key role in cognitive control (Verguts & Notebaert, 2009).

F26

ERRORS: DID SOMETHING GO WRONG IN THE MOTOR COMMAND? Clémence Roger[1], Elena Núñez Castellar[1], Wim Fias[1]; [1]Ghent University, Belgium — We often advise children not being impulsive otherwise they might end up making an error. Indeed the reaction times (RT) in errors are shorter than in correct trials. Peripheral indices, like EMG activity, showed that even if the erroneous command has been sent there is an on-line tentative to overtake it. However, no evidence of these mechanisms has been observed at the cortical level so far. In the present study we investigated the differences between the organization of the motor command in error and correct trials. For that purpose, participants performed a flanker task and the EEG and EMG was recorded. We compared our results with the ones of previous studies which have shown that during correct responses in between hand RT tasks, the motor command is organized in a way that the effecter involved in the selected response is activated (negativity over contralateral M1) whereas the effecter involved in the non-selected response is inhibited (positivity over ipsilateral M1) (Vidal et al., 2003). Such an inhibition has been interpreted as an error prevention mechanism. First, our results showed that the contralateral activation of the selected response is reduced in errors suggesting an on-line inhibition of the erroneous response activation at the M1 level. Second, we found that the ipsilateral inhibition of the alternative response was absent in errors. Because in correct trials the non-desired action is inhibited, we interpreted the absence of inhibition in errors as reflecting impulsivity at the response selection stage.

F27

BEHAVIORAL AND NEURAL CORRELATES OF COGNITIVE CONTROL TRAINING: IMPLICATIONS FOR MAJOR DEPRESSION Alexander Millner[1], Diego Pizzagalli[2]; [1]Harvard University, [2]McLean Hospital, Harvard Medical School — Research has shown that individuals with major depressive disorder (MDD) display impaired performance in cognitive control tasks (e.g., Stroop task) and dysfunctions within frontocingulate pathways. Preliminary research suggests that training MDD individuals on tasks that target abnormally functioning brain regions could have therapeutic effects. As a first step in this direction, the current study tested healthy individuals in a 3-day training program aimed at enhanc-

ing cognitive control function. The long-term goal of this research is to evaluate whether cognitive training probing executive functions and underlying frontocingulate pathways could enhance treatment response for MDD patients. Twenty-two healthy controls participated in a 3-day training with cognitive and affective control tasks. The training sessions employed different tasks relative to the pre/post-training sessions to assess improvement across cognitive control tasks. Additionally, 128-channel EEG was collected during resting and task states in the pre- and post-training sessions to probe the effects of training on brain function. Preliminary behavioral analyses show that participants improved performance over the course of training (i.e. reduced RT and increased accuracy). Critically, comparison of pre- vs. post-training data revealed improved post-training performance (RT) specific to trials requiring recruitment of cognitive control. Furthermore, improvement in pre-to-post RT was significantly correlated with dorsal anterior cingulate cortex and dorsolateral prefrontal cortex activity (using low-resolution electromagnetic tomography (LORETA) to source localize EEG), while rostral anterior cingulate cortex was associated with post-error adaptation. These results suggest that cognitive control can be improved in healthy subjects. We hypothesize that MDD individuals might benefit from a similar training.

F28

NEURAL EVIDENCE FOR A RETRIEVAL-BASED MODEL OF CONFLICT ADAPTATION Derek Nee[1,2], Sabine Kastner[3], Joshua Brown[1]; [1]Indiana University, [2]University of Michigan, [3]Princeton University — A central tenet of many theories of cognitive control is that sustained, goal-related activation in lateral prefrontal cortex (LPFC) drives dynamic adjustments in control. By contrast, opposing theories posit that adaptation results from rapid learning and retrieval mechanisms. Here, we delineated between these accounts by examining the time-course of control-related activations in LPFC in a Stroop-like task. Conflict adaptation effects were present behaviorally even in the absence of sustained top-down signals. Instead, adaptive effects in the LPFC were reflected by speeded activations consistent with retrieval-based priming. Strikingly, these effects were independent of conflict and instead reflected the degree to which the current stimulus category matched the most recent stimulus category in memory. Moreover, speeded activations in the LPFC were correlated with downstream enhancements and behavior. These results challenge the notion that sustained LPFC activations drive flexible behavior and establish that transient retrieval-based effects produce adaptive control.

F29

THE ROLE OF EXECUTIVE FUNCTIONS IN HUMAN PROSPECTIVE INTERVAL TIMING Ruth S Ogden[1], Egle Salominaite[1], Luke A Jones[2], John E Fisk[3], Catharine Montgomery[1]; [1]School of Natural Sciences and Psychology, Liverpool John Moores University, UK, [2]School of Psychological Sciences, University of Manchester, UK, [3]School of Psychology, University of Central Lancashire, UK — Human timing is thought to be based on the output of an internal clock. Whilst the functioning of this clock is well documented in the literature, it is unclear which other cognitive resources may moderate timing. Previous research suggests that the central executive of working memory may be recruited during human prospective timing (Brown, 2006; Rattat, 2010), in particular inhibitory control. However it seems likely that the other executive component processes identified by Miyake et al. (2000) and Fisk and Sharp (2004) may contribute to timing performance; further exploration of this was the aim of the present study. An interference paradigm was employed in which participants completed an interval production task, and tasks which have been shown to tap the four key executive component processes (shifting, inhibition, updating and access) under single and dual-task conditions. Comparison of performance on all tasks under single and dual-task conditions indicated that timing always became more variable when concurrently performing a second task. Bidirectional interference only occurred between the interval production task and the memory updating task, implying that both tasks are competing for the same executive resource of updating. There was no evidence in the current study to suggest that switching, inhibition or access were involved in timing, however it is acknowledged that under more difficult task conditions switching and inhibition resources may be recruited.

F30

DIFFERENTIAL EFFECTS OF AN NMDA RECEPTOR ANTAGONIST ON GO/NO-GO FMRI ACTIVITY IN INDIVIDUALS WITH AND WITHOUT A FAMILY HISTORY OF ALCOHOLISM Sharna Jamadar[1], Shashwath Meda[1], Elise DeVito[2], Michael Stevens[1,2], Marc Potenza[2], John Krystal[2], Godfrey Pearlson[1,2]; [1]Olin Neuropsychiatry Research Center, Institute of Living, Hartford CT, [2]Department of Psychiatry, Yale University, New Haven, CT — Individuals family history positive for alcoholism (FHP) show increased alcoholism rates and are more impulsive than those without alcoholism family histories (FHN), possibly due to altered NMDA/DA interactions in FHP. We investigated whether the NMDA receptor antagonist, memantine, differentially affects Go/No-Go brain activity in matched FHP (n=15) and FHN (n=15) individuals. On two separate days, participants received 40mg memantine or identical-appearing placebo 4-hrs prior to fMRI testing in a double-blind placebo-controlled within-subjects design. During fMRI participants responded to Go stimuli (85%) and withheld responses to No-Go stimuli (15%). SPM results were thresholded at p<.001 (k=5voxels). Behaviorally, there were no differences between groups on Go-RT or No-Go false alarms on placebo. Go-RT was increased (p<0.05) on memantine vs. placebo; this effect was marginally larger in FHN. FMRI activity for successful inhibitions (No-Go>Go) and false alarms (No-Go Errors>Go) did not differ between groups on placebo. Successful inhibitions during placebo activated a distributed fronto-temporal-parietal-subcortical network including middle/inferior frontal gyri (MFG/IFG), middle/inferior temporal gyri (MTG/ITG), cingulate, and putamen. Memantine increased No-Go>Go activity in caudate, IFG and MTG/ITG for FHN. For FHP, this modulation was absent except in IFG. Instead, memantine decreased activity in cingulate and caudate. False alarms during placebo activated a distributed fronto-temporal-parietal-subcortical network including bilateral IFG, putamen, and MTG. Memantine increased No-Go errors>Go activity in MTG for FHN, and decreased MTG and putamen activity in FHP. Overall, results show that NMDA receptor antagonists do not modulate an extended response inhibition neural system in FHP to the degree seen in FHN.

F31

METHYLPHENIDATE BUT NOT ATOMOXETINE OR CITALOPRAM IMPROVES INTERFERENCE CONTROL: A PHARMACOLOGICAL EEG STUDY Jessica Barnes[1], Angela Dean[1], L. Sanjay Nandam[1], Redmond O'Connell[2], Mark Bellgrove[1]; [1]Queensland Brain Institute, University of Queensland, [2]School of Psychology and Trinity College Institute of Neuroscience, Trinity College Dublin — The ability to monitor performance and ignore distracting information is critical for achieving goals, and multiple neurotransmitter systems have been implicated. Electrophysiological indices of both interference control and error processing, such as the error-related negativity (ERN) and error positivity (Pe), have been shown to be modulated following dopaminergic, noradrenergic or serotonergic pharmacological challenge. In this study, 27 non-clinical males took part in a randomised, double-blind, placebo-controlled, cross-over study. Each participant was administered methylphenidate (dopamine/noradrenaline reuptake inhibitor), atomoxetine (noradrenaline reuptake inhibitor), citalopram (serotonin reuptake inhibitor) or placebo across 4 separate sessions. Each participant performed the Eriksen flanker task while undergoing electroencephalogram recording in each of the 4 sessions. Repeated measures ANOVA revealed that task accuracy was significantly improved by methylphenidate compared to atomoxetine (p=0.024), citalopram (p=0.039) and placebo (p=0.001). This increased accuracy due to methylphenidate was not associated with a commensurate slowing of reaction time. There was also a significant main effect of drug on accuracy for incongruent trials which reflected enhanced accu-

racy under methylphenidate compared to placebo (p=0.002). The effect of drug on accuracy for congruent trials tended towards significance (p=0.06). Changes in the amplitude or latency of the relevant event-related potentials (ERN, Pe) as a function of drug condition will also be presented. The results from this study suggest that methylphenidate, but not atomoxetine or citalopram, has a specific effect on improving interference control. Since methylphenidate has a dual action on both dopamine and noradrenaline, our results provide further evidence for the catecholaminergic modulation of interference control.

F32

DOPAMINE TRANSPORTER GENOTYPE PREDICTS BEHAVIOURAL AND NEURAL MEASURES OF RESPONSE INHIBITION Tarrant Cummins[1], Ziarah Hawi[1], Julia Hocking[1], Mark Strudwick[1], Joe Wagner[1], Robert Hester[2], Christopher Chambers[3], Hugh Garavan[4], Mark Bellgrove[1]; [1]The University of Queensland, [2]The University of Melbourne, [3]Cardiff University, [4]Trinity College Institute of Neuroscience — Response inhibition, a key component of executive control, refers to the ability to inhibit pre-potent responses. The Stop-Signal task, a paradigmatic measure of response inhibition, allows for the calculation of Stop-Signal Reaction Time (SSRT) - a reflection of the speed of the inhibitory process. Behavioural measures of inhibitory control, such as SSRT are highly heritable and have been proposed as endophenotypes for disorders of catecholamine dysregulation such as ADHD. Here we used genetic association analyses and functional magnetic resonance imaging to elucidate the genetic drivers of response inhibition in non-clinical participants. In a sample of 405 healthy adults, we investigated the association between SSRT and allelic variation in Single Nucleotide Polymorphisms (SNPs) of a range of catecholamine system genes involved in the regulation and signaling of dopamine and/or noradrenaline. Markers on the Dopamine transporter gene, DAT1, accounted for significant variance in SSRT, after controlling for age and gender, and survived corrections for multiple comparisons. The influence of the most significantly associated SNP, rs37020, was then further investigated in a targeted fMRI study of inhibitory control using a subset of the larger cohort (n=50). Activation associated with response inhibition (successful stop–go contrast) varied significantly with genotype in frontal and caudate regions. Thus our imaging genetic data support our behavioural associations and indicate that DNA variation in dopaminergic genes modulates fronto-striatal circuits supporting inhibitory control. Given that response inhibition is a viable endophenotype for ADHD, these data suggest that DAT1 rs37020 might be profitably investigated as a susceptibility marker for ADHD.

F33

EFFECTS OF MINDFULNESS-BASED COGNITIVE THERAPY ON THE ERROR-RELATED NEGATIVITY EEG/ERP IN ATTENTION DEFICIT HYPERACTIVITY DISORDER Poppy L.A. Schoenberg[1,2,3], Sevket Hepark[3], Marieke M. Lansbergen[2,3], Henk Barendregt[1], Jan K. Buitelaar[2,3], Anne E.M. Speckens[3]; [1]Faculty of Science, Radboud University Nijmegen, Netherlands, [2]Donders Centre for Cognitive Neuroimaging, Netherlands, [3]Department of Psychiatry, UMC St. Radboud, Netherlands — Aim: The error-related negativity (ERN) event-related brain potential (EEG/ERP) provides an index of dopamine transmission in the anterior cingulate cortex (ACC), a central neural circuit in target detection, error-processing and response monitoring. Research has shown attenuated amplitude of the ERN in ADHD, reflecting disturbed ACC and dopaminergic functioning, proposed to underlie attention problems in the disorder. In this study error-processing (ERN) was examined in ADHD before and after exposure to mindfulness based cognitive therapy (MBCT). We hypothesized the mindfulness process would improve ACC modulation, reflected by changes in the ERN/ERP. Method: N = 14 (7M) adults with DSM-IV diagnosed ADHD were randomly allocated to either; 1) MBCT (N = 7; mean age =37), or 2) waiting-list control (N=7; mean age =32). All patients performed a visual continuous performance task (X-CPT; 20% inhibition rate), concomitant to EEG/ERP recording, before and after the 8-week MBCT intervention period. Results: Preliminary findings showed increases in amplitude of the early ERN/Ne (error-negativity) and later Pe (error-positivity) components of the ERN/ERP to false alarms, following exposure to MBCT compared to baseline amplitude measures. Pre-to-post increases in ERN amplitude were not apparent in the waiting-list control data. Neurophysiological effects were specific to amplitude; no differences were evident in latency measures. Summary: ERN amplitude increase correlates to increases in dopamine receptor levels and greater ACC efficiency in error processing. We found MBCT enhanced ERN amplitudes to errors in adults with ADHD. Such preliminary findings suggest MBCT may provide a promising intervention for ADHD symptoms, specifically impulsivity and inattentiveness.

F34

ALTERED ERROR PROCESSING IN PATIENTS WITH FOCAL THALAMIC LESIONS Jutta Peterburs[1], Kathrin Gajda[1], Benno Koch[2], Michael Schwarz[2], Irene Daum[1], Klaus-Peter Hoffmann[1], Christian Bellebaum[1]; [1]Ruhr University Bochum, Germany, [2]Klinikum Dortmund, Germany — Event-related potentials (ERP) research has identified a negative deflection within about 100 ms after an erroneous response as a correlate of awareness-independent error processing. This component, referred to as error-related negativity or error negativity (Ne/ERN), has been shown to originate from the anterior cingulate cortex (ACC). Its time course suggests an internal error monitoring system acting rapidly based on central information such as an efference copy signal. However, there is as yet no empirical evidence directly linking the Ne/ERN to efference copy signals. Since both studies on monkeys and humans have implicated the thalamus as an important relay station for efference copy signals, the present study investigated the Ne/ERN in patients with focal vascular damage to the thalamus. Five patients and 40 control participants completed an antisaccade task with simultaneous electroencephalographic recording (EEG). While behavioural performance in regard to the number of errors did not differ between patients and controls, Ne/ERN amplitude was generally attenuated in patients. Three patients showed a significant reduction of the Ne/ERN compared to a subgroup of age-matched controls. In these patients, no clear NE/ERN could be identified for both left- and rightward saccade errors. Lesions comprised the right mediodorsal and ventroanterior thalamus in two patients, and the left ventrolateral and right ventroanterior thalamus in one patient. The results suggest altered error processing in focal thalamic lesion patients and support the notion that the Ne/ERN is based on efference copy signals. The functional contributions of different thalamic substructures remain to be determined.

F35

EFFECTS OF SEMANTICS ON INHIBITORY PROCESSES IN AGING Raksha Anand[1], Hsueh-Sheng Chiang[1], Michael Kraut[2], Elizabeth Bartz[1], Mandy Maguire[1], John Hart[1]; [1]Center for BrainHealth, The University of Texas at Dallas, [2]Department of Radiology, Johns Hopkins Hospital — The ability to inhibit irrelevant information and attend to relevant information is critical for efficient processing of information. The extent to which aging affects inhibition that is contingent upon semantic information is unknown. We examined inhibitory processes using event-related potentials (ERPs) in 28 younger and older adults (65 y+) on two Go-NoGo tasks that required different degrees of semantic categorization. The simpler task (Single Cars-Dogs; SC) included a line drawing of a dog (Go Stimuli) and a car (NoGo Stimuli). The complex task (Object Animal; OA) consisted of objects (Go) and animals (NoGo). Participants pushed a button for the 'Go Stimuli' and withheld responses for the 'NoGo Stimuli'. ERP data revealed that in the semantically simpler task (SC), the N2 amplitude was more negative for Go trials compared to NoGo trials in older adults ($p = .007$), a pattern opposite that of younger adults. Additionally, the P3 latency for Go trials was longer compared to NoGo trials ($p = .009$) in older adults, however these differences were not significant in younger adults. In the more complex task (OA), the N2 did not differ significantly across Go-NoGo trials in older adults contrary to those in younger adults ($p < .001$). These findings indicate that older adults appear to attend to the Go stimuli as a strategy in the simpler task (SC) whereas they tend to treat both the Go and NoGo stimuli similarly on

the more complex task (OA) suggesting that aging effects the way semantic information interacts with inhibitory processes.

F36

COGNITIVE CONTROL IN CHRONIC METHAMPHETAMINE ABUSERS WITH AND WITHOUT ADHD DURING A RESPONSE INHIBITION PARADIGM

Catherine Fassbender[1,2], Julie B. Schweitzer[1], Ruth Salo[2]; [1]M.I.N.D Institute, University of California Davis Medical Center, [2]Imaging Research Center, University of California Davis Medical Center

— Faulty response inhibition has also been implicated in long term substance abuse and ADHD. An ADHD diagnosis puts one at an increased risk of substance dependence compared to the general population. As inhibition has been associated with brain regions that are impaired in both ADHD and methamphetamine (MA) abusers, the identification of common and differing cognitive impairments in MA abusers with and without ADHD may provide insight into addiction, drug-seeking behaviors and the cessation of drug use. We used a GO/NOGO paradigm with varying stimulus presentation times to investigate cognitive control and response inhibition in long-term MA abusers who were currently drug abstinent (3 mos to 2 yrs) compared to healthy controls. MA abusers were divided into two groups: MA+ADHD and MA-ADHD). MA-ADHD and MA+ADHD groups made more omission errors on the GO/NOGO task compared to controls; however post hoc comparisons revealed significant differences only between MA-ADHD and control subjects. There was a significant interaction between group status and stimulus presentation time for commission errors (pressing a button to a NOGO) such that the MA-ADHD group displayed a different pattern of commission errors with varying stimulus presentation time compared to the other two groups. Thus far our data suggest differences between MA abusers with and without an ADHD diagnosis on inhibition with differing speed-accuracy trade-offs. We aim to pinpoint cognitive impairments associated with performance monitoring and attention in MA-ADHD and MA+ADHD in a larger group.

F37

INHIBITION OF IMITATIVE AND SPATIALLY COMPATIBLE RESPONSES SHARE NEURAL CIRCUITRY

Katy Cross[1], Marco Iacoboni[1]; [1]UCLA

— Recent work demonstrates that imitation can be unconscious and automatic, and the existence of patients exhibiting reflexive imitation suggests that some mechanism normally inhibits imitative behavior. It has been proposed that control of imitation occurs through a dedicated mechanism related to social cognition. In contrast, proponents of the common coding hypothesis argue that imitation is simply an extreme form of stimulus-response compatibility, implying a similar mechanism for overcoming automatic imitation and spatially compatible stimulus-response associations. To disentangle these possibilities, 16 subjects performed a stimulus-response compatibility task during fMRI. Video stimuli depicted either extension of a finger (index or middle; imitative stimuli), or one of two dots moving with the same trajectory (spatial stimuli). Subjects were instructed to extend their own index or middle finger on the same (compatible blocks) or opposite (incompatible blocks) side as the stimulus. Dual route models explaining stimulus-response compatibility effects propose that inhibition of the compatible response is required to respond correctly on incompatible trials. Incompatible > Compatible contrasts for spatial and imitative cues revealed identical patterns of activation: bilateral dorsal premotor, superior parietal and pre-supplementary motor areas. Direct comparison between imitative and spatial compatibility effects revealed no differences. Reaction time analyses also reflected a single inhibitory mechanism: 2(stimulus type) x 2(compatibility) ANOVA revealed only a compatibility main effect and the two compatibility effects were highly correlated (r=0.87). Thus, in agreement with the common coding hypothesis, these data suggest that overcoming automatic response activation by both imitative and spatial cues occurs through a common neural mechanism.

F38

WHEN HIGH-POWERED PEOPLE CHOKE UNDER PRESSURE: THE COST OF BEING WATCHED BY THE EXPERIMENTER

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— Only individuals with a high working-memory capacity (WMC) choke under performance pressure on difficult tasks, suggesting that pressure consumes the executive resources they usually rely on to achieve their superior performance. We predicted that only those individuals choke under evaluative audience in a task requiring executive control. After having completed a WM span test, 54 participants performed a Simon task either in isolation, in presence of a peer-confederate, or in presence of an evaluative audience—the experimenter. The Simon task consisted to a fast button-press according to the colour of a stimulus located to the left or the right side of a panel. Classically, reaction time is shorter on congruent than on incongruent trials (stimulus presented in the same vs. opposite spatial location of the response), referred to as the "Simon effect". When working in isolation, participants with a high WMC displayed better performance (smaller Simon effect) than their low WMC counterparts (14 ms vs. 28 ms), providing further evidence that individual differences in WMC correspond to differences in executive control. As expected, however, the high WMC participants' advantage did not persist in presence of a confederate (23 ms vs. 23 ms), and turned in favour of the low-WMC participants in presence of the experimenter (37 ms vs. 24 ms). This suggests that performance pressure undermines executive control in high WMC individuals. More generally, the fact that this effect occurred in the experimenter's presence has strong implications for research in Experimental Psychology.

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THETA-BAND OSCILLATIONS COORDINATE LOCAL AND LONG-RANGE NEURAL NETWORKS IN THE MEDIAL FRONTAL CORTEX DURING COGNITIVE CONTROL

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— Theta is a prominent frequency band observed in direct recordings of the medial prefrontal cortex in humans and nonhuman primates. Medial frontal theta has been linked to error monitoring and feedback processing during learning tasks, and, at the neurobiological level, to synaptic mechanisms of learning, information coding, and inter-regional communication. I will present evidence consistent with the idea that the medial frontal cortex uses theta oscillations to coordinate local and long-range neural networks during cognitive control processes. First, activity recorded locally from the medial frontal cortex correlates with response errors, conflict, and negative performance feedback, and in some cases predicts the extent to which behavior is adjusted in the near future. Second, hypothesis-driven synchronization analyses suggest that the medial frontal cortex uses the theta band to interact with lateral prefrontal, occipital, and ventral striatal regions. Third, hypothesis-free, exploratory mass-synchronization analyses based on graph theory confirm that medial frontal theta during cognitive control tasks reflects a strong "hub" for information flow. Finally, combined EEG and diffusion tensor imaging (which measures structural white matter tracts) reveals that error-related medial frontal theta is linked to anatomical tracts to the ventral striatum and inferior frontal gyrus, whereas long-range cortico-cortical functional connectivity strength is linked to corpus callosum white matter tracts. Together, these findings paint a picture of theta as a language used by the medial frontal cortex to monitor actions and bias activity in brain circuits involved in sensory, motor, social, and emotional processing in order to optimize goal-directed behavior.

F40

NEURAL COMPONENTS OF CONSCIOUS AND UNCONSCIOUS CONFLICT: AN EEG STUDY

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— 'Conscious conflict' has been a central topic in the history of neuroscience. Consider Luria's emotional conflicts, Hull's conflicting

'drives,' and Neal Miller's examination of competing inclinations. We outline how conscious conflict is just one of many kinds of interaction in the nervous system and analyze what is special about it. Other kinds of interactions, such as 'afference binding' (e.g., intra- or inter-sensory interactions), or interactions involving non-skeletal muscle effectors, can occur unconsciously. Similarly, stimulus-response associations ('efference binding'), such as pressing a button in response to a subliminal stimulus, can occur unconsciously. In our within-subjects designed EEG study (n = 13), we compared the neural correlates of conscious conflict (Stroop conflict) to those of an unconscious, intersensory conflict (the McGurk effect). Analyses of Event-Related Spectral Perturbation (ERSP) and inter-regional coherence revealed that, compared to unconscious forms of conflict, conscious conflict consistently resulted in increased gamma band activity (~40 Hz) at various frontal and parietal sites, in addition to increased gamma and theta band coherence between frontal and parietal regions. (We also examined conflict during a more motivational task, the 'cold pressor' task.) The Stroop conflict results are consistent with findings that implicate synchronous frontal-parietal gamma and theta oscillations in the integration of cortical information, a form of large-scale integration that has been associated with conscious experience (Doesberg et al., 2009; Melloni et al., 2007; Morsella, 2005). Together, these data begin to illuminate the difference between the cognitive and neural aspects of conscious and unconscious conflicts.

F41

PERFORMANCE ON GO/NOGO AND STOP-SIGNAL RESPONSE INHIBITION TASKS IS NOT CORRELATED Diane Swick[1,2], Victoria Ashley[1], And Turken[1]; [1]VA Northern California Health Care System, [2]University of California, Davis — Two major tasks are used to assess response inhibition, an essential executive control function. In the Go/NoGo (GNG) task, a motor response is made to one stimulus class and withheld to another. In the Stop-Signal Task (SST), responses are made on every trial unless a stop signal is presented. Although these two tasks are often treated interchangeably, it is unclear whether they tap the same cognitive processes and neural substrates. A previous meta-analysis of the neuroimaging literature suggested they have both overlapping and distinct neural substrates, the latter reflected by differential recruitment of two cognitive control networks (Swick et al., 2010). Here, we present data from 49 subjects tested in standard versions of GNG and SST. We wished to see whether performance on the two tasks was correlated. Participants included controls (n=25) and patients with TBI and/or PTSD (n=17) or focal frontal lesions (n=7). In GNG, subjects responded to all letters except for X, the NoGo stimulus occurring on 50% or 10% of trials. In SST, subjects responded to all R or L arrows unless they heard the stop signal tone on 25% of the trials. Stop signal delay was adjusted using a 4-staircase procedure designed to produce 50% error rate. Stopping ability was measured by stop signal reaction time (SSRT) and compared to GNG error rates. Results demonstrated that within and across groups, NoGo errors were not correlated with SSRT. Combined with the meta-analysis results, these data suggest GNG and SST are not identical measures of response inhibition.

F42

THE USE OF SUPPORT VECTOR MACHINE PATTERN CLASSIFICATION TO DISTINGUISH PSYCHOPATHS FROM NON-PSYCHOPATHS IN A PRISON POPULATION Scott Freeman[1], Craig Bennett[1], Kent Kiehl[2,3], Michael Gazzaniga[1], Michael Miller[1]; [1]University of California, Santa Barbara, [2]The Mind Research Network, [3]University of New Mexico — Psychopathy is a term used to classify individuals who exhibit low levels of affect, interpersonal problems, and socially deviant behaviors. Based on recent neuroimaging studies, it is hypothesized that such abnormalties in psychopaths result from dysfunction in paralimbic regions, such as the anterior cingulate, posterior cingulate, and orbitofrontal cortex (Kiehl, 2006). Using fMRI data collected from a prison population, we sought to distinguish psychopaths from non-psychopaths on a Go/Nogo task. Individuals were identified as "psychopaths" if their Psychopathy Checklist-Revised (PCL-R) score exceeded an established threshold for psychopathy. We predicted that psychopathic prisoners, relative to non-psychopathic prisoners, would have less activation in paralimbic regions. Using the General Linear Model (GLM), our results indicated no differences in activation between psychopaths and non-psychopaths when using thresholds correcting for multiple comparisons. Similarly, a regression analysis that correlated individuals' PCL-R scores with their BOLD activity yielded no significant areas of activation. We then analyzed the fMRI data with support vector machine (SVM) classification, which investigates regional patterns of activity that the GLM is not sensitive to. The most predictive region was the right posterior cingulate, separating psychopaths from non-psychopaths with 80 percent accuracy (Chance = 50 percent). Other high-performance regions include the left posterior cingulate and the right superior orbitofrontal cortex, both of which achieved 77 percent accuracy. These results indicate that the support vector machine classifiers were able to detect patterns of activity that were not detected with standard GLM method, and the results from the SVM analyses lend support to the paralimbic hypothesis.

F43

ERROR PROCESSING AND POST ERROR ADJUSTMENT IN A FLANKER TASK Yann Cojan[1,2], Camille Piguet[1,2], Patrik Vuilleumier[1,2]; [1]University of Geneva, [2]Center for Neuroscience — The ability to detect errors and adjust behavior accordingly is essential for maneuvering in an uncertain environment. the brain correlates of post error adjustments that occur in executive control tasks are poorly known. We recorded 32 subjects performing a modified flanker task in a 3T magnet. As expected the behavioral results showed a significant incongruency effect ($F = 27.689$, $p<0.001$) and a strong post error slowing ($t = 2.97$, $p = 0.006$). Those behavioral results were concomitant with activation of a conflict network including anterior cingulate cortex (ACC), anterior insula, and lateral prefrontal cortex (LPFC). In addition, an error detection network including the same regions (ACC and insula) was more activated, but additionally accompanied by specific dorsal striatal activations. Finally, we observed an increase in a bilateral attentional network including parietal cortex and LPFC for the post error trials. Conversely, post error trials disengaged ventral striatum. Those results support recent findings that frontal cortical areas play distinct executive roles in behavioral adjustments: the ACC acts retroactively to enable behavioral adaptation whereas the LPFC reconfigures cognitive processes constituting the adjustment. Furthermore, we found a striatal involvement in the post error adjustments. This new finding in fMRI investigations support the striatum mediate cortical signals to achieve behavioral adjustments. We conclude that adaptation of behavior requires a fine-tuned recruitment of the frontal cortical-basal ganglia neural network.

F44

METACOGNITVE AND ATTENTION TRAINING AND ERROR MONITORING IN EARLY CHILDHOOD M. Rosario Rueda[1], J. Paul Pozuelos[1], Pedro M. Paz-Alonso[1,2], Lina Combita-Merchan[1], Alicia Abundis[1]; [1]Universidad de Granada, [2]Basque Center for Brain and Language — Adjustment to task demands is a crucial ingredient of goal-directed behavior. The ability to detect and monitor errors helps adjusting responses to the environment. The error-related negativity (ERN) is an early (~80ms) component frequently used to study conflict resolution. The ERN is characterized by a negative deflection in fronto-medial sites after incorrect responses, and constitutes an electrophysiological marker of error detection. Recent evidence indicates that this ERN effect emerges over middle childhood years, with smaller but consistent changes across adolescence. The present ERP study was aimed at investigating the effects of attentional training (metacognitive, standard, and control) on error detection and monitoring processes in children aged 5 to 6. We designed a child-friendly flanker task using rows of five robots of different shapes (rounded, squared) as stimuli. Participants were asked to focus on the middle robot, ignoring the flanker robots (congruent vs. incongruent to middle robot), to indicate its rounded or squared shape by two-button key presses. The duration of the target stimuli was tailored to individuals'

performance to ensure similar levels of challenge and number of errors across participants. Behavioral results revealed no differences in the percentage of errors committed by children assigned to the different training groups. Children who received metacognitive training showed the ERN component in frontal sites (AFz-Fz) about 55-90ms after response. This effect did not emerge in the standard training and control groups. These findings underscore the importance of using metacognitive strategies in attentional training programs to enhance error detection processes during early childhood.

F45

IMPROVEMENT OF INHIBITORY CONTROL OVER REWARD-RELATED STIMULI AND INCREASES IN CONTROL-RELATED BOLD ACTIVITY ASSOCIATED WITH MONETARY PUNISHMENT David O'Connor[1], Sarah Rossiter[1], Robert Hester[1]; [1]Department of Psychological Sciences, University of Melbourne — Previous research has indentified the neural mechanisms associated with inhibitory control, including regions in the prefrontal cortex and anterior cingulate cortices, but it remains unclear how these mechanisms are influenced by reward and punishment. Our aim was to examine the impact that reward and punishment has on the ability to exert inhibitory control. Understanding this relationship is critical to understanding the failure to control impulsiveness for reward seen in clinical conditions such as drug addiction. Using a Go/No-Go response inhibition paradigm that rewarded 17 participants for successful inhibition in an event-related fMRI design, we assessed how the presence of either monetary gain or loss for inhibition failure influences No-Go inhibition performance and associated BOLD activation. Findings showed that response inhibition accuracy over rewarding stimuli was significantly higher for the punishment condition compared to the reward condition. Similarly, activation in the right inferior frontal gyrus during successful inhibition was found to be greater for the punishment condition. Such a finding implies that a motivational influence can be exerted on cognitive control processes, whereby an absence of punishment for commission of errors increases the difficulty of inhibiting rewarding stimuli. Results suggest a particular sensitivity of the right inferior frontal gyrus within the cognitive control network to exert top-down attentional control of prepotent responses during circumstances in which an incorrect response can result in a negative outcome.

F46

SOURCES OF INDIVIDUAL DIFFERENCES IN NEURAL ACTIVITY: A GENE-TRAIT INTERACTION IN FUNCTIONAL MAGNETIC RESONANCE IMAGING OF EASY AND DIFFICULT EXECUTIVE TASKS Colin DeYoung[1], Zarrar Shehzad[2], Elena Grigorenko[2], Jeremy Gray[2]; [1]University of Minnesota, [2]Yale University — Systematic individual differences in normal brain function are increasingly of interest. We explored multiple sources of variability in neural response to executive cognitive tasks in a healthy, adult, male sample (N = 104) using a gene-trait interaction model. "Externalizing" is a trait representing risk for behavior problems involving impulsivity, aggression, antisocial behavior, and/or drug abuse. Externalizing problems are associated with poor executive function. We tested whether variation in dopaminergic genes specifically influential on the functions of prefrontal cortex (DRD4 and COMT) would interact with Externalizing to predict individual differences in neural activity during easy and difficult executive tasks. The Multiple Sources of Interference Task (MSIT) requires inhibitory control over prepotent responses; it induces few errors but reliably activates a cingulo-frontal-parietal executive attention network similar to that activated by the more difficult 3-Back task, which requires detection of matches between the current stimulus and that presented three previously. We observed significant gene x trait x task-difficulty interactions in the prediction of neural activity. Both COMT and DRD4 moderated the association of Externalizing with neural activity during executive cognition; however, the directions of association for different genotypes were opposite for easy versus difficult tasks. In the MSIT, low dopamine-function genotypes were associated with a positive slope for Externalizing, and high dopamine-function genotypes were associated with a negative slope. In the 3-Back, the slopes for each genotype group were reversed. These results illustrate the extent of meaningful individual differences in neural activity and provide proof of concept that their sources can be identified.

F47

NOS1 EX1F-VNTR POLYMORPHISM AFFECTS PREFRONTAL OXYGENATION DURING RESPONSE INHIBITION TASKS Juliane Kopf[1], Martin Schecklmann[2], Tim Hahn[1], Alica Dieler[1], Andreas Reif[1]; [1]University of Wuerzburg, Germany, [2]University of Regensburg, Germany — Objective: Impulsivity is a trait shared by many psychiatric disorders and therefore could be a suitable intermediate phenotype for underlying biological mechanisms. One of the molecular determinants involved is a regulatory repeat length polymorphism in the gene encoding the neuronal isoform of nitric oxide synthase (NOS1), termed NOS1 ex1f-VNTR: short variants of NOS1 ex1f-VNTR, causing decreased expression of the transcript, are associated with a variety of impulsive behaviours. Method: 56 healthy controls were stratified into a homozygous long and short allele group matched for age and sex. All subjects completed a combined stop-signal go/nogo task, while the oxygenation in the prefrontal cortex was measured with functional near-infrared spectroscopy. An EMG was administered to control for the differences in muscle activity in the two inhibition tasks. Test subjects also completed the I7 and the UPPS. Results: Differences between the two tasks could be shown by means of significantly different areas of oxygenation in the prefrontal cortex. After correction for multiple testing, the nogo task showed activation mostly in the dorsolateral prefrontal cortex, whereas the successful and unsuccessful inhibition conditions of the stop-signal task showed the predicted activity in the inferior frontal cortex. Although the two genotype groups does not show significant differences in either the questionnaires or the behavioral data, the long allele group displayed dorsolateral prefrontal activity during the nogo condition while there were no significant activation in the short allele group. Additionally they show the predicted activation in the inferior frontal cortex, meanwhile the short allele group does not.

F48

INTERACTION BETWEEN STOP-SIGNAL INHIBITION AND TASK CONFLICT IN THE STROOP TASK: EVIDENCE FOR TWO SEPARATE CONTROL MECHANISMS Eyal Kalanthroff[1], Liat Goldfarb[2], Avishai Henik[1]; [1]Department of Psychology and Zlotowski Center for Neuroscience, Ben-Gurion University of Negev, Beer Sheva, Israel, [2]Department of Psychology, Center for the Study of Brain, Mind, and Behavior, Princeton University, Princeton, New Jersey — Performance in the Stroop task reflects effects of two conflicts: the informational conflict (between the information provided by the incongruent word and ink color) and the task conflict (between the relevant color naming task and the irrelevant word reading task). Neuroimaging studies imply that congruent as well as incongruent trials cause a conflict, which Goldfarb and Henik (2007) argued is due to the task conflict. They found that when task control was damaged, there was a Stroop reverse facilitation (reaction times for congruent trials were slower than for neutral trials), which is the behavioral indication for task conflict. Task conflict requires certain control processes that may be different from those involved in the informational conflict. Here we suggest that the stop-signal and Stroop task conflicts can be conceptualized as inhibition of prepotent responses, and share the same control mechanism. In the current study, we combined the stop-signal and the Stroop tasks, and found that when participants' control failed during the stop-signal task (i.e., the response did not stop), a reverse facilitation emerged in the Stroop task (Experiment 1). This reverse Stroop facilitation was restricted to the condition in which no task conflict existed in the neutral condition (Experiment 2). In addition, when participants failed in the stop-signal task the informational conflict was not affected. This suggests that task conflict and stop-signal inhibition share a common mechanism of prepotent response inhibition and that a different control mechanism exists in the Stroop informational conflict.

F49

ALERTNESS CAN INTERACT WITH COGNITIVE CONTROL BY INCREASING THE INFLUENCE OF DISTRACTING VISUAL STIMULI Noam Weinbach[1], Avishai Henik[1]; [1]Ben-Gurion University of the Negev — Researchers have suggested that distinct attentional systems can interact under certain conditions. Specifically, the alerting system has been found to increase interference of cognitive conflict in the flanker task. This effect was interpreted as an inhibition of the alerting system on executive control. We explored the mechanisms underlying this effect. Twenty healthy participants performed a flanker task in which they indicated whether a rectangle target was tilted to the left or right. Flankers could be tilted in the same direction as the target (congruent condition) or in the opposite direction (incongruent condition). We used two target-flanker conditions. In the difficult perceptual condition, the target and flankers were tilted only 5 degrees to the left or right of a vertical position, making perceptual discrimination in the incongruent condition difficult. In the easy perceptual condition, the target and flankers were tilted 45 degrees from a vertical position, making discrimination easier in the incongruent condition. In half of the trials an alerting auditory tone was presented prior to the target. Our results revealed a significant interaction between alertness and congruency in the difficult perceptual condition—the congruency effect was larger after alerting signals. When perceptual discrimination was easier, the congruency effect was not modulated by alertness. We suggest this indicates an adaptive mechanism that allows better allocation of attention to perceptual information when highly alerted. However, this mechanism creates a cost when selective attention to detail is required.

F50

DISSOCIATION OF BRAIN REGIONS ASSOCIATED WITH PERCEPTUAL AND MOTOR CONFLICT Suzanne Clerkin[1], Olga Berwid[1,2], Stavroula Galanopoulos[1,2], Kurt Schulz[1], Jin Fan[1,2], Jeffrey Halperin[1,2]; [1]Mount Sinai School of Medicine, [2]Queens College, City University of New York — Ignoring irrelevant information and suppressing inappropriate motor responses are hallmarks of cognitive control. It has been proposed that distinct neural systems are responsible for resolving perceptual and motor conflict. The dorsal anterior cingulate cortex (dACC) has a role in detection of response conflict, and the dorsolateral prefrontal cortex (DLPFC) is involved in response conflict resolution. However, perceptual conflict studies have yielded varied results in regards to the involvement of DLPFC, dACC, and inferior frontal gyrus (IFG). Conflicting results might be the due to varying task demands that have included extraneous stimulus-response modality conflicts. The Perceptual and Motor Conflict Task (PMCT) is a non-verbal task designed to probe neural systems associated with perceptual, motor, and combined perceptual and motor conflict. Twenty-two adults (mean age = 23.95, SD = 1.52) were scanned with fMRI while performing the PMCT. Stimulus conflict was associated with activation of supplementary motor area (SMA), DLPFC, and fusiform gyrus. Motor conflict was associated with activation of SMA, DLPFC, insula, dACC, IFG, thalamus, and caudate. The combined conflict condition induced more diffuse activation in the SMA, DLPFC, dACC, IFG, thalamus, caudate, insula, and the brainstem. These results suggest partially overlapping neural systems for perceptual and motor conflict monitoring and resolution. DLPFC and SMA were activated by all conflict conditions. In contrast, response conflict and combined conflict activated subcortical regions associated with attention and motor inhibition. Increased interference from competing stimuli and increased demands on cognitive control systems might be responsible for more diffuse activation during the combined conflict condition.

F51

AN ERP INVESTIGATION OF CONTEXT SPECIFIC COGNITIVE CONTROL USING A SIMON TASK Chris Blais[1], George R Mangun[1]; [1]UC Davis — Blais and Bunge (2010, Journal of Cognitive Neuroscience) reported an fMRI study indicating that anterior cingulate and left dorsolateral prefrontal cortices subserve proportion effects at both the list- and item-specific levels. The list-level proportion congruency effect--the observation that the Stroop effect increases as the proportion of congruent trials in a block increases--has long been used as an index of cognitive control. Contemporary work shows that proportion effects can also be item-specific; if the items in a Stroop task are 75% congruent when presented at the top of the screen and 25% congruent when presented on the bottom of the screen, then the Stroop effect is larger for the items appearing at the top. An ERP study is reported investigating these item-specific proportion effects in the context of a Simon effect. The Simon effect refers to the observation that responses are faster and more accurate the targets that are spatially compatible with there response button. Specifically, if X requires a left button press, it is faster to respond to an X on the left side of the screen compared to the right side. In addition to attention related effects on P1 and N1 amplitudes we find a strong N2 effect. The scalp topography for the N2 is consistent with a generator located in the anterior cingulate. These results are consistent with a conflict monitoring mechanism that is sensitive to environmental contingencies (see Blais, Robidoux, Risko, & Besner, 2007, Psychological Review; Verguts & Notebaert, 2008, Psychological Review).

Executive Processes: Working memory

F52

EVIDENCE FOR A NON-MONOTONIC RELATIONSHIP BETWEEN PREFRONTAL AND PARIETAL CORTEX ACTIVATION AND WORKING MEMORY LOAD Jared X Van Snellenberg[1,2], Jochen Weber[1], Edward E Smith[1,2]; [1]Columbia University, [2]New York State Psychiatric Institute — Classic studies in the neuroimaging of working memory have led to the view that a network of brain regions exhibit monotonic increases in activation with increasing memory load, although several authors have proposed that activation may become non-monotonic at sufficiently high loads. In order to test this hypothesis, we carried out functional Magnetic Resonance Imaging while participants performed a Self-Ordered Working Memory task (SOWMT). On each trial participants were presented with eight line drawings of 3D objects in an array. On each step of every trial, participants were instructed to select any object that they had not previously selected; after each step, the object positions were re-randomized. The SOWMT produced activation in a network of regions typically activated by WM tasks. Activation in many of these regions was non-monotonic across steps, with activation highest at the intermediate steps. Furthermore, the step at which individual subjects exhibited peak activation in posterior parietal cortex (PPC) was significantly correlated with a behavioral estimate of their WM capacity. Thus, activation in the classic WM network varies non-monotonically with load when a sufficiently sensitive task is employed. Although the cause of decreases in activation at higher loads is unclear, they likely reflect a shift in strategy by participants--for example a shift to a long term memory strategy or from retrospective to prospective coding of target stimuli. Furthermore, the step at which activation peaks in PPC is correlated with estimates of WM capacity, consistent with the results of studies of visual change detection.

F53

AUDITORY-VISUAL SPEECH ENHANCES WORKING MEMORY PERFORMANCE IN YOUNGER AND OLDER ADULTS Jana Frtusova[1], Axel Winneke[2], Natalie Phillips[1]; [1]Concordia University, [2]Jacobs Center on Lifelong Learning & Institutional Development, Jacobs University Bremen — Adding visual speech information (i.e., lip movements) to auditory speech information can enhance speech comprehension while at the same time facilitating electrical brain responses, as measured by event-related potentials (ERPs). Thus, fewer resources seem to be allocated to speech comprehension when auditory-visual speech information is available. This study examined whether the brain resources saved at the perceptual level during auditory-visual presentation allow participants to improve on a working memory (WM) task, and whether older adults (OA) benefit to the same extent as younger adults (YA). Twenty OAs and 23 YAs completed a WM n-back task (0-, 1-, 2-, 3-back) under visual-only, auditory-

only, and auditory-visual conditions while ERPs were recorded. The results showed a decrease in reaction time across all memory loads and improvement in accuracy for 2-back and 3-back during auditory-visual compared to visual-only and auditory-only conditions. The ERP analysis showed a smaller N1 amplitude in the auditory-visual compared to A+V (auditory-only +visual-only) condition for YAs, and compared to the A+V and auditory-only conditions for OAs. Additionally, the N1 occurred earlier in the auditory-visual than in A+V or auditory-only conditions for both age groups. The reduction in amplitude of N1 during the auditory-visual condition correlated positively with improved performance on the WM task and with changes in the latency and amplitude of the P3, an ERP that reflects WM processes. This study provides evidence that auditory-visual speech enhances WM performance and indicates that processing resources saved at the perceptual level can be used for higher-order processing.

F54

FUNCTIONAL MRI INVESTIGATION OF VARIATION IN WORKING MEMORY CAPACITY: LOOKING FORWARD OR LOOKING BACKWARD? Thomas Redick[1], Ashley Ahrens[1], Hillary Schwarb[1], Michael Dulas[1], Eric Schumacher[1], Randall Engle[1]; [1]Georgia Institute of Technology — Variation in working memory capacity (WMC) is predictive of higher-order cognition in a variety of situations requiring cognitive control. One prominent theory of WMC (Unsworth & Engle, 2007) states that both goal maintenance within primary memory and retrieval from secondary memory are critical to success in many cognitive activities. More recently, we (Redick, Calvo, Gay, & Engle, in press) have argued that variation in WMC is related to the likelihood that an individual will engage in maintenance versus retrieval. Specifically, high-WMC individuals are more likely to look forward in time for upcoming stimuli by actively maintaining relevant information. In contrast, low-WMC individuals are more likely to wait until a stimulus has occurred and then look backward in time to retrieve the necessary information (see also Braver, Gray, & Burgess, 2007). The current study sought additional evidence to confirm the inferences based on the behavioral data in Redick et al. Twelve high- and 12 low-WMC individuals were identified outside of the scanner via a combination of complex span measures of WMC. In the scanner, participants performed a conditional go/no-go task used in Redick et al. and based on an fMRI study by Garavan, Ross, and Stein (1999). The behavioral data were consistent with Redick et al. in that low-WMC individuals made more errors specifically on target and lure trials. Critically, low-WMC individuals showed more bilateral hippocampal activity than high-WMC individuals on targets, consistent with the idea that low-WMC individuals are more likely to rely on retrieval instead of active maintenance processes.

F55

TRAINING WORKING MEMORY AND NON-VERBAL REASONING IN CHILDREN WITH MENTAL RETARDATION Stina Söderqvist[1,2], Sissela Bergman Nutley[1,2], Jon Ottersen[3], Katja Maria Grill[3], Torkel Klingberg[1,2]; [1]Karolinska Institutet, Sweden, [2]Stockholm Brain Institute, [3]Sykehuset Buskerud, Norway — Background: Working memory (WM) can be improved through targeted training. Recently, it was also shown non-verbal reasoning (NVR) was improved after training in healthy preschool children (Bergman Nutley et al. in press, Dev. Sci.). Aim: The current study investigated the applicability and effects of NVR and WM training in a clinical sample of children with mild to moderate mental retardation. Methods: Children with a chronological age of six to twelve years, with IQ < 70 were included. The study was double-blinded and participants were pseudo-randomly divided into a training group or an active control group. The training group (n=31) trained with a computerised programme designed to tap both WM and NVR. Difficulty of tasks was adapted throughout the training period in order to match each participant's capacity. The active control group (n=17) used the same programme but with unvarying difficulty levels. Results: Training progress varied largely within the training group, and was significantly related to baseline performance for training on NVR but not WM tasks. Furthermore, training progress influenced the effect of training, with significant improvements on non-trained WM and NVR tasks (all p-values <0.05) being observed for participants with high training progress only. Conclusion: We show that it is possible to improve WM and NVR function in a sample of children with mental retardation, which could have implications for future treatment opportunities for this population. However, further research is needed to identify factors influencing training ability and how to further individualize training for children with low intellectual ability.

F56

EVALUATION AND ADJUSTMENT OF CONTROL STRATEGIES DURING PROACTIVE INTERFERENCE RESOLUTION Ilke Öztekin[1], Lauren McShane[2], David Badre[2]; [1]Koc University, [2]Brown University — Proactive interference (PI) occurs when prior learning interferes with memory performance and is a prime cause of forgetting. Cognitive control mechanisms, supported by ventrolateral prefrontal cortex (VLPFC), are crucial for the resolution of PI. However, a key question concerns how the efficacy of cognitive control is evaluated and how adjustments are made to control strategies depending on their outcome. Here, we manipulated overt feedback under varying conditions of PI in order to investigate the neural systems supporting evaluation and adjustment of interference resolution strategies. Participants were scanned using functional magnetic resonance imaging (fMRI) during a short-term item recognition task. Trials consisted of presentation of a 5-item study list, and a recognition probe following a distractor period. We progressively induced PI by arranging trials such that consecutive study lists drew words from the same semantic category. On accurate feedback blocks (AF), participants were given correct feedback on their response. On false feedback blocks (FF), participants were given inaccurate feedback half the time when they correctly identified a studied item. Thus, the FF condition disproportionately punished retrieval strategies deployed to resolve PI. Providing AF compared to no-feedback (NF) increased memory performance overall, but did not interact with the presence of PI. By contrast, FF selectively impacted PI conditions, eliminating the effect of PI on performance and suggesting a shift in memory control strategy due to outcome. Preliminary fMRI results indicate interactions between VLPFC and the basal ganglia may be critical in evaluating and then adjusting interference resolution strategies based on feedback conditions.

F57

WORKING MEMORY PROCESSING FOR SIGN AND SPEECH IN BROCA'S AREA Örjan Dahlström[1], Ingrid Johnsrude[1], Jerker Rönnberg[1], Mary Rudner[1]; [1]Linnaeus Centre HEAD, Linköping University, Sweden — Working memory (WM) for speech and sign language activates largely similar neural networks. However, modality-specific processing differences may be manifest in the anterior (Brodmann area, BA 45) and posterior (BA 44) portions of Broca's area. In BA 44, the longer duration of articulation for signs than words may be associated with higher WM activation for sign than speech and in BA 45 the smaller lexicon for signed than spoken languages may be associated with higher activation for WM for speech than sign. We tested this hypothesis in an event-related fMRI experiment in which 13 hearing native signers performed 2-back tasks based on speech and sign. Examined contrasts were Sign > Speech to reveal net activation for WM for sign language, and Speech > Sign to reveal net activation for WM for speech. Within the region of interest (ROI), defined by Broca's area, extended to control for individual functional variation, the mean of the y-coordinates (anterior-posterior axis) of the most highly activated voxels occurring in each cluster of at least five voxels was identified for each contrast and individual. A paired samples t-test showed that mean peak activation in the Speech > Sign contrast was more anterior than in the Sign > Speech contrast, $t(10) = 1.92$, $p = .04$ (one-tailed). This finding suggests that different WM processing demands for sign and speech are reflected in differential neural substrates in Broca's area.

F58

LEVELS OF PROCESSING IN WORKING MEMORY FOR SIGNED AND SPEECH-BASED LANGUAGE Mary Rudner[1], Thomas Karlsson[1], Jerker Rönnberg[1]; [1]Linköping University, Sweden — Working memory processing and maintenance components are supported by a fronto-parietal network that is largely similar, yet subtly different, for signed and speech-based languages. We investigated for the first time modality-specific differences in the neural correlates of three different levels of processing (semantic, phonological and orthographic) in working memory in 11 deaf early users of Swedish Sign Language and 19 hearing native Swedish speakers using a picture-based 2-back fMRI paradigm. Contrasts between each of the processing levels and a 2-back, picture-based but non-linguistic baseline condition activated distinct networks across groups. For the semantic task, activation was found in right parahippocampal gyrus, insula and cerebellum, as well as left thalamus; for the phonological task in SMA, left cingulate and medial frontal gyri and right caudate head; and for the orthographic task in left superior and middle temporal gyri, middle frontal gyrus, precentral gyrus and insula as well as lingual gyrus. All three contrasts interacted with group, showing differential activation in left hemisphere language areas. For the semantic and orthographic tasks these included inferior frontal gyrus and superior temporal gyrus and for the phonological task, the superior temporal gyrus. This pattern suggests that different levels of linguistic processing in working memory have different neural representations and that these representations are partially modality specific. In particular, the posterior language area seems to be differentially engaged across language modality at all three levels of working memory processing, while the anterior language area is differentially engaged for semantic and orthographic but not phonological processing.

F59

NO IDLING AT ALL: ALPHA OSCILLATIONS ENHANCED BY MEMORY LOAD AND AUDITORY SIGNAL DEGRADATION Jonas Obleser[1], Malte Wöstmann[1], Nele Hellbernd[1], Burkhard Maess[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany — Cortical Alpha oscillations (8–14 Hz) are no mere reflection of the "idling" brain: Increased short-term memory load has been shown to particularly elicit event-related Alpha synchronization (ERS). How specific to memory load is this Alpha ERS? Is it prevalent in audition, and will additional challenges to listeners, e.g. degraded speech, also elicit such enhanced ERS? In an auditory Sternberg paradigm, we parametrically varied memory load (set size of 2, 4, or 6 auditory presented digits) and signal degradation (noise-vocoding in 16,8, or 4 bands) and measured the magnetoencephalographic response (N = 16; time–frequency analysis; gradiometer data; wavelet convolution; time–frequency–channel cluster statistics using the Fieldtrip toolbox). In the retention interval, we found a significant monotonic Alpha ERS at centro-parietal sensors, in two additive main effects of set size (more memory load) and of degradation (worse signal quality). No significant interaction was found. In 15 of 16 subjects, Alpha ERS during retention was positively correlated with the reaction time effects observed in response to the ensuing probe digit (mean Fisher-z = .46; slopes greater zero: $p < 0.02$). While the Alpha ERS appears unspecifically modulated by both factors, a monotonic Beta (16–24 Hz) desynchronization (ERD) was observed specifically for memory load but not for degradation. Results suggest that enhanced alpha-band synchronization indexes not only a memory-specific load but more domain-independent challenges such as the acoustic degradation of the speech signal. This bears relevance to and offers a new parameter to test in the aging and hearing-impaired brain.

F60

DISEMBODYING MEMORY: WHY ARE MEMORY CELLS TYPICALLY FOUND IN PREFRONTAL CORTEX? Max Garagnani[1], Friedemann Pulvermüller[1]; [1]MRC Cognition & Brain Sciences Unit, Cambridge (UK) — The neurobiological basis of working memory has been elucidated by the discovery of "memory cells", neurons that exhibit several seconds of persistent activity when animals have to keep in mind stimulus information in view of future action. These memory cells, and the corresponding neurometabolic changes in the human brain, are typically found in prefrontal cortex and higher sensory areas, distant from primary cortices. However, assuming that the formation of distributed memory circuits is the result of correlated activity in motor and perceptual systems, why should these circuits emerge far away from their antecedent activations in sensorimotor areas, leading to what could be called "disembodiment" of memory? We use a six-area neuronal-network architecture (modelling primary motor and sensory cortex, secondary and higher association areas in frontal and temporal lobes) to simulate formation of memory circuits and memory cells. The long-range, between-area connections implemented reflect known neuroanatomical links between corresponding cortices. We report results in terms of recorded network activity at single-cell, circuit-, and area-specific level. Similarly to previous models, we observed the spontaneous emergence of memory circuits (cell assemblies, CAs) and cells replicating various realistic behaviours. Due to the intrinsic between-areas connectivity of the model, however, the formation of strong synaptic links holding the CA together was facilitated in higher, associative (but not in primary) areas, leading to more memory cells in prefrontal and anterior-temporal than in primary cortices. As these findings answer the "where" question of cortical working memory in terms of neuroanatomy, they further strengthen a distributed-network memory account.

F61

BRAIN TRAINING: DOES IT TRAIN THE BRAIN? THE NEURAL SUBSTRATES UNDERLYING GAINS IN COGNITIVE CONTROL CAPACITY Susanne Schweizer[1], Jessica Grahn[1], Adam Hampshire[1], Dean Mobbs[1], Christina Asuquo-Brown[2], Tim Dalgleish[1]; [1]MRC Cognition and Brain Sciences Unit, [2]Maastricht University — Increasing popularity of so-called brain-training has spurred research into improving cognitive control capacity (CCC), which has been associated with successful academic/professional performance and greater well-being. Preliminary evidence suggests that extensive training on complex working memory (WM) tasks can augment CCC. However, little is known about the neural substrates underlying "brain"-training gains. We aimed to investigate the reality of brain-training by exploring changes in neural functioning associated with improved training performance and whether training translates to generalisable gains in CCC. 47 young adults were randomly assigned to a neutral or affective dual n-back training (DnT) or a non-CCC-dependent training control group. While all participants improved on their respective training tasks, only the DnT-groups showed transferable increases in CCC, as measured by WM improvements on an untrained task. In line with our understanding of the functional networks related to CCC, CCC-gains were associated with greater activation decrease in posterior cingulate and parietal regions and with less increase in the anterior cingulate cortex. We further showed these CCC-improvements to extend beyond the control of neutral information to the type of emotional information (words and faces) we process in everyday life. Improved behavioral control over emotional information also elicited greater activation decreases in the right superior temporal regions and temporal pole. These findings show that brain-training does indeed train the brain and is associated with improved CCC, which optimizes functioning in our emotionally-laden environment. This training then could ultimately benefit not only the healthy population but also individuals suffering from anxiety or mood disorders.

F62

INDIVIDUAL DIFFERENCES IN CHANGE DETECTION MEASURES OF SHORT-TERM MEMORY CAPACITY CAN BE EXPLAINED BY ENCODING STRATEGY Annika C Linke[1], Alejandro Vicente-Grabovetsky[1], Daniel J Mitchell[1], Rhodri Cusack[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK — Individual differences in visual short-term memory (VSTM) capacity have been a popular topic in both behavioural and neuroimaging research, and have often been shown to predict performance

in a range of other cognitive tasks and measures of intelligence. Often, VSTM capacity is assessed using change detection tasks. Recently, Cusack, Lehman, Veldsman and Mitchell (2009) found that an attentional component necessary for change detection and not memory capacity itself correlates with intelligence. It remained unclear, however, when attentional control takes effect in change detection measures of short-term memory, during encoding, maintenance or both. We have addressed this question in two behavioural experiments and by conducting a meta-analysis of five imaging studies recently carried out in our laboratory. In the first study, we showed that change detection performance of lower-IQ participants improved when they were encouraged to adopt a more efficient attentional strategy. In the second study, we found that capacity of participants with low change detection performance was significantly alleviated when they were provided with helpful grouping cues during encoding. Finally, a meta-analysis of neuroimaging data from 112 participants performing a variety of visual change detection tasks showed that performance correlates with activity in several parietal and frontal regions during the encoding but not the maintenance phase of the tasks. Taken together, these results suggest that variations in VSTM capacity as assessed by change detection are primarily determined by differences in encoding strategy.

F63

DOUBLE DISSOCIATION OF WORKING MEMORY LOAD EFFECTS INDUCED BY BILATERAL PARIETAL MODULATION Marco Sandrini[1,2], Anna Fertonani[3,4], Leonardo Cohen[1], Carlo Miniussi[3,5]; [1]Human Cortical Physiology Section, NINDS-NIH, [2]Center for Neuroscience and Regenerative Medicine (USUHS), [3]IRCCS Fatebenefratelli, Brescia, Italy, [4]University Campus Biomedico, Rome, Italy, [5]National Institute of Neuroscience, University of Brescia, Italy — Transcranial magnetic stimulation and neuroimaging data revealed parietal involvement during verbal working memory (WM) with conflictive reports of increases or decreases in activation with task practice. The aim of this study was to gain insight into the relative function of the two cerebral hemispheres in maintenance and executive processes of WM using bilateral transcranial direct current stimulation (tDCS). We tested WM using a verbal n-back task (1-back and 2-back) before and after tDCS. The results showed a double dissociation of WM load effects induced by differential bilateral modulation. In the 1-back task, there was a significant difference between sham and left anodal-right cathodal modulation. Conversely, in the 2-back task, there was a significant difference between sham and left cathodal-right anodal modulation. Interestingly, tDCS abolished the practice-dependent increase in WM in both tasks. These findings demonstrated a differential parietal involvement in verbal WM as a correlate of increased load, which may reflect greater demand on storage, rehearsal, temporal coding and inhibition processes. These maintenance and executive processes may account for the differences found between the two modulation conditions.

F64

AMNESIA IMPAIRS MAINTENANCE OF A SINGLE FACE FOR JUST ONE SECOND, UNLESS IT'S PARIS HILTON Nathan S. Rose[1,2], Rosanna K. Olsen[1,2], Fergus I.M. Craik[1,2], R. Shayna Rosenbaum[1,3]; [1]Rotman Research Institute, [2]University of Toronto, [3]York University — Recent research has demonstrated profound impairments in amnesics' ability to maintain small amounts of information (e.g., a single face) over very short retention intervals (e.g., 1 second; Ezzyat & Olson, 2008). However, the types of tasks that have demonstrated working memory impairments in amnesia tend to have involved novel stimuli. One hypothesis is that short-term memory is impaired in amnesia for tasks that require maintaining novel information (Olson et. al., 2006; Jonides et. al, 2008), but may be preserved for more familiar material. To test this hypothesis, patient HC, a 22-year-old developmental amnesic with relatively preserved semantic memory (Moses et al., 2008), and a group of matched controls performed a delayed match-to-sample task which required maintaining a single famous or nonfamous face for either 1 or 8 seconds. We made the faces from photographs using FaceGenModeller software in order to exclude salient features (e.g., hair, makeup, etc.). Lures were made by creating perceptual morphs between the studied face and a different, non-studied face. HC's memory was impaired for nonfamous faces after both short and long delays. However, HC's performance was preserved for famous faces at the short delay, but was worse than controls' performance at the longer delay. In addition, performance for all subjects was better for famous than nonfamous faces. These results provide support for the hypothesis that an intact hippocampus is required for remembering novel information, even at very short delays, and stimulus familiarity supports short-term memory via cortical regions outside of the medial temporal lobe.

F65

THE NEURAL BASIS OF WORKING MEMORY UPDATING: DISSOCIATING LOCAL AND GLOBAL UPDATING Yoav Kessler[1], Ronit Leibling-Milman[1], Morris Moscovitch[1]; [1]Rotman Research Institute, Baycrest Centre — Working memory (WM) updating is composed of two sub-processes (Kessler & Meiran, 2008). Local updating refers to the actual modification of the updated items. It is followed by global updating, that binds together the entire the content of WM, and acts on both the modified and unmodified items. By using fMRI to investigate the brain structures that support these processes, we hoped to provide further evidence for differentiation between the two processes, and gain insight into the mechanisms that underlie them. A version of the Sternberg task was used, in which the participants were presented with sequences of screen, each containing 3 letters. After a random number of screens, a probe appeared and the participants had to indicate whether it was part of the last screen or not. Importantly, each screen could be either identical to the previous one (no-update), different in one of the item (1-update) or different in all the 3 items (3-update). Global updating, defined as the difference between update (1-update and 3-update) and no-update, was associated with activity in the left globus pallidus, supporting the role of basal ganglia as a gating mechanism involved in WM updating, as well as the left inferior frontal gyrus, right thalamus and left parahippocampal gyrus. The latter supports the role of global updating in binding between WM items. Local updating, defined as the difference between 3-update and 1-update, was associated with activity in the left middle orbital gyrus. The results provide further dissociation between local and global updating.

F66

VISUAL AND AUDITORY WORKING MEMORY TRAINING LEAD TO DIFFERENTIAL NEURAL ACTIVATION CHANGES IN LEARNING CHINESE AS A SECOND LANGUAGE: AN FMRI STUDY Julia A. Schneiders[1], Bertram Opitz[1], Christoph M. Krick[2], Axel Mecklinger[1]; [1]Saarland University, [2]Saarland University Hospital — Whereas previous research has shown a systematic relationship between phonological working memory (WM) capacity and second language proficiency for alphabetic languages, little is known about the impact of WM on second language learning in Chinese. In this training study we tested whether visual WM training, due to the greater complexity of Chinese characters, has a greater impact on learning Chinese orthography, and, conversely, whether auditory WM training has a stronger impact on learning Chinese phonology. Training induced modulations in language-related brain networks were examined using functional magnetic resonance imaging in a pretest-posttest design. Both WM trainings led to positive transfer effects on orthographic learning as compared to no training, whereas for phonological learning no transfer effects were obtained. For learning Chinese phonology decreased activity in the left insula was found after auditory training, whereas left insula activation increased after visual training. Conversely, in the orthographic task there was an activation decrease in the left mid-fusiform gyrus after visual training and an increase after auditory training. Moreover, visual training led to the additional recruitment of brain regions in the orthographic task, i.e. the anterior part of the fusiform gyrus and the right precuneus. This pattern of antipodal activation changes arose in brain regions engaged in visual and auditory language processing. It indicates that intra-modal WM training enhances the efficiency of visual

and auditory language processing areas (activation decreases), whereas cross-modal WM training presumably facilitates flexible engagement of those regions to enable the same performance level as after intra-modal training.

F67

COMMON AND DISTINCT NEURAL CORRELATES OF PROACTIVE AND REACTIVE CONTROL MECHANISMS UNDERLYING HIGH-INTERFERENCE RESOLUTION IN WORKING MEMORY: A UNITARY FLEXIBLE ROLE OF RIGHT INFERIOR FRONTAL GYRUS Petter Marklund[1], Lars Nyberg[2], Jonas Persson[1]; [1]Department of Psychology, Stockholm Universitet & Stockholm Brain Institute, [2]Department of Integrative Medical Biology, Umeå University — The dual mechanisms of control (DMC) (Braver et al., 1997) model is a posited theoretical framework for understanding the dynamic nature of human executive functions by invoking two dissociable cognitive control modes, proactive and reactive control. These may involve partially overlapping, but temporally distinct neural implementation in the prefrontal cortex (PFC). Proactive control is utilized in situations defined by high predictabiliy with respect to impending need for conflict resolution. Reactive control is preferred in situations where it is difficult to foresee when conflict will occur. Prior imaging studies of these dual control mechanisms used variants of the AX-CPT paradigm, requiring subjects to only respond "yes" to the stimulus 'X' if it is preceded by the stimulus 'A' (AX trials) and to respond "no" otherwise. Thus, very low demands are imposed on proactive control only requiring information about single-items to be retained over unfilled delays. It however remains to be elucidated whether proactive control can also facilitate performance in more complex working memory tasks, in which concurrent processing of intervening items and updating is mandatory during context maintenance. We used two variants of a verbal 3-back paradigm, one with predictive cue information embedded, to examine this issue. Performance improved with trial-specific lure cues despite increasing cognitive load. The temporal dynamics of right IFG activity indicated a flexible role in high-interference resolution, with greater sustained responses elicited in the 3-back task involving context maintenance of cue information and greater transient responses elicited without it.

F68

UPDATING SPATIAL REPRESENTATIONS IN WORKING MEMORY: AN EVENT-RELATED POTENTIALS STUDY Chui Luen Vera Hau[1], Hoi-Chung Leung[1]; [1]Stony Brook University, SUNY — Directing spatial attention was suggested as a possible mechanism for selective encoding and maintenance of visual stimuli in working memory (WM) to improve task performance. To directly investigate selective maintenance of spatial representations in WM, we collected behavioral and event-related potentials (ERPs) data from 22 young adults using a delayed recognition paradigm with an updating cue presented after the presentation of a memory array of 2 or 4 dot locations. We included two types of cues: a Memory Selection (MS) cue (requiring reducing the memory set from 4 to 2 locations) and a Non-Selection (NS) cue (requiring continue holding of either 4 [NS4] or 2 [NS2] dot locations). Cue-related ERPs revealed two positive components related to WM updating. ERP between 300-500ms was larger in the NS4 than the MS and NS2 conditions ($p<0.005$), suggesting selective retrieval of relevant target locations. ERP between 450-900ms was larger in the MS than the NS conditions ($p<0.005$), suggesting labeling of target locations. Probe-related ERPs between 200-700ms of the MS condition were comparable to the NS2 condition ($p=.307$) and more positive than the NS4 condition ($p<.001$ and $p<.05$, respectively). This latter finding corroborates with the behavioral benefit observed for the MS condition, of which the average reaction times in correspondence to probe recognition was comparable to the NS2 condition ($p=.393$) but shorter than that of the NS4 condition ($ps<.001$). Our data suggest that the updating cue facilitates selective spatial information processing manifested in behavior and modulates neural activity during post-cue delay and probe recognition.

F69

MULTIFOCAL FMRI HYPOACTIVATION ON A WORKING MEMORY TASK AFTER MILD TRAUMATIC BRAIN INJURY Tracy Luks[1], Fan-Pei Gloria Yang[1], Sara Lahue[1], Shelly Cooper[1], Ann Hefferman[1], Pratik Mukherjee[1]; [1]University of California San Francisco — The present study investigated the impact of acute mild traumatic brain injury (TBI) on the neural circuitry of working memory (WM). Eight controls and 6 patients (1 month post injury) were enrolled in the study. We administered a block-design n-back WM task with 3 memory load conditions. fMRI was acquired on a 3T GE scanner. All image processing was performed using SPM8. In the 0-back condition, relative to healthy controls, mild TBI patients demonstrated decreased activation in right precentral and right superior temporal gyri. Patients showed significantly lower activation in left supplementary motor area, anterior cingulate, cuneus, middle temporal gyrus and ventrolateral prefrontal cortex in response to the 1-back condition. In response to the 2-back condition, patients exhibited hypoactivation in the left insula, in addition to the hypoactivated regions found in the 1-back condition. Comparison of the 2-back condition to the 0-back condition revealed patients' hypoactivations in left SMA, left insula, left orbitofrontal gyrus, left supramarginal gyrus and middle temporal gyrus. Hypoactivations in the 0-back condition suggest that mild TBI patients' attention was significantly affected. Lower activations in VLPFC and temporal gyri in conditions with higher memory loads may suggest affected verbal memory responses to the language-related stimuli in the WM task. In general, acute mild TBI patients may have worse attentional support, verbal memory and self-monitoring than controls in response to high WM loads.

F70

STAGE-SPECIFIC NEURAL NETWORKS INVOLVED IN WORKING MEMORY Todd Woodward[1,2], Dara Manoach[3,4,5]; [1]University of British Columbia, Vancouver, BC, Canada, [2]BC Mental Health and Addictions Research Institute, Vancouver, BC, Canada, [3]Massachusetts General Hospital, Charlestown, MA, [4]Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, MA, [5]Harvard Medical School, Boston, MA — The current study is a multivariate analysis of the Sternberg Item Recognition Paradigm (SIRP) for working memory (WM), with manipulation of the duration of the delay epoch (0, 2, and 4s). This manipulation greatly facilitates mapping neural networks to WM stages (encoding, delay and probe), because distinct hemodynamic response shapes are expected for all possible combinations of the three task stages. Constrained Principal Component Analysis for fMRI (fMRI-CPCA) was applied, which allows estimation of the hemodynamic response function (HRF) associated with each network, instead of that associated with individual regions (the latter being the product of univariate analyses). The results identified three networks involved in WM. The first was involved in encoding and probe only, and was dominated by visual cortex regions. The second was involved in the probe period only, and was dominated by dorsal anterior cingulate cortex, insula, basal ganglia, and sensorimotor cortex. The third was involved in encoding and delay, and was dominated by activation in V1, and deactivation in the superior temporal and left supramarginal gyrus. This set of regions replicates the networks discovered previous multivariate work on working memory, but allowed more precise assignment of each network to WM task stages.

F71

ROLE OF INDIVIDUAL CORTICAL AREAS AND NETWORK DYNAMICS IN MAINTAINING TASK-RELEVANT INFORMATION David Fegen[1], Bradley Buchsbaum[2], Mark D'Esposito[1]; [1]University of California, Berkeley, [2]Rotman Research Institute, Toronto, Ontario — We investigated the neural mechanisms underlying the ability to temporarily maintain task-relevant information in a goal-directed manner, a collection of processes referred to as working memory (WM). Uncertainty still exists as to the precise role of individual brain regions as well as how multiple regions form a network supporting WM maintenance processes. Given methodological limitations with fMRI, it has been particularly difficult to investigate network

interactions during WM maintenance processes. Thus, we employed a task with a long retention period and precisely controlled rehearsal processes. This allowed differentiation of different time courses of responses from individual brain regions (transient vs. sustained) as well as assessment of their interactions during WM maintenance. During fMRI scanning, participants (n=19) were presented with either three or five letters that they were instructed to maintain over a forty-five second delay period. To ensure rehearsal during the entire delay period, a repeating visual pacing cue prompted them to subvocally rehearse each letter. Results revealed that prefrontal and parietal cortex exhibit transient responses consistent with a role in "control" processes, while Sylvian-parietal-temporal (Spt) and motor/pre-motor areas exhibited sustained responses consistent with a role in "storage" processes. Significant functional connectivity was observed in these frontal, parietal and temporal regions during WM maintenance, with individual regions exerting influence on other connected regions. These data support the idea that verbal WM arises from nodal interactions within a fronto-parietal-temporal network, and that individual network nodes support different WM component processes.

F72

CONTRIBUTIONS OF PREFRONTAL CORTEX, BASAL GANGLIA, AND EXTRASTRIATE CORTEX TO VISUAL WORKING MEMORY MAINTENANCE Kartik K. Sreenivasan[1], Caterina Gratton[1], Jason J. Vytlacil[1], Mark D'Esposito[1]; [1]University of California, Berkeley — An emerging view is that visual working memory (WM) maintenance is instantiated via preferentially weighted activity in extrastriate cortex (EC) neurons that form percepts of the maintained item. While EC neurons are thought to retain information about the memory item, it is not known whether these neurons code for specific feature values during WM maintenance. Furthermore, the top-down sources that maintain preferential weighting in EC have yet to be elucidated. We conducted an fMRI study in which subjects viewed a series of faces and indicated whether each face matched a Target face held in WM. A morphing procedure created a set of Non-Target faces that varied parametrically in the degree of visual features they shared with the Target face. We hypothesized that if EC neurons code for specific feature values, then maintaining the Target in WM would bias EC activity in favor of neurons that code for the features of the Target face. Accordingly, we found that activity elicited by Non-Target faces in face-selective regions within EC scaled linearly with the degree of overlap between Target and Non-Target features. A seed-based functional connectivity analysis identified areas within dorsolateral prefrontal cortex (dlPFC) and basal ganglia as being functionally coupled to EC. This pattern of results (i) supports the notion that EC contributes to WM maintenance via preferential activity in neuronal populations that code for features of memory items, and (ii) suggests that basal ganglia and dlPFC may be the source of top-down signals that bias EC activity.

F73

INTACT VISUAL WORKING MEMORY CAPACITY AFTER MEDIAL TEMPORAL LOBE DAMAGE Annette Jeneson[1], John Wixted[1], Ramona Hopkins[2,3], Larry Squire[1,4]; [1]University of California, San Diego, [2]Brigham Young University, [3]Intermountain Medical Center, Utah, [4]Veterans Affairs Medical Center, San Diego — Patients with medial temporal lobe (MTL) damage are sometimes impaired at remembering visual information across delays as short as a few seconds (e.g., 3 colored squares after 4 seconds; Olson et al., 2006). Such impairments could reflect impaired visual working memory (VWM) capacity or an impairment in long-term memory (because attention has been diverted or working memory capacity has been exceeded). We asked whether MTL damage impairs or spares VWM capacity. We tested patients with bilateral hippocampal lesions and one patient with large MTL lesions on a change-detection task modeled after Luck and Vogel (1997). Participants saw an array of 1, 2, 3, 4 or 6 colored squares, followed by a second array with one of the colored squares marked by a cue. The second array was presented after a blank retention interval of 1, 3, 4 or 8 seconds. The task was to decide whether the cued square had the same color as the corresponding square in the first array or a different color. At the 1 s delay (typically used to assess VWM capacity), patients performed as well as controls at all array sizes. Performance was nearly perfect for array sizes of 1, 2, and 3 items, and then at larger array sizes declined similarly for patients and controls. At longer delays, patients performed as well as controls at the smaller array sizes and worse than controls at the larger array sizes. The findings suggest that VWM capacity is intact after MTL damage.

F74

HIGH WORKING MEMORY IS ASSOCIATED WITH A STRONGER CONFLICT ADAPTATION EFFECT Maria Kharitonova[1], Tim Curran[1], Yuko Munakata[1]; [1]University of Colorado at Boulder — What is the role of working memory (WM) in the ability to regulate cognitive control? We postulate that high WM capacity should be associated with dynamic changes in cognitive control strategies, based on task demands. We tested this theory by measuring the magnitude of the conflict adaptation effect in the Flanker task, where participants need to respond to the direction of a central arrow, which can be flanked by arrows pointing in the same direction (congruent trials) or in the opposite direction (incongruent trials). We assessed WM capacity based on performance in an ERP-based visuospatial working memory task (as in Vogel et al., 2005). All participants showed the conflict adaptation effect, such that they were faster on incongruent trials that followed incongruent trials (II trials) than on incongruent trials that followed congruent trials (CI trials). These sequential effects are typically interpreted in terms of conflict-driven adjustments in cognitive control (e.g. Egner, 2007). Consistent with our predictions, high WM was associated with greater conflict adaptation, such that II trials were performed faster by high WM participants than low WM participants, when controlling for CI RTs. Conversely, CI trials were performed slower by high WM participants than low WM participants, when controlling for II trial RTs. Thus, high WM predicted a sharper contrast between the two types of trial sequences and was therefore associated with greater dynamic adjustments in cognitive control, based on preceding task demands.

F75

COMPUTATIONAL MECHANISMS OF SCALAR VALUE REPRESENTATION IN THE PREFRONTAL CORTEX Ashley N. Cline[1], Jeremy R. Reynolds[1], Randall C. O'Reilly[2]; [1]University of Denver, [2]University of Colorado, Boulder — The ability to maintain scalar values over a delay is critical for various functions such as value comparison and time discrimination. However, this ability is notoriously problematic to accomplish for many biologically plausible neural network approaches. The current study investigates how interactions between the prefrontal cortex and basal ganglia may produce the ability to maintain scalar values, and how such PFC-mediated scalar value representations may be developed via experience. We model a task in which a base scalar value (e.g. frequency of tactile stimulation) is presented and then removed. After an empty delay, a comparison value is presented, and the subject must determine whether that comparison value is higher or lower than the base value. This paradigm has well characterized psychophysical and neural profiles (Hernandez, et al, 1997; Romo et al, 1999). The framework used to model this task is the prefrontal cortex-basal ganglia working memory (PBWM) model developed by O'Reilly & Frank (2006), in which areas of PFC are associated with corresponding areas of the basal ganglia, and these "stripes" learn to appropriately update and maintain information based on their previous history of reinforcement. This framework is shown to be capable of processing scalar values by replicating psychophysical performance characterized by Hernandez et al (1997) and neurophysiological correlates examined by Romo et al (1999). Further analysis of the activity patterns in the model revealed several novel predictions relating to the identification of non-monotonic tuning curves and the distributed patterns of activity over the delay period.

F76

ANTICIPATORY SPECTRAL ACTIVITY DURING SPATIAL AND NON-SPATIAL AUDITORY WORKING MEMORY TASKS Saskia Helbling[1], Maria Rieder[1], Benjamin Rahm[1,2], Christoph Polkowski[1], Michael Wibral[1], Jochen Kaiser[1]; [1]Goethe University, Frankfurt, Germany, [2]Gutenberg University, Mainz, Germany — Previous studies have found task-specific gamma-band activity (GBA) in auditory ventral and dorsal pathways during working memory tasks based on auditory pattern and spatial information, respectively. Here we used magnetoencephalography to explore the role of GBA as a correlate of anticipatory processes during auditory spatial and non-spatial tasks. In a delayed match-to-sample task, sample sounds were characterized by both a variable interaural time delay and a variable central frequency. To investigate task-specific anticipatory activity we assessed the preparatory phase prior to the sample stimuli. At sensor level, comparison with a passive listening condition revealed pronounced beta synchronization at central sensors for both tasks. Frequency-domain beamforming located this activity in motor cortex suggesting a sustained beta-rebound following the motor response given in the two active tasks. Lower GBA at posterior sensors was found during the lateralization task compared to the passive listening condition. The sources of this gamma decrease were located in the right cerebellum. Statistical comparisons in source space indicated that the frequency task led to higher gamma activity in the right cerebellum than the lateralization task. The cerebellum has been linked to the processing, discrimination and anticipation of sensory input, as well as to auditory working memory. Furthermore, we found differences between both tasks in areas previously linked to spatial and non-spatial auditory processing, i.e. the right temporal lobe, the parietal cortex and the prefrontal cortex.

F77

IS PRESSURE STRESSFUL? THE IMPACT OF PRESSURE ON STRESS REACTIVITY AND CATEGORY LEARNING Steve Hutchinson[1], Brandon Cosley[1], Shannon McCoy[1], Shawn Ell[1,2]; [1]Department of Psychology, University of Maine, [2]Maine Graduate School of Biomedical Sciences — Recent research in cognitive neuroscience has shown that pressure may impair or enhance learning depending upon the cognitive system mediating task performance. The physiological mechanisms by which pressure may mediate these effects are unclear. Given that pressure is so often associated with stress, the focus of the current study is whether pressure might lead to increased stress reactivity? To investigate this question, we used a pressure manipulation that has been shown to impair accuracy on a rule-based category learning task (i.e., learning depends primarily upon a hypothesis-testing system) and to enhance accuracy on an information-integration category learning task (i.e., learning depends primarily upon a procedural-based memory system). Pressure was increased by informing participants that they (and a fictitious partner) would be eligible for a monetary bonus only if they achieved a criterion accuracy level (which the fictitious partner had already achieved). Behaviorally, increased pressure impaired accuracy on the rule-based task, but had no affect on accuracy on the information-integration task. Physiologically, pressure led to a modest increase in arousal (i.e., heart rate) on the rule-based task only. For these participants, a pattern of stress reactivity that is physiologically and psychologically adaptive was associated with higher accuracy. These data suggest that pressure may not necessarily be stressful. Moreover, these data highlight the importance of considering variability in the stress response in understanding the stress-cognition relationship.

F78

ALTERATIONS IN PERFORMANCE AND FRONTAL BRAIN ACTIVATIONS PRIOR TO CHEMOTHERAPY FOR BREAST CANCER Mary K. Askren[1], Marc G. Berman[1], Mi Sook Jung[1], Barbara Therrien[1], Daniel F. Hayes[1], Scott Peltier[1], Douglas C. Noll[1], Min Zhang[1], Patricia A. Reuter-Lorenz[1], Bernadine Cimprich[1]; [1]University of Michigan — Chemotherapy has been associated with cognitive impairments, commonly termed "chemo brain." Recent research suggests that neurocognitive differences between chemotherapy patients and healthy controls may exist even before chemotherapy has begun (Cimprich et al., 2009). The present experiment expands previous work by comparing cognitive function in women with breast cancer scheduled for treatment with and without chemotherapy. Three groups (n=20 per group) were compared: pre-chemotherapy patients, pre-radiation therapy patients, and controls without breast cancer. Participants were assessed using fMRI while completing a verbal working memory task (VMT). On each VMT trial, participants indicated whether a presented probe letter was part of the current trial's memory set. Performance and brain activation in predetermined regions of interest, including inferior frontal gyrus (IFG), were compared for trials on which the current probe was not presented in the memory sets of the past few trials (low demand) and trials on which the current probe was presented in the previous trial's memory set (high demand). Pre-chemotherapy patients were less accurate than controls on the VMT (p=.05). Pre-radiation patients showed accuracy levels between those of the pre-chemotherapy and control groups. Control and pre-radiation groups selectively increased recruitment of left IFG in response to high versus low demand trials. However, pre-chemotherapy patients showed bilateral recruitment, with no significant difference in activation of left versus right IFG. These results suggest neurocognitive disruptions in breast cancer begin even before chemotherapy. Patients may attempt to compensate for these declines by increasing bilateral recruitment of frontal control regions.

F79

WORKING MEMORY TRAINING IN TYPICALLY DEVELOPING CHILDREN AND CHILDREN WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER – EVIDENCE FOR PLASTICITY IN EXECUTIVE CONTROL PROCESSES Susanne Jaeggi[1], Martin Buschkuehl[1], John Jonides[1], Priti Shah[1]; [1]The University of Michigan — We trained typically developing children (N=62) as well as children with Attention Deficit Hyperactivity Disorder (ADHD; N=44, data collection ongoing) on a motivating working memory game for 4 weeks. Before and after training, the children were tested on a non-trained WM task and on an executive control task that is a common marker for ADHD, the continuous performance task. We compared the WM training groups' improvements on those transfer tasks to improvements of control groups who practiced a general knowledge and vocabulary game for the same duration as the experimental groups. Our results show that for both the healthy and the ADHD children, working memory training is more effective than the control training in improving the transfer measures of working memory and executive control. The improvements are primarily based on reductions in errors of commission; a result which is of particular relevance for the children with ADHD. We conclude that our working memory game is an effective intervention for children with and without deficits in working memory and executive control. The ongoing data collection and follow-up assessments will establish whether and how long the transfer effects last.

F80

COMMON PARIETAL RESPONSES DURING WORKING AND LONG-TERM MEMORY TASKS Marian Berryhill[1]; [1]University of Nevada, Reno — Two traditionally separate literatures study the role of parietal regions in memory. In the long-term memory (LTM) literature parietal activations are often linked with memory retrieval, e.g. the 'parietal old/new effect'. Greater parietal activity is observed after endorsing an item perceived as 'old' in contrast to rejecting an item as 'new'. In the working memory (WM) literature, parietal activations are associated with phonological and visuospatial maintenance processes. There is striking resemblance between the parietal activations observed in WM and LTM tasks, but these separate literatures required comparisons across research groups, scanners and experimental methods. Here, we employed a within-subjects design to ask: Are there common parietal activations during WM and LTM tasks? We used event-related functional magnetic resonance imaging (fMRI) to identify the conjunction of activity for the WM and LTM tasks. We selected a standard verbal LTM list-learning task and a visuospatial WM change-blindness task. These tasks were deliberately selected to use distinct stimuli (verbal, visual) so that any conjoint activa-

tions could not be attributed to stimulus processing. The results from fifteen healthy young adults revealed dorsal stream clusters in the intraparietal sulcus that were significantly activated by both the WM and LTM tasks. These data confirm that not only is the parietal lobe active during various forms of memory, but the same regions are involved in both WM and LTM.

F81

COGNITIVE AND EEG CHANGES FOLLOWING SUBTHALAMIC NUCLEUS STIMULATION: A CASE STUDY Katherine Selzler[1], Michelle Burack[1], David Loiselle[1], Jonathan Mink[1], Mark Mapstone[1]; [1]University of Rochester — Deep brain stimulation (DBS) of the subthalamic nucleus (STN) is an accepted treatment for Parkinson's disease (PD) motor disability. The therapeutic effect of DBS may be related to disruption of pathological beta synchrony thought to underlie PD motor features. We and others have previously shown that in addition to improving motor function, STN DBS can negatively affect working memory in some patients. In this case study, we use EEG to link DBS-related cortical changes to our cognitive and motor outcomes. We collected 32-channel continuous EEG while a non-medicated 54-year old male PD subject was at rest, or performed working memory or finger tapping tasks. We recorded EEG with DBS ON and OFF in the same testing visit. We applied a band pass filter (0.5 – 100Hz) to eliminate the fundamental stimulation frequency (130Hz). The subject showed a load dependent deficit in working memory performance, but improvement in motor speed with DBS. DBS produced an overall reduction in synchrony (power) at most frequency bands in the resting EEG. EEG collected during task performance revealed little DBS-related change in activity at any frequency during the finger tapping task, but marked de-synchronization of theta and alpha activity during the working memory task. Oscillatory activity in the theta band is known to be important for working memory (Onton et al, 2004). DBS-related disruption of pathological beta synchrony in PD patients may lead to motor improvement, while disruption of normal theta activity may underlie the working memory deficits seen in some patients.

F82

RELATING INDIVIDUAL DIFFERENCES IN SHORT-TERM MEMORY-DERIVED EEG TO COGNITIVE TRAINING EFFECTS Bornali Kundu[1], Bradley R. Postle[1]; [1]Neuroscience Training Program, University of Wisconsin, Madison — Voltage (i.e., ERP) measures of the delay-period during a working memory (WM) task show considerable individual differences that correlate with memory span. We have also shown that individual differences in spectral measures of delay-period EEG activity are stable and trait-like. In this study we explored the relationship between delay-period spectral power (DPSP) and WM training. Prolonged, adaptive training on WM tasks improves performance on the task itself, as well as on nonmnemonic tests of general fluid intelligence (gF), with the largest gains seen in low gF individuals (Jaeggi et al., 2008). Prior to beginning training, we measured DPSP for each subject, then divided subjects into experimental and control groups. The experimental group trained on a dual n-back task 40 minutes per day, 5 times per week, for 4 weeks. The control group trained on a task without overt memory demands (Tetris). For this group, there was no relation between DPSP and training-related improvement on the control task. In the experimental group, greater improvement on the training task was seen in the subjects with greater DPSP in the theta (4-7Hz), alpha (8-14Hz), and gamma (25-50Hz) bands. No such relation was observed for DPSP in the beta (15-25Hz) band. These results suggest that individual differences in DPSP may predict amenability to cognitive training. This approach, in turn, suggests a way that training might be used to investigate the functions of discrete frequency bands in DPSP.

F83

BRAIN REGIONS UNDERLYING VERBAL SHORT-TERM MEMORY: EVIDENCE FROM VOXEL-BASED LESION SYMPTOM MAPPING Juliana Baldo[1], Shira Katseff[1,2], Nina Dronkers[1,2,3]; [1]Veterans Affairs Northern California Health Care System, [2]University of California, Berkeley, [3]University of California, Davis, [4]University of California, San Diego — Verbal short-term memory (STM) is often tested by immediate repetition/recall of auditory-verbal information. A number of functional imaging studies of verbal STM with normal participants have implicated a left hemisphere network of regions, including inferior frontal and posterior temporal/inferior parietal cortex. Case studies of neurologic patients have provided evidence of cognitive dissociations with respect to STM and its putative components; however, less emphasis has been placed on anatomic localization in these cases. In the current study, we used a relatively new technique, voxel-based lesion symptom mapping (VLSM), which allowed us to identify brain regions critically involved in verbal STM on a voxel-by-voxel basis in a large group of 82 left hemisphere stroke patients. Several different behavioral measures were administered, including repetition of words, pseudowords, and digits. The VLSM analyses revealed that overall STM performance was associated with left temporo-parietal cortex, with the maximal t-value centered in the left superior temporal gyrus (MNI coordinates -62, -42, 22). STM for single words was also associated with left temporo-parietal cortex, while STM for pseudowords showed a more extensive network of significant voxels, with the maximal t-value at the border of the superior temporal gyrus and inferior parietal cortex. STM for digits showed dependence on voxels primarily in left middle and superior temporal gyri. These data suggest that while a network of left hemisphere regions is recruited in normal STM, posterior regions in left superior temporal/inferior parietal cortex are most critical for immediate STM and represent a likely locus of the phonological store.

F84

FLEXIBLE HUBS: GLOBAL BRAIN CONNECTIVITY CORRELATES OF HUMAN INTELLIGENCE Michael Cole[1], Todd Braver[1]; [1]Washington University in St. Louis — Cognitive flexibility is the hallmark of human intelligence. We hypothesized that this flexibility emerges from extensive global brain connectivity (GBC) in lateral prefrontal cortex (LPFC), allowing LPFC to respond to a wide variety of brain states with a wide variety of possible control signals. We used resting state functional connectivity MRI with a large dataset (N=96) to test for a region within LPFC showing high global brain connectivity (GBC) correlating with individual differences in general fluid intelligence (gF). We found that the identified LPFC region is one of the most highly connected brain regions (i.e., a hub), and that its activity predicts performance on the N-back task. Importantly, we found that despite this region's inclusion as part of the cognitive control network (CCN), gF was best predicted by its connectivity with regions outside the CCN. These findings support our hypothesis that LPFC's high GBC supports the high cognitive flexibility central to human intelligence.

F85

"WHAT" AND "WHERE" AUDITORY PATHWAYS INFLUENCED BY BILINGUALISM AND MUSIC EXPERIENCES Sylvain Moreno[1,2], Ada Leung[1], Ellen Bialystok[1,2], Claude Alain[1]; [1]Rotman Research Institute & University of Toronto, [2]York University — Bilinguals and musicians have been shown to perform better than monolinguals in executive function, memory and working memory tasks. For bilinguals, these findings have been attributed to their need to manage attention to two languages that are jointly available during linguistic performance. For musicians, these findings have been attributed to their training requirements. To further explore these effects of experiences, we tested 30 young adults who were either English monolinguals, bilinguals, or monolingual musicians while they performed an auditory N-back task with two conditions (category type and stimuli location - using the same stimuli). Our hypothesis was that music will rely on the "What" system because of the verbal advantage of musicians and the brain areas stimulated by musical training whereas bilingualism will relate to the "Where" system because of bilingual advantages in non-verbal tasks and the brain areas stimulated by bilingualism. Results showed a main effect of group, with greater activa-

tion in musicians than in bilinguals in the Heschl gyrus, Precuneus and LIFG. Results also showed a similar activation in the Right superior frontal gyrus between musicians and bilinguals but greater in monolinguals. There was an interaction between Group and Condition; for the category condition, there was greater activation for musicians than monolinguals in LIFG whereas for the location condition there was greater activation for bilinguals than monolinguals in LIFG too. The findings demonstrate how experiences differentially shaped the brain at the functional level and how similar behavioral performance could be achieved involving different brain networks.

F86

DIFFERENT NETWORKS AND CAPACITY LIMITS FOR ARTICULATORY AND NON-ARTICULATORY MECHANISMS OF VERBAL SHORT-TERM MEMORY Sabrina Trapp[1], Karsten Mueller[1], Stephan Konrad[1], Jöran Lepsien[1], Bernd Krämer[2], Oliver Gruber[1,2]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, [2]Georg August University Goettingen — It is assumed that maintenance in verbal short-term memory (STM) is accomplished by means of vocal or subvocal rehearsal (Baddeley, 1986). Recently, attention as an alternative mechanism to refresh memory traces has been discussed intensively (Barrouillet et al., 2004; Gruber & Goschke, 2004; Raye et al., 2007). While the capacity of verbally rehearsed information is thought to span the amount of material that can be articulated in 2 s (Baddeley et al., 1975), attentional refreshing seems to be limited to the amount of objects that can be maintained in the focus of attention, usually estimated to about four items (Cowan, 2001). In this fMRI study, we directly contrasted the processing capacity of STM with and without subvocal rehearsal by varying the amount of load for each memory condition. Subjects memorized either three, six or eight in the articulatory rehearsal and three or six letters in the non-articulatory maintenance condition. The results show that key nodes of the articulatory-rehearsal network parametrically increase activation with the amount of memorized information. In contrast, we found evidence for an off-level of neural activity after three items for the network underlying non-articulatory maintenance of phonological information. Moreover, in supra-capacity condition, the articulatory-based network additionally recruited key nodes of the non-articulatory, presumably attention-related network. This study yields further support for a dissociation between two different neural networks for verbal STM based on their processing capacities, informs about potential compensatory mechanisms with information overload and supports previous proposals on the limited focus of attention.

F87

EFFECTS OF THETA BURST STIMULATION OF MIDDLE FRONTAL GYRUS AND INFERIOR PARIETAL LOBULE ON LOAD AND FILTERING PROCESSES IN SPATIAL WORKING MEMORY Peter A Butcher[1], Richard B Ivry[1]; [1]Department of Psychology, UC Berkeley — The exclusion of task-irrelevant information from working memory has been associated with activation in the middle frontal gyrus (MFG) and basal ganglia (McNab, 2007). In contrast, activation in right inferior parietal lobule (IPL) is associated with WM load. To further explore these hypotheses, we disrupted MFG and IPL in the right hemisphere with offline theta burst stimulation (TBS). On each trial, subjects viewed a display of 14 squares arranged along a virtual circle about a fixation point. Three different conditions were verbally cued for each trial. Low Load: Four red circles indicated possible target location. High Load: Memory load was increased to six items, 4 red and 2 yellow circles. Filter: 4 red and 2 yellow circles were presented but yellow circles were ignored. After a delay, a probe appeared and participants indicated if it was one of the target locations. While TBS to rMFG and rIPL produced minimal change in load cost (Low-High) or filter cost (Low-Filter), there was a change in the correlation pattern of the two measures across individuals. The measures were strongly correlated following control stimulation. Following TBS to either area, these correlations were reduced for contralateral targets, but remained unchanged for ipsilateral targets. Thus, while TBS of either region affected performance for contralateral targets, we did not observe dissociable contributions of MFG and IPL to spatial WM.

F88

INCREASING VISUAL WORKING MEMORY CAPACITY WITH TRANSCRANIAL DIRECT CURRENT STIMULATION Philip Tseng[1,2], Tzu-Yu Hsu[2], Ovid Tzeng[2], Daisy Hung[2], Chi-Hung Juan[2]; [1]University of California, Santa Cruz, [2]National Central University, Taiwan — The limited capacity of visual working memory (VWM) has been well documented. This limit in capacity has also been found to be highly predictive of individual differences in fluid intelligence. Neuroimaging studies have pointed to the posterior parietal cortex (PPC) as the neural locus of VWM as its activity is positively correlated with working memory load and reaches an asymptotic neural activity level right around 3~4 items, perfectly reflecting the capacity limit of VWM in human performance. Although PPC activity has been proven critical to VWM performance, it has never been shown whether humans can increase VWM capacity by pushing PPC activity higher. Here we show that increasing right PPC activity via the use of direct transcranial current stimulation can indeed improve people's VWM capacity. We found that people were able to hold more items in their VWM and improve their performance instantly and effortlessly. Furthermore, although individual differences existed in our sample, nearly everyone was able to benefit from the electrical stimulation regardless of their baseline performance. These results suggest that VWM capacity is not fixed, and can be readily improved with external neural stimulation or perhaps long-term behavioral practices that targets PPC activity.

F89

ATTENTION NEEDS TIME TO SHIFT BETWEEN ITEMS IN WORKING MEMORY Ryan Tanoue[1], Dwight Peterson[1], Kevin Jones[1], Marian Berryhill[1]; [1]University of Nevada, Reno — Attention enhances perceptual processing, but it also enhances processing of items encoded in working memory (WM). This happens when you are looking for something and you realize you passed it three drawers ago. The retro-cue paradigm serves as a window into attentional operations within WM. Stimuli are presented and after encoding a cue indicates the to-be-probed item. A post-cue delay duration follows cue presentation and next, participants judge whether a probe is old or new. A retro-cue benefit emerges (5-10%) when comparing valid and neutral retro-cues. How this benefit occurs is mysterious since no new information becomes available. We investigated two hypotheses: prioritization (cues reshuffle the WM-probe comparison order) and protection (cued item is preserved, other WM contents are ejected). Prioritization predicts that greater post-cue delays should reduce the retro-cue benefit, whereas protection predicts no change in the retro-cue benefit. In Experiment 1, we found that increasing the delay between cue and test actually enhanced the retro-cue effect. In Experiment 2, we replicated this finding and also found that invalid cues did not cause a retro-cue deficit. In Experiment 3, we used a double retro-cue paradigm where the second cue could countermand or confirm the first cue. The data reveal that the retro-cue benefit remained when the second cue countermanded the first. These data lead us to propose a modified protection account in which protection of the cued item develops over time and memory representations of uncued items are maintained and not ejected from WM.

F90

THE ROLE OF FRONTAL EYE FIELDS IN SPATIAL WORKING MEMORY AND ATTENTION: A CONCURRENT TMS-FMRI APPROACH Alexander J. Shackman[1], Yelena Guller[1], Adam C. Riggall[1], Jeffrey S. Johnson[1], Bradley R. Postle[1]; [1]University of Wisconsin-Madison — Working memory allows organisms to retain information when it is no longer present, facilitating goal-directed behavior. A central question concerns the mechanisms underlying the maintenance of locations in spatial WM (SWM). This is putatively accomplished via covert shifts of spatial selective attention (SSA) to memorized locations, manifesting as sustained excitation of the corresponding regions of visual cortex (VC). Although the source of sus-

tained VC excitation remains unclear, several lines of evidence suggest that reentrant signals from the frontal eye fields (FEF) could contribute. First, microstimulation experiments in monkeys and transcranial magnetic stimulation (TMS) studies in humans suggest that the influence of SSA on VC reflects biasing signals from FEF. Second, FEF itself exhibits sustained activity during tasks requiring the maintenance of locations. To more directly probe task-dependent functional coupling between FEF and VC, we delivered single-pulse TMS to right FEF during the performance of lateralized SWM (delayed-recognition) and SSA (target-detection) tasks in 10 participants (6 male; M=20.3 years). Concurrent functional magnetic resonance imaging (fMRI) was used to measure the task-dependent propagation of TMS-evoked impulses to VC. Absent TMS, both tasks activated contralateral VC. FEF was independently identified using a saccade/anti-saccade task. Analyses revealed bilateral activation near the superior frontal and precentral sulci in all participants. VC regions (V1-V4) were independently identified by mapping visual eccentricity/angle onto single-subject cortical flat-maps. Using these functionally-derived regions, we were able to discriminate the propagation of FEF stimulation to regions of VC that matched memorized (SWM) or attended (SSA) locations from those that did not.

F91

OMEGA-3 FATTY ACID SUPPLEMENTATION AND COGNITION IN A COLLEGE-AGED POPULATION: A RANDOMIZED, PLACEBO-CONTROLLED, DOUBLE-BLIND PILOT STUDY Justin Karr[1], Tyler Grindstaff[1], Joel Alexander[1]; [1]Western Oregon University — With increasing awareness of nutritional influences on physical and mental health, researchers have further investigated the benefits of omega-3 polyunsaturated fatty acids (n-3 PUFA) on health and the brain; however, these benefits remain unclear across different age groups. The research suggests that n-3 PUFA positively affect prenatal neurodevelopment; however, this cognitive-enhancing effect might diminish postnatally with maturation. Thereafter, few studies have examined n-3 PUFA and cognition from childhood to middle-age, cohorts requiring further investigation. At later age, n-3 PUFA appears protective against neurodegeneration. The current study used a double-blind, randomized, placebo-controlled design for three weeks of n-3 PUFA supplementation (200 mg EPA/200 mg DHA) compared to a coconut oil placebo on 20 college students. Participants underwent baseline and post-supplementation assessments through the Rey Auditory Verbal Learning Test, Stroop Test, and Trail Making Test. Across all measures, the researchers hypothesized greater improvement in the above assessments among the n-3 PUFA group compared to placebo group. A series of two-way ANOVAs indicated that n-3 PUFA supplemented participants (n=10) did not differ from placebo-condition participants (n=10) in their improvement from baseline across all measures, possibly indicating n-3 PUFA as ineffective at improving cognition in college-aged populations; however, a larger sample must be tested in order to verify this claim.

Monday, April 4, 5:00 - 7:00 pm, Pacific Concourse

Long-Term Memory: Development & Aging

G1

NEURODEVELOPMENTAL CORRELATES OF ENCODING PROCESSES UNDERLYING FALSE-MEMORY FORMATION Pedro M. Paz-Alonso[1], Emily Hembacher[2], Pamela Gallego[2], Simona Ghetti[2]; [1]BCBL, Basque Center on Cognition, Brain and Language, Spain, [2]University of California, Davis — The Deese/Roediger-McDermott (DRM) paradigm is frequently used to examine true and false memories. After studying lists of semantically associated words, participants respond to a recognition test that includes studied items (targets), non-studied semantic associates (critical lures), and new unrelated items (distracters). Adults typically falsely recognize lures as frequently as they correctly recognize previously studied targets; both true and false recognition increase during middle childhood. Recent findings indicated that developmental improvements in semantic processing during encoding may underlie these behavioral trends in the DRM paradigm lists. The present mixed block/event-related fMRI study was aimed at investigating developmental correlates of brain activation associated with encoding processes of high and low associative strength lists in 8- to 9-year-old children (n = 16) and adults (n =15). During scanning, participants studied 18 auditorily presented DRM lists (9 of High associative strength and 9 of Low associative strength). Then, they performed a yes/no recognition test including targets, critical lures, and distracters. Across age groups, true and false recognition were higher for High- compared to Low-Associative strength lists. Also, compared to adults, children exhibited fewer hits and false recognition of critical lures, but more false recognition of distracters. Neuroimaging results revealed that temporal regions and dlPFC were implicated in semantic processing of High versus Low association strength lists, and that these regions were more strongly recruited in adults relative to children. Our findings underscore neurodevelopmental changes in key regions leading to false-memory formation during encoding processes.

G2

NEURAL BASIS OF IMPLICIT ASSOCIATIVE LEARNING AND AGING Jessica R. Simon[1], Chandan J. Vaidya[1,2], Darlene V. Howard[1], James H. Howard, Jr.[1,3,4]; [1]Department of Psychology, Georgetown University, [2]Children's Research Institute, Children's National Medical Center, [3]Department of Psychology, Catholic University of America, [4]Department of Neurology, Georgetown University — Few studies have investigated how aging influences the neural basis of implicit associative learning (IAL) and available evidence is inconclusive. One emerging behavioral pattern is that age differences in learning increase with practice, perhaps reflecting the involvement of different brain regions with training. Studies show that the medial temporal lobe (MTL) governs responding early on, whereas learning is increasingly dependent on the striatum throughout practice. We propose that the balance of these interactive learning systems changes with age, due to greater age-related striatal vs. MTL declines. We assessed age-related differences in brain activation during IAL using the Triplets Learning Task. Over 3 event-related fMRI runs, 11 young and 12 healthy older adults responded to only the third (target) stimulus in sequences of three stimuli by corresponding keypress. Unbeknownst to participants, the first stimulus' location predicted one target location for 80% of trials (High-Probability) and another target location for 20% of trials (Low-Probability). Both age groups learned associative regularities, but age differences in favor of the young emerged with practice. Using SPM5, the neural basis of learning was examined by contrasting regions more active on High- relative to Low-Probability trials and vice versa. Both age groups engaged the MTL early, but with training the young recruited their striatum whereas the old continued to rely on their MTL. This pattern enables old to maintain near-young levels of performance early in training but not later, and adds to evidence that IAL is supported by different learning networks in young and old adults.

G3

THE INFLUENCE OF DIRECTED ATTENTION ON SOURCE MEMORY RETRIEVAL IN THE YOUNG AND OLD: AN ERP STUDY Michael Dulas[1], Yashu Jiang[1], Audrey Duarte[1]; [1]Georgia Institute of Technology — Numerous studies have shown that source memory accuracy declines with age and neuroimaging evidence suggests that under-recruitment of frontally-mediated executive processes, like post-retrieval monitoring, may accompany this decline. Behavioral evidence suggests that directing one's attention toward item-source associations during encoding may enhance source memory in the young and old. However, it is presently unclear how directed attention during encoding modulates retrieval-related neural activity in young and older adults. The present event-related potential (ERP) study investigated the effect of directing attention toward item-source associations during encoding on age-related changes in source memory retrieval. Young and older adults studied colored objects, either under item-oriented encoding or under instructions that directed attention towards the conjunction of an object and its presented color, and were later tested on their memory for the objects and their previously presented color (source). Results demonstrated that source accuracy was significantly improved via directed attention in both groups. ERPs revealed that, compared to the item-oriented condition, directing attention to the object-color conjunctions reduced the presence of frontal-maximal source retrieval ERPs in young adults. In contrast, while older adults successfully recruited these frontal effects, they showed greater post-retrieval monitoring ERPs for the directed attention condition compared to the item-oriented condition. Results suggest that, while directing attention toward item-source associations successfully improves source memory accuracy in both young and old, the underlying mechanisms behind this improvement may change with age.

G4

MEMORY TRAINING-INDUCED CHANGES IN NEURAL ACTIVITIES ASSOCIATED WITH SOURCE MEMORY RETRIEVAL IN OLDER ADULTS

Juan Li[1], Ting Zhou[1], Bing Li[1], Jing Yu[1], Xin Li[1]; [1]Center on Psychological Aging, Institute of Psychology, Chinese Academy of Science — Training old adults on mnemonic strategies can effectively increase their performance. But, memory training that incorporates electrophysiological data as the outcome measure has not been investigated. We tried to approach this issue by using an episodic retrieval paradigm (Li et al., 2004) in which a negative old-new effect observed only in elder (not in young) subjects. Therefore, a specific aim was to explore after training whether older brains would resemble young ones by showing the negative pattern reduced. 16 healthy older individuals (aged 68.4 years old) completed 16 memory training sessions (3 sessions per week, 1 hour per session), during which several mnemonics (e.g. method of loci, face-name mnemonic) were trained. ERPs were recorded when source memory retrieval was assessed during both pre- and post- tests. The results did not show significant improvements on source performance after training, and the age-specific negative old/new pattern did not change either. But the old adults did performed better in terms of item accuracy,and corresponding comparison between pre- vs. post-ERPs were greater, lasted longer and involved more left-lateralized activations. Healthy controls will be tested soon to further identify the observed effects were resulted from training or practice. These results suggested that healthy older adults indeed benefit from memory training in a quantitative way as memory performance improved with additional activation suggesting a compensation process, but not in a qualitative way as they stably used a different neural circuitry from the young to optimize their performance even after memory training.

G5

DUAL PROCESS THEORY OF EPISODIC MEMORY: FINDINGS FROM THE SWEDISH NATIONAL STUDY ON AGING AND CARE IN KUNGSHOLMEN (SNAC-K)

Beata Ferencz[1], Sari Karlsson[1], Erika Jonsson Laukka[1], Laura Fratiglioni[1], Lars Bäckman[1]; [1]Aging Research Center, Karolinska Institute, Stockholm, Sweden — Episodic memory exhibits age- and dementia-related deficits, making it imperative to assess this form of memory in large population samples. A cross-sectional study was conducted, utilizing recent behavioral and structural imaging data from a non-demented population sample. We compared recall and recognition performance across age groups with a focus on the dual process theory of episodic memory. Postulating that recognition is supported by recollection and familiarity processes, we aimed to assess this theory from a behavioral and structural standpoint. Data from the SNAC-K population study were used, with a main sample of 2665 participants and an MR subsample of 527 participants across 6 age groups (age = 60-100 years). Free recall and recognition, including remember, know and guess responses of recognition, were assessed with a 16-item word list. Delineation of the hippocampus was performed manually. Multiple linear regressions of behavioral data revealed expected age-related deficits in recall and recognition. Reliable correlations were observed between hippocampal volume and free recall (R2 = .03) and recognition (R2 = .03). Furthermore, the recognition data indicated an age-related decline in remember responses, but not for know responses. Partial correlations of structural data, however, did not indicate a specific relationship between hippocampal volume and remember. Thus, behavioral, but not structural data supported the dual process theory, indicating two distinct processes of recognition, with recollection being more sensitive to aging effects.

G6

AN ASSOCIATIVE LEARNING PROCEDURE MEASURED BY EVENT-RELATED POTENTIALS CORRELATES WITH EVENT MEMORY IN 14 MONTH OLD CHILDREN

Emelie Nordqvist[1], Mikael Heimann[1], Mikael Johansson[2], Magnus Lindgren[2]; [1]Linköping University, Sweden, [2]Lund University, Sweden — Deferred imitation (DI) reflects an early form of event memory but the underlying neural processes is to a large degree unknown. Thus, the present study examines how associative learning observed through event-related potentials (ERP) relates to DI as measured with an observation-only design. Thirty children participated in the study and acceptable ERP data was collected from 15 (9 boys). DI was measured with a thirty minutes delay and ERP was recorded with a Geodesic High Density Net with 128 electrodes. The ERP procedure consisted of two pairs of pictures presented six times (= the learning phase) and a test phase introducing two violations: Two familiar pictures in a new combination (ASSO) or a combination of one familiar and one novel picture (NOV). In addition, visual recognition memory was also measured. ERP revealed an Nc within 300-600 ms post stimuli. A higher mean amplitude was observed for ASSO ($p < .05$) and a marginal effect was noted for NOV ($p = .055$). Better DI performance correlated with larger Nc change scores between ASSO and the last presentation in the learning phase ($rs (15) = .57$; $p < .05$). Preliminary analyses of slow waves revealed no further relationship between ERP and DI and no significant correlation between DI and novelty preference. These findings indicate that electrophysiological indices of associative learning can be related to behavioral observations of early memory processes in young infants. (FUNDING: FAS 2006-XXXX)

G7

ELECTROPHYSIOLOGY OF RULE-BASED CATEGORY LEARNING AS A FUNCTION OF AGE

Krishna Bharani[1], Dietta Chihade[1], Kevin Nuechterlein[1], Sandra Weintraub[2], Ken A Paller[2], Paul J Reber[2], Robert G Morrison[1]; [1]Loyola University Chicago, [2]Northwestern University — A central challenge for translational cognitive neuroscience is to develop neurocognitive markers for normal and pathological aging. To this end we tested healthy younger (m=21 years) and older (m=71 years) adults using a rule-based category-learning task where participants learn to categorize visual gratings using trial-by-trial feedback while brain potentials were recorded. We have previously characterized the event-related potentials (ERPs) sensitive to strategy and categorization accuracy in this task. Previous functional Magnetic Resonance Imaging studies also with this task have demonstrated the importance of prefrontal cortex and medial temporal lobe, two areas implicated in pathological aging including Alzheimer's disease. In this study, older adults showed lower accuracy and longer RTs than did younger adults, but there were two distinct subgroups. The Rule subgroup learned slightly more slowly than younger adults, but showed equivalent asymptotic accuracy. The No-Rule subgroup did not learn and showed near chance performance throughout the task. ERPs for the Rule subgroup showed a Late Positive Complex larger for correct than incorrect trials, similar to that observed for younger adults. The Rule subgroup also showed a feedback-locked P300 difference for correct/incorrect trials, but it was smaller than that in younger adults suggesting decreased rule-learning confidence (despite similar accuracy across groups). The No-Rule subgroup showed ERPs characteristic of chance performance. In conclusion, rule-based category learning may be sensitive to factors predicting subsequent decline in executive and long-term memory abilities, as it appears to stratify older adults with neuropsychological profiles in the normal range.

G8

ADULT AGE DIFFERENCES IN THE ABILITY TO SUSTAIN INTERFERENCE IN EPISODIC MEMORY: NEURONAL CORRELATES AND INTERACTION WITH BINDING MECHANISMS

Yana Fandakova[1], Yee Lee Shing[1], Ulman Lindenberger[1]; [1]Max Planck Institute for Human Development, Berlin, Germany — We examined the contribution of the prefrontal cortex (PFC) to adult age differences in the ability to withstand interference from highly familiar past events, and how these differences relate to binding impairments in old age. 28 younger adults (YA) and 30 older adults (OA) underwent fMRI assessment while performing a modified version of the continuous recognition task. Participants saw the same set of unrelated word pairs in three runs and identified pairs that were repeated within runs. We hypothesized that OA will show higher false recognition of familiar events compared to YA, reflecting deficits in PFC-mediated

memory monitoring mechanisms. We expected OA's false recognition to be especially pronounced when associative information has to be retrieved, due to additional age deficits in binding. The results revealed that false recognition increased across runs for OA but not for YA, suggesting that monitoring mechanisms are not functioning optimally in old age. Both age groups showed decrease in false recognition of rearranged pairs across runs, but the decrease was more pronounced for YA, suggesting that deficits in memory control in interaction with binding deficits contribute to age differences in recall-to-reject processes. On the neuronal level, YA but not OA showed increasing engagement of dorsolateral PFC across runs of the task, reflecting increasing control of memory interference due to previous encounters of the word pairs. In sum, deficits in memory monitoring in old age reflect changes in the involvement of prefrontal regions in situations that place high demands on memory control and binding mechanisms.

G9

RELATIONSHIPS BETWEEN DEVELOPMENT, CORTICAL THICKNESS, AND MEMORY Rebecca E. Martin[1], Xiaoqian J. Chai[1], Sunil Patel[1], Kristen M. Morin[1], John D.E. Gabrieli[1], Noa Ofen[1]; [1]Massachusetts Institute of Technology — Cortical thinning in development from childhood through adulthood is a well-established phenomenon, however, little is known about its relationship to memory abilities. We examined the relationship between cortical thickness, age, and performance on a verbal source memory task in 84 participants between the ages of 8 and 24. Structural MRI images were processed and average measures of cortical thickness were obtained using Freesurfer. Regions of interest included areas in the medial temporal lobe (MTL) and lateral prefrontal cortex (lPFC). Consistent with previous reports, we found strong negative correlations between age and cortical thickness bilaterally in parahippocampal cortex (PHC), a sub-region within the MTL, and in lPFC. Memory accuracy (correct old and new responses) negatively correlated with cortical thickness in the left PHC (p=.003), and this relationship remained significant when controlling for age (p=.004). In the lPFC, cortical thickness was not related to memory accuracy. There was, however, a significant negative correlation between cortical thickness in the left lPFC and the number of source details participants remembered (ps<.04). There was also a negative correlation between the number of source details remembered, and cortical thickness in the PHC (p=.008). When controlling for age, these effects were not significant. Taken together, these data suggest that memory ability is related to cortical thickness in MTL and lPFC. However, the relations between cortical thickness and memory ability in lPFC are mediated by age, whereas those in the MTL may reflect individual differences in memory ability not accounted for by development.

G10

MEMORY SUPPORTS FACE PROCESSING ACROSS THE LIFESPAN Jennifer Heisz[1], Jennifer Ryan[1]; [1]Rotman Research Institute — We assessed whether past experience minimizes age-related differences in face processing by monitoring the eye movements of older and younger adults as they viewed faces that varied in the type/amount of prior exposure. Prior exposure was manipulated by including famous and novel faces, and by presenting faces up to five times. Compared to novel faces, younger and older adults processed famous faces similarly with fewer eye movements, with those fixations predominantly directed to the inner features. Eye movements decreased across repeated exposures, though more slowly for older than younger adults. Recruiting existing memories may provide protection against age-related changes in face processing that may be indicative of age-related deficits in the development of lasting face representations.

G11

EFFECTS OF DRINKING PATTERNS ON PROSPECTIVE MEMORY PERFORMANCE IN COLLEGE STUDENTS Sarah Raskin[1], Marta Zamroziewicz[1], Kristina Foster[1], Lara Novak[1], Ethiopia Kabtimer[1], Rivkah Rosen[2], Howard Tennen[3], Carol Austad[4], Carolyn Fallahi[4], Rebecca Wood[4], Godfrey Pearlson[2]; [1]Trinity College, [2]Olin Neuropsychiatry Research Center, Institute of Living, [3]University of Connecticut, [4]Central Connecticut State University — Alcohol consumption in college students is of interest due to interactions between alcohol and the developing brain and this is an important age for the development of prospective memory (PM). Fifty-seven first-year college students completed the Self-Rating Effects of Alcohol (SREA), Modified Timeline Follow-back (TFLB), and Alcohol Effects Questionnaire (AEQ) and two measures of PM. The time-based measure required students to close the testing room door in exactly two minutes. The event-based measure required students to sign their name if they encountered a colored sheet of paper in the testing package. Both measures were scored as 0 if no recognition of the task was given, 1 if the task was partially completed or completed late, and 2 if the task was correct. The ongoing task was the MINI DSM-IV-TR alcohol use items. Binge drinking was defined as consuming 5 or more drinks (male), or 4 or more drinks (female), in ~ 2 hours. Surprisingly, students performed better on the time-based (mean = 1.60, s.d.=0.80) than on the event-based measure (mean=0.77, s.d.= 0.98) of prospective memory. Students who had binged in the last 30 days performed worse (mean=1.20, s.d.=0.41) than social drinkers (mean=1.84, s.d.=0.57) and teetotalers (mean=1.82, s.d.=0.21) on the time-based measure, whereas teetotalers (0.50, s.d.=0.25) were the poorest performing group on the event-based measure. This suggests that binge drinking may have a specific detrimental effect executive functions associated with PM. The findings of teetotalers were not due to religious or cultural differencess and may reflect a degree of rigid thinking.

G12

AGE-RELATED DIFFERENCES IN THE FUNCTIONAL NEUROANATOMY OF EPISODIC ENCODING: A COMBINED DTI AND FMRI STUDY Alireza Salami[1,3], Lars Nyberg[1,2,3], Johan Eriksson[1,3]; [1]Department of Integrative Medical Biology (Physiology), Umeå University, 90187, Umeå, Sweden, [2]Department of Radiation Sciences (Diagnostic Radiology), Umeå University, 90187, Umeå, Sweden, [3]Umeå Center for Functional Brain Imaging (UFBI), Umeå, Sweden — A large body of research has demonstrated age-related differences in white matter (WM) microstructure as well as age-related functional (BOLD) differences on episodic memory tasks. However, little is known whether age differences in WM integrity mediate task-induced changes in BOLD signal within a memory network. To address this issue, the present study combined measures from functional magnetic resonance imaging (fMRI) of a face-name paired-associates task and diffusion tensor imaging (DTI). During the episodic encoding task, across age groups (N = 111), increased activations were found in extensive regions including bilateral fusiform gyrus, dorsolateral prefrontal cortex, and bilateral hippocampus. An age-related functional increase was observed in right prefrontal cortex, whereas a decrease was found in left occipital cortex. Analysis of WM integrity (fractional anisotropy, FA) revealed an extensive age-related linear decline that was more pronounced for anterior corpus callosum (CC). Moreover, mean FA measures in the anterior/posterior CC correlated with activation in occipital cortex, such that lower WM integrity was associated with weaker BOLD signal. Collectively, the results suggest that WM changes may at least in part mediate age-related functional reductions.

G13

P600 WORD REPETITION EFFECTS DIFFERENTIATE FRAGILE X-ASSOCIATED TREMOR/ATAXIA SYNDROME (FXTAS) FROM VERY EARLY ALZHEIMER'S DISEASE John Olichney[1], Sara Teichholtz[1], Jinchen Yang[1], Andrea Schneider[1], Rawi Nanakul[1], Ralph Nowacki[2], Andreea Seritan[1], Charles DeCarli[1], Vicente Iragui-Madoz[2], Marta Kutas[2], Paul Hagerman[1], Randi Hagerman[1]; [1]University of California, Davis, [2]University of California, San Diego — We compared cognitive event-related potentials (ERPs) related to memory and language between patients with Fragile X-associated Tremor/Ataxia Syndrome (FXTAS) and those with early Alzheimer's Disease (AD) or Mild Cognitive Impairment (MCI). FXTAS is a recently described neurodegenerative disorder associated with premutations (55-200 CGG repeats) of the FMR1 gene. Patients with FXTAS typically dis-

play cerebellar ataxia, peripheral neuropathy, and "frontal-subcortical" cognitive impairment. At autopsy, FXTAS brains typically have numerous mRNA-containing intranuclear inclusions in neurons and astrocytes. Clinical neuropsychological tests have not found robust discriminators between FXTAS and AD, possibly explained by the overlap of predilection sites (neocortex and hippocampus) for FXTAS inclusions and AD pathology. ERPs were recorded during a semantic judgment task in which congruous (50%) and incongruous target words were repeated between ~10-140 seconds later, using a 32-channel EEG system. We compared the N400 and P600 components of 23 FXTAS patients (mean age= 72.7, MMSE= 26.3) to a matched-comparison group of 23 patients with early AD/MCI (N= 2 mild AD, 21 MCI, of whom 12 later converted to AD, mean age= 73.3, MMSE= 26.5) with split-plot ANOVAs. Analyses revealed decreased N400 repetition effects of similar magnitude in both groups, but significantly (p= 0.01) smaller P600 word repetition effects (e.g. mean amplitude= -0.21 vs. 1.80 ?V at channel Pz) in the early AD/MCI group compared to the FXTAS group. We believe this difference in P600 word repetition amplitude reflects the relative sparing of episodic memory and verbal memory-related neural circuits in FXTAS patients compared to early stage AD.

G14

AGING REDUCES THE SELECTIVITY OF DORSOLATERAL PREFRONTAL CORTEX DURING RETRIEVAL MONITORING Ian M. McDonough[1], Jessica T. Wong[1], David A. Gallo[1]; [1]University of Chicago — We investigated age-related changes in the neural correlates of retrieval monitoring using fMRI. Retrieval monitoring is the ability to evaluate the contents of memory to determine if an event occurred at all or in a specific context. At study, younger and older adults were presented either with pictures of common objects (rich perceptual context) or with the names of common objects, and were asked to decide whether the object is made in a factory (rich conceptual context). Two memory tests were completed in the scanner. One test focused on perceptual information ("seen as a picture?"), and the other focused on conceptual information ("made a factory judgment?"). Across both age groups, memory accuracy was better when oriented towards perceptual than conceptual information. Moreover, accuracy was equated between age groups when oriented towards perceptual information, but was impaired in older adults when oriented towards conceptual information. Independent of test-orientation, younger adults showed greater activity in dorsal lateral prefrontal cortex when correctly rejecting studied than non-studied lures. This finding suggests that younger adults selectively recruited DLPFC when monitoring familiar test items. In contrast, older adults showed the same level of activity in this prefrontal region when correctly rejecting studied and non-studied lures, independent of the type of information being retrieved and when accuracy was equated with younger adults. This pattern indicates that aging altered the relationship between DLPFC and retrieval monitoring, potentially because older adults non-selectively engaged in effortful retrieval monitoring across all test items.

G15

LEARNING AND MEMORY IN ADOLESCENCE: FEEDBACK-BASED LEARNING AND FLEXIBLE GENERALIZATION Juliet Y. Davidow[1], Eva Alba[1], Juan Deliz[1], Itamar Kahn[2], Daphna Shohamy[1]; [1]Columbia University, [2]Technion – Israel Institute of Technology — Converging evidence demonstrates that different kinds of learning depend on distinct neural systems. The hippocampus supports rapid encoding of single events – often referred to as 'episodic' memory. The striatum, by contrast, is thought to support feedback-based gradual learning of stimulus-response associations, or 'incremental' learning. Traditionally, these forms of learning were thought to operate as distinct and independent systems. However, emerging evidence suggests that the hippocampus and striatum interact during learning, either competitively or cooperatively. Here, we addressed two questions about the nature of the interactions between these systems and their relevance for learning-guided behavior. First, in adults, we sought to characterize intrinsic interactions between the hippocampus, the striatum and midbrain dopamine regions using resting-state fMRI. Second, we probed the development of both memory systems during adolescence using a two-phase behavioral paradigm that tests feedback-based learning, as well as memory-based generalization, previously shown to depend on the striatum and hippocampus, respectively. Our results suggest that in adults successful generalization is driven by interactions between the hippocampus and midbrain dopamine regions. In adolescents, we found variability in the ability to generalize, and this ability was independent of the ability to use feedback to drive learning. These results are consistent with emerging evidence suggesting that the striatum and the hippocampus may develop at different rates during adolescence, with important implications for developmental changes in learning-guided behavior.

Long-Term Memory: Episodic

G16

CAN INDIVIDUAL DIFFERENCES IN FUNCTIONAL CONNECTIVITY PREDICT MEMORY PERFORMANCE? Danielle King[1], Michael Miller[1]; [1]University of California, Santa Barbara — The default mode network (DMN) is a set of brain regions that commonly exhibit task-related decreases in BOLD activity. These regions are functionally connected, demonstrating coherent, spontaneous, fluctuations in BOLD activity during rest. The functionality of this network remains uncertain; however, several groups have suggested the network's involvement in episodic memory processing. In the present study, we sought to examine how individual differences in the strength of the functional connection between DMN regions could predict memory performance. Task and resting state time-course data for both DMN regions as well as task-positive regions were extracted and cross-correlated. These correlation values were then entered into a multiple regression analysis predicting performance on a source memory task. The results demonstrate that the strength of the functional connections between both task-positive and DMN regions during rest is strongly negatively associated with memory performance, whereas the strength of functional connections during both encoding and retrieval are far less predictive of performance. These results suggest that intrinsic resting state brain activity is strongly related to memory performance.

G17

THE ROLE OF THE HIPPOCAMPUS IN THE RETRIEVAL OF GENUINELY EPISODIC MEMORY FROM THE REMOTE PAST Peter Bright[1], Michael D Kopelman[2]; [1]Anglia Ruskin University, Cambridge, UK, [2]King's College London, Institute of Psychiatry — The role of the hippocampus and other medial temporal structures in the retrieval of remote episodic memories remains fiercely contested in the literature. For the current investigation we addressed an issue which has been identified as a primary reason for conflicting theoretical positions: the sensitivity of employed behavioural measures for distinguishing genuine episodic recollection from more semantic memories. In our first study, we recoded existing data from a recently developed autobiographical memory test administered to patients with organic amnesia to ensure that all scores entered into our analysis reflected genuinely episodic detail. We found that patients with restricted medial temporal lesions were unimpaired (relative to controls) in recalling episodes from the remote past but impaired in recalling episodes from the recent past (patients with widespread temporal lesions were at or close to floor in recollecting recent and remote periods). In a second study we selected a subset of patients (hippocampal; widespread temporal). The same pattern was observed: hippocampal patients were unimpaired in retrieving episodic details from the remote past but severely impaired at retrieving from the recent past. The present findings, backed up by supportive quantified MRI evidence, indicate that damage to the hippocampi or medial temporal lobes has a time-limited effect upon the retrieval (or recollection) of remote episodic memories.

G18

RELATING INDIVIDUAL DIFFERENCES IN REALITY MONITORING TO MEDIAL PREFRONTAL CORTEX STRUCTURE Marie Buda[1], Alex Fornito[1,2], Zara M. Bergström[1], Jon S. Simons[1]; [1]Behavioural and Clinical Neuroscience Institute, Department of Experimental Psychology, University of Cambridge, UK, [2]Melbourne Neuropsychiatry Centre, University of Melbourne, Australia — Reality monitoring refers to the memory retrieval process whereby one introspectively judges whether a memory came from an internal or external source (e.g., whether an event was imagined or actually occurred). Neuroimaging research has implicated the medial prefrontal cortex (mPFC) in this cognitive process. In the healthy population, people often vary in their reality monitoring ability, and the question explored here is whether this variability is associated with structural differences in the mPFC. A structure of potential interest to this question is the paracingulate sulcus (PCS), which has a high level of morphological variability within the normal population. In the current study, 53 healthy volunteers were selected on the basis of MRI scans and classified into four groups according to absence or presence of the PCS in their left or right hemisphere. These participants performed a reality monitoring task that tested their ability to discriminate whether stimuli had been perceived or imagined, or whether they or another person had performed a task. Results showed that the group with absence of the PCS in both hemispheres showed significantly reduced reality monitoring performance compared with the other participants. It might be predicted that absence of the PCS could mean greater volume in the surrounding frontal gyri. In accordance with this prediction, voxel-based morphometry analysis revealed significantly greater mPFC gray matter in individuals who performed poorly on the reality monitoring task. The current findings provide evidence that individual differences in reality monitoring performance may be associated with structural variability in the mPFC.

G19

INDIVIDUAL DIFFERENCES IN EXECUTIVE FUNCTION UPDATING PREDICT EPISODIC RETRIEVAL Erika Nyhus[1,2], Tim Curran[2]; [1]Brown University, [2]University of Colorado at Boulder — The right prefrontal cortex and left parietal cortex have been implicated in the cognitive control of episodic memory retrieval. In addition, the relationship between executive function tasks and episodic retrieval indicate that they both depend on similar cognitive control processes. We recently proposed that theta oscillations represent interactions between brain systems for the control of episodic retrieval (Nyhus & Curran, 2010). Top-down control of episodic retrieval is generally greater during source retrieval (e.g. retrieving contextual information such as the study task that was associated with a word) than during item retrieval (e.g. retrieving whether a word was studied or not). The current experiment explored the relationship between individual differences in executive function updating and theta oscillations during item and source retrieval. Frontal theta power was greater for old than new words from 500-800 ms. Theta coherence between frontal and parietal regions was greater for old than new words and was greater for incorrect than correct source judgments. In addition, executive function updating positively correlated with item and source accuracy, and there was a negative correlation between executive function updating tasks and theta coherence. These results indicate that monitoring the contents of working memory and monitoring the contents of long-term episodic memory retrieval engage similar executive control processes, and that subjects who have better executive control are more efficient at monitoring the contents of episodic retrieval.

G20

NEURAL MECHANISMS UNDERLYING SUPPRESSION OF MEMORY RETRIEVAL Ean Huddleston[1,2], Michael C. Anderson[2]; [1]Cambridge University, [2]MRC Cognition and Brain Sciences Unit — Recent neuroimaging work using the Think/No-Think (TNT) paradigm has shown that when people suppress retrieval of unwanted memories, hippocampal activation is reduced. It remains unclear, however, whether retrieval suppression also modulates regions of neocortex supporting the representation of the memory itself. To examine this issue, we developed a modified TNT paradigm wherein people attempt to suppress the retrieval of faces and scenes. Faces and scenes are ideal stimuli in that the cortical bases for processing these types of stimuli are well documented, providing specific brain regions in which to search for evidence of neocortical suppression—the fusiform face area (FFA) for faces, and parahippocampal place area (PPA) for scenes. During the learning phase of our study, participants studied word-picture pairs. Then, during the Think/No-Think phase, participants were shown the cue words for numerous word-picture pairs. For some words, participants were instructed to think of the associated picture ("Think" condition), and for other words, participants were instructed to not think of the associated picture ("No-Think" condition). Behavioral results showed that memory for suppressed items was impaired, extending retrieval suppression effects to memories of faces and scenes. Replicating prior work, imaging results showed hippocampal downregulation and DLPFC upregulation during No-Think trials compared to Think trials. Furthermore, PPA (but not FFA) activation was shown to be downregulated during No-Think trials compared to Think trials, supporting the hypothesis (at least in the PPA) that retrieval suppression modulates activation in the region of neocortex that supports the representation of the memory.

G21

RECOLLECTION AND FAMILIARITY FOR WORDS AND SCENES: SHARED AND INDEPENDENT NEURAL COMPONENTS Anthony Ryals[1], Anne Cleary[1], Carol Seger[1]; [1]Colorado State University — Previous research suggests that recollection involves the hippocampus while familiarity involves extrahippocampal regions such as perirhinal cortex (PRC) (e.g., Bowles et al., 2007; 2009, Montaldi & Mayes, 2010). The present study used fMRI and the Recognition-without-Cued-Recall (RWCR) paradigm to separate recollection from familiarity and directly compare RWCR of words with RWCR of scenes (Cleary, 2004). Participants received three study-test blocks of word stimuli and two study-test blocks of scene stimuli. At test, participants received cues, some resembling studied items and others not. In the word condition, study-test resemblance was in the potential visual word form similarity of each cue to a studied word. In the scene condition, resemblance was in the potential similarity of the configuration of elements within the cue scene to that of a studied scene. Memory for words recruited reading-related regions (angular/ supramarginal region and visual word form area), whereas memory for scenes recruited scene-processing and navigation areas (posterior cingulate/ retrosplenial region and precuneus). In both the word and scene conditions, an RWCR effect was shown: In the absence of cued recall, participants gave higher ratings to test cues resembling studied items. fMRI correlates of this RWCR effect replicated our prior research in showing that PRC activity, but not hippocampal activity, correlated with the RWCR effect. PRC activity was greater for cues resembling than not resembling studied items. This pattern held for both the word and scene conditions, suggesting that PRC involvement in RWCR may be amodal.

G22

REWARD FACILITATES CONSTRUCTION AND LATER MEMORY OF AUTOBIOGRAPHICAL EPISODES Katherine E. MacDuffie[1], Elizabeth B. Johnson[1], Tara Iyengar[1], Donna Rose Addis[2], R. Alison Adcock[1]; [1]Duke University, [2]The University of Auckland — Recent work suggests that dopaminergic modulation of the hippocampus promotes declarative memory encoding (see Shohamy & Adcock, 2010). However, the effects of such modulation on autobiographical event retrieval, another hippocampal process, have never been investigated. We have previously shown that engaging in a stimulating reward-anticipation task, which has been shown to elicit activation of the VTA, results in a persistent enhancement of encoding that lasts for a period of minutes (Johnson et al., 2010). The current study investigates the carryover effects of the same reward anticipation task on autobiographical event construction. Participants engaged in two blocks of a cued autobiographical event construction paradigm (Addis et al., 2007), each preceded by a Reward-anticipation or

Control version of a cued reaction time (RT) task. Participants indicated successful event construction with a button press, and then described the event verbally. Twenty-four hours later, participants returned for a surprise retrieval test in which they were asked to recall the events constructed the day before. Participants were faster to retrieve past events that had been constructed in the block that followed the Rewarded RT task than in the block that followed the Control RT task. Furthermore, past events constructed in the minutes following the Rewarded RT task were rated as more significant and were preferentially remembered in a retrieval test twenty-four hours later. This study provides preliminary evidence that retrieving autobiographical episodes during a generalized state of reward motivation may influence their content and later representation in memory.

G23

SIMILARITIES AND DIFFERENCES BETWEEN THE NEURAL MECHANISMS OF EPISODIC AND AUTOBIOGRAPHICAL MEMORY RECALL Jared Stokes[1], Yoni Mazuz[1], Sander Daselaar[1], Morris Moscovitch[2], Roberto Cabeza[1]; [1]Center for Cognitive Neuroscience, Duke University, [2]Rotman Research Institute, Baycrest Centre, University of Toronto — In general, episodic memory (EM) refers to memory for micro-events experienced in the laboratory (e.g., reading "dog" on a computer screen), and autobiographical memory (AM) to memory for events from one's own life (e.g., meeting first pet). It is currently debated whether EM and AM depend on similar or different neural mechanisms. Although metaanalyses of fMRI studies indicated very little overlap between EM and AM activation patterns, this finding could reflect differences in tasks rather than differences in mechanisms. For example, EM studies typically measure fast recognition of simple events whereas AM studies usually assess slow recall of complex events. In the present fMRI study, we measured slow recall of complex events for both EM and AM. In each EM trial, participants read a word (e.g., dog) and covertly recalled three studied pairs forming a chain (e.g., dog-cat, cat-tiger, tiger-stripe). In each AM trial, participants read a word and covertly recalled an associated autobiographical event. In both tasks, they pressed a key when recall was complete. Reaction times were around 4.5 sec in both tasks. EM and AM tasks recruited a similar retrieval network, including prefrontal cortex (PFC), posterior parietal, and posterior cingulate regions. At the same time, some regions showed clear differences. For example, left dorsolateral PFC was differently engaged by EM, possibly reflecting greater monitoring, whereas medial PFC was differentially recruited by AM, possibly reflecting greater self-referential processing. In sum, EM and AM involve similar neural mechanisms but differ in a few components of the memory retrieval network.

G24

INSTRUCTED SALIENCE MODULATES REWARD-MOTIVATED ENHANCEMENTS IN ITEM AND RELATIONAL MEMORY Jeff MacInnes[1], Kate MacDuffie[1], Alison Adcock[1]; [1]Duke University — Previous research has demonstrated that the anticipation of future reward, associated with conjoint activation of midbrain and hippocampus can enhance declarative memory for naturalistic scenes (Adcock et al. 2006). To determine whether the entire mnemonic representation of events experienced during reward anticipation is enhanced, or only the features relevant to obtaining future reward, the current study tested incentive effects on component memory processes - item and relational memory – using a color binding task (Staresina & Davachi, 2009). In this task, subjects were required to bind a gray-scale object (item) to a colored border (relational). In a between-subjects design, experimental instructions were manipulated to test the effects of explicitly incentivizing either item or relational memory. In the item group (N=17), participants were instructed that correct item-memory performance earned monetary bonuses, while in the relational group (N=17) participants were instructed that correct relational memory would earn monetary bonuses. We observed a double dissociation across groups: Item memory performance for high-value items was significantly greater than low-value items only in the item group, while relational memory performance for high-value items was significantly greater than low-value items only in the relational group. These results indicate that instructing participants about salient features of upcoming experience can lead to feature-selective memory advantages, suggesting similarly selective enhancements of MTL component processes by anticipated reward.

G25

COMMON AND DISTINCT NETWORKS SUPPORTING EMOTIONAL MODULATION OF SUCCESSFUL MEMORY ENCODING AND RETRIEVAL Maureen Ritchey[1], Laura Lorenzo-López[1,2], Sander M. Daselaar[1], Kevin S. LaBar[1], Roberto Cabeza[1]; [1]Duke University, [2]University of Santiago de Compostela, Galicia, Spain — Emotion exerts its influence on both memory encoding and retrieval processes. One way to study this influence is to test emotion effects on encoding success activity (ESA) and retrieval success activity (RSA)-- activity distinguishing between remembered and forgotten items at the encoding or retrieval phase. Previous studies taking this approach have highlighted the role of the amygdala and medial temporal lobes during emotional ESA or RSA. However, to our knowledge, there has not yet been a direct comparison of emotion effects on ESA and RSA in the same study. In this study, participants encoded emotionally negative, positive, and neutral pictures. Two days later, they returned for a surprise recognition memory test. FMRI data were collected during both the encoding and recognition phases. First, we investigated the overlap between ESA and RSA effects. Across both phases, the hippocampus supported successful memory for both emotional and neutral stimuli, whereas the amygdala supported successful memory for emotional relative to neutral stimuli. Second, we tested for ESA-RSA differences that varied by emotion type. Consistent with previous findings, a network of posterior midline and parietal regions negatively predicted memory during encoding (reverse ESA) but positively predicted memory during recognition. Emotion modulated the encoding-retrieval flip in these regions: negative valence accentuated the reverse ESA effect, whereas both negative and positive emotion enhanced RSA. Thus, whereas emotion affects memory processes in the amygdala and MTL similarly across encoding and retrieval, its interactions with memory success in posterior midline and parietal regions are more complex, suggesting distinct mechanisms.

G26

COMMON AND DISTINCT PATTERNS FOR MEMORY SUCCESS AND FAILURE DURING ENCODING AND RETRIEVAL Erik Wing[1], Sander M. Daselaar[1], Scott M. Hayes[2], Roberto Cabeza[1]; [1]Department of Psychology & Neuroscience, Duke University, Durham, NC,, [2]Memory Disorders Research Center, Neuroimaging Research Center, Boston VA Healthcare System, Boston, MA — The posterior midline and ventral parietal cortex (VPC) have been identified as key components in a set of regions showing activity during successful retrieval (Retrieval Success Activity/RSA) but unsuccessful encoding (reverse Encoding Success Activity/ESA) (Daselaar et al., 2009). While the processes underlying this encoding/retrieval flip are not fully understood, one explanation is that during retrieval, RSA reflects the beneficial effects of bottom-up attentional capture by task-relevant memory items. Conversely, during encoding, reverse ESA elements reflect the effects of reflexive attentional capture by internal or task-irrelevant thoughts, which disrupt rather than facilitate successful encoding (Cabeza, 2008). Instead of reverse ESA/RSA overlaps, other approaches have looked at regions where such activity differs by phase, indicating phase-specific memory processes. In order to both delineate the extent of reverse ESA/RSA overlaps and examine processes specific to each phase, we examined encoding and retrieval activity across several fMRI memory studies encompassing a range of stimuli (pictures, words, objects, etc.). In addition to finding flip activity in posterior midline and VPC, phase-specific comparisons revealed that reverse ESA profiles were relatively uniform across studies while RSA was more variable. Reverse ESA contrasts also indicated stronger activation in right parietal and dorsal midline regions whereas RSA activity was stronger in left parietal and ventral midline areas. These findings dem-

onstrate the robust nature of encoding/retrieval overlaps but also suggest the operation of distinct phase-related processes. Exploring such processes may reveal similarities in the disruption of attention-reliant encoding processes and variability in retrieval activity influenced by stimulus- or strategic-specific processing.

G27

AN FMRI STUDY OF AUTOBIOGRAPHICAL EMOTIONAL MEMORY RETRIEVAL IN CHILDREN Stephan Hamann[1], Thanujeni Pathman[1], Cory Inman[1], Carolina Campanella[1], Priscilla Sansouci[1], Robyn Fivush[1], Patricia Bauer[1]; [1]Emory University — Autobiographical memory (AM), episodic memory for significant life events, is a critically important form of memory that undergoes substantial developmental changes from childhood to adulthood. However, relatively little is known regarding the functional neural correlates of AM retrieval in children as assessed with FMRI, and how these may differ from adult patterns. We investigated AM retrieval with FMRI in 14 children ages 7-12, contrasting retrieval among three types of AMs (affectively positive, negative, and neutral) and a semantic memory retrieval control. Subjects identified and extensively described target AMs prior to scanning and Galton-method two-word cues were created to cue later AM retrieval during scanning, with postscan verification. AM retrieval was elicited by cue presentation (16 s; button-press upon retrieval, followed by rest (12 s); semantic trials had the same structure but involved verifying semantic properties. AM retrieval activated key regions identified in adults during AM retrieval, including medial prefrontal, posterior cingulate/retrosplenial cortex and hippocampal/parahippocampal regions, and these regions were more active relative to the semantic control condition. Emotional AM elicited activation in additional regions linked to emotional AM retrieval in adults including the amygdala, insula, and prefrontal regions, and activation patterns differed substantially between positive and negative AMs. These findings are the first to characterize regional brain activations during AM retrieval in children and to contrast positive and negative emotional AM retrieval, and highlight basic similarities in regions activated during AM retrieval and previous adult studies. Ongoing work will characterize adult performance on these AM tasks to identify age-related differences.

G28

EXPERIENCE-RELATED EYE MOVEMENTS REFLECT DECLARATIVE MEMORY FOR EMOTIONAL AND NEUTRAL PICTURES Cory Inman[1], Stephan Hamann[1]; [1]Emory University — Considerable evidence suggests that increased arousal as elicited by an emotional stimulus is related to narrower attention and enhanced recollection of the stimulus. Using eye tracking, a previous study found that attention was narrower for subsequently recollected items relative to familiar items, independent of emotional arousal. Our study examined whether attentional resources are differentially distributed during encoding and retrieval as a function of emotion arousal, valence, and subsequent memory. Eye tracking measures were recorded while participants encoded and later retrieved positive, negative, and neutral pictures in a free recall task and a remember/know recognition task. In contrast to the earlier report, we found that increased clustering at encoding predicted successful subsequent recognition for recollected items, but only for emotionally negative pictures that were highly arousing. Salient features of highly arousing negative pictures may more strongly capture attention during encoding, which allows for rich cognitive elaboration and successful encoding of the stimulus. We also found that during recognition, eye fixations were more clustered for 'remembered' relative to 'known' pictures, especially negative remembered pictures. This finding suggests that during recognition, recollection may be prompted by enhanced memory for the salient features of previously seen negative photos. Freely recalled items were associated with more clustered attention relative to items that were not freely recalled, independent of emotional valence or arousal. Our findings differ from the previous study's findings. Our findings suggest that visual attention during encoding and retrieval reliably reflect emotion, subsequent recall, and the subjective experience that accompanies recognition of a stimulus.

G29

EXAMINING THE EFFECTS OF POST-LEARNING SLEEP ON CONSOLIDATION OF ASSOCIATIVE EMOTIONAL DECLARATIVE MEMORIES Carolina Campanella[1], Stephan Hamann[1]; [1]Emory University — Binding different attributes of an event together and maintaining these associations is an essential function of episodic memory. Previous studies suggest sleep plays a key role in strengthening these associations, and this facilitation may be greater for emotionally salient stimuli than for emotionally neutral stimuli. However, it remains unclear whether post-learning sleep preferentially boosts emotional associations relative to neutral associations, in a similar way that it boosts memory for emotional single items. Using a cued-recall task, we examined whether sleep preferentially enhanced memory for emotionally negative vs. neutral verbal associates. Semantically unrelated word pairs were constructed by pairing a neutral cue word and a target word (either negatively arousing or neutral). Participants studied a list of 90 word pairs (45 neutral, 45 negative) and were instructed to attempt to form associations between the two words of each pair. The study phase was repeated once to increase levels of learning. Following a 12-hour break filled with either a period of sleep or wakefulness, participants were given a surprise cued-recall test for all previously presented pairs. As with previous studies, sleep enhanced cued recall for all pairs. However, the effect of sleep was equivalent for negative and neutral pairs, rather than disproportionately enhancing memory for negative pairs. Our results suggest the enhancing effect of sleep on paired-associate cued recall is independent of the emotional arousal of target items. These results contrast with previous findings and indicate the effects of sleep on memory for emotional material can differ substantially across different memory tasks.

G30

FALSE RECOGNITION, RETRIEVAL FAILURE, AND ATTENTIONAL PROCESSES DURING EPISODIC MEMORY RETRIEVAL Scott A. Guerin[1], Clifford A. Robbins[1], Adrian W. Gilmore[2], Daniel L. Schacter[1]; [1]Harvard University, [2]Washington University, St. Louis, MO — People often falsely recognize objects that are similar to items they have encountered recently, a form a gist-based memory distortion. However, people can retain detailed information about recently encountered objects. Thus, it is possible that people retain specific details but do not utilize them when memory illusions occur. We created a paradigm that encouraged subjects to attend to the perceptual features that distinguish targets from related distracters. On each trial of the recognition test, an array of three objects was presented; two of them were related to each other. FMRI scanning was conducted during recognition testing. Subjects selected one of the items as "old" or rejected all items as "new". When a related distracter was presented with two unrelated items, false recognition rates were high (41%). However, when the related distracter was presented alongside its associated target, false recognition rates fell to baseline levels (12%), suggesting that the details are accessible under appropriate conditions. Performance during this latter condition was associated with increased activity in the dorsal attention network and ventral visual cortex. Eye tracking data revealed that participants in this condition systematically compared the two related items, but also showed that the patterns of brain activation could not be attributed to differential eye movement patterns across conditions. Collectively, these findings suggest that suppression of false recognition involves an iterative interaction between attention and episodic memory: retrieval guides the deployment of visuospatial attention to mnemonically relevant details, which in turn improves the retrieval of diagnostic information from memory.

G31

TWO WAYS OF ACCESSING THE PERSONAL PAST: AN FMRI STUDY EXAMINING THE FUNCTIONAL CONNECTIVITY OF THE HIPPOCAMPUS DURING AUTOBIOGRAPHICAL MEMORY RETRIEVAL

Peggy L. St. Jacques[1], Martin Conway[2], Matthew W. Lowder[1], Roberto Cabeza[1]; [1]Duke University, [2]University of Leeds

— Autobiographical memories (AMs) are typically elicited using either verbal (i.e., event descriptions) or visual stimuli (i.e., photographs), but the effects of these cues on the neural mechanisms supporting memory retrieval are not well understood. The present study compared the functional connections among the regions supporting the rich experience of the personal past elicited via verbal descriptions or visual images. We used a novel camera technology, which employs a sensor and timer to automatically take hundreds of photographs when worn, in order to generate personal photographs to elicit AMs and compared this to memories retrieved via event descriptions taken from logs of daily events that participants recorded. Following AM retrieval, online ratings of subjective recollection, or reliving, were acquired on each trial during functional MRI scanning to identify a common functional region of interest in the hippocampus that was used in subsequent functional connectivity analysis. Given the central importance of visual imagery in AM, we predicted that visual images would foster integration among the brain regions supporting memory retrieval. Consistent with this prediction, the results indicated that AMs elicited using visual versus verbal cues involved greater co-activation among the hippocampus and three critical regions of the retrieval network: 1) lateral prefrontal cortex (PFC) regions involved in retrieval control, 2) medial PFC associated with self-referential processing, and 3) ventral parietal cortex linked to bottom-up attention processes. In sum, these results suggest that visual images augment the recollection of autobiographical experiences by strengthening the functional connections among the retrieval network.

G32

IDENTIFYING THE COMPONENT PROCESSES OF MENTAL SIMULATION: EVIDENCE FROM REPETITION-RELATED DECREASES IN THE BOLD RESPONSE

Karl Szpunar[1], Gagan Wig[2], Peggy St. Jacques[1], Cliff Robbins[1], Daniel Schacter[1]; [1]Harvard University, [2]Washington University in St. Louis

— In recent years, cognitive neuroscientists have demonstrated that a core network of brain regions involved in remembering past events is also involved in simulating possible future events. However, it remains unclear what processes are subserved by specific regions within this network. The purpose of the present study was to investigate what regions are involved in processing familiar locations and objects during mental simulation, as indexed by repetition-related decreases in BOLD activity. Using event-related fMRI, subjects were presented with a series of location-object-action (l-o-a) pairings that required them to simulate being in familiar locations, performing given actions with given objects. Subjects first completed "study" sessions during which they simulated a subset of l-o-a pairings two times (in random order). Subjects then completed "test" sessions during which they simulated additional l-o-a pairings that were either systematically related or unrelated to the l-o-a pairings from the study sessions. To ascertain what regions exhibit sensitivity to processing familiar locations and objects during simulation, the BOLD responses associated with new l-o-a pairings were respectively contrasted against: (1) l-o-a pairings in which the location was once again repeated from the study sessions (but paired with a new action-object pair) and (2) l-o-a pairings in which the object-action pair was once again repeated from the study sessions (but paired with a new location). Preliminary results suggest that, in the context of mental simulation, distinct regions are responsible for processing familiar locations (left anterior prefrontal and left posterior parietal cortex) and objects (anterior and lateral temporal cortex).

G33

WHITE MATTER CORRELATES OF EPISODIC MEMORY AND CONFABULATIONS IN ALZHEIMER'S DISEASE

Eve Attali[1], Michel Thiebaut de Schotten[1], Gianfranco Dalla Barba[1,2]; [1]Institut du Cerveau et de la Moelle Epinière. INSERM U975 Paris, [2]Università degli studi di Trieste

— Patients with Alzheimer's disease (AD) not only have great difficulty retrieving memories but also suffer from memory distorsions like confabulation. Impaired episodic memory in AD results from the dysfunction of an integrated limbic-diencephalic network and involves both gray and white matter (WM) pathologies. The neural substrates of confabulation still remain unknown. Our study aims to determine the contribution of WM changes to episodic memory impairments in patients with AD and more particularly neural correlates of the production of confabulation. Twelve AD patients and 12 normal controls (NC) participated in the study. All participants received a clinical examination, a large neuropsychological testing battery including the Confabulation battery, and an imaging protocol including structural Magnetic Resonance Imaging (MRI) and Diffusion Tensor Imaging (DTI). Fractional anisotropy (FA) and Mean Diffusivity (MD) were mesured at different locations of white matter using ROI-based analysis and were correlated with neuropsychological tests score. Results show a significant group effect on neuropsychological tests score and on DTI measures. Compared with NC, AD patients had increased MD and reduced FA in widespread brain regions, most notably in frontal and temporal lobes, cingulum, corpus callosum, fornix and uncinate fasciculus. Moreover, we found a significant correlation between episodic memory scores and MD of the cingulum and fornix. Confabulations were associated with DTI measures of the uncinate fasciculus. Our results are consistent with previous studies underlying the role of hippocampal circuitry in episodic memory but also reveal a probable correlation between the production of confabulation and the WM tracts downstream the hippocampus.

G34

CAUSAL RELATIONSHIP BETWEEN SIMULATED DISSOCIATION DURING ENCODING OF AUTOBIOGRAPHICAL-LIKE MEMORY AND DISTURBED EPISODIC RETRIEVAL

Loretxu Bergouignan[1], Lars Nyberg[2], Henrik Ehrsson[1]; [1]Karolinska Institutet, [2]Umeå University

— Until now only animal studies have properly controlled the encoding processes of episodic-like memories. But episodic memory is based on the subjective level of the retrieval, which can only be assessed in humans. Here we demonstrate that the human brain can use two fundamentally different encoding processes for autobiographical-like memory. We used a perceptual illusion to simulate the experience of being out-side one's body ('out-of-body-illusion'; Ehrsson Science 2007, 317:1048) which is common in post-traumatic stress disorder (PTSD) with dissociation symptom (encoding in third person perspective, E3PP). We compared encoding from this illusory E3PP perspective in healthy participants with encoding from the first person perspective (E1PP). During these states the participants took part in life-like realistic role-playing scenarios with a professional actor. In experiment 1 the retrieval session was a Remember/Know paradigm assessed one week later. The E3PP induced significantly less episodic retrieval than the E1PP. In experiment 2 we compared brain activity during retrieval of these memories encoded in E3PP or E1PP (fMRI). There was a significant difference during retrieval on in one unique region: the left posterior hippocampus. This study demonstrates, for the first time, that the first person perspective is essential for normal memory encoding. Further, the human brain can use two different encoding processes for autobiographical-like memories depending on the perspective, but these rely on different hippocampus-mechanisms during retrieval. The observed causal relationship between the simulated dissociation and disturbed episodic retrieval is a crucial step to understand the labile trauma memory of PTSD.

G35

ITEM/SOURCE MEMORY PERFORMANCE OF SCHIZOPHRENIA PATIENTS IN 3D VIRTUAL ENVIRONMENTS: AN EVENT-RELATED POTENTIAL STUDY JiWoon Jeong[1], Seung-Hwan Lee[2], Hyun-Jung Han[1], Hyun Taek Kim[1]; [1]Korea University, [2]Inje University College of Medicine — Recent studies have demonstrated that schizophrenia with hallucination can be associated with source memory deficits. The present study investigated the item/source memory performance of schizophrenia patients in 3D virtual environments, which is a useful means to assess memory of the spatial context of an event. Twenty schizophrenia patients (10 with auditory hallucination and 10 without hallucination, respectively) and fourteen healthy controls were subjected to an encoding session in which they navigated four different places equipped with sixty 3D objects. After the encoding session, the event-related potentials (ERPs) were recorded during item/source recognition memory tests for previously studied objects. For correctly recognized item/sources, posterior old/new effects were observed (~300-600ms) in all three separate groups. Frontal positivity (~200-500ms) was evident in normal control group but not in the other two schizophrenia groups. Importantly, occipital positivity (~900-1100ms) was observed in the both the normal control group and the schizophrenia without hallucination group. These results suggest two possibilities. First, that the latter two ERP components reflect source memory deficits in schizophrenia patients. Second, the occipital positivity is correlated with source memory deficits caused by hallucination.

G36

DESTABILIZED PREDICTION AFTER RARE BREACHES OF EXPECTANCY Anne B. Kühn[1], Ricarda I. Schubotz[1,2]; [1]Max Planck Institute for Neurological Research, Cologne, Germany, [2]Westfälische Wilhelms-Universität, Münster, Germany — We are used to well-experienced and rarely altered perceptual events like songs or movies. While forward models provide a theoretical framework for prediction of such events and how we detect breaches of expectation, imaging studies have attributed the prediction of sequences to premotor cortices and the detection of breaches and its immediate effects to the anterior cingulate and the lateral prefrontal cortex. For the first time, the present fMRI study explored remote effects after rare breaches of expectancy. Destabilization of prediction was hypothesized to be reflected either by an attenuation of long-term memory related areas like the hippocampus, or by an increase of lateral fronto-parietal areas related to the encoding of current stimuli. Subjects monitored a repeatedly presented digit sequence and were asked to indicate occasional sequential omissions. Destabilization of prediction was expected to be revealed by contrasting stimuli whose equivalent was omitted in the preceding sequential run (destabilized events) with stimuli without such history (non-destabilized events). Remote destabilization of prediction was reflected by attenuation of activity in the medial Brodmann Area 9 bilaterally. Moreover, activation of the same area, the retrosplenial area, and the left parahippocampal gyrus were enhanced by contrasting predicted events with breaches of expectancy. The decrease of dorsal frontomedian activation in destabilized events may be interpreted as a top-down modulation on perception causing a less expectation-restricted encoding of the current stimulus, enabling the adaptation of prediction in the long run.

G37

TWO MECHANISMS OF VOLUNTARY MEMORY SUPPRESSION Roland G Benoit[1], Justin C Hulbert[1], Michael C Anderson[1]; [1]Medical Research Council UK — When confronted with an unwelcome reminder of a past event, people often attempt to prevent the event from coming to mind. Previous research has shown that repeatedly preventing retrieval of an unwanted memory leads to forgetting of the avoided memory item (Anderson & Green, Nature, 2001). Neuroimaging evidence implicates extensive, bilateral aspects of lateral prefrontal cortex in mediating such memory suppression (Anderson et al., Science, 2004; Depue et al., Science, 2007). However, these studies did not examine the exact mechanism supported by different prefrontal subregions. The present functional magnetic resonance imaging study employed a between-subject design to elucidate the neural correlates of two potential mechanisms: 'thought substitution' (i.e., retrieving an alternative thought to distract from the unwanted memory) and 'direct suppression' of the unwanted item. Though both mechanisms led to forgetting of the suppressed items compared to a baseline condition, they were supported by partly separable prefrontal subregions. The results thus suggest that voluntary memory suppression can be mediated by two distinct neuro-cognitive mechanisms.

G38

SOURCE MEMORY CAN BE IMPAIRED BY ANODAL TRANSCRANIAL DIRECT CURRENT STIMULATION OVER THE LEFT PARIETAL CORTEX Shih-kuen Cheng[1], Nei-Feng Chen[1], Chi-Hung Juan[1], Daisy L. Hung[1], Ovid J.-L. Tzeng[1,2]; [1]Institute of Cognitive Neuroscience, National Central University, Taiwan, [2]Institute of Linguistics, Academia Sinica, Taiwan — Recent neuroimaging studies of episodic-memory retrieval frequently reported activations in the left posterior parietal (LPP) cortex. Various interpretations have been raised to construe the contributions of this region to memory retrieval, yet very few studies investigate whether the involvement of the LPP is necessary for memory retrieval, and how memory would be affected if neural activities in the LPP is facilitated or interfered. In this study we used transcranical direct current stimulation (tDCS) to probe the LPP's functional role in memory retrieval. Four blocks of source memory tests were conducted on separate days. At study, participants were presented with concrete nouns shown in green or blue color. At test, participants made old/new and source judgments to studied and unstudied items. Between the study and test phases of the four blocks, participants received either sham, anodal, cathodal, or no tDCS over the left parietal cortex (P3 site of the 10-20 system) for 10 minutes. The results showed that the old/new recognition performance was statistically equivalent for the four conditions. The analysis of source memory performance, however, yielded an intriguing pattern when the gender of the participants was taken into account. For male participants, no tDCS effects were found on the source memory performance. For female participants, a worse source memory performance was observed when anodal tDCS was applied. It is not clear why there was a gender difference on the tDCS effect yet the current finding did provide evidence that source memory could be modulated by stimulating the left parietal cortex.

G39

GLUCOSE MODULATES EVENT-RELATED POTENTIAL COMPONENTS OF RECOLLECTION AND FAMILIARITY IN HEALTHY ADOLESCENTS Michael Smith[1], Leigh Riby[1], Sandra Sünram-Lea[2], Anke van Eekelen[3], Jonathan Foster[3,4,5]; [1]Northumbria University, [2]Lancaster University, [3]Telethon Institute for Child Health Research, [4]Curtin University, [5]University of Western Australia — Behavioural evidence supports the notion that glucose ingestion enhances recognition memory judgements based on recollection, but not familiarity. This study sought to clarify and extend upon these behavioural findings by investigating the influence of glucose administration on event-related potential (ERP) components that are thought to be differentially mediated by recollection and familiarity processes in healthy adolescents. Retrieval ERP effects of interest were the left parietal old/new effect (recollection) and mid-frontal old new effect (familiarity), while we were also interested to investigate subsequent memory effects, including a left frontal slow wave effect (recollection), and a left inferior-temporal N400-like effect (familiarity). In a within subjects design, participants performed a recognition memory task, during which time EEG was recorded, subsequent to ingestion of either a) glucose, or b) placebo in a counterbalanced order. Response times during the recognition memory task were observed to be faster for the glucose condition, relative to placebo. Further, glucose ingestion was associated with enhanced ERP effects of both 'recollection' and 'familiarity', relative to placebo. These findings suggest that glucose enhances both the recollection and familiarity components of recognition memory. The

observed ERP profile has implications for the proposal that glucose specifically targets the hippocampus in modulating cognitive performance.

G40

ELECTRICALLY ENHANCING MEMORY CONSOLIDATION DURING SLEEP: A NOVEL METHOD FOR MODERATING AGE-RELATED MEMORY DECLINE Carmen E Westerberg[1], Susan M Florczak[1], Sandra Weintraub[1], Lisa Marshall[2], M-Marsel Mesulam[1], Phyllis C Zee[1], Ken A Paller[1]; [1]Northwestern University, [2]University of Lübeck — Our ability to remember previously experienced episodes and facts depends on neural plasticity at learning and on further memory stabilization during the time between initial learning and retrieval. One likely mechanism for memory stabilization involves the strengthening of connections among cortical subcomponents initially linked via the hippocampus. This process of consolidation may be advanced through intentional memory rehearsal as well as through slow-wave activity during sleep. Slow-wave sleep is reduced in aging, possibly contributing to age-related memory decline. We investigated whether a memory improvement can be achieved in older adults through transcranial slow-oscillatory stimulation during sleep. We adopted procedures for passing a low-frequency current through scalp electrodes during sleep, which modestly improved memory in young adults (Marshall et al., 2004, 2006). On two afternoons separated by one week, healthy 65- to 80-year-olds took a 90-min nap while electroencephalographic activity was monitored. Word-paired-associate recall was assessed just prior to and shortly after each nap, one of which also included a 30-min stimulation period during non-REM sleep. Comparing post-nap to pre-nap recall yielded a memory improvement measure. We observed a greater memory improvement with stimulation compared to without stimulation in 70% of participants (mean 10% larger improvement for N=10). Slow-wave activity and other physiological sleep measures provided additional data on possible mechanisms of sleep-related memory improvement. These results provide novel insights regarding the role of sleep in memory consolidation and memory decline, and may be of further value for designing treatments aimed at improving memory function in individuals with memory deficits.

G41

HIGH-RESOLUTION FMRI MEASUREMENTS OF HIPPOCAMPAL AND MEDIAL TEMPORAL LOBE SUBREGION INTERACTIONS DURING EPISODIC MEMORY FORMATION AND RETRIEVAL. Katherine Duncan[1], Lila Davachi[1,2]; [1]Department of Psychology, New York University, [2]Center for Neuroscience, New York University — Although it is well established that the medial temporal lobe (MTL) is involved in both the formation and retrieval of episodic memories, how MTL subregions support these different processes is still poorly understood. To date, the majority of research in this area has focused on identifying which MTL subregions display memory-related responses during either encoding or retrieval tasks. Although some studies have found that individual regions are differentially involved in encoding or retrieval (Eldridge et al., 2005; Preston et al., 2010), these dissociations have not been consistent across studies. As an alternative approach, we measured how responses across MTL subregions correlate differentially during periods of encoding and retrieval using high-resolution fMRI (1.5 x 1.5 x 3mm voxels). During functional scans, participants performed a series of tasks, each with similar trial-timing and response options. First, subjects performed an arithmetic task that served as a baseline measure of inter-region correlation during a task with no explicit episodic memory demands. Next, participants performed 4 cycles of an associative encoding task, an intervening arithmetic task, and an associative recall task. Time-courses were extracted from the individual subregions of the hippocampus and MTL cortex and measures of inter-regional correlations were calculated separately for each of the tasks. Recall accuracy was high, indicating that participants were successfully encoding and retrieving memories. Preliminary analysis of the imaging data provides evidence for reliable MTL inter-regional correlations. Moreover, the results suggest that these correlations are, indeed, modulated by the task (encoding, retrieval, and arithmetic) performed.

G42

A CONTEXTUAL SOURCE MEMORY EFFECT FOR OBJECTS IN THE PERIRHINAL CORTEX Hilary Watson[1,2], Edward Wilding[1], Kim Graham[1]; [1]Wales Institute of Cognitive Neuroscience, School of Psychology, Cardiff University, UK, [2]Department of Experimental Psychology, Oxford University, UK — One account of the role of the medial temporal lobe (MTL) in recognition memory is that the perirhinal cortex (PrC) processes item information, the parahippocampal cortex (PHC) context information, and the hippocampus (HC) binds items with their contexts (Diana et al, 2007). Another view highlights the distinct contribution of these regions to memory for different types of visual stimuli, independently of item and context (Graham et al., 2010). To investigate the neural correlates of item and context memory encoding for pictures of everyday objects, participants studied objects in one of two encoding tasks in the MRI scanner. Outside of the scanner they then made item (old vs. new) and context (encoding task) memory judgements to previously seen and novel objects. An orthogonal functional localiser task was used to identify voxels sensitive to processing objects (intact objects > scrambled objects) within PrC, PHC, and HC. Activity in the voxels identified by the functional localiser was separated according to performance on the memory test to investigate which MTL regions predicted accurate item and context memory judgements for objects. No memory effects for objects were detected in the HC object-sensitive voxels. Activity within the left PrC, however, predicted context memory for the objects, with greater activity for trials that were later identified in the correct study context versus those that were not. These data argue against accounts that ascribe the sole function of the perirhinal cortex to processing item-based mnemonic information.

G43

DISTINCT MECHANISMS FOR ASSOCIATIVE AND ITEM MEMORY OVER TIME Xiaoya Du[1], Jiongjiong Yang[1]; [1]Peking University — Studies have shown that compared to item memory, associative memory elicits stronger activation in the hippocampus when tested at a short interval after study. However, little is known whether remote item and associative memory differ in their neural mechanisms over time. To address the issue, a behavioral experiment was first conducted to observe the forgetting rates of the two kinds of memory after 10 min, 1 day, 1 week and 1 month. Item memory began to decrease rapidly after 1 day, whereas associative memory was well reserved till 1 week later. The difference could be attributed to the predominant contribution of recollection process to associative memory. The following functional magnetic resonance imaging (fMRI) design was used to further examine the brain activation for associative and item memory. Learning conditions were adjusted to yield comparable memory performance in different time points and between item/associative memory. Activity in the hippocampus gradually decreased from 40 min to 1 month for item test; but it kept relatively constant across time for association test. In particular, although the activity of the hippocampus was comparable between item and association tests after 40 min, its activation was significantly stronger for associative memory than for item memory after 1 day ,1 week and 1 month. In addition, the parahippocampal gyrus also elicited stronger activity for associative memory than item memory after 1 month. These fMRI data was consistent with the behavioral results, and suggested that associative memory relies on distinct cognitive and neural mechanism from item memory.

G44

THE NEUROLOGICAL COMPONENTS OF METACOGNITIVE MONITORING: ITEM DIFFICULTY AND MONITORING ACCURACY Sara Haber Halcomb[1], Jessica M. Logan[1], A. Cris Hamilton[1]; [1]Rice University — Traditional memory research evaluates memory accuracy (encoding success); however, predicting memory (monitoring accuracy) is a critical component to learning new material, as individuals can allocate their cognitive resources

depending on the assessment of their future performance. The current study investigated neural correlates of monitoring accuracy and how they are related to structures historically associated with encoding success (e.g., hippocampus). To evaluate monitoring, subjects provided Judgments of Learning (JOLs), in which they predicted their future memory performance during encoding. Twelve young adults provided a JOL response ("will remember" or "will forget") for 150 intact (easy) and 150 scrambled (difficult) visual scenes while in a 3.0 T scanner. We hypothesized that areas associated with monitoring accuracy would recruit regions separate from traditional areas associated with encoding success. Predictive judgments and actual memory performance were compared and subsequent neural activation was independently explored for memory accuracy and monitoring accuracy. Areas in the hippocampus, bilateral superior temporal gyrus, and left medial temporal lobe (MTL) were associated with encoding success. Monitoring accuracy recruited some overlapping areas; however, it was also associated with regions that are related to self awareness (bilateral cuneus, bilateral precuneus and right superior frontal gyrus). These findings provided a more complete account of monitoring accuracy, and should be explored further to disambiguate monitoring as a unique contributor to performance.

G45

AGE-RELATED NEURAL DIFFERENCES IN RELATIONAL BINDING ACROSS TIME Lily Riggs[1,2], Douglas Mcquiggan[1], Esther Oziel[1], Steve Ly[1], Timothy Bardouille[3], Jennifer Ryan[1,2]; [1]Rotman Research Institute, [2]University of Toronto, [3]NRC Institute for Biodiagnostics — Differences underlying the construction of, and subsequent access to, representations regarding the relative spatial relations among sequentially presented objects were examined using magnetoencephalography (MEG) for younger (M=25.3 years) and older adults (M=62.5 years). Participants were presented with a series of single objects. Subsequently, a test display revealed the objects simultaneously and participants judged whether the relative relations were maintained. Accuracy was approximately 85.3% for intact displays and 76.1% for manipulated displays, and did not differ significantly between younger and older adults. MEG results revealed activity in posterior visual regions within the first 200 ms after stimulus onset. Activity within the precuneus and middle frontal gyrus was found within 170-300 ms after stimulus onset. Examination of contrast maps between younger and older participants revealed that compared to younger adults, older adults showed stronger neural activity in the hippocampus, the superior temporal gyrus, and the anterior cingulate gyrus. In contrast, younger adults showed stronger neural activity in posterior cortices such as the lingual gyrus and cuneus. This suggests that younger and older adults may adopt different strategies in which to bind spatial relations across time in order to achieve comparable performance. Specifically, while younger adults may maintain the visual information active in the posterior sensory cortices, older adults may rely more on a hippocampal-frontal system, possibly as a compensatory response.

G46

AGE-RELATED EYE MOVEMENT DIFFERENCES IN RELATIONAL BINDING ACROSS TIME. Douglas McQuiggan[1], Rachel Bloom[1], Christina Villate[1], Lily Riggs[1,2], Jennifer Ryan[1,2]; [1]Rotman Research Institute, [2]University of Toronto — Age-related differences in the construction of, and subsequent access to, relative spatial relations among objects were investigated using eye movement monitoring (EMM) for older (M=73.13 years) and younger adults (M=24.94 years). During the study phase, participants were presented with a series of single objects. Subsequently, a test screen displayed all of the objects simultaneously and participants judged whether the relative relations were maintained. Accuracy was lower for older (intact M = 81%, manipulated M= 75%) versus younger adults (intact M= 90%, manipulated M = 87%). EMM revealed age-related differences in viewing during the study and test phase. When the third and final object was presented during the study phase, younger participants not only directed viewing to the object itself, but also to the empty locations which had been previously occupied by objects 1 and 2; this pattern was reduced in older adults. During viewing of the test displays, younger adults directed increased viewing to the manipulated region compared to the same region of intact displays. This pattern of viewing was absent among older adults. These findings suggest that eye movements are used to construct and integrate information across time (Ryan & Villate, 2009). The observed age-related differences in accuracy and eye movement behaviour may reflect age-related declines in one's ability to bind information across time, possibly as a consequence of declines in hippocampal function (Ryan et al., CNS abstract submission 2011). Alternatively, such age-related differences may reflect the use of different strategies to support performance on the task.

G47

THE CRITICAL ROLE OF THE HIPPOCAMPUS IN RELATIONAL BINDING ACROSS TIME. Jennifer Ryan[1], Douglas Mcquiggan[1], Rachel Bloom[1], Christina Villate[1], Lily Riggs[1], R. Shayna Rosenbaum[1,2]; [1]Rotman Research Institute, [2]York University — The effect of the hippocampus on the construction of, and subsequent access to, relative spatial and temporal relations among objects was investigated using eye movement monitoring (EMM) in one session with a developmental amnesic patient HC (22 years), and in three sessions with patient DA who developed amnesia as a result of herpes encephalitis (56 years at time of testing), and their age-matched controls. During the study phase, participants were presented with a series of single objects, each in a unique location. Subsequently, a test screen displayed the objects simultaneously and the participants judged whether the relative relations were maintained. Accuracy for HC was near 100% for intact and manipulated trials and was not different from controls; accuracy for DA was 100% for intact trials in each session, and varied from 50-100% for manipulated trials across sessions. During the study phase, control participants directed eye movements towards not only the presented object, but also to the empty locations that had been previously occupied by other study objects. This viewing pattern was greatly reduced in HC and DA. This dissociation between eye movements and explicit memory suggests that the hippocampus is critical for the integration of information across time as indexed by eye movements, however, the hippocampus is not critical for successful performance on this task.

G48

SIMILARITY OF PATTERNS OF NEURAL ACTIVITY DURING PERCEPTION AND VIVID REMEMBERING OF SHORT MOVIE CLIPS Bradley Buchsbaum[1,2], Candice Fang[1,2], Sabrina Lemire-Rodger[1], Jeremy Young[1]; [1]Rotman Research Institute, Baycrest, [2]University of Toronto — The subjective essence of a rich and vivid memory is that it is a kind of imperfect revisitation of a past experience. This seeming similarity between a memory and the perceptual experience which it represents may occur because the very same neural structures that were active during perception are reactivated during memory . Insofar as memory captures something of the complex and multimodal aspect of perception, the cortical representations of memory should resemble the widely distributed patterns of activity elicited during perception. To test this hypothesis we used fMRI to scan subject (N=17) while they passively viewed a set of 12 9-s video clips, which were chosen to be maximally diverse in their subject matter. A subset of these subjects (N=8) then took part in a 6-8 week training regimen consisting of at least 18 1-hour sessions in which they practiced mentally recalling each of the 12 video clips. After training, subjects were scanned in three post-training sessions where they performed a task requiring them to vividly remember each of the video clips. Results showed that patterns of activation evoked during vivid remembering were highly similar to the corresponding patterns at perception. In addition, the multivariate similarity structure, as assessed with multidimensional scaling, among the activity patterns associated with each video were structurally similar across perception and memory. The findings show that perception and memory share an overlapping cortical representation, and that this representation is distributed and specific to the particular content matter of the remembered experiences.

G49

REPETITION-INDUCED CHANGES IN FACE VIEWING ARE NOT AFFECTED BY MANIPULATION OF FACE VIEWPOINT ACROSS REPETITIONS

Rosanna Olsen[1,2], Yunjo Lee[1,2], Cheryl Grady[1,2], Morris Moscovitch[1,2], Jennifer Ryan[1,2]; [1]Rotman Research Institute at Baycrest, [2]University of Toronto — When viewing recently repeated items (such as a face), eye fixations decrease as a function of repetition. These repetition-induced decreases are thought to index learning, as previous experiences with a given face provide a mnemonic trace that facilitates subsequent processing. We investigated whether small changes in viewpoint between repetitions (5-25 degree rotational shifts) affected the typical viewing decrease. We conducted two experiments to address this question. In Experiment 1, participants viewed 80 famous and 80 non-famous faces (for 4s) three times across three study blocks. In Experiment 2, 80 non-famous faces were viewed (for 4s) five times across five study blocks. In both studies, eye-movements were recorded with a head-mounted eye-tracker while participants made a gender judgment for each face. Half of the faces were displayed from the same viewpoint across repetitions (static viewpoint condition) and half of the faces were shown from different viewpoints across repetitions (alternating viewpoint condition). In both studies, participants showed the typical face repetition effect: fewer eye fixations were observed with each repetition. Interestingly, this effect was equivalent for faces that were presented in the static viewpoint condition and for those which were presented in the alternating viewpoint condition. These findings suggest that repetition-induced viewing patterns reflect at least a partially viewpoint independent representation in memory.

G50

A BRAIN SIGNATURE FOR FALSE RETRIEVAL? AN ERP STUDY

Giulio Pergola[1,2], Michele Trotta[3], Irene Daum[1,2], Boris Suchan[1,2]; [1]Ruhr-University Bochum, [2]International Graduate School of Neuroscience, Bochum, [3]Faculty of Psychology, Padua — Several data point to a role of right prefrontal cortex in retrieval monitoring (Schacter and Slotnick, 2004). It has been proposed that late frontal ERP components can distinguish false from true memories (Wiese and Daum, 2006; Curran et al., 2001; Goldmann et al., 2003). We employed pictorial stimuli in an associative memory task during an ERP recording session. Subjects learned associations between two pictures. Later on, single studied and unstudied items were shown and subjects performed an old/new assessment. After "old" responses subjects retrieved the associated picture using the picture shown as a cue. Cues were either ambiguous or unambiguous. Ambiguous cues were semantically linked to an item presented in another pair of the study list. Unambiguous cues had no semantically related pictures in the study list. The percentage of correct cued retrieval did not differ across conditions. ERPs of hits followed by correct ambiguous (Ha+) and false retrieval (Hf) differed from hits followed by no cued retrieval (H-) at right prefrontal sites [800-1000 ms]. ERPs did not differ between correct and incorrect retrieval. Ha+ and Hf share a higher cognitive demand: multiple memory traces are available - the encoded and the incorrect in case of false retrieval; the encoded and the semantically-related in case of ambiguous retrieval - and subjects perform a task-directed selection. The inconsistent evidences noted by Schacter and Slotnick may depend on different experimental designs. We suggest that the increased cognitive load during strategic retrieval suffices to account for late higher right frontal activity.

G51

HEMISPHERIC ASYMMETRIES IN THE PERCEPTUAL SPECIFICITY OF IMPLICIT AND EXPLICIT MEMORY ACCESS

Kristina Küper[1], Anna M. Arend[1], Hubert D. Zimmer[1]; [1]Saarland University, Saarbruecken, Germany — Explicit and implicit memory representations differ in their perceptual specificity. Changing perceptual features from study to test reduces old/new effects in explicit tasks but leaves repetition priming effects relatively unaffected. Using the visual half-field technique in an event-related potential (ERP) study, we examined how hemispheric asymmetries at the level of feature processing can affect these differences in perceptual specificity. In an incidental study phase, two subject groups performed a natural/artificial decision on centrally presented visual objects. At test, new objects, identical repetitions and different exemplars of study items were briefly presented in either the left or the right visual field. Participants in the implicit group again performed the study task whereas the explicit group was assigned a recognition memory task in which both identical repetitions and different exemplars had to be accepted as old (inclusion task). In the explicit task, reliable ERP old/new effects emerged for both types of old items when stimuli were presented to the left hemisphere. With right hemisphere presentation, however, only identical repetitions but not different exemplars gave rise to old/new effects. In contrast, ERP repetition priming effects in the implicit task were elicited only by identical repetitions, irrespective of presentation side. Our data thus corroborate a right hemisphere bias towards differentiating specific exemplars and indicate that the focus of left hemisphere processing can be subject to task demands. More importantly, hemispheric processing asymmetries proved to have a significant impact on the perceptual specificity of implicit and explicit memory access.

G52

BEING RELATED VS. BEING ASSOCIATED: IMPACT OF PROPERTIES OF SEMANTIC RELATIONS ON ASSOCIATIVE EPISODIC RECOGNITION

Olga Kukina[1,4], Xuchu Weng[2,4], Jiongjiong Yang[3,4], Axel Mecklinger[1,4]; [1]Saarland University, Saarbrücken, Germany, [2]Hangzhou Normal University, Hangzhou, China, [3]Peking University, Beijing, China, [4]International Research Training Group — Previous research showed that presence of a semantic link between to-be-remembered items affects episodic associative recognition. Unrelated word pairs are retrieved on the basis of recollection, a slow threshold mnemonic process typically found in associative recognition tests and thought to lead to retrieval of detailed item-in-context information. In contrast, semantically related pairs are can also be recognized on the basis of familiarity, a relatively automatic strength-like mnemonic process typically involved in retrieval of single item information. Using event-related potentials (ERP), we examine whether different types of semantic relations, i.e., categorical, where items are characterized by a high-feature overlap (e.g., dancer- singer), and thematic, where items are associated but do not share many common semantic features (e.g., dancer- stage), differentially affect mechanisms involved in associative recognition in German participants. Results suggest that the two types of semantic relations indeed differentially affect processes driving associative recognition. Successful recognition of categorical pairs seems to necessitate the involvement of recollection while familiarity appears to be more diagnostic in the retrieval of thematic relations. To investigate whether the observed pattern of results can be further generalized to the speakers of languages other than German and, thus, be regarded as language/culture-independent, we ran a mirror experiment with Chinese participants. The data indicates that the results of the two experiments are largely comparable, and suggests that underlying semantic structure has a similar impact on mnemonic processes engaged in episodic retrieval for the speakers of both languages.

G53

INFLUENCES OF PREDICTIVE PROCESSING ON MEMORY ERRORS

Laura Matzen[1], Kara D. Federmeier[2]; [1]Sandia National Laboratories, [2]University of Illinois at Urbana-Chamapaign — The event-related potential (ERP) difference related to subsequent memory performance, the Dm effect, is a robust but poorly understood effect. The Dm effect suggests that differences in brain activity during encoding can be predictive of later memory performance. In the present study, we investigate the relationship between brain activity at study and subsequent memory errors and compare that relationship to the typical Dm effect. Participants studied pairs of adjectives and nouns and were later tested on old pairs, pairs in which the noun was replaced by a synonym (semantic lures), recombined pairs (conjunction lures), and new items. Brain activity recorded

during the study phase of the experiment was backsorted based on subsequent memory (for old items) or subsequent memory errors (for the parent items of lures). The results revealed Dm-like ERP effects that were related to subsequent memory errors. Brain activity recorded during the test phase of the experiment showed that participants were likely to predict the noun that they would see next when they were presented with the adjective in a tested word pair. This predictive processing was also related to the participants' susceptibility to the lures. In both the study and test phases, brain activity associated with memory errors differed for the semantic and conjunction lures.

G54

TRIPARTITE FUNCTIONAL ANATOMY OF EPISODIC MEMORY RETRIEVAL Sze Chai Kwok[1], Emiliano Macaluso[1]; [1]Santa Lucia Foundation, Rome — Episodic memory provides information about the 'when' of events as well as 'what' and 'where' they happened. We investigated this tripartite model of episodic memory using fMRI. Subjects watched a 45-min TV episode (encoding, unscanned) and, 24 hours later, made discriminative choices of scenes from the clip during fMRI (retrieval). The subject was presented with two scenes and was required to either choose the scene that happened earlier in the film (temporal task), or the scene with a correct spatial arrangement (spatial task), or the scene that had been shown (object task). We identified a retrieval network comprising posterior and superior parietal cortex, precuneus, middle frontal and medial temporal areas. Direct comparisons between conditions exhibited dissociations in the functional anatomy within the same experience. The precuneus and the right parallel sulcus associated with retrieval of temporal order of events; and activity in the precuneus was modulated, in a negative correlational manner, by the temporal distance between events. We advocate the temporal task evoked a subjective, conscious self-percept experience during retrieval. Second, regions in the frontal and parietal cortices related to the recall of spatial information; the engagement of the superior parietal areas was highlighted with control analyses accounting for task difficulty and oculo-motor behaviour between conditions. Third, our data reflected the role of the anterior part of the hippocampus in object recognition after discounting spatio-temporal contexts. This experiment confirms the assumption of domain-specific anatomical dissociations and contributes to a tripartite content retrieval model.

G55

NEURAL REPRESENTATIONS OF EVIDENCE IN PERCEPTUAL AND MEMORY-BASED DECISIONS Alan Gordon[1], Roozbeh Kiani[1], William Newsome[1], Anthony Wagner[1]; [1]Stanford University — Electrophysiological and fMRI studies of non-human primates and humans demonstrate that lateral parietal and prefrontal cortices are associated with the integration of sensory information into decision variables that govern motor responses. Recent work suggests that in source memory judgments similar cortical areas track the integration of competing mnemonic signals into decision-variables. The present study employed multivariate pattern analysis of BOLD data to elucidate the extent to which the neural mechanisms of mnemonic decision-making resemble those of perceptual decision-making. In the perceptual task, human subjects viewed noisy images of faces and houses and, when ready, reported the category of the image and their confidence about the judgment. In the mnemonic task, subjects first learned associations between randomly chosen abstract nouns and images of specific faces and houses, and then, at test, reported their choice and confidence about the category of the image associated with each noun. A multi-voxel pattern classifier was trained with independent data to dissociate patterns of distributed BOLD activity associated with perception of faces and houses. This classifier was then presented with BOLD data from the two decision-making tasks, enabling quantitative measures of the degree to which perceptual and mnemonic evidence was present during each trial. Initial analyses demonstrate that estimates of neural evidence correlate with objective perceptual and mnemonic coherence, as well as subjective confidence reports.

G56

A DIFFERENTIATION ACCOUNT OF RECOGNITION MEMORY: STRENGTH-BASED MEMORY FOR FOIL EFFECTS FOUND IN PARIETAL CORTEX Amy H. Criss[1], Mark E. Wheeler[2], James L. McClelland[3]; [1]Syracuse University, [2]Washington University, [3]Stanford University — Differentiation models of recognition memory predict a strength based mirror effect (SBME) in the distributions of subjective memory strength. Subjective memory strength (e.g., familiarity) should increase for targets and simultaneously decrease for foils following a strong encoding list compared to a weak list. An alternative explanation for the SBME is that participants adopt a stricter criterion following a strong list than a weak list. Behavioral experiments support the differentiation account. Distributions for direct ratings of memory strength follow predictions of differentiation models, i.e., ratings are higher for targets and lower for foils following a strong list. Reaction time distributions analyzed with Ratcliff's diffusion model show greater rates of evidence accumulation (e.g., larger drift rates) for foils and targets following a strong list. The purpose of this study was to identify the neural bases for these differences. Encoding strength was manipulated (strong, weak) in a rapid event-related fMRI paradigm. At test, foils were presented in blocks containing strong or weak targets, allowing us to investigate the effect of retrieval context on foils. Subjects responded old/new with high or low confidence. Imaging analyses identified eight regions, four in the left parietal cortex and two in the right frontal cortex, in which activity increased faster for strong than weak foils. These effects were observed only when confidence was high. The results support a differentiation account of memory and indicate that the left parietal and right frontal lobes play a key role in evaluating evidence related to the memory decision, even for new items.

G57

EFFECTS OF CONTEXTUAL KNOWLEDGE ON PROCESSING OF PLACES AND FACES IN THE PARAHIPPOCAMPAL CORTEX: AN FMRI INVESTIGATION Ingrid Olson[1], Lars Ross[2]; [1]Temple University, [2]Albert Einstein College of Medicine — Portions of the parahippocampal cortex (PHC) have been suggested to play a specialized role in the encoding and processing of scenic stimuli. However, others have proposed that the fMRI activations in this region are due to contextual processing rather than spatial or scenic processing per se. In this study we assessed the influence of contextual knowledge on the engagement of the PHC and the retrosplenial complex (RC) to unfamiliar, familiar, and famous places and faces presumably differing substantially in associated contextual knowledge. We found that in the PHC the average BOLD response to places was significantly larger than to faces regardless of associated contextual knowledge. We observed a significant interaction between stimulus class and contextual knowledge in the RC. In an additional experiment we investigated the effect of contextual knowledge in previously unknown faces and places that was acquired in a preceding training session. Again, in both regions the BOLD response was significantly larger in response to place- than to face stimuli, but no effect of context was observed. These results confirm the role of the PHC in the processing of scenic stimuli but do not lend support for the notion that this engagement is due to the contextual richness of the stimuli.

G58

TRIPLE DISSOCIATION WITHIN THE MEDIAL TEMPORAL LOBE IN MEMORY FOR CONTEXT Yaakov Hoffman[1,2], Niv Reggev[1], Anat Maril[1]; [1]The Hebrew University of Jerusalem, [2]Bar-Ilan University — Recent studies of recognition have mapped context processing to the parahippocampus and item recognition to the perirhinal cortex. Context was typically addressed solely from the perspective of item memory. Here we applied a novel measure of memory for context itself, while ensuring that it was still cognitively processed incidentally at both study and test. Of interest were the questions: 1) Will the same activation for context be observed when memory for the context itself is measured and 2) Would a memory trace for the context be affected by target status? 18 subjects were asked at study to incidentally encode black target words (item) which were

superimposed on larger gray words (context) in composite stimuli. Participants were scanned during a subsequent recognition test where they were asked to make an old-new judgment on the black word. Test included four types of stimuli which were obtained by crossing the target-context dimension with old-new status. Memory for the context (old vs. new) was assessed twice, once for each of the two target conditions. This design enabled the definition of Hits and False alarms to be applied not only to target items but also to the trial-by-trial changing context. Anterior and posterior PHc activation patterns revealed significant interactions of context (old vs. new) with Response ("yes" vs. "no"). These activations were completely lateralized by target condition. This triple dissociation suggests that memory for context can be represented in one of two distinct traces, one for context-item information and another for context out of bound.

G59

ITEM RECOGNITION AND INTER-TEMPORAL ASSOCIATIONS: A MEG STUDY Daniel A. Levy[1], Roni Tibon[2], Eli Vakil[2], Abraham Goldstein[2]; [1]The Interdisciplinary Center Herzliya, [2]Bar-Ilan University — Context effects (CEs) on recognition memory provide important insights into associative memory processes. Associations yielding CEs are not limited to items that are processed simultaneously, but can also occur when items are processed sequentially. We conducted a MEG study (N=40) of memory for pairs of items encoded and retrieved sequentially, to identify neural activity associated with the retrieval of inter-temporal associations. Participants studied pairs of successive objects pictures, and were asked to make old-new judgments for each pair member, under 5 different retrieval conditions: (1) Repeat: target old, context old – same; (2) Repair: target old, context old – different; (3) Target old, context new; (4) Target new, context old; (5) Target new, context new. Activation patterns at ~100ms, ~400ms, and ~700ms were associated with item recognition. Beamformer analysis of this old-new effect revealed increased activation for new items in right occipital regions and bilateral paracentral lobule at ~100ms, and increased activation for old items adjacent to right central sulcus at ~700ms. Activation patterns at ~100ms, ~200ms, and ~400ms were further modulated by temporal associations, with stronger activation for probes in the Repeat condition (in which probes were accompanied by their original contextual sequential pair-members) compared to the Re-pair condition (in which probes were accompanied by studied stimuli but not their original contextual sequential pair-members). Beamformer analysis located increased activation for repeated vs. repaired pairs at ~400ms in occipital and temporal regions. These results show dissociable modulations of event-related magnetic fields associated with item recognition and inter-temporal binding.

G60

PHYSICAL ACTIVITY ASSOCIATION WITH INCREASED RESTING-STATE CONNECTIVITY OF THE HIPPOCAMPUS IN MULTIPLE SCLEROSIS Alisha Janssen[1], Beth Patterson[1], Amir Abduljalil[1], Aaron Boster[1], Ruchika Shaurya Prakash[1]; [1]The Ohio State University — Multiple Sclerosis is an inflammatory disease of the central nervous system, resulting in physical, cognitive and affective disturbances. Among the wide range of cognitive dysfunction, individuals with MS experience a significant decline in their capabilities to learn and retain new information. Episodic memory, through both lesion and neuroimaging studies of healthy adults, is known to rely on the functioning of the medial temporal cortices, particularly the hippocampus. In this study, we examined if higher levels of physical activity in MS individuals was associated with an increased resting-state connectivity of the hippocampus and cortex, resulting in improved performance on a task of episodic memory. Forty-five individuals with a clinically definite diagnosis of MS were recruited for the study. All participants wore an accelerometer, and participated in a neuropsychological and imaging session. Seed-based connectivity analyses were performed for each participant, suing the left and right hippocampi as seeds of interest. Consistent with previous reports, hippocampus was functionally connected to the precuneus, lateral parietal areas, posterior cingulated cortex/retrosplenial cortex, and the medial frontal gyrus. Higher levels of physical activity in MS patients were associated with an increased coherence between the hippocampus and the posterior cingulated cortex/retrosplenial cortex. The increased connectivity between these two regions, in turn, was predictive of better relational memory, such that MS patients that showed increased coherence between the hippocampus and the posterior cingulated cortex/retrosplenial cortex also showed better episodic memory. Increased resting-state connectivity may be one pathway through which physical activity influences episodic memory.

G61

ANTICIPATORY HIPPOCAMPAL RESPONSES PREDICT INDIVIDUAL DIFFERENCES IN REWARD-BASED MODULATION OF MEMORY Sasha Wolosin[1], Dagmar Zeithamova[1], Alison Preston[1]; [1]The University of Texas at Austin — Emerging evidence suggests that medial temporal lobe (MTL) memory processing is modulated by reward, resulting in enhanced encoding of episodic information—long-term memory for events. Recent neuroimaging research has further revealed activation in hippocampus prior to stimulus presentation that predicts later memory performance, suggesting that modulatory processes such as reward may influence encoding processes in anticipation of upcoming events. Moreover, individual differences in neural responses to reward predict performance in reinforcement learning paradigms. Such individual differences in reward sensitivity may similarly influence the degree to which reward impacts MTL encoding. Using high-resolution functional magnetic resonance imaging (fMRI), the present study examines (1) how cues indicating future rewards influence MTL subregional activation prior to associative encoding and (2) how individual differences in reward sensitivity are reflected in MTL subregional activation. A high-value or low-value monetary cue preceded a pair of objects indicating potential reward for successful retrieval of the association. Memory was tested using a two-alternative forced-choice paradigm. Behaviorally, memory was superior for high-value associations relative to low-value associations. fMRI analysis revealed anticipatory responses within the hippocampus predicting memory formation that were further modulated by reward. Importantly, the observed enhancement of anticipatory activation for high-value compared to low-value pairs correlated with individual differences in behavioral reward sensitivity (hit rate for high-value pairs – hit rate for low-value pairs). The results suggest that reward-based motivation influences memory by facilitating hippocampal encoding processes prior to stimulus presentation, and that increased behavioral sensitivity to reward is reflected by increases in reward effects within the hippocampus.

G62

SEQUENTIAL MEMORY RETENTION IN CHAOTIC NEURAL NETWORKS Timothee Leleu[1], Kazuyuki Aihara[1]; [1]The University of Tokyo — Processing sequences with neural systems, fundamental for applications such as natural language processing, is at the center of attention of much research. Early work by Elman and Pollack suggested that the memory of past symbols can be encoded in the state-space of the processing-units, and that the formalism of dynamical systems was well-fitted to describe neural dynamics. However, these simple networks were not scalable. To overcome these limitations, reservoir computing, exploiting the high-dimensionality of the state-space, and chaotic trajectories, was proposed to allow decision-making without imposing unnatural internal representations. We propose a paradigm for word memorization, adding to the reservoir computing view a stabilization of the trajectories in the case of recognized sequences. The formalism developed is based on a model of discrete-time analog neurons, where the memory of past inputs is encoded by a sparse population, fed by hot-one inputs and eventually read by read-out units. The weights of the memory-encoding population are normally distributed initially, and updated by a Hebbian-like rule while a constant input is activated. As a consequence, weights are reorganized in a mixture of Gaussians, creating a new distribution of internal states which remains stable after the input is removed. The analysis of the statistical behavior of internal states, and numerical simulations,

show that the Hebbian rule creates a hysteresis of the past state, by synchronizing two populations of neurons. The generalization of this result may be at the basis of a robust (to input/synaptic noise and lags), scalable and realistic model for sequence processing.

G63

PARIETAL ACTIVITY IS MODULATED BY FEELING OF KNOWING IN EPISODIC AND SEMANTIC FACT RETRIEVAL Jeremy A. Elman[1], Diane E. Marian[1], Alice Verstaen[1], Arthur P. Shimamura[1]; [1]University of California, Berkeley — In neuroimaging studies, the posterior parietal cortex (PPC) signals episodic retrieval (hits>correct rejections), though its exact role in remembering remains unclear. Previous research has centered on studies of word lists and yes/no recognition memory. We examined retrieval related PPC activity using a "feeling of knowing" (FOK) paradigm for factual information. Subjects were asked to learn 80 obscure facts (e.g., The name of the largest Confederate military prison during the Civil War is…? Andersonville.). Subjects were scanned as they rated how likely they would be able to provide the answer if given a recognition test. We assessed FOK ratings for the recently learned facts (episodic retrieval) and for previously known facts (semantic retrieval). PPC activity was modulated by FOK response (high>low) and this effect was greater for recently learned facts compared to the retrieval of remote factual knowledge. These results suggest that retrieval related PPC activity is sensitive to feeling of knowing, particularly for recently learned (i.e., episodic) information.

G64

THE NEURAL MECHANISMS OF TEMPORAL AND SEMANTIC CONTIGUITY EFFECTS IN FREE RECALL. Lucas Jenkins[1], Sean Polyn[2], Charan Ranganath[1]; [1]University of California at Davis, [2]Vanderbilt University — Recent computational models of verbal free recall have suggested that items may be associated at encoding with a slowly-evolving contextual representation and that this representation may serve as a cue to reconstruct the relative order of items at retrieval. These models predict that recall of a previously studied word is more likely to be followed by recall of words encoded in close temporal proximity (i.e. the temporal contiguity effect). Here we used event-related fMRI to investigate the neural mechanisms that support encoding of these temporal associations as well as those that support semantic associations. Participants were scanned while encoding lists consisting of 24 words, a subset of which were selected to share a moderate degree of semantic similarity (e.g. dish/food). The 12 s interval between words was filled with an arithmetic distractor task to prevent rehearsal. Following each encoding period and an additional 12 s filled delay, participants were cued to recall the words from the previous list in any order. Preliminary analyses suggest that activity in prefrontal and medial temporal lobe regions during encoding was related to successful recall. Further analyses will be performed in which multi-voxel pattern changes (cf. Jenkins & Ranganath, J. Neurosci. 2010) during encoding will be related to temporal and semantic contiguity (i.e. the tendency to cluster semantically related words) at recall.

G65

AN FMRI STUDY OF SCENE CONSTRUCTION IN HIPPOCAMPAL-DAMAGED AMNESIC PATIENTS Sinead Mullally[1], Demis Hassabis[1], Faraneh Vargha-Khadem[1], Eleanor Maguire[1]; [1]University College London, London, UK — Patients with bilateral hippocampal damage and amnesia are generally unable to imagine fictitious/future scenarios. However, two patients can construct novel scenes/events despite dense amnesia for autobiographical experiences, patient P01 (Hassabis et al., PNAS, 2007) and Jon (Maguire et al., Neuropsychologia, 2010). P01 became amnesic in adulthood, while Jon has developmental amnesia. Both patients have hippocampal volume reductions of ~50% bilaterally. We sought to examine how these patients were able to construct scenes by examining the underlying neural substrates using fMRI. For P01 there was robust activation in the remnant of his right hippocampus during scene construction, suggesting his ability may be hippocampal-dependent, which accords with his subjective experience of scene construction as automatic and effortless. By contrast, Jon's scene construction was associated with increased activity in retrosplenial cortex, middle and superior frontal gyri, with little activity in the medial temporal lobes. This may reflect a compensatory mechanism, an account that supports his description of scene construction as non-automatic and effortful. Thus, while both patients can describe constructed scenes, only adult-acquired damage case P01 does so spontaneously and engages what is left of his hippocampus, in common with control participants (Hassabis et al., J. Neuroscience, 2007). We suggest this basic scene construction ability, whilst intact, is insufficient to support autobiographical memory. By contrast, Jon's early hippocampal damage and probable re-wiring of his memory system, may permit a form of scene construction perhaps based on his intact semantic memory that is, at the neural level, distinctly different from control participants.

G66

SLEEP ENHANCES EMOTIONAL MEMORY AND PROTECTS EMOTIONAL REACTIVITY Rebecca Spencer[1], Bengi Baran[1], Edward Pace-Schott[1]; [1]Department of Psychology and Neuroscience, University of Massachusetts, Amherst — Studies illustrating preferential sleep-dependent consolidation of emotional memories led to the hypothesis that sleep deprivation may reduce PTSD (Wagner et al., Biol Psych 2006). Conversely, others posit that emotional memory consolidation reduces the emotional tone on the memory (Walker & Stickgold, Nat Rev Neuro, 2009). However, studies of emotional memory consolidation have failed to measure changes in emotional reactivity. To address this, participants encoded negative and neutral IAPS images and incidental memory for these items was tested after a 12-hr interval either containing wake (n=25) or sleep (n=25). Negative items were recalled better than neutral items following sleep relative to wake. Importantly, for those who consolidated most over sleep, subjective valence of negative images remained stable while those with the least over-sleep improvement on negative items exhibited reduced reactivity. This pattern was opposite of that observed following wake: Those with the greatest accuracy for negative images after 12-hrs awake exhibited the greatest reduction in emotional reactivity whereas those with weak memory for negative items following wake had stable or increased emotional reactivity. Morning and evening single-session control groups and physiological recordings (PSG) in the sleep group – illustrating correlations between sleep measures and performance changes – collectively rule-out circadian and other accounts for these results. We conclude that sleep protects the memory for emotional events as well as the memory for the memory for the emotional tone experienced in conjunction with the emotional event. Conversely, memory enhancement over wake reduces subjective emotionality, perhaps due to daytime rumination.

G67

DECODING OVERLAPPING MEMORIES IN THE HUMAN HIPPOCAMPUS USING HIGH-RESOLUTION FMRI Martin J. Chadwick[1], Demis Hassabis[1], Eleanor A. Maguire[1]; [1]University College London, London, UK — We used fMRI to investigate the representational properties of episodic memories in the human hippocampus where event content and spatial context were not uniquely specified in any single memory, but instead overlapped between memories. In order to create episodes with overlapping elements, we filmed two brief episodes against a green-screen background. We then superimposed each episode on the same two spatial contexts, creating four movie clips which included every combination of the two episodes and the two contexts. Prior to scanning, participants (n=15) viewed the four movies. Each participant was then scanned using high-resolution fMRI while they recalled the movies. The hippocampus, entorhinal, perirhinal, and posterior parahippocampal cortices were defined for each participant, and the voxel patterns from each region were used in multivariate pattern classification analyses. Of all the regions tested, only the classifier operating on the hippocampal voxels displayed successful decoding of the four memories significantly above chance. This result is consistent with the role of the hippocampus in both episodic memory and pattern separation, and demonstrates that the hip-

pocampus contains specific information about memories even when they contain highly overlapping elements. Our experimental design also allowed the separate investigation of spatial and event information that was in common between pairs of memories. For instance, memories A and B had the same spatial context, but differing episodic contents. This analysis showed that the hippocampus contained generalized information about spatial context, but not about episodic content, further underlining the role of the hippocampus in representing space.

G68

THE ROLE OF ANTICIPATORY NEURAL ACTIVITY IN THE ENCODING OF EMOTIONAL EVENTS Giulia Galli[1], Noham Wolpe[1], Leun J Otten[1]; [1]University College London — Neural activity elicited immediately before an event can predict whether the event will later be remembered or forgotten. This suggests that memory formation is influenced by anticipatory mechanisms engaged ahead of stimulus presentation. Little is known, however, about the relevance of anticipatory brain activity in the formation of new emotional memories, and how this activity differs between men and women. In this study we investigated sex differences in anticipatory brain activity related to the encoding of emotional information. Event-related potentials were recorded from the scalps of healthy adults while they performed an incidental encoding task on pleasant, unpleasant and neutral pictures. Each picture was preceded by a cue indicating the emotional valence of the impending picture. Memory was tested after a short delay with the Remember/Know procedure. Memory performance did not differ between men and women. Sex differences emerged in encoding-related activity preceding unpleasant, but not pleasant, pictures. In men, anticipatory activity before unpleasant events was short-lived and left-lateralized relative to the activity observed in women. Surprisingly, sex differences also emerged in the magnitude of encoding-related activity preceding neutral events. In conclusion, anticipatory neural activity can predict successful memory formation of emotional events. However, men and women anticipate the encoding of emotional events differently. Potential clinical implications for psychiatric disorders will be discussed.

G69

PAIN ENHANCES MEMORY CONSOLIDATION FOR ORIGINALLY NEUTRAL IMAGES Ulrike Schwarze[1], Ulrike Bingel[2], Tobias Sommer[1]; [1]Department of Systems Neuroscience, University Medical Center Hamburg-Eppendorf, Germany, [2]Department of Neurology, University Medical Center Hamburg-Eppendorf, Germany — The perception of pain is an aversive emotional event. In general, emotional events are better remembered than neutral ones. But, studies investigating pain have shown diminished memory performance for concomitantly presented information. However, when pain is present throughout the experiment, it is not clear whether the effects on memory are mediated by disturbed attentional or visual processes. Therefore, in the present study, we investigated whether pain influences memory performance also when it is applied shortly after stimulus perception. Healthy participants encoded 80 neutral images. Half of the images were randomly followed by an electrical painful stimulus which was adjusted to the individual pain threshold. Recognition was either probed on the same or the following day with 20 subjects in each group. While pain did not affect immediate recognition performance, images paired with pain were better remembered than neutral images when tested on the following day. Therefore, pain seems to improve the consolidation of associated images. An fMRI-study using the same paradigm showed that a subsequent memory effect for pictures paired with pain compared to neutral ones was associated with prolonged and enhanced activation of the right fusiform gyrus. Thus, pain influences activity in a brain area incorporated in successful memory formation. In conclusion, pain enhances memory for images by influencing consolidation processes rather than initial encoding when delivered subsequently to these images. This finding is in line with previous studies showing more efficient consolidation based on emotional arousal and resultant enhanced memory performance for emotional events.

G70

THE COMPLEX PATTERN OF VENTRAL STRIATAL ACTIVITY DURING RECOGNITION Tobias Sommer[1], Ulrike Bingel[1], Ulrike Schwarze[1]; [1]Dept. of Systems Neuroscience, University Medical College Hamburg — The activity difference between successful recognized old items ('hits') and correctly rejected lures ('correct rejections') in a standard recognition test is termed the retrieval success effect. This contrast is associated with a greater activity in the medial temporal, parietal and frontal regions. However, also the ventral striatum, a brain area traditionally linked to reward processing, is frequently associated with this contrast. Recently it was suggested that the activity increase in this area reflects the subjective motivational preference to reach an old decision in standard memory tests (Han et al., 2010). The aim of the current study was to further elucidate the role of the ventral striatum during recognition. 19 subjects were scanned during a recognition test for pictures encoded the day before. Subjects indicated their confidence on a 6 point scale (1- 'sure old', 6 – 'sure new'). Crucially, the analysis of activity was not restricted to hits and correct rejections but took also misses and false alarms into account. Besides the retrieval success effect, also the main effects of confidence and the subjective memory status, i.e. 'old' vs. 'new' responses, are correlated with striatal activity. Moreover, the old-new effect is greater for correct than incorrect responses and the slope of confidence if steeper for old items. The partial co-localization of these analyze is supported by a formal conjunction analysis of these contrasts. In conclusion, the striatal activity during recognition reveals a more complex pattern than previously reported and more than one process might contribute to the retrieval success effect.

G71

THE RELATIONSHIP BETWEEN ERPS AT ENCODING AND RETRIEVAL OF MEMORY Yvonne Chen[1], Kirstie Lithgow[2], Jumjury Hemmerich[1], Jeremy Caplan[1,2]; [1]Department of Psychology, University of Alberta, [2]Centre for Neuroscience, University of Alberta — Memory reflects the trajectory of an item from encoding to retrieval. Therefore, a main goal of electrophysiology of memory research should be to understand the relationship between memory-related ERPs at study (known as the "Dm" or "subsequent memory effect", SME) and memory-related ERPs at test (known as the "old/new effect"). Although SMEs and old/new effects have been analyzed independently, even within the same study, it is unclear how components relate to one another. For example, the Late Positive Component (LPC) of the SME and the (early) FN400 old/new effect have both been linked to shallow levels of representation (rote rehearsal and familiarity-based recognition; Karis et al., 1984 Warren, 1980). Similarly, the slow wave SME and the Late Parietal Component of the old/new effect have both been linked to deep levels of representation (semantic processing and recollection-based recognition). We tested this apparent alignment (LPC with FN400 and slow wave with Late Parietal Component) by asking whether they explain common variance across participants. 60 participants studied and were given recognition tests on 9 lists of 25 items. We correlated both SMEs with both old/new effects across participants. The FN400 did not correlate significantly with the LPC or the slow wave. Contrary to our hypothesis, the late parietal component correlated significantly with the LPC (Spearman's rho(56) = 0.28, $p<0.05$) and positively, although not significantly, with the slow wave. This pattern of findings suggests that ERPs at study and test may require a subtler cognitive interpretation.

G72

EFFECTS OF STRESS IN EPISODIC MEMORY UPDATING Bhaktee Dongaonkar[1], Lynn Nadel[1]; [1]University of Arizona — It has been recently shown that episodic memory can be updated. Updating occurs only when a prior memory is reactivated before another episode of learning similar information. Without reactivation, new learning is not integrated with old learning. We decided to explore the effects of stress on the updating effect. Participants learned a set of 20 objects (Set 1) on Day 1. Two days later on Day 2, participants were either stressed or not

stressed. Next they were or were not reminded of their learning on Day 1. They then learned another set of 20 objects (Set 2). Forty eight hours later, on Day 3, all participants had to recall Set 1 objects. There was no difference in the Set 1 recall performance between groups. Participants who received a reminder but were not stressed recalled higher number of objects from Set 2 (intrusions) which evidences the updating effect. Those participants who were stressed before the reminder show a trend of fewer objects from Set 2 being recalled as Set 1 objects compared to non-stressed participants. This may suggest that stress prevents updating of Set 1 with Set 2 objects. This may have implications for learning under stress and problem solving.

G73

ANTERIOR AND POSTERIOR HIPPOCAMPAL CONNECTIVITY DURING THE ENCODING OF FUTURE SIMULATIONS Victoria C. Martin[1], Daniel L. Schacter[2], Michael Corballis[1], Donna Rose Addis[1]; [1]The University of Auckland, [2]Harvard University — Some hippocampal regions are preferentially recruited for imagined future events relative to remembered past events. To investigate the basis of this increased activity, we recently had 25 healthy participants imagine future events in response to person, location, and object cue sets in an fMRI scanning session, followed by a post-scan cued recall test probing memory for these event details. We showed that anterior and posterior regions of the right hippocampus are more active for later-remembered imagined future events than later-forgotten ones, suggesting that the increased hippocampal activity seen for future events reflects, at least in part, the process of encoding these scenarios into memory. To examine how these two regions contribute to encoding of future events, we examined the connectivity of the anterior and posterior clusters. They were entered into a multivariate seed partial least squares (PLS) analysis, with the aim of identifying networks that are functionally connected to these seeds during successful and unsuccessful encoding. Both the anterior and posterior seeds showed common functional connectivity to core autobiographical network regions (e.g. medial frontal gyrus, parahippocampal gyrus, and precuneus) when imagined future events were later remembered. However, only the anterior seed showed this same connectivity when the events were later forgotten. This finding demonstrates that the contribution of both hippocampal regions is crucial for the successful encoding of future simulations, and that the anterior cluster may reflect a process that is beneficial to but not sufficient for encoding, such as the recombination of event details into a novel scenario.

G74

THE EFFECTS OF POST-ENCODING STRESS ON RECOLLECTION AND FAMILIARITY FOR EMOTIONAL AND NEUTRAL IMAGES Andrew McCullough[1], Andrew Yonelinas[1]; [1]University of California Davis — A variety of empirical techniques have shown that post-encoding stress can affect recall performance, and that the emotionality of the to-be-remembered information may interact with the effects of stress. However, the specific nature of stress effects on memory processes is unclear. Recognition tasks provide a useful approach for exploring how stress affects the processes supporting memory performance. The current research investigated how a laboratory stressor (i.e., the cold-pressor task) affects recognition memory by comparing performance of participants exposed to post-encoding stress with participants in a non-stressed control condition. Recognition was assessed for negative and neutral photographs using a hybrid remember/know confidence procedure in order to characterize overall performance and to separate recollection- and familiarity-based responses. Preliminary analysis indicates that post-encoding stress significantly improved recognition memory relative to the control condition. Subsequent analyses will examine whether the stress-related memory improvements influenced recollection and/or familiarity and whether these effects were modulated by the arousal level of the materials. The results suggest that physiological stress can significantly enhance memory for information encountered prior to the stressful event.

G75

CORTICAL REINSTATEMENT OF AUDITORY AND VISUALLY PRESENTED CONTEXTUAL INFORMATION AS INDEXED BY MULTI-VOXEL PATTERN CLASSIFICATION Tracy H. Wang[1,2], Jeffrey D. Johnson[1,3], Michael D. Rugg[1,2]; [1]University of California, Irvine, [2]The University of Texas at Dallas, [3]University of Missouri — Cortical reinstatement refers to overlap between the patterns of neural activity elicited during the encoding and the subsequent retrieval of an episode, and is thought to underlie recollection of episode-specific information. The current experiment used multi-voxel pattern analysis to determine the relationship between cortical reinstatement, recollection and familiarity during retrieval of visual and auditory contextual information. At study, subjects (N=18) were presented with a series of pictures of objects. Each picture was accompanied either by a visually- or an auditorily-presented word. The study task was to determine whether the object denoted by the word corresponded to the picture. Test items comprised previously presented and new pictures. The test task required one of four responses: 'remember' (recollection of a study detail), 'familiar' (confident recognition in the absence of recollection), 'new' and 'guess'. fMRI data from the encoding phase were employed to train a classifier to discriminate between visual and auditory study trials. fMRI data from the test phase were then analyzed with the same classifier in order to assess its ability to discriminate between studied pictures according to the modality of the word that had accompanied each picture at study. The classifier performed significantly above-chance for items endorsed as recollected, but was unable to reliably classify trials endorsed as familiar. These findings converge with prior results to suggest that cortical reinstatement is stronger for items that elicit a phenomenological sense of recollection than it is for items recognized on the basis of an acontextual sense of familiarity.

G76

NEURAL CORRELATES OF CRITERION SHIFTING IN MEMORY Elissa Aminoff[1], Scott Freeman[1], David Clewett[1], Christine Tipper[1], Amy Frithsen[1], Arianne Johnson[1], Scott Grafton[1], Michael Miller[1]; [1]University of California, Santa Barbara — Decision criterion plays an important role in recognition memory; it is this threshold used to determine whether there is enough evidence to consider an item as something previously encountered. A conservative criterion designates more items as new, and a liberal criterion designates more items as previously studied. Optimal decision-making may require criterion to flexibly adapt in response to changing information (e.g., base rate). Thus, the ability to flexibly shift criterion can have a direct influence on recognition memory performance. In the current study, we used fMRI to examine criterion shifting in recognition memory using two separate memory tests with data from ninety-five participants. Our results uncover the neural correlates of criterion shifting in recognition memory, which span regions of the lateral prefrontal and parietal cortices, specifically within posterior prefrontal cortex and superior parietal cortex. Investigating individual differences within the fMRI data reveal that the strategy adopted (e.g., criterion shifting) had a profound effect on the activity elicited from neural regions recruited for successful memory. The results of this study also functionally differentiated the large regions of the frontal and parietal cortices related to recognition memory, isolating those regions specifically related to the recognition memory judgment and criterion shifting. The results of this study provide insight into the function of lateral regions of the prefrontal and parietal cortices and into the neural mechanisms underlying recognition memory. Supported by Army Research Office Contract W911NF-07-1-0072 with the Institute for Collaborative Biotechnologies at UC Santa Barbara.

G77

NEURAL CORRELATES OF TEMPORAL CONTEXT ENCODING AND RETRIEVAL Andrew Heusser[1], Matthias Gruber[2], Laura Kelly[1], Charan Ranganath[1]; [1]University of California-Davis, [2]University College London — The process of forming an episodic memory relies on the ability to bind representations of the elements of an episode (who and what) to a represen-

tation of the temporal context. Little is known about how the brain represents temporal context, but some computational models suggest that neural oscillations might play an important role. Here, we used electroencephalography (EEG) to investigate the role of oscillatory brain activity in the recovery of temporal context information. Subjects encoded a series of fractals, and at test, they alternated between pleasantness judgments on previously studied items and recognition memory judgments on studied and unstudied items. On "Temporally Contiguous" (CT) trials, items shown during the pleasantness and recognition judgments were items that had been presented in succession during the encoding phase. On temporally incontiguous trials (ICT), the items shown during the pleasantness and recognition judgments had been studied in separate encoding blocks. Results from a behavioral study indicated that recollection-based recognition was significantly higher on CT trials than on ICT trials, suggesting that reinstantiating temporal context on CT trials facilitated recognition of the temporally contiguous item. Preliminary analyses of data from the EEG study indicated that oscillatory activity in the theta band (4-8 Hz) was enhanced during processing of temporally contiguous cues, relative to incontiguous cues. Further analyses will investigate oscillatory activity related to temporal context encoding.

G78

BEHAVIORAL CORRELATES OF HUMAN HIPPOCAMPAL THETA OSCILLATIONS DURING NAVIGATION Andrew Watrous[1,2], Itzhak Fried[3], Arne Ekstrom[1,2,4]; [1]Neuroscience Graduate Group, UC Davis, [2]Center for Neuroscience, UC Davis, [3]Department of Neurosurgery, David Geffen School of Medicine and Semel Institute For Neuroscience and Human Behavior, University of California, Los Angeles, CA., [4]Department of Psychology, UC Davis — Prior studies have demonstrated movement-related increases in theta oscillations in rodents and recent evidence suggests that multiple navigationally relevant variables are reflected in rodent hippocampal theta activity. Human invasive recordings have revealed movement related modulations in theta activity, although it is not known if additional behavioral variables are responsible for modulating this neural activity during navigation. We sought to test the role of theta oscillations during navigation by addressing whether spatial-related processing, in addition to speed and task-related variables, modulates theta activity. Analysis of 317 hippocampal intracranial electrodes in ten patients undergoing surgery monitoring revealed increasing delta and theta power with increasing virtual speed at significantly more electrode sites than would be expected by chance, replicating and extending previous findings in lower mammals. However, low frequency power was more consistently modulated as a function of spatial-view, which included when subjects looked at stores in the virtual environment both to find a relevant goal or for spatial updating. A larger proportion of electrodes showed view-related modulations than speed-related modulations. Although speed, task, and spatial-view affected theta activity, individual electrodes were most frequently modulated by only one of these variables, rather than a combination of variables. One interpretation of these findings is that these electrodes sampled independent theta generators, which reflected movement-related and allocentric processing, respectively. These results replicate and extend previous findings in both non-human mammals and humans, expanding our knowledge of the role of hippocampal low-frequency oscillations generally in navigation.

G79

EFFECTS OF STIMULUS FORMAT CHANGE ON THE NEURAL CORRELATES OF RECOLLECTION AND FAMILIARITY Sarah Yu[1,2], Heidi Negendank[1], Michael Rugg[1,2]; [1]University of California, Irvine, [2]University of Texas, Dallas — Previous event-related potential (ERP) studies of recognition memory have reported that amount of perceptual overlap between study and test modulates the magnitude of neural correlates of both recollection and familiarity. The present study employed a modified remember/know (R/K) procedure to further investigate the impact of stimulus format change on the putative ERP correlates of familiarity and recollection, the mid-frontal and left parietal 'old/new' effects, respectively. Participants (N=17) made animacy decisions to intermixed visually presented words and pictures. The following test phase comprised words only; some of these were presented at study, some were names of studied pictures , and the remainder were unstudied. Instructions were to endorse items as 'remembered' if detail of the study presentation could be retrieved and if not, to judge the old/new status of the item using a 4-point confidence scale (confident old to confident new; assumed to reflect familiarity strength). Relative to new items attracting low ratings of familiarity strength, old test items rated highly familiar elicited a reliable mid-frontal effect regardless of study format, suggesting that the mid-frontal effect is not affected by degree of perceptual overlap between study and test. The later-onsetting left-parietal effect was greater for items corresponding to studied words than to studied pictures, which suggests that perceptual overlap between study and test items led to recollection of more information than when overlap was conceptual only. Together, these findings suggest that the neural correlates of familiarity and recollection are differentially affected by the amount of perceptual overlap between study and test.

G80

THE EFFECTS OF LATERAL PREFRONTAL THETA-BURST STIMULATION ON ITEM MEMORY ENCODING Robert Blumenfeld[1], Antonio Fidalgo[2], Mark D'Esposito[1]; [1]Helen Wills Neuroscience Institute and Department of Psychology, University of California, Berkeley, [2]Department of Surgery and Cancer, Imperial College London — Over twelve years of functional neuroimaging research investigating long-term memory encoding has established that activity in left inferior frontal gyrus (Lifg) correlates with subsequent memory for individual items. Activity in left middle frontal gyrus (Lmfg) is rarely correlated with subsequent memory for items but rather has been shown to correlate with subsequent memory for inter-item relational information. Surprisingly, most studies investigating the causal role of prefrontal subregions using repetitive Transcranial Magnetic Stimulation (rTMS), implicate Lmfg and not Lifg in item memory encoding. However, few studies have actually targeted Lifg and most studies relied upon imprecise scalp-based landmarks rather than anatomical landmarks to define prefrontal targets. Furthermore, no study, to our knowledge, has directly compared effects of rTMS on Lifg and Lmfg in a single experiment. Thus in the present study, we used repetitive theta-burst stimulation (rTBS) on precisely defined Lifg and Lmfg targets to investigate whether the function of these regions are critical to normal item memory encoding. Thirty seconds of rTBS was administered prior to an encoding task in which participants were presented with a list of individual nouns and asked to judge whether each noun was concrete or abstract. After a 40 minute filled delay period, item recognition memory was tested. Preliminary results indicate that rTBS to Lifg leads to an impairment in item memory relative to vertex rTBS and secondly, rTBS to LmFG has little affect on item memory performance compared to vertex rTBS.

G81

WAKE DETERIORATION AND SLEEP RESTORATION OF HUMAN LEARNING Bryce Mander[1], Sangeetha Santhanam[1], Matthew Walker[1]; [1]University of California, Berkeley — In contrast to consolidation, the role of sleep in facilitating the initial stage of memory encoding remains largely uncharacterized. NREM sleep-oscillations have been proposed to restore neural dynamics supporting optimal memory processing. Here we test the hypothesis that episodic learning ability deteriorates with continued time awake, but that NREM sleep-spindle oscillations restore such hippocampal encoding capacity. Thirty-nine participants (20.7±0.3 years) performed two separate episodic memory-encoding sessions: 12:00 and 18:00. After the first learning session participants either remained awake for 6 hr (No-Nap group; n=19), or obtained a 100-minute high-density EEG monitored sleep period (Nap-group; n=20). Episodic learning ability was measured using a face-name associative encoding task known to demand hippocampal-dependent processes. Face-name encoding capacity deteriorated across the 6hr waking interval in the No-Nap group, yet

sleep blocked this deterioration in the Nap-group, and actually enhanced learning capacity (p=0.049). The restoration of learning capacity in the Nap-group correlated significantly with NREM stage-2 sleep (p=0.015), and specifically the number of fast sleep-spindles over left prefrontal cortex (p=0.018). EEG source-mapping analysis of these spindles revealed a time-series of current-density activity repeating through the left temporal lobe. No relationships between slow wave oscillations in NREM sleep and learning were detected. Together, these findings demonstrate that episodic learning ability is not stable across a waking day, deteriorating over a 6-hr period. However, sleep, and specifically NREM stage-2 fast spindles, restored this hippocampal-dependent encoding capacity. Such evidence supports a model of sleep-dependent hippocampal-neocortical memory transfer, which, as a consequence, reinstates efficient next-day learning ability.

G82

THE NEURAL BASIS OF THE GENERATION EFFECT Zachary Rosner[1], Arthur Shimamura[1]; [1]University of California, Berkeley — Previous research has demonstrated that actively generating verbal responses such as semantic associates, antonyms, or rhymes to word cues facilitates retrieval of these items compared to passively reading the same information. This memory phenomenon, known as the generation effect, is robust, though the neural circuit underlying this effect is unknown. Some suggest that the effect is related to an increase in attention to the target stimulus, while others claim that generation increases conceptual processing. We scanned subjects using fMRI at encoding and retrieval to explore the neural basis of the generation effect. In the study phase, participants either generated a target synonym from a cue (e.g. cool-c_ld) or read that same information (e.g. cool-cold). At test, participants saw generated items, read items, and new items and were asked to indicate whether each item was old or new with confidence ratings. Replicating previous findings, synonym generation provided a strong benefit for item recognition. During the encoding phase, there was increased activation for items generated compared to read in regions including the inferior frontal gyrus and middle frontal gyrus, which have been implicated in refreshing previously activated information. Additionally, there was increased activity in the left superior and inferior parietal lobules, areas which demonstrate subsequent memory effects. Further, these differences persisted when controlling for recognition and confidence. These findings suggest that active generation may not only enhance memory in a quantitative fashion, but rather changes in a qualitative manner the way which information is encoded.

G83

NEURAL CORRELATES OF ACROSS-MODALITY MULTIFEATURAL ENCODING Lauren Gottlieb[1], Michael Rugg[1]; [1]University of California, Irvine — fMRI subsequent memory effects predictive of successful source memory dissociate according to the source feature(s) that are remembered. Furthermore, subsequent memory effects associated with the memory for multiple visual features have been identified in regions additional to those associated with the retrieval of either feature alone, suggesting that these additional regions play a role in 'feature binding' at the time of encoding. Here, we investigated the neural correlates of the conjoint encoding of visual and auditory contextual features. Subjects were scanned while they studied a series of pictures, each paired with an auditory word, judging whether the word denoted the pictured object. The pictures were presented to the left or right, and the words were spoken in a male or a female voice. At test, subjects determined whether each picture was old or new. If a picture was judged old, two source judgments ensued, about the location of the studied picture, and the gender in which the associated word was spoken. Relative to study items later misclassified as new or associated with two incorrect source judgments, subsequent memory effects associated with memory for either location or voice alone were identified in distinct cortical regions. Effects uniquely predictive of memory for both features were identified in right lateral occipito-temporal cortex. These findings add to the evidence that subsequent memory effects differ according to the nature of the encoded contextual feature, and suggest that the 'binding' of auditory and visual features is supported at the cortical level.

G84

DISSOCIATION OF PRESTIMULUS SUBSEQUENT MEMORY EFFECTS BY STUDY TASK Marianne de Chastelaine[1], Michael D Rugg[1]; [1]University of California, Irvine — Previous research has demonstrated that neural activity during the interval between a warning cue and a study item can predict whether or not the item will be remembered on a later memory test. We have hypothesized that such prestimulus subsequent memory effects are a reflection of the adoption of an optimal preparatory state ahead of an upcoming stimulus event. Here we employed fMRI to investigate whether this state is task-specific or task-general. We employed two study tasks that have previously been shown to doubly dissociate both item- and state-related subsequent memory effects. Eighteen young participants were scanned while study words were visually presented. Cues presented prior to each word denoted whether the word should be subjected to an animacy or a syllable (odd or even number?) judgment. To allow cue- and item-related activity to be deconvolved, the cue-item interval varied randomly between 1s, 3s and 5s. Following the study phase, a surprise recognition memory test was administered in which each test item had to be endorsed as 'Remembered', 'Known' or 'New'. Task–selective prestimulus subsequent recollection (R>K) effects were uniquely evident in the right parahippocampal cortex for cues preceding an animacy judgment, and in left inferior frontal gyrus for cues preceding a syllable judgment. These findings add to the evidence that prestimulus neural activity is an important determinant of successful episodic memory encoding. They also indicate that, as reported for putative item-related subsequent memory effects, the loci of prestimulus effects are sensitive to the nature of the associated study task.

G85

MEMORY, VISUAL DISCRIMINATION PERFORMANCE, AND THE HUMAN HIPPOCAMPUS Soyun Kim[1], Annette Jeneson[1], Anna van der Horst[1], Jennifer Frascino[1], Ramona Hopkins[3,4], Larry Squire[1,2]; [1]University of California, San Diego, California, [2]Veterans Affairs Healthcare System, San Diego, California, [3]Brigham Young University, Provo, Utah, [4]Intermountain Medical Center, Murray, Utah — We evaluated recent proposals that the hippocampus supports certain kinds of visual discrimination performance, for example when spatial processing is required and the stimuli have a high degree of feature overlap. Patients with circumscribed hippocampal lesions tried to discriminate between images of similar faces or images of similar scenes. In one condition, elements of the stimulus display repeated from trial to trial, and in another condition every trial was unique. In the repeated condition for both faces and scenes, controls gradually improved their performance across testing. In the trial-unique condition, no improvement occurred. The patients were impaired for both faces and scenes in the repeated condition where controls could benefit from learning. However, the patients were fully intact in the trial-unique condition. The results suggest that previous reports of impaired discrimination performance after medial temporal lobe damage may reflect impaired learning rather than impaired visual perception. The findings support the fundamental idea that memory is a distinct cerebral function separable from other perceptual and cognitive abilities.

G86

THE UPS AND DOWNS OF HIPPOCAMPAL MODULATION: MNEMONIC CONSEQUENCES OF MEMORY CONTROL Justin Hulbert[1,2], Michael Anderson[2]; [1]University of Cambridge, [2]MRC Cognition and Brain Sciences Unit — People often try to control which memories enter awareness, and these efforts have been shown to have lasting consequences for the later accessibility of suppressed memories. In the Think/No-Think (TNT) procedure used to study such control, intentionally suppressing retrieval leads to a reduction, rather than an augmentation, in hippocampal activity. We hypothesized that this modulation would alter one's ability to encode and consolidate novel information presented between TNT trials. Specifically, attempts to suppress retrieval prior to an incidental-encod-

ing task should disrupt encoding, whereas suppressing retrieval after incidental encoding should truncate ongoing consolidation. In the current series of studies, we employed the novel Hippocampal Modulation (H.M.) paradigm, in which participants confronted novel stimuli presented between TNT trials. Both source recognition memory and cued-recall for items presented around suppression trials were significantly impaired. Thus, engaging cognitive control to suppress retrieval can be adaptive for preventing unwanted memories from entering awareness, but detrimental to the encoding or retention of experiences in the temporal surround. The H.M. paradigm offers a means of selectively and temporarily modulating the hippocampus in healthy human participants, thereby providing a non-invasive, focused method to study the functions of the hippocampus. The current results indicate that, as a result of suppressing unwanted thoughts, one is disadvantaged for learning new mnemonic connections. Individuals who chronically suppress memories could fall victim to extensive gaps in memory resulting from their coping strategy. Adopting alternative strategies to deal with unwanted thoughts that do not induce a hippocampal deactivation may be preferable in these circumstances.

G87

MULTIMODAL IMAGING REVEALS THE SPATIOTEMPORAL DYNAMICS OF CONTENT GENERAL AND CONTENT SPECIFIC NEURAL PROCESSES IN EPISODIC RETRIEVAL Zara Bergström[1], Richard Henson[2], Jon Simons[1]; [1]University of Cambridge, [2]MRC Cognition and Brain Sciences Unit, Cambridge — Previous research has shown that whereas some brain activity patterns during episodic retrieval appear to be content general, different patterns of prefrontal cortical (PFC) brain activity are elicited depending on whether the task requires recall of externally or internally generated information, as indicated by both fMRI (Simons et al., 2005) and EEG methods (Herron & Wilding, 2004). To our knowledge however, no one has yet related these effects across imaging modalities. In the current study, we collected fMRI and EEG/MEG data from the same group of participants who completed an identical source memory task in two sessions. Participants studied pictures of famous faces presented either on the left or the right of the screen and made either a semantic or pleasantness judgement on each trial. In a subsequent memory test, they were asked to remember either the previous location of a face (external source) or which judgment they had made on the face (internal source). External and internal source retrieval was contrasted and compared against a semantic retrieval control condition. General source retrieval was associated with fMRI activation in a typical episodic fronto-parietal network, and with both early and late EEG and MEG modulations with left parietal/right frontal maxima. Recollection of internal source details was associated with greater activation in several PFC areas, and more broadly distributed late EEG and MEG slow-drifts. The results demonstrate converging effects across imaging modalities and contribute to our understanding of the spatiotemporal dynamics of content general and content specific brain processes in episodic retrieval.

G88

AGING EFFECTS ON VISUAL CORTEX ACTIVITY ASSOCIATED WITH SUCCESSFUL PICTURE RECOLLECTION Sasha C. Cervantes[1], Ian M. McDonough[1], David A. Gallo[1]; [1]University of Chicago — We used fMRI to investigate the effects of healthy aging on brain activity associated with complex picture recollection. Previous neuroimaging studies have found reactivation of visual regions when participants recollect studied pictures from memory, but no study has investigated parametric changes in memory reactivation as a function of age. In the current study, younger and older adults studied pictures of complex scenes (e.g., people and objects in naturalistic settings) just prior to the brain scan. Each picture was associated with a unique label describing the scene. These labels were then used as retrieval cues on the memory test, which was administered using an event-related fMRI design. For each label participants were instructed to recollect the corresponding picture and to rate the amount of retrieved details from '0' (none) to '3' (high). We found that memory-related reactivation of visual regions (e.g., lingual gyrus) more strongly tracked the amount of recollected details in younger adults than in older adults. However, these aging effects were less pronounced when objective memory accuracy was equated between the age groups, as indicated by a two-alternative forced choice test administered after the scan. These findings suggest that aging effects on memory reactivation may be primarily caused by reductions in the amount of recollected details, as opposed to aging effects on the memory reactivation processes itself.

G89

INVESTIGATING FAMILIARITY'S CONTRIBUTION TO SOURCE RECOGNITION Matthew Mollison[1], Tim Curran[1]; [1]University of Colorado at Boulder — It has been debated whether source information for encoded items (i.e., contextual associations from when the items were previously encountered) is only accessible through recollection, or whether familiarity can contribute to successful source recognition. Prior research has shown that familiarity can assist in perceptual source monitoring when the source attribute is an intrinsic property of the item (e.g., an object's surface color). However, few studies have researched familiarity's contribution to recognizing extrinsic source associations that are independent from the item itself. We examined behavioral and EEG-based familiarity measures in two experiments using extrinsic perceptual sources. In Experiment 1 the source context was an extrinsic color border associated with each item, and Experiment 2 used spatial location as extrinsic source information. The FN400 event-related potential component, associated with familiarity, showed an effect for source recognition accuracy of previously encoded items only when spatial location, but not color, was used as a source characteristic. Additionally, behavioral results revealed above chance source accuracy for items judged to feel familiar. These results are surprising in light of familiarity being previously found to contribute to source recognition only when the source information was intrinsically bound to the item, and they show that familiarity can be used to successfully monitor extrinsic sources.

G90

THE ROLE OF THE PARIETAL CORTEX IN PICTURE ORIENTATION RECOLLECTION: A WITHIN-SUBJECTS INVESTIGATION WITH ERPS AND FMRI Grit Herzmann[1], Mingwu Jin[2], Dietmar Cordes[2], Tim Curran[1]; [1]Department of Psychology and Neuroscience, University of Colorado at Boulder, [2]C-TRIC and Department of Radiology, School of Medicine, University of Colorado Denver — We investigated the role of the parietal cortex in recollecting the study orientation of pictures. For each subject we measured event-related potentials (ERPs) and fMRI in different sessions of a recognition task. Previously studied pictures were tested in either the same or different (mirror image) orientation. Participants made orientation judgments for old pictures. While holding other recollection processes constant, we analyzed the contrast between mirror-image and same-image conditions in order to test the effect of active episodic recall of studied pictures, which is stronger for mirror images. In fMRI, mirror-image as opposed to same-image recollection was associated with stronger bilateral activation in all parietal retrieval-success regions includinhg the superior (BA 7) and inferior (BA 40) parietal lobe, precuneus (BA 7), supramarginal cortex (BA 40), and angular cortex (BA 39). The ERP parietal old/new effect, observed between 500 and 800 ms after target onset and taken as an indicator of recollection, showed significant correlations with activation in left, parietal retrieval-success regions. Larger ERP parietal old/new effects for mirror images than same images were correlated with larger mirror/same fMRI activation differences in left superior (BA7) and left inferior (BA 40) parietal cortex. These results show that all retrieval success regions in the parietal cortex contribute to active episodic recall and that individual differences in the ERP parietal old/new effect are related to fMRI activation in the left parietal cortex.

G91

RECOGNITION MEMORY FOR REAL-WORLD SCENES IS SUPPORTED BY RECOLLECTION: INTERPRETING FRONTALLY DISTRIBUTED EVENT-RELATED POTENTIAL OLD/NEW EFFECTS Graham MacKenzie[1], John M Henderson[2]; [1]University of Edinburgh, [2]University of South Carolina — Event-related potentials (ERPs) were used to investigate recognition memory for scenes. Dual process models propose that familiarity and recollection support recognition and ERP studies have identified neural signatures for each retrieval process. Familiarity has been associated with a mid-frontal old/new effect (300 – 500ms) and recollection with a left parietal effect (500 – 800ms). However, the generality of these retrieval processes has been challenged by unfamiliar face recognition studies, which suggest that recollection may be material specific because context retrieval can elicit frontal activity. In the present study, participants studied scenes while attending to their orientation; at test, half the studied scenes were presented in the same orientation (studied) and half were mirror-reversed (similar). Participants were instructed to press 'yes' for studied scenes and to press 'no' for similar and new scenes. ERP old/new effects for studied hits and similar false alarms were maximal over frontal scalp from 500 – 800ms; the effects differed quantitatively (studied 'yes' > similar 'yes') but not qualitatively. Mid-frontal effects (300 – 500ms) associated with familiarity were not reliable. The old/new effect observed for scenes appears to reflect recollection due to its resemblance to effects observed for unfamiliar faces and the absence of the typical familiarity index. These findings extend the range of ERP studies showing that recollection can display material specific neural signatures. Recognition memory for scenes is supported by recollection; qualitatively similar effects for hits and false alarms to mirror-reversed scenes indicate that when orientation is not retrieved other contextual information is recollected.

G92

FUNCTIONAL ANALYSIS OF EPISODIC MEMORY USING A WHAT-WHERE-WHEN DESIGN Ruth M. Johnson[1], Stephanie J. Babb[1], A. Cris Hamilton[2], Laura B. Hawkins[1]; [1]University of Houston-Downtown, [2]Rice University — Tulving (1972) defined episodic memory as a distinct memory system that focuses on recollections of personally-experienced events in the past, and the spatial and temporal relations of those events (i.e., what, where, and when). This study characterized the cortical mechanisms for processing episodic memory using the behavioral criteria of what (object), where (spatial arrangement), and when (temporal order). During the functional magnetic resonance imaging experiment, participants were shown 80 unique visual scenes of the interiors of furnished homes across four blocks of 20 trials each. After viewing 20 visual scenes for 4 seconds each, participants were randomly given 5 trials of each of the four conditions (What, Where, When, and Control). Participants' accuracy and reaction time were examined with respect to memory for what, where, and when. Cortical activations were found in the left middle frontal gyrus and right middle temporal gyrus during the What condition, right superior parietal lobe during the Where condition, and right middle frontal gyrus during the When condition. Functional activations were also found in the parahippocampal gyrus during spatial and temporal order memory tasks. Our results support theories consistent with involvement of the prefrontal cortex in temporal order retrieval, the medial temporal lobe in spatial and temporal memory tasks, and the ventral and dorsal pathways in recall of object and spatial memory, respectively. Further research should be able to distinguish previously unknown subcomponents of this extended network of brain areas by their differential activation across the three components of episodic memory (what, where, and when).

G93

BRAIN ACTIVATION ASSOCIATED WITH ITEM AND SOURCE MEMORY STRENGTH Brion Woroch[1], Brian Gonsalves[1]; [1]University of Illinois, Urbana-Champaign — Functional Magnetic Resonance Imaging (FMRI) studies of memory have shown dissociable patterns of activation for item recognition and source memory within the medial temporal lobes (MTL). Item recognition is associated with activity in the perirhinal cortex, while source memory is associated with activity in the hippocampus and parahippocampal cortex. However, many studies confound differences between item and source memory with differences in the overall strength of memory. The current study addresses two main questions: 1) To what extent does incomplete or partial source information contaminate brain activity attributed to item recognition? 2) Is activation of the hippocampus associated with source memory specifically or strong memory more generally? Participants encoded common visual objects in one of two different task contexts by performing either a like/dislike or natural/manmade judgment about the object. On a subsequent memory test inside the scanner, participants made an old/new decision on a 4-point confidence scale followed by a source memory confidence judgment, in which they indicated their confidence about which task they had performed with the object at encoding. fMRI activity from the memory test was examined for activity that varied with item confidence while holding source confidence constant, and vice versa. Preliminary data shows that item and source memory strength are associated with dissociable patterns of brain activity both within and beyond the MTL, indicating that the type of memory (item vs. source), rather than memory strength per se, determine which brain regions are involved in recognition memory.

G94

THE NEURAL CORRELATES OF FLUENCY ATTRIBUTION IN RECOGNITION MEMORY Brian Kurilla[1], Brian Gonsalves[1]; [1]University of Illinois, Urbana-Champaign — The current experiment was designed to identify the electrophysiological correlates of the attributional processes thought to underlie fluency effects in recognition memory. Participants studied a list of words. Half studied the words visually and half studied them aurally. Both groups received the same visual recognition memory test, during which ERPs were recorded. During the test, fluency was enhanced for half the items by means of perceptual priming. Preliminary results suggest that, although priming had a similar effect on ERPs in both groups, primed test items that were claimed to be "unstudied" exhibited a late frontal positivity (~ 800 ms) compared to primed test items that were claimed to be "studied." This finding parallels the results from an earlier study that used a more conceptually-based manipulation of fluency (Wolk et al., 2004), and it suggests that fluency attribution (either to prior study or some other source) is associated with activity at frontal recording sites. In addition to this, early differences (300 – 500 ms) between the waveforms associated with hits and correct rejections were larger following visual study than following auditory study, even though behavioral measures of accuracy (d') showed superior discrimination following auditory study. This apparent dissociation suggests that early ERP differences (e.g., FN 400effect) might reflect factors in addition to memory strength, such as expectations regarding fluency. On a visual test, people might anticipate a higher level of overall fluency following visual study, and this might occasionally lead to a failure to notice fluency due to actual repetition.

G95

HAVE A LITTLE BIT OF SELF-CONTROL! STRATEGIC STUDY BEHAVIORS THAT ENHANCE MEMORY Joel Voss[1], David Warren[2], Brian Gonsalves[1], Kara Federmeier[1], Daniel Tranel[2], Neal Cohen[1]; [1]University of Illinois Urbana-Champaign, [2]University of Iowa — Exploration is characterized as a strategic process because animals continuously update their sensory sampling behaviors in a manner that appears to optimize the efficacy of information gathering. Little information exists regarding the mechanisms for this sort of behavioral control in humans. We therefore investigated the neural substrates of a visual exploration strategy that occurred when individuals studying an array of objects spontaneously looked "backwards" in their scanning paths to view recently seen objects again. This spontaneous revisitation of recently viewed objects was a strong predictor of learning outcome, as individuals (N=40) displayed better later recall and recognition performance for objects studied using this strategy

relative to objects studied using other, more linear viewing patterns. In an experiment on amnesic individuals with severe damage to the hippocampus (N=5), we found that viewing patterns rarely showed evidence for spontaneous revisitation. Furthermore, revisitation viewing patterns did not increase memory performance in amnesic individuals. These neuropsychological results provide a striking demonstration of the necessity of the hippocampus in the short-term adaptive control of behavior. fMRI data collected in healthy individuals without brain damage (N=14) confirmed the role of the hippocampus by showing that hippocampal activity correlated strongly with the expression of the spontaneous revisitation viewing pattern, and further indicated that fronto-cerebellar circuits interact with the hippocampus to produce the memory benefits associated with this learning strategy. Our findings thus demonstrate the role of these brain structures in the strategic control of information-seeking behaviors, and indicate that fronto-hippocampal interactions are involved in exploration.

G97

UNITIZATION AND RECOGNITION MEMORY: ELECTROPHYSIOLOGICAL EVIDENCE FOR BOTH BENEFITS AND COSTS Lea K Pilgrim[1], Cindy M Gray[1], Jamie G Murray[1], David I Donaldson[1]; [1]University of Stirling — Dual process accounts of episodic memory have lead to the identification of familiarity and recollection as two independent bases for remembering. The specific role of familiarity remains unclear however, particularly in relation to memory for associations. Item and associative recognition tasks have long provided a strong means of dissociating familiarity and recollection. By this view, associative recognition of stimulus pairs is supported solely by recollection, whereas item recognition of individual stimuli is supported by both familiarity and recollection. Recent findings suggest, however, that familiarity may also support associative recognition when to-be-remembered stimulus pairs are unitized into a single, coherent representation (the so-called 'benefit' of unitization). What has not yet been addressed is whether there is also a 'cost' of unitization to recognition of individual items. In two studies we used Event-Related Potentials (ERPs) to address whether there are 'benefits' of unitization to associative recognition and also 'costs' to item recognition. In one study participants encoded word pairs under conditions that encouraged unitization and then performed both item and associative recognition tasks. In the other study, participants encoded word pairs under two conditions (one that encouraged unitization and one that did not) and then performed an item recognition test. We found that following unitization, familiarity was able to support associative recognition. In contrast, following unitization, familiarity was unable to support item recognition. These results reveal a measureable 'benefit' and 'cost' of unitization, suggesting that the representational nature of to-be-remembered stimuli is critical in determining whether familiarity can contribute to episodic memory.

G98

ASSOCIATIVE STRENGTH, UNITIZATION AND THE BILATERAL FRONTAL OLD/NEW EFFECT Daniele Ortu[1], Kevin Allan[2], David Donaldson[1]; [1]University of Stirling, [2]University of Aberdeen — Studies of episodic retrieval using Event-Related Potentials (ERPs) consistently reveal the early (300-500ms) bilateral frontal old/new effect, a putative correlate of familiarity based remembering. Although typically elicited by item recognition, previous research (Rhodes & Donaldson, 2007) has shown that the frontal effect can also be elicited by associative recognition - when a degree of associative relationship exists between a pair of words (.206 associative strength in the Edinburgh Association Thesaurus). By contrast, when no associative relationship exists, typically no frontal effect is observed. This finding fits well with a 'unitization' account of familiarity; by this view associatively linked words are unitized, allowing a familiarity signal to be generated for studied vs. unstudied word-pairs. Here we tested this view by manipulating associative strength from moderate to high levels (moderate = .068; high = .357), hypothesising that increases in associative strength should further enhance the size of the frontal effect. Recognition performance was equivalent across experimental conditions, as was the magnitude of the late left parietal ERP correlate of recollection. Importantly, the moderate association condition replicated prior findings; the frontal effect was evoked by correctly discriminated studied vs. unstudied pairs. By contrast however, and contrary to our hypothesis, a higher associative strength did not enhance the frontal effect; it was in fact completely eliminated. This finding presents a severe challenge for a unitization-based familiarity account of the early frontal old/new effect, suggesting either a complex non-linear relationship between associative strength and familiarity, or that the ERP effect simply does not reflect familiarity.

G99

HIGH-RESOLUTION FMRI REVEALS DISTINCT FORMS OF ASSOCIATIVE NOVELTY ACTIVATION IN HIPPOCAMPUS Christine Manthuruthil[1], Dagmar Zeithamova[1], Alison R. Preston[1]; [1]Center for Learning and Memory, Department of Psychology, and Institute for Neuroscience, University of Texas at Austin — Hippocampal activation is greater when encountering novel relative to repeated events. Novelty, however, can take several forms—e.g., discrimination of never-before-seen stimulus combinations (associative novelty per se) or stimulus configurations that violate existing memories (associative mismatch novelty)—to support distinct learning processes. Previous research suggests that signals indicating associative novelty per se predict binding of information within individual events, whereas associative mismatch responses have been implicated in integrative encoding where information is bound across discrete episodes. By comparing hippocampal activation across repetitions of non-overlapping object associations (XY) with those elicited by overlapping associations (AB, BC), we sought to isolate distinct forms of associative novelty activation within hippocampus using high-resolution fMRI. We hypothesized that hippocampal activation would differ between non-overlapping and overlapping associations: non-overlapping pairs would generate decreasing hippocampal activation across repetitions, reflecting diminishing novelty of associations, while overlapping pairs would generate increasing hippocampal activation across repetitions, reflecting enhanced associative mismatch detection as memories are established. In line with these predictions, we observed two distinct novelty signatures within hippocampus. Bilateral hippocampus, inclusive of all subfields, showed decreased activation across repetition of non-overlapping associations, consistent with a signature of associative novelty per se. In contrast, a left hippocampal region, peak in subiculum, showed increased activation across repetition of overlapping events relative to non-overlapping events, consistent with an associative mismatch response. These results reveal distinct forms of associative novelty detection within the hippocampus, and further suggest that a hippocampally-mediated associative mismatch response enables integration of related memories to support flexible use of experience.

G100

THE RIGHT HIPPOCAMPUS SUPPORTS THE PERCEPTUAL RICHNESS OF COMPLEX EPISODIC MEMORIES: BEHAVIOURAL AND FUNCTIONAL MRI EVIDENCE FROM UNILATERAL TEMPORAL LOBE EPILEPSY Marie St-Laurent[1,2], Morris Moscovitch[1,3], Mary Pat McAndrews[1,2]; [1]University of Toronto, Canada, [2]Krembil Neuroscience Center and Toronto Western Research Institute, Canada, [3]Rotman Research Institute, Toronto, Canada — Unilateral medial temporal lobe epilepsy (mTLE) impairs the retrieval of detailed autobiographical memories (AM) but it is unclear whether this reflects a loss of content or a reduction in perceptual richness. Our goal was to assess whether perceptual richness is one of the factors mediating medial temporal lobe involvement during complex episodic memory retrieval. Much of the existing evidence linking vivid recollection to MTL function is correlational and here we designed a paradigm where we manipulated richness while holding content stable. We presented laboratory episodes as perceptually enriched film clips versus perceptually impoverished written narratives (with AM included as a comparator condition). Healthy controls and patients with right mTLE were given 16s to retrieve an AM or a laboratory memory, and then described its

content and perceptual features in their own words. Controls retrieved a greater number of perceptual details in the film condition than in the narrative condition, but this difference was reduced for patients. Similarly, recall of perceptual details in AM was reduced in patients. In a parallel fMRI study, controls showed greater activation in the anterior right hippocampus during retrieval for the AM and the film conditions in comparison to the narrative condition, indicating a sensitivity to perceptual richness. In right mTLE patients, this task-related difference in activation was significantly reduced in comparison to controls, paralleling the behavioural results. Together, our findings indicate that the right medial temporal lobe is a key component of the neural circuitry supporting the integration of perceptual details into complex episodic memories.

G101

THE ROLE OF THE MEDIAL TEMPORAL LOBES IN CONSTRUCTING AN IMAGINED EVENT Kristoffer Romero[1], Morris Moscovitch[1,2]; [1]University of Toronto, [2]Rotman Research Institute — Recent evidence suggests that brain regions crucial for long-term memory (i.e., the medial temporal lobes) are implicated in imagination in 2 ways: during the retrieval of task-relevant episodic information, and during the actual construction of imagined events. However, the exact manner by which the medial temporal lobes (MTL) contribute to the process of event/scene construction is not known. To investigate the role of the MTL in constructing imagined events, patients with MTL lesions and matched controls were given a context word and 3-6 item words on a screen, and asked to imagine a new event with the words, being sure to explicitly relate the words as often as possible. The number of explicit relations per trial was tallied as a measure of relational coherence, and the likelihood of failing to include all stimuli words was measured to determine forgetting. Compared to matched controls, patients with MTL lesions consistently produced fewer relations per trial and were more likely to fail to include all item words, even though all stimuli were present for the duration of the trial. These data suggest that the MTL are involved in constructing an imagined event, possibly by (re)encoding information into long-term memory to be manipulated in working memory during the imagination process.

G102

SYNCHRONIZED THETA OSCILLATIONS OF THE HIPPOCAMPUS DURING ENCODING AND RETRIEVAL OF EPISODIC MEMORY IN HUMANS Cornelia McCormick[1,2], Mary Pat McAndrews[1,2], Andrea B. Protzner[2], Melanie Cohn[1,2], Taufik A. Valiante[1,2]; [1]Krembil Neuroscience Center & Toronto Western Research Institute, [2]University of Toronto — It is well established that the hippocampus is involved in encoding and retrieval of context-rich declarative memories. However, little is known about the temporal coordination between the hippocampus and cortex during those mnemonic processes. Recent research suggests that hippocampal theta oscillations (4-8Hz) provide a temporal window for the coordination of this network, however, it remains unclear whether and how hippocampal signalling differs between encoding and retrieval processes. Here, we studied 6 patients with mesial temporal lobe epilepsy with intracranial EEG electrodes in hippocampus, entorhinal and lateral temporal cortex. Recordings took place while patients performed encoding (30 new and 15x2 repeated) and retrieval (30 old and 30 new) of complex scenes. We examined three different oscillatory parameters in the theta frequency range: 1. Power, 2. Phase-locking and 3. Synchrony (i.e., phase-locking over distant locations). During encoding, we found increased phase-locking and synchrony for scenes that were presented only once (new) in comparison to repeated scenes. During retrieval, power, phase locking, and synchrony parameters were increased for remembered (versus new) scenes. These changes in theta parameters were specific to the hippocampus and interactions involving the hippocampus and cortex. These results parallel our fMRI findings that both encoding and retrieval of episodic information rely on a similar hippocampal-neocortical network. Here we add that hippocampal theta oscillations provide the temporal window for the transient link between these regions. This offers new insight in the functional connectivity between hippocampus and cortex that is directly related to neuronal processes.

G103

INVOLVEMENT OF EXECUTIVE FUNCTIONING IN EPISODIC MEMORY PERFORMANCE IN YOUNGER AND OLDER ADULTS Badiaa Bouazzaoui[1], Lucie Angel[1], Séverine Fay[1], Laurence Taconnat[1], Michel Isingrini[1]; [1]University of Tours, France — Neuropsychological models of memory agree that medial temporal lobes are primarily involved in memory functioning but numerous evidence link also episodic memory to the frontal lobes which act as an executive function supervisor. Moreover, the executive decline hypothesis of cognitive aging proposes that executive functioning is a major factor explaining age-related differences in episodic memory performance. Recent imaging data suggest that memory high-performing older adults exhibit significant activation of prefrontal cortex not recruited by young adults. Given that the prefrontal cortex sustains executive functioning, we may suggest that the use of executive functions to improve memory performance should be more important with increasing age. Correlational and regression analyses were performed to specify the link between episodic memory and executive performance in young and older adults and to test the mediating role of executive functioning in age-related differences in episodic memory performance. Five experiments were led in which we made vary memory tasks (free-recall, cued-recall, recognition, logical memory) and executive tasks (inhibition, switching and updating measures). Results showed that (1) memory and executive performance were consistently positively correlated in older adults while the correlations were globally not significant in younger adults, (2) executive functioning had a strong mediating role in age-related differences in memory performance. This finding seems parallel the prefrontal overactivation observed in certain older adults and supports the view that memory performance is linked to executive functioning particularly in older adults, suggesting that this is a functioning of brain aging that could be compensatory.

G104

RECOLLECTION- AND FAMILIARITY-BASED FALSE MEMORIES IN AMNESICS Jason D. Ozubko[1], Andrew P. Yonelinas[2]; [1]University of Waterloo, [2]University of California Davis — Recognition memory can be based on two distinct processes: recollection and familiarity. Recollection refers to one's ability to mentally recreate an experience or episode, whereas familiarity refers to an undifferentiated "feeling" that something has been experienced before. Past work has demonstrated that amnesic patients with hippocampal damage are impaired at recollection but exhibit relatively preserved familiarity. Interestingly, while amnesics' recollective impairment often results in poorer memory, it also insulates amnesics against false memories (Verfaellie et al., 2005). In the current study we examine the false memories of amnesics more closely, by considering cases of recollective- and familiarity-based false memories. We predicted that, because amnesics show spared familiarity, they would be vulnerable to familiarity-based false memories. In the first experiment, subjects read sentences describing one of four events and later used a 5-point remember-know scale to discriminate between studied and unstudied sentences describing those same events. As with past work, we find that amnesics show impaired recollection but are insulated against false recollection. In the second experiment, subjects studied a list of words. At test, before each test trial, subjects were primed with a context word—either the upcoming test word or a new word. Again, subjects responded using a 5-point remember-know scale. When context words matched the upcoming test word, fluency of the test word was enhanced, resulting in more familiarity-based false alarms in both amnesics and controls. We conclude that amnesia does insulate individuals against recollective-based false memories however, amnesics are still susceptible to familiarity-based false memories.

G105

INTERNAL AND EXTERNAL SOURCE MONITORING IN CONFABULATION Irene P. Kan[1,2], Karen F. LaRocque[2], Mieke Verfaellie[2]; [1]Villanova University, [2]Memory Disorders Research Center, VA Boston, Boston University School of Medicine — "Confabulation," commonly observed in patients with ruptured anterior communicating artery aneurysm, refers to patients' tendency to confuse true and untrue memories. This condition is sometimes referred to as "honest lying" because individuals who confabulate tend to believe in the distorted memories with conviction. Although the nature of these memory distortions varies, one frequently observed characteristic is confabulators' impairment in source monitoring. However, relatively little is known about the specificity of this source monitoring deficit. Here, we examined whether confabulators may be differentially impaired at monitoring information from different sources. We compared monitoring of internally-generated information (imagined/perceived: Did I imagine or see a picture of an apple?) and monitoring of externally-provided information (spatial location: Was the picture presented on the left or on the right?). Compared to non-confabulators (n = 8), confabulators (n = 10) are impaired at monitoring internally-generated information; however, the two groups performed similarly when required to monitor externally-provided information.

G106

DECODING RECENT AND REMOTE AUTOBIOGRAPHICAL MEMORIES IN THE HIPPOCAMPUS USING HIGH-RESOLUTION FMRI Heidi M. Bonnici[1], Martin J. Chadwick[1], Demis Hassabis[1], Antoine Lutti[1], Nikolaus Weiskopf[1], Eleanor A. Maguire[1]; [1]University College London, London, UK — The role of the hippocampus in supporting remote autobiographical memories is debated. One theory suggests that, once consolidated, autobiographical memories are no longer represented in the hippocampus and instead become neocortically-dependent (consolidation theory). Other theories, e.g. the multiple trace theory, the scene construction theory, posit that autobiographical memories have a permanent representation within the hippocampus, no matter how remote the memories. In this study we set out to examine the neural representations of recent and remote autobiographical memories using high-resolution fMRI and multivariate pattern analysis (MVPA). One week before scanning participants (n=12) were asked to recall memories from the recent (two weeks ago) and remote (ten years ago) past. Three memories of each type were chosen, matched for ease of recall, vividness, level of detail, and valence. During scanning participants recalled the six memories numerous times, in a random order. Medial temporal (hippocampus, entorhinal, perirhinal, posterior parahippocampal cortices) and temporal neocortical (temporal pole, middle temporal gyrus) regions were defined for each participant, and the voxel patterns from each area were used in multivariate pattern classification analyses. The classifier operating on the hippocampal voxels displayed successful decoding of both recent and remote autobiographical memories significantly above chance. This result shows that the hippocampus contains representations of remote memories, as well as recent memories, in line with the multiple trace and scene construction accounts.

G107

DIFFERENTIAL INVOLVEMENT OF THE HIPPOCAMPUS IN ASSOCIATIVE MEMORY: BETWEEN-DOMAIN ASSOCIATION AND TASK-DIFFICULTY Juyoun Jung[1], Soo-Jung Min[1], Sanghoon Han[1], Do-Joon Yi[1]; [1]Yonsei University, Seoul, Korea — Although the medial temporal lobe, including the hippocampus, is generally agreed to play a crucial role in associative memory, unique contribution of its sub-structure remains a subject of debate, perhaps because typical paradigms do not divorce the domain specificity and retrieval effort during associative memory. We used event-related functional magnetic resonance imaging (efMRI) to examine hippocampal activation during associative memory retrieval in which the type of material that has to be associated was manipulated across domains (Piekema et al., 2009). During the encoding phase, participants learned to associate three types of pairs; face-house, house-house, and face-face. During the retrieval phase, participants performed a pair-recognition test with intact (old) pairs intermixed with rearranged (lure) pairs. The memory accuracy of both face-house and house-house conditions was similarly superior to face-face condition. Despite the accuracy difference among stimulus types, anterior hippocampus activation for between-domain pairs (face-house) exceeded that of within-domain pairs (face-face and house-house). However, the contrast between two retrieval conditions of within-domain pairs yielded significant activation in relatively posterior hippocampal/parahippocampal regions for face-face retrieval, demonstrating that the regions are activated as a function of greater retrieval difficulty arising from the type of stimulus category, and not reflective of a cross-domain association. Together, these findings indicate that hippocampus is more involved in retrieving associative memory of between-domain information and the sub-regions of hippocampus might be functionally differentiated according to the task difficulty and the process of associative memory.

G108

EPISODIC CONSTRUCTION VERSUS ELABORATION: EVIDENCE FROM DEVELOPMENTAL AMNESIA Donna Kwan[1], Nicole Carson[1], Donna Rose Addis[2], R. Shayna Rosenbaum[1,3]; [1]York University, Toronto, Canada, [2]The University of Auckland, New Zealand, [3]Rotman Research Institute, Baycrest, Toronto, Canada — Recent investigations of two developmental amnesic individuals have generated inconclusive results regarding whether such individuals have preserved episodic future imagining, unlike their adult-onset counterparts (cf. Kwan et al., 2010; Maguire et al., 2010). A possible reason for this discrepancy may be differences in the experimental tasks used: both studies required elaboration of the imagined events but the one in which the patient was found to be impaired also required event construction (Kwan et al., 2010). To investigate whether removing constructive demands could account for the deficit observed, we tested the same developmental amnesic individual, H.C., on a task of episodic future imagining that required only elaboration of a given event. In contrast to her previous performance, HC's future imagining was found to be intact when the task had no constructive demand and required only event elaboration. Results highlight that episodic thought consists of both event construction and elaboration, two processes that may be dissociable in hippocampal amnesia.

G109

THE INFLUENCE OF LIST POSITION AND EARLY-ONSET HIPPOCAMPAL DAMAGE ON THE LAG EFFECT Janet L. Roberts[1], Nicholas J. Cepeda[1], R. Shayna Rosenbaum[1,2]; [1]York University, Toronto, Canada, [2]Rotman Research Institute, Baycrest, Toronto, Canada — The lag effect refers to the phenomenon whereby recall of repeated items increases as a function of inter-repetition interval. However, few studies include the average list position for each lag condition, and it is unclear whether the lag effect persists following hippocampal damage. The goal of Experiment 1 was to determine if controlling for list position would eliminate the typical lag effect, as lists used in previous studies have not been matched in terms of list position, possibly leading to an artificially enhanced lag effect. To this end, we presented 10 lists of words with lags of 0, 1, 6 and 24 intervening items, with each list followed by a period of free recall. Average list position was controlled for in half of the lists and was left uncontrolled in the remaining lists, but yielded no signficant differences. In Experiment 2, we investigated whether a developmental hippocampal amnesic, H.C., would exhibit a normal lag effect with a task identical to the controlled condition of Experiment 1. Adult-onset amnesic individuals have been shown to benefit from spacing between repetitions (Cermack et al., 1996), but this has yet to be demonstrated in developmental amnesic individuals who had never experienced intact episodic memory and with longer lags. H.C., a young woman with early-onset hippocampal damage, did show a lag effect despite overall lower recall. Together, these experiments support the findings in existing lag effect literature, and extend our knowledge of developmental hippocampal amnesic individuals.

G110

SPATIAL MEMORY FOR HIGHLY EXPERIENCED ENVIRONMENTS IN A CASE OF DEVELOPMENTAL AMNESIA Benjamin Cassidy[1], Donna Kwan[1], Janet Roberts[1], Shayna Rosenbaum[1,2]; [1]York University, [2]Rotman Research Institute — The hippocampus has been implicated in general spatial memory with a particular role in allocentric representations of space. These representations are thought to rely most on the hippocampus during initial acquisition while becoming increasingly reliant on neocortical areas of the brain over time. Support for this belief comes from adult and animal hippocampal lesion studies that show impaired learning of new spatial environments, but preserved memory of those acquired premorbidly. However, it is unclear if spatial memories can be acquired in an individual who has sustained hippocampal lesions in early development. This study investigates memory of familiar spatial environments in a young adult, HC, who acquired bilateral hippocampal lesions in infancy. HC's spatial memory of her local neighbourhood was tested using 10 standard mental navigation tasks. Her performance was compared to that of healthy controls (n=5) from the same residential area. HC was significantly impaired on some, but not all, tasks reliant on allocentric representations of space, as well as some requiring an egocentric framework. These results suggest HC has acquired at least some spatial representations of a familiar environment in the absence of normally functioning hippocampi, which may be the result of alternative compensatory strategies acquired by HC during early development.

G111

FUNCTIONAL ROLE OF AGE-RELATED HEMISPHERIC ASYMMETRY REDUCTION AND OF EXECUTIVE FUNCTIONING IN MEMORY AND: AN ERP APPROACH Michel Isingrini[1], Lucie Angel[1], Badiaa Bouazzaoui[1], Laurence Taconnat[1], Severine Fay[1]; [1]University of Tours, France — This experiment explored the functional significance of age-related hemispheric asymmetry reduction associated with episodic memory and the cognitive mechanisms that mediate this brain pattern. Parietal old/new effect-event-related potentials were recorded while younger and older adults performed a word stem cued-recall task. We also investigated age differences in lateralization by computing a lateralization index of the parietal old/new effect for each individual, based on left and right hemisphere activation differences. Results confirmed that the parietal old/new effect was of larger latency, of reduced magnitude and less lateralized in the older group than the young group. Correlation analyses indicated that only in the older group memory performance and executive level were reliably related to the lateralization index. The older participants who presented a high level of memory performance and of executive functioning were those with the higher level of hemispheric asymmetry reduction. Moreover, in this group, regression analyses indicated that the degree of laterality of brain activity mediates age-related differences in memory performance. Results of regression analyses are also compatible with a cascade model in which the individual's level of executive functioning mediates age-related differences in the degree of lateralization of brain activity, which, in turn, mediates age-related differences in memory performance. Overall, our findings support the view that age-related hemispheric asymmetry reduction is beneficial in old age, suggesting compensation mechanisms. They also strongly suggest that cognitive abilities may determine brain reorganization during aging.

Tuesday, April 5, 8:00 - 10:00 am, Pacific Concourse

Long-Term Memory: Other

H1

NEUROPHYSIOLOGICAL REPETITION EFFECTS ON MARKERS OF OBJECT KNOWLEDGE ACTIVATION WITH PERCEPTUALLY SIMILAR CATEGORY EXEMPLARS Stephen Maher[1], Phillip Holcomb[1]; [1]Tufts University — People are quickly able to categorize objects they have never seen before if the object is from a known category. Previous work has posited that more abstract representations of objects in a left-lateralized visual subsystem, which may also represent semantic aspects of object knowledge, might allow for this ability. The frontopolar N3 is an event-related potential (ERP) and putative correlate of object categorization that indicates object representations are view - but not contour - specific, and active between 200 and 400 ms. While the N3 shows attenuation with repetition of identical objects or objects with global shape preserved, no repetition effects on the N3 have been found for repeated category exemplars. For the current experiment, people categorized objects during an indirect memory test in a 2 repetition (new, old different category exemplar) x 2 naming (same or different subordinate name from study to test) design. Results showed highly left-lateralized repetition effects (perceptually similar exemplars were attenuated compared to new items) on the N3 from 200-400 ms. Repetition and naming did not interact, inconsistent with semantic representation activation in visual processes indexed here. Control analyses for explicit memory confounds indicated that N3 effects were not due to subject perception that exemplars were simply identical items. These data indicate that categorization of novel objects from known categories may be achieved by abstract visual form representations, possibly in a lateralized abstract subsystem, which generalize across some changes in global form. Semantic representation in this system, however, is not supported by this work.

H2

SLOW WAVE SLEEP PLAYS A ROLE IN THE TRANSFER OF STATISTICAL INFORMATION FROM THE MEDIAL TEMPORAL LOBE TO THE STRIATUM DURING CONSOLIDATION Simon Durrant[1], Scott Cairney[1], Penelope Lewis[1]; [1]School of Psychological Sciences, University of Manchester, UK. — Memory consolidation during sleep has been increasingly documented in the last decade. Perceptual learning, and in particular the important field of exposure learning, is currently under-represented in this research. Here we studied the impact of sleep upon abstraction of statistical patterns from exposure learning. 36 participants divided equally between Sleep and Wake groups took part in a statistical learning task which involved exposure to a structured auditory stream followed by an immediate-recall session, and after a consolidation gap a delayed-recall session, in both of which they were required to identify short sequences with a structure similar to the exposure stream. The Sleep group were trained and immediately tested at 3pm on Day 1. Their overnight sleep was then monitored with polysomnography, and they were retested in the fMRI scanner at 3pm on Day 2. Participants in the Wake Group were trained and immediately tested at 3pm and then placed immediately in an fMRI scanner for the second test session, with no consolidation delay. Behaviourally, identification of structured sequences improved more in the Sleep than the Wake group, and this improvement correlated with the amount of slow wave sleep obtained. Functionally, we found a decreased dependence on the hippocampus and increased activation of the striatum after sleep during correct identification of structured sequences. Importantly, this functional shift correlated with the amount of slow wave sleep obtained. Our findings broadly support the standard model of consolidation and highlight the importance of slow wave sleep in this process.

H3

EXTINCTION AND SPONTANEOUS RECOVERY OF CONTEXTUAL FEAR MEMORIES Evelyn Glotzbach[1], Heike Ewald[1], Christian Tröger[1], Andreas Mühlberger[1], Paul Pauli[1]; [1]University of Würzburg — During extinction a fear eliciting stimulus is experienced without aversive consequences and fear responses decrease. Nevertheless, previous studies on cue conditioning revealed spontaneous recovery effects, meaning that extinguished fear responses can return after a passage of time, because the fear memory is not erased but inhibited. Besides cue conditioning contextual conditioning, where an aversive event is not linked to a specific stimulus but to a complex context, can be used to study sustained anxiety. Until now it is unsettled which effect extinction has on contextual fear memories. To study contextual conditioning in humans we created two immersive virtual environments (office rooms). On day one participants received electric stimuli (unconditioned stimulus, US) in one context (CXT+) but never in a second context (CXT-). On day two participants underwent extinction in both contexts. To test spontaneous recovery, participants were again exposed to the two contexts on day three. Startle response, skin conductance level (SCL) and ratings for valence were recorded. We found startle potentiation and heightened SCL in CXT+ on day one and during the first extinction block on day two. Physiological fear reactions were extinguished at the end of day two and did not return on day three. Contrary, valence ratings for CXT+ compared to CXT- remained more negative on all three days. In sum, after extinction of context conditioning we found sustained effects for subjective responses, but no hints for spontaneous recovery. In humans, spontaneous recovery may be specific for cue conditioning and cannot be easily verified in context conditioning.

H4

THE CRUCIAL ROLE OF EVENT TIMING IN ASSOCIATIVE LEARNING Marta Andreatta[1], Andreas Mühlberger[1], Ramona Kenntner-Mabiala[1], Bertram Gerber[2], Paul Pauli[1]; [1]Department of Psychology, University of Würzburg, [2]Department of Neurobiology and Genetic, University of Würzburg — In order to survive, organisms avoid pain, approach rewards and learn how to predict these biologically salient events. Interestingly, organisms respond with avoidance-like behaviors to a stimulus (conditioned stimulus, CS) preceding a painful event (unconditioned stimulus, US), but with reward-like behaviors to CS following the painful US. Here, we further investigated the role of the event timing in associative learning. During a differential conditioning paradigm, a geometric shape (CS+)

was either presented before (forward conditioning) or after (backward conditioning) a painful electric shock (US). Moreover, the timing between CS-onset and US-onset (interstimulus interval, ISI) varied among groups. Two groups of participants underwent forward conditioning with ISI lasting either 8 s or 14 s and two groups underwent backward conditioning with ISI lasting -6 s or 0 s. Startle amplitude and explicit ratings were measured as dependent variable. No conditioned startle responses were found after forward conditioning with 14 s ISI. Startle amplitude was potentiated after both forward conditioning with 8 s ISI and backward conditioning with 0 s ISI. To the contrary, startle response was attenuated after backward conditioning with -6 s ISI. Importantly, participants rated the CS as "emotionally" aversive independently from event timing. In summary, the temporal proximity to a biologically salient event may crucially determine the affective properties of such a conditioned stimulus. Noteworthy, the dissociation between the implicit (startle response) and the explicit (subjective ratings) responses after backward conditioning suggests that event timing might explain dissociations found in psychiatric disorders like drug addiction or anxiety.

H5

THE ROLE OF THE PERIRHINAL CORTEX IN FEATURE AMBIGUITY AND CONTEXT Jonathan P. Shine[1], Carina S. Hibbs[1], Kim S. Graham[1]; [1]Wales Institute of Cognitive Neuroscience, School of Psychology, Cardiff University, UK — Recent research suggests that perirhinal cortex is necessary for processing objects with a high degree of feature ambiguity (Graham et al., 2010; Saksida et al., 2010). We asked, therefore, whether manipulating object feature ambiguity using an oddity task would modulate activity in perirhinal cortex (high>low). Complementary to this, we tested whether activity in this region would be modulated by context (e.g., a strong association with a particular location), a factor thought to influence activity in the parahippocampal place area (PPA, Bar et al., 2003). Healthy volunteers were scanned whilst performing a task in which they had to select the different item from three concurrently presented stimuli. Scene and object stimuli were presented. Half the object trials were considered high context (e.g., hard hat), and the other half low context (e.g., bowl). Left perirhinal cortex showed a main effect of stimuli (object>scenes), with greater activation for object trials that were high in feature ambiguity and high in context (relative to all other conditions). In the PPA, greater activation was associated with high versus low context object oddity trials but processing of both virtual reality and real world scene oddity was associated with significantly greater activity than all object oddity conditions. These data suggest that perirhinal cortex does not simply process feature ambiguity but also processes the context with which an item is associated. Although PPA showed a significant effect of context, the biggest response was clearly for scenes over all object oddity decisions, implying that this region primarily processes scene stimuli.

H6

COMBINING FMRI AND EYE-TRACKING TO UNDERSTAND CONTEXTUAL CUEING IN VISUAL SEARCH Anna Manelis[1], Lynne M. Reder[1]; [1]CMU — Contextual cueing is characterized by facilitation of visual search when a target appears within learned spatial configurations. We recorded eye movements while subjects performed an abbreviated contextual cueing task in a scanner. Both response time and number of eye fixations to locate the target in a display decreased with practice but this decrease was greater for repeated than novel displays. While improvement for novel displays may reflect procedural learning, improvement for repeated displays may reflect a mixture of both task learning and learning of the contextual cues. If contributions from procedural learning and contextual cueing are independent, the patterns of neural activity in the procedural learning regions should not depend on whether spatial configurations are novel or repeated. The analysis of repeated configurations revealed a strong correlation between repetition-related changes in BOLD signal and the number of fixations in rHPC, rITG, bilateral frontal and parietal regions. The same analysis of novel displays revealed a strong correlation between these measures in right superior parietal lobule, bilateral occipital fusiform and prefrontal regions, a network distinct from that for repeated displays. Given that the pattern of neural response for novel displays were not replicated for repeated displays, there is little support for the position that procedural learning and contextual cuing are independent. The strong correlation for repeated trials between increases in hippocampal activation and decreases in the number of fixations leads us to believe that the contextual cueing effect results from successful binding of a specific target location to its repeated spatial context

H7

SHIFTING SPATIAL LEARNING STRATEGIES: PLACE AND RESPONSE MECHANISMS FOR DIFFERENT NAVIGATIONAL PRIORITIES Amy L. Shelton[1], Steven A. Marchette[1], Andrew J. Furman[1], Arnold Bakker[1], Scott R. Clark[1], Joshua Lachewitz[1]; [1]Johns Hopkins University — Studies of rat spatial learning and memory have suggested that two parallel learning mechanisms contribute to navigation: place learning and response learning. Generally, place learning is a flexible system relying on the hippocampus for learning the locations of objects relative to cues in the environment, whereas response learning is a rigid system relying on the striatum for learning a fixed sequence of responses that lead to a goal. Both systems support successful navigation, under most circumstances, but they likely represent solutions that optimize different goals and priorities. In a series of experiments we used a Dual Solution paradigm, inspired by tasks used in the rat, to investigate the role of place and response mechanisms in human navigation. In this paradigm, participants learned a virtual environment via passive navigation on the same route over many repetitions. At test, participants were subjected to different conditions that reveal their dependence on environmental cues vs. familiar routes. In Exp. 1, we observed individual differences in the preferential use of novel shortcuts versus familiar routes. These differences corresponded to brain activation differences in the hippocampus and striatum, as predicted by a distinction between place and response learning (Exp. 2). In Exp. 3 and 4, we explored the hypothesis that different strategies are optimal for different situations by investigating how varying the experimental conditions shifted people from one strategy to another. Taken together, our results suggest that humans, like rats, are able to opportunistically engage different spatial learning systems to achieve complex navigational goals.

H8

NEURAL CORRELATES OF SOURCE MEMORY ENCODING IN YOUNG ADULTS Julia Mattson[1], Michael Rugg[1]; [1]Center for the Neurobiology of Learning and Memory, University of California-Irvine — fMRI investigations of successful source memory encoding are often confounded with the strength of item memory. Here, we used a memory test that incorporated separate five-point item and source confidence ratings in order to investigate the neural correlates of the encoding of source information while holding item memory strength constant. fMRI data were acquired while subjects were cued to make size or indoor/outdoor judgments, on a series of pictures denoting everyday objects. During a later unscanned test phase, studied (old) and unstudied (new) pictures were presented under the requirement to make sequential old/new and source (size? vs. where?) judgments, rating the confidence of each judgment on a 5-point scale. 'Source subsequent memory effects' were defined as greater activity for correctly and confidently identified study items that attracted confident correct as opposed to inaccurate source judgments. By restricting the subsequent memory contrast to confidently recognized old items we ensured that subsequent memory effects reflecting successful source encoding were not confounded with differences in the strength of item memory. The right posterior hippocampus demonstrated a subsequent memory effect that was uniquely associated with successful source memory. This region was anatomically distinct from extra-hippocampal regions of the medial temporal lobe that predicted item memory. The findings suggest that the hippocampus is differentially engaged during successful vs. unsuccessful contextual encoding, even when item memory strength is controlled. This is consistent with the proposal that the

hippocampus plays more of a role in formation of item-context associations than in the encoding of item information alone.

Long-Term Memory: Priming

H9

ENCODING EFFECTS FOR IDENTICAL AND DIFFERENT REPETITIONS AND SUBSEQUENT FAMILIARITY VS. RECOLLECTION-BASED RECOGNITION Lindsay Victoria[1], Xiaonan Liu[1], Lynne Reder[1]; [1]Carnegie Mellon University — This event-related potential (ERP) experiment explores neural and behavioral priming effects as a function of type of repetition: identical or different exemplar. We investigated priming as a function of whether items are subsequently recognized at test. During the encoding phase, subjects judged photographs of common objects as "natural" or "man-made." Half of the repeated items were presented again with the same photograph and half with a different exemplar of the same item. Additional trials were items shown only once during the encoding phase. Subjects then viewed a series of words during a surprise recognition phase. They judged whether they had seen one or two pictures that corresponded to the word, or none at all. If they thought they had seen two pictures, they indicated whether they previously viewed identical or different repetitions. Accuracy on the latter judgment was an index of recollection-based responding. Response time (RT) and ERP data were collected during the encoding and test phases. Response time analyses support the conclusion that there is facilitation for both identical and different exemplar repetitions beyond simple practice at the task. Patterns of RTs based on subsequent memory accuracy show a more complex pattern. Exploring the ERP components during encoding, we found a difference in P300 amplitude as a function of the different types of repetitions. ERP components corresponding to recollection vs. familiarity also indicated a differential effect of repetition type on subsequent memory. The findings have implications for the study of priming as a familiarity-based memory process.

H10

UNCOUPLING PRIMING EFFECTS FROM STIMULUS-RESPONSE LEARNING BY USING A FOUR-CHOICE CLASSIFICATION PARADIGM Sina Kuehnel[1,2], Hans Markowitsch[1,2], Dennis Dal Mas[1], Christine Muench[4], Fiona Hayes[2], Martina Piefke[1,3]; [1]Center of Excellence Cognitive Interaction Technology, Bielefeld University, [2]Psychology, Bielefeld University, [3]Cognitive Interaction Technologies for Medicine, Bielefeld University, [4]Psychology, American University — Priming is described as an improvement in speed, bias, or accuracy when processing a stimulus, following unconscious prior exposure to the same stimulus. Recent studies have investigated the role of stimulus-response (S-R) learning during repetition priming tasks. By using task switches between the study and test sessions, these studies claim to avoid binding between a specific motor-action, a decision, and a task-specific classification with a stimulus during repetitive exposures. These studies have found that most priming results are explainable solely as S-R bindings. A possible confound is the higher executive function demands from processing the stimuli at several different levels, i.e. switching target finger responses creates interference as participants must repeatedly modify their decision criteria. We addressed the issue with a counterbalanced four-category classification task using natural visual stimuli (animal species), and a long-lag priming design administered to 27 healthy participants. We assumed that task difficulty would hinder automatization of the subjects' response pattern, thus avoiding S-R bindings. Our results indicate a strong significant priming effect, though surprisingly, only for one of the four animal categories. In theory, the stimuli used to prime should be interchangeable, showing no difference in effectiveness. However, our results argue differently. Though it remains unclear why only rodents produced priming, what has become evident by removing the S-R effect is that the stimuli used in priming studies is far from irrelevant. These results are discussed in terms of the possible stronger involvement of a priori prototypes, and other issues related to the S-R learning paradigm.

H11

INFLUENCE OF COLOR ON PERCEPTUAL PRIMING: A PICTURE-FRAGMENT COMPLETION PARADIGM Dennis Dal Mas[1], Sina Kuehnel[1,2], Hans Markowitsch[1,2], Martina Piefke[1,3]; [1]Center of Excellence Cognitive Interaction Technology, Bielefeld University, [2]Psychology, Bielefeld University, [3]Cognitive Interaction Technologies for Medicine, Bielefeld University — Neuroscientific investigations of priming have controversially discussed the effects of color-information on identification performance. In the present work, we investigated the influence of color on the identification of natural images in the context of perceptual priming. For this purpose, thirty-three healthy participants were tested across different conditions using a unifactorial between-subjects design. Our study consisted of a learning phase with an interference-task, a neuropsychological test-battery and a retrieval phase with a picture-fragment completion test. The learning phase was composed of three groups of participants whereby the stimuli were presented in different formats to the first two groups, i.e. colored vs. gray-staged. The third group did not participate in the learning phase (control group). During the retrieval phase the fragmenting step by which a stimulus was correctly recognized was measured (i.e. the recognition stage). Lower recognition stages indicated better identification performance. The results clearly demonstrate that previously seen colored stimuli increased the subsequent identification performance of colored and even gray-staged stimuli. In contrast, prior viewed gray-staged stimuli caused poorer identification performance. Particularly, prior seen colored compared to gray-staged stimuli provoked much better identification performance of the same subsequently presented stimuli in their gray-staged format. We concluded that color significantly raises effects of perceptual priming, even if targets are not colored but gray-staged during retrieval. Importantly, these findings suggest the existence of lucid color-effects on perceptual priming within the frame of early learning processes.

H12

ATTENTIONAL TOP-DOWN MODULATION OF UNCONSCIOUS SEMANTIC PRIMING BY TASK SETS Sarah Adams[1], Markus Kiefer[1]; [1]University of Ulm, Department of Psychiatry, Ulm, Germany — The automaticity of semantic processing is controversially debated. While some argue that semantic processing depends on strategic retrieval, evidence from masked semantic priming studies indicates that access to semantics can also occur automatically. This contradiction can be accommodated by the attentional sensitization model proposed previously (Kiefer & Martens, 2010) which suggests that semantic processing is initiated without deliberate intention. However, automatic semantic processing is modulated by attentional task sets which differentially sensitize semantic pathways by prefrontal top-down signals. In ERP studies we used a modified masked semantic priming paradigm to investigate which attentional task sets enhance or attenuate unconscious semantic word processing. Participants were first engaged in semantic and phonological induction tasks that should either activate a semantic or phonological task set. Subsequent to the response in the induction task, a masked prime word, either associated or non-associated to the following lexical decision target word, was presented. Across experiments, we varied the nature of the phonological induction task (phonological word/ letter categorization) to test the boundary conditions for unconscious semantic processing to occur. Results showed a differential modulation of masked semantic priming effects by the induced task sets: attention towards reading the entire word in the semantic and word phonology induction tasks facilitated unconscious priming. Contrarily, the letter phonological task attenuated priming. This indicates that unconscious semantic processing depends on an attentional task set that involves lexical but not necessarily semantic processing. The present results therefore further specify how attentional top-down control modulates unconscious semantic processing.

H13

CAN HYPNOTIC SUGGESTION ALTER THE AUTOMATICITY OF SEMANTIC PRIMING? Klaus Hoenig[1], Martin Ulrich[1], Walter Bongartz[2], Georg Grön[1], Markus Kiefer[1]; [1]University of Ulm, Germany, [2]Klingenberg Institute for Clinical Hypnosis, Konstanz, Germany — Semantic priming is held to ensue from automatic spreading activation within an associatively organized memory network. Such automaticity is considered to occur autonomously, independent of top-down control, and to be not easily interrupted. However, recent findings suggest that even automatic (unconscious) processes might be susceptible to top-down control. Whether cognitive control can be exerted over automatic processes is of both theoretical and clinical importance. Hypnotic suggestion is one practice for which the potential for such top-down control of automatic processes has been claimed. To date, it is unclear whether hypnotic suggestion can modulate automatic semantic priming, and if so, at what level of processing. We investigated this potential of hypnotic suggestion using eventrelated fMRI in a semantic priming study. Within the context of a lexical decision task, pairs of words were presented that were either semantically relate or unrelated. Subjects with high (HHS) and low hypnotic susceptibility (LHS) performed the semantic priming task in two scanning sessions (with and without hypnotic suggestion). Both groups evidenced equal amounts of semantic priming in normal wakefulness (i.e. without hypnotic suggestion). With hypnotic suggestion in trance, semantic priming was substantially reduced in subjects with HHS. FMRI analysis revealed preliminary evidence for a modulation of priming-associated brain activity by hypnotic suggestion in left middle temporal, fusiform, and inferior frontal gyri. These findings demonstrate that within HHS subjects semantic priming is susceptible to top-down control by hypnotic suggestion. Hypnotic suggestion appears to exert its influence directly on brain regions commonly associated with automatic semantic activation.

H14

IMPLICIT RECOGNITION BASED ON LATERALIZED PERCEPTUAL FLUENCY Iliana M. Vargas[1], Joel L. Voss[2], Ken A. Paller[1]; [1]Northwestern University, [2]Beckman Institute — In some circumstances, accurate recognition of repeated kaleidoscope images is driven by implicit-memory processes. For instance, when we tested recognition with two-alternative forced-choice procedures with perceptually similar foils, guesses were more accurate than confident responses and neural correlates of correct guessing resembled perceptual-priming correlates. Moreover, images learned under divided attention were recognized more accurately than those learned under full attention. We proposed that "implicit recognition" results from perceptual fluency that influences responding without awareness of memory retrieval. This fluency may arise from plasticity in visual cortex regions responsible for object perception. Here we examined whether recognition would vary if images appeared in the same or different visual field during learning and testing. Kaleidoscope images were briefly presented left or right of fixation during divided-attention encoding. Presentation on the same side at test produced higher recognition accuracy than presentation on the other side. Additionally, accuracy was higher for confident responses than for guesses, a pattern typical for explicit memory—but this pattern was present only for different-side trials. For same-side trials, accuracy was higher for guesses than for confident responses. Guessing accuracy for same-side trials reached 77% correct, comparable to that in our prior studies and presumably reflecting an implicit influence of fluency signals. The dramatic difference in guessing accuracy as a function of whether the initially stimulated visual field was the same at study and test suggests that implicit recognition arises from memory storage in specific networks in the visual cortex yet-to-be identified, but likely mediating repetition-induced fluency increments.

Long-Term Memory: Semantic

H15

HOW DOES THE TIMING OF SEMANTIC PROCESSING EVOLVE OVER THE COURSE OF MULTIPLE REPETITIONS? AN ELECTROPHYSIOLOGICAL INVESTIGATION Louis Renoult[1,3], Xiaoxiao Wang[2], J. Bruno Debruille[2,3]; [1]Rotman Research Institute, Toronto, Ontario, Canada, [2]McGill University, Montreal, Quebec, Canada, [3]Douglas Mental Health University Institute, Montreal, Quebec, Canada — The N400 event-related potential (ERP) has consistently been associated with semantic processing. Recent studies have reported that its peak latency was much earlier for highly repeated words than non-repeated words (Debruille & Renoult, 2009; Renoult & Debruille, in press). There was however no difference in onset latency, suggesting that these N400s were rather characterized by a shorter duration than an earlier occurrence. It might be concluded from these studies that the use of high rates of repetition results in a shortening of semantic processing. However, only two target words were used in these experiments. This small number could also have influenced the duration of semantic processing. The present study aimed to test this possibility. 28 subjects participated in 3 semantic categorization tasks, which differed only in the number of target words used (4, 12 and 24). Each word was repeated 15 times. The results showed that the number of target words did not influence N400 amplitude or latency. In the condition where 24 different target words were used, the number of trials was sufficient to compare individual levels of repetition (24 words x 28 participants).This analysis revealed that N400 peak latency decreased after a few presentations: from 390ms post-onset for the first presentation to a plateau of about 350ms at the fifth presentation. These results suggest that repetition itself rather than the number of target words used can shorten the duration of semantic processing and that a minimal duration is reached after a few presentations.

H16

THE ANATOMY OF SEMANTIC FEATURES IN OBJECT RECOGNITION Marianna Riello[1], Benno Gesierich[2], Alessia Monti[1], Valentina Brentari[1], Jorge Jovichic[1], Maria Luisa Gorno-Tempini[1,2]; [1]Center for Mind/Brain Sciences, University of Trento, Italy, [2]Memory and Aging Center, Department of Neurology, University of California, San Francisco — The processing of different object categories leads to the activation of partly segregated brain areas, depending on the nature of their most salient features (e.g. sensory, motor, encyclopedic). In order to investigate this segregation of object features further, we used fMRI and a paradigm with two different tasks requiring the processing of different features: subjects had either to decide whether two objects are typically found at the same place, or whether they typically move in the same way. Three different object categories were presented: animals, manipulable and non-manipulable objects. Thirteen right-handed subjects took place in the study and were scanned on a 4 Tesla scanner, using parameters optimized for the temporal poles. Contrasting the "place" versus the "movement" task, the precuneus, angular gyrus, anterior middle temporal gyrus, fusiform gyrus, and superior medial frontal gyrus were active in the left hemisphere. Instead, by contrasting the "movement" to the "place" task, we found bilateral activations in the posterior inferior temporal gyri, supramarginal gyri, superior parietal lobes, and the posterior inferior frontal gyri (IFG). Our results suggest that the "place" feature is processed mainly in left hemisphere areas, reported by a variety of previous studies to be involved in semantic processing. By contrast, the "movement" feature seems to rely more on areas in the dorsal stream, bilaterally. These findings are in correspondence with previously reported results, demonstrating that object categories with a salient movement feature, like tools, activate those areas even in a task being neutral with respect to movement.

H17

USING EEG AND EMG TO TEST THE RETRIEVAL EFFORT HYPOTHESIS OF THE TESTING EFFECT Leonora Coppens[1], Peter Verkoeijen[1], Remy Rikers[1]; [1]Erasmus University Rotterdam — Retrieval effort is often considered to be a factor in the emergence of the testing effect (i.e., tested information is retained better than restudied information in the long term). Usually, the measure of effort in testing effect paradigms is response latency. In the present study, EEG and EMG were used to measure retrieval effort during learning more directly. Participants studied and were tested on word pairs. During learning, event-related synchronization (ERS) of the theta band and muscular activity in the corrugator supercilii area were used as a measure of effort. Preliminary results show that testing evoked a higher frontal theta ERS percentage and higher corrugator supercilii activity than restudying. Moreover, tested items were more often recalled correctly on the retention test after 2 days than restudied items. Thus, items that were retrieved with more effort during learning were recalled better on the final test. These results support the retrieval effort hypothesis of the testing effect.

H18

AN ERP INVESTIGATION OF SEMANTIC ELABORATION IN VISUAL WORKING MEMORY Elizabeth Orme[1], Leigh Riby[1]; [1]Northumbria University — Previous research has employed the Visual Patterns Test as an index of visuo-spatial working memory task performance. However, the specific cognitive mechanisms engaged during task performance remain unclear. For instance, Brown et al (2006) reported that the availability of verbal coding (i.e. visual patterns resembling familiar shapes versus abstract unfamiliar shapes) during the encoding of stimuli impacts on the richness of the memory trace and subsequent successful retrieval. Using the temporal precision of event related potential methodology (ERP; derived from the EEG), this study extends recent behavioural work in this area. Specifically, the study examines known ERP components related to the encoding and retrieval of stimuli differing in familiarity. At encoding, visual patterns which are rated as high in familiarity lead to a greater amplitude of the p3 component in parietal and occipital regions along with an increase in amplitude of a frontally distributed N400 component and a prolonged negative slow wave. These are taken as indeces of enhanced semantic encoding of patterns rated as high in familiarity compared to patterns rated as low in familiarity. This enhanced encoding is coupled with a superiority in memory for the familiar patterns relative to the unfamiliar patterns. At retrieval a parietally distributed positive slow wave is observed for correct rejections of new patterns that are low in familiarity. This is coupled with an increase in amplitude of the p2 component. The retrieval results are discussed in terms of the unfamiliar patterns placing a greater demand on working memory.

H19

INFLUENCE OF HANDEDNESS ON THE NEURAL REPRESENTATION OF OBJECT AND ACTION CONCEPTS Donghoon Lee[1], Yuna Jung[1], Myung-yung Jeong[1], Cheonwoo Shin[2], HyunJung Shin[2], Nam Gu Kang[3], Hakjin Kim[3], Myeong-Ho Sohn[4]; [1]Department of Cogno-Mechatronics Engineering, Pusan National University, South Korea, [2]Department of Psychology, Pusan National University, South Korea, [3]Department of Radiology, Pusan National University Hospital, South Korea, [4]Department of Psychology, George Washington University, U.S.A. — The purpose of the current study is to investigate the influence of hand action experience on the neural representation of objects and actions. We hypothesized that the neural activity in the ventral route (i.e., "what" pathway) for object recognition would not be influenced by the handedness of subjects since objects could be correctly recognized without engagement of certain actions. On the contrary, the neural activity in the dorsal route (i.e., "how" pathway) for recognition of actions manipulating with man-made objects would be specifically influenced by the handedness because such actions are typically dominated by a certain hand. We tested these hypotheses with 21 right-handed and 22 left-handed subjects using a picture-word verification task for two object categories(animals vs. tools) and for two categories of actions(manipulating actions vs. non-manipulating actions) in two successive event-related fMRI experiments. Results of the experiment 1 showed categorically distinctive activation patterns in the ventral route regardless of handedness of subjects; the more ventrolateral temporal activation for animals and the more ventromedial temporal activation for tools. Comparably, results of experiment 2 showed a striking group difference. While right-handed subjects showed a strongly lateralized activation to the left, the left-handed subjects showed bilateral or right-sided activation in the temporo-parietal regions when the manipulating action contrasted with non-manipulating action. The overall results indicate that the differential hand action experience does influence on the neural representation of manipulating action concepts along the dorsal pathway, but not on the category-specificity of object representations in the ventral pathway.

H20

PERFORMING A CONCURRENT MANUAL TASK MAKES IT MORE DIFFICULT TO CLASSIFY THE NAMES OF OBJECTS THAT ARE INTERACTED WITH MANUALLY Eiling Yee[1], Evangelia G Chrysikou[1], Esther Hoffman[2], Sharon L Thompson-Schill[1]; [1]University of Pennsylvania, [2]Cornell University — Sensorimotor-based theories of semantic memory claim that semantic ?information about an object is distributed over the neural substrates that are? invoked when we perceive and interact with that object. This predicts that? occupying a neural substrate that is an important part of an object's? representation (e.g., with a concurrent secondary task) should interfere with? the ability to access that representation. We tested this prediction as it? pertains to the manipulation component of an object's representation by ?requiring participants to make concreteness judgments about (heard) names of objects under conditions of? "interference" (performing a concurrent manual or visual task) or "no? interference" (no concurrent task). Objects varied (according to ratings) in the extent to which one interacts with them manually? (e.g., tiger = low manual interaction, kitten = high manual interaction).? Results show that performing a concurrent task increases? errors for all objects. Critically, however, when performing a manual task the increase in errors is? greatest for objects rated as high in manual interaction. In contrast, a concurrent visual task does not selectively increase errors for manual objects. This interference ?effect suggests that the conceptual representations of frequently ?manipulated objects share resources (specifically, motor resources) with those ?that are required to perform an overt manual task. Further, it suggests that ?motor information about these objects is accessed even when the primary task ?(concreteness judgment on a heard word) does not manifestly require it.

H21

FEATURE DIAGNOSTICITY AFFECTS THE REPRESENTATION OF NOVEL OBJECT CATEGORIES Nina S. Hsu[1], Margaret L. Schlichting[2], Sharon L. Thompson-Schill[1]; [1]University of Pennsylvania, [2]University of Texas at Austin — Distributed models of semantic memory posit that information about objects is stored in brain regions responsible for perceiving that information. Such models describe differences between the representations of objects from different categories by assuming that some features (such as color) are more diagnostic of object identity for some categories (e.g., fruit) than others (e.g., tools). Rarely, however, has feature diagnosticity been directly manipulated in order to determine its role in object representations. We explored the role of feature diagnosticity through a training paradigm, in which subjects learn that for a given set of novel objects with assigned colors and names, color is a necessary feature (similar to the yellow of lemons), or they learn that color is an available feature but not necessary (similar to the red of stop signs). Following training, subjects recalled object names and colors accurately, but behavioral measures showed group differences. When listing adjectives to describe the objects, color-necessary subjects nearly always listed colors first, whereas color-available subjects rarely did. When rating similarity for two objects of the same color, color-necessary subjects assigned higher ratings than color-available subjects. Functional magnetic resonance imaging (fMRI)

results demonstrate that when retrieving object shape information, brain regions involved in color or shape perception are activated differently for color-necessary subjects than for color-available subjects. These results suggest that feature diagnosticity interacts with object knowledge in ways previously uninvestigated, and also provide behavioral and neural measures for capturing details of object representations, which may be richer and more nuanced than previously thought.

H22

MENTAL IMAGERY MODULATES KNOWLEDGE ABOUT OBJECTS AND FACES AT MULTIPLE TIMES Haline E. Schendan[1], Giorgio Ganis[1,2,3]; [1]University of Plymouth, Plymouth, Devon, UK, [2]Harvard Medical School, Boston, MA, [3]Massachusetts General Hospital, Charlestown, MA — The brain basis of meaning has been elusive. Recently, grounded (embodied) cognition theory has enjoyed increasing support and proposes that meaning depends, to some extent, on sensorimotor processes and introspective states. This theory also proposes that mental simulation is the process that grounds cognition. Simulation is a type of mental imagery that re-enacts sensorimotor or introspection processes in the neocortex that had been associated together during prior learning experiences to construct the concept. This predicts that mental imagery should modulate sensory processing related to visual knowledge. To test this, event-related potentials were recorded to pictures of objects and faces while people mentally visualized either the same object or face (congruent condition) or different ones (incongruent condition). Results show that mental imagery enhances the N170/VPP, as reported previously (Ganis & Schendan, 2008). In addition, after 200 ms, the frontocentral N3 complex was less negative to objects congruent than incongruent with ongoing mental imagery. The frontal N400 to faces showed the same. Later, the late positive complex (LPC) showed the opposite congruity effect. These effects resemble semantic congruity effects to pictures in sentence and scene contexts. However, the centroparietal linguistic N400 showed minimal mental imagery effects, demonstrating the visual sensory (non-linguistic) nature of imagery effects. Thus, to ground knowledge in visual object processing, two types of mental simulation operate at two times. Automatic simulation operates between 200 and 500 ms during frontal negativities indexing object knowledge, and strategic simulation operates between 400 and 700 ms during LPC indices of strategic mental visualization.

H23

BRAIN DAMAGE TO AUDITORY CORTEX AFFECTS THE PROCESSING OF SOUND-RELATED CONCEPTS Natalie Trumpp[1], Daniel Kliese[1], Klaus Hoenig[1], Thomas Haarmeier[2], Markus Kiefer[1]; [1]University of Ulm, [2]University of Tuebingen — Evidence supporting modality-specific approaches to semantic memory organisation has been accumulating during the last years. A previous study provided direct evidence for a link between the perceptual and conceptual brain systems by showing that visually presented words referring to sound-related concepts recruit auditory brain regions in posterior superior/middle temporal gyrus (pSTG/MTG). However, it is an open question whether auditory brain areas play a causal role in processing sound-related concepts. To address this issue, we investigated patient JR, who received a focal lesion in left pSTG/MTG. We compared JR's performance with six matched control subjects in four different experiments: (I) Lexical decision on visually presented words referring to objects with high versus low acoustic feature relevance and pseudowords, (II) category fluency on tools, animals and acoustic objects, (III) sound recognition, testing the ability to match sounds of animals, musical instruments and other acoustic objects with visually presented words/pictures of corresponding objects and (IV) voice classification of male/female voice recordings, requiring a decision on the speakers gender. Analysis of the behavioural data showed that JR's lexical decisions on words with high acoustic feature relevance were significantly slower and less accurate, he generated less acoustic objects, and his reactions in artifact sound recognition were significantly slowed down. Voice classification was intact. The results revealed across tasks a selective, but consistent impairment in JR, affecting processing of sound-related concepts and recognition of object sounds. Going beyond correlational neuroimaging results, these unique findings show that modality-specific cortex plays a causal role in conceptual processing.

Long-Term Memory: Skill Learning

H24

CAUDATE AND HIPPOCAMPAL FUNCTION DURING IMPLICIT LEARNING OF PERCEPTUAL VERSUS MOTOR SEQUENCES Freja Gheysen[1,2], Filip Van Opstal[1], Chantal Roggeman[3], Hilde Van Waelvelde[1,2], Wim Fias[1]; [1]Ghent University, Belgium, [2]University College Arteveldehogeschool, Belgium, [3]Karolinska Institute, Sweden — To date, neuroimaging data converge on the idea that multiple neural systems are involved in implicit sequence learning. However, no consensus has been reached on the specific function of these different neural systems. In the present fMRI study, we wanted to test the idea that the neural activation involved in implicit sequence learning is defined by the type of information that is being learned. Participants were scanned while performing a perceptual or motor version of an identical serial color matching paradigm. Imaging results indicated that implicit sequences can be acquired by at least two neural systems: the caudate nucleus and the hippocampus, having different operating principles. The caudate nucleus contributed to the implicit sequence learning process for perceptual as well as motor information in a similar and gradual way. The hippocampus, on the other hand, was engaged in a much faster learning process which was more pronounced for the motor compared to the perceptual task. Interestingly, the perceptual and motor learning process occurred on a comparable implicit level, suggesting that consciousness is not the main determinant factor dissociating the hippocampal from the caudate learning system. To fully understand the distinct learning function of both neural systems, it appears that other factors, such as the type of information, need to be taken into account.

H25

WHO READS THE INSTRUCTIONS, ANYWAY? EXPLICIT KNOWLEDGE BENEFITS PERCEPTUAL-MOTOR SEQUENCE LEARNING INDEPENDENT OF INSTRUCTION Daniel J. Sanchez[1], Abigail H. Wesley[1], Paul J. Reber[1]; [1]Northwestern University — Motor skill training, outside of the laboratory, is typically accompanied by explicit instruction for the sequence of motor movements to be learned. However, expert performance is often unaccompanied by awareness of the sequence being executed, suggesting a role for implicit learning. Perceptual-motor sequence learning was assessed with, and without, explicit pre-instruction in order to examine the effect of explicit instruction on skill learning. Participants in the explicit instruction condition observed the 12-item training sequence five times before training, whereas in the implicit condition no mention was made of the repeating sequence. Both groups received 2880 trials of training with the Serial Interception Sequence Learning (SISL) task, followed by tests of implicit and explicit sequence knowledge. In the SISL task, cues scroll vertically towards targets on a computer screen and participants attempt to press a corresponding key when a cue reaches its target zone. Explicit instruction did not reliably affect sequence learning overall, but did lead to high levels of explicit knowledge in many, but not all, of these participants. Some participants in the implicit training condition acquired significant explicit knowledge as well. Participants were divided post-hoc into high and low explicit knowledge groups by the median of the sequence recognition test scores. Participants with greater explicit knowledge exhibited better learning of the embedded repeating sequence than those with only implicit knowledge, after an initial period of similar performance. This suggests that even with a continuous performance task requiring precisely timed responses, explicit knowledge provides a benefit to procedural learning.

H26

IMPLICIT LEARNING OF A SERIAL INTERCEPTION SEQUENCE BY COGNITIVELY HEALTHY ELDERLY PARTICIPANTS Eric W. Gobel[1], Kelsey M. Blomeke[1], Sandra Weintraub[2], Paul J. Reber[1]; [1]Northwestern University, [2]Northwestern Feinberg School Of Medicine — Skilled performance of complex motor skills requires learning a specific order of movements with precise timing. The Serial Interception Sequence Learning (SISL) task has been used to study this type of perceptual-motor sequence learning. During SISL, participants make keypress responses to coincide with the passage of a moving spatial cue though a target zone. Participants are not told that the cues follow a repeating sequence, but implicit sequence knowledge is observed through sequence-specific performance enhancement. Implicit learning with little concomitant explicit knowledge of the sequence has been demonstrated in undergraduate populations. This implicit-explicit memory dissociation is likely enhanced by the continuous performance demands and video-game-like interface. However, it is not known if SISL will be an effective tool for examining sequence learning in older adults given the overall task difficulty. Cognitively healthy elderly participants (mean age 70.0 years, range 63 – 76) performed a modified SISL task designed to provide an appropriate level of difficulty. The number of possible responses was reduced to three (making the task unimanual) and an initial performance pre-assessment identified an appropriate cue velocity for each participant. As in prior research, cues followed a 12-item repeating sequence during 80% of training trials. On a subsequent test phase, participants exhibited implicit sequence knowledge but no ability to recognize or recall the trained sequence. This cognitively healthy elderly sample demonstrated reliable implicit learning and would serve as a suitable comparison group for patient populations with impaired memory function, such as those with MCI, Alzheimer's disease, and Parkinson's disease.

H27

CONSOLIDATION IN IMPLICIT SEQUENCE LEARNING: RETROACTIVE INTERFERENCE EFFECTS MODULATED BY CONCOMITANT EXPLICIT KNOWLEDGE Paul J. Reber[1], Daniel J. Sanchez[1], David Fraser[2]; [1]Northwestern University, [2]Chatham University — Memory consolidation is a vital process by which knowledge representations become stable and long-lasting. While well-studied in declarative memory, implicit skill learning also appears to undergo a consolidation process after the training period. Immediately after learning a new motor sequence, knowledge may be vulnerable to retroactive interference from learning of another novel sequence. To assess whether retroactive interference is observed during implicit perceptual-motor sequence learning, participants learned three different 12-item second-order conditional sequences over two sessions using the Serial Interception Sequence Learning (SISL) task. In the SISL task, cues scroll vertically towards targets on a computer screen. Participants attempt to press a corresponding key when a cue reaches its target zone. During the first session participants trained on a first sequence (A), which was immediately followed by training on a second sequence (B). Either 24 or 48 hours later, participants returned for a second session and trained on a third sequence (C), followed by tests for implicit and explicit sequence knowledge for all three sequences. Retroactive interference for sequence A was observed in participants who had low explicit knowledge of sequence A, but not in participants with high explicit knowledge. No interference was observed for sequence B, for which there was a substantial delay period prior to learning sequence C. These results suggest that implicit sequence learning requires a consolidation period to avoid retroactive interference, but this interference effect can be ameliorated by concomitant explicit sequence knowledge.

H28

COGNITIVE DEPLETION HAS A NEGATIVE IMPACT ON THE RATE OF IMPLICIT PERCEPTUAL-MOTOR SEQUENCE LEARNING Abigail H. Wesley[1], Daniel J. Sanchez[1], Paul J. Reber[1]; [1]Northwestern University — Ego-depletion theory states that humans possess a limited store of cognitive resources that, when depleted, produce deficits in self-regulation or cognitive control. Depletion effects on implicit learning, which is not thought to require cognitive control, have not previously been reported. However, if depletion reflects transiently lower levels of dopamine, ego-depletion might be associated with slower learning for tasks dependent on dopamine-gated plasticity in cortico-striatal circuits. The relationship between ego-depletion and implicit learning was examined by comparing participants' levels of cognitive depletion with sequence learning performance. Participants first completed the Stroop Task to assess depletion, measured as the reaction time difference between control and incongruent trials. Participants then performed the Serial Interception Sequence Learning (SISL) task. The SISL task is a perceptual-motor sequence learning task whereby circular cues scroll across a computer screen toward targets, and participants attempt to press the correct key when a cue fits within the target zone. Participants received 2880 trials of training on a covertly embedded 12-item second-order conditional sequence, followed by tests of both implicit and explicit sequence knowledge. Implicit sequence knowledge was assessed as the percent correct difference between performance on the trained sequence and novel sequences. A negative correlation was found between the interference effect and the amount of implicit learning exhibited, with a slightly stronger relationship observed for participants who did not demonstrate explicit knowledge of the sequence. These results show that ego depletion may lead to slower implicit learning, implying this process is not as automatic as previously hypothesized.

H29

ENHANCING MOTOR MEMORY FOR A MELODIC SEQUENCE BY REPLAYING THE MELODY DURING SLEEP James W. Antony[1], Eric W. Gobel[1], Justin K. O'Hare[1], Paul J. Reber[1], Ken A. Paller[1]; [1]Northwestern University — A steadily increasing body of evidence supports a role for sleep in memory reactivation and consolidation. Memory traces are thought to be spontaneously reactivated during sleep, enhancing storage and improving subsequent memory performance. This natural process can apparently be triggered by auditory or olfactory stimuli during sleep, if those stimuli had previously been linked with learning (Rasch et al., 2007; Rudoy et al., 2009; Smith & Weeden, 1990). We now report that motor memories for a 12-item musical sequence, played using four fingers on four keys in time with moving visual cues (as in the video game, "Guitar Hero"), can be improved by presenting the corresponding tone sequences during sleep. Sixteen participants explicitly learned two repeating melodies composed with either four high tones or four low tones. Training involved 40 repetitions of each sequence in interleaved blocks. Performance was tested before and after a 90-minute afternoon nap. Responses were scored as correct only if made with the correct key and within the target time window. Performance on the learned sequences was superior to performance on novel sequences. Crucially, one musical sequence was played softly through a speaker 20 times during a 4-minute segment of slow-wave sleep, without the participants' knowledge. After the nap, but not before, performance was significantly better on the cued sequence than on the non-cued sequence. These results demonstrate that motor memories can be selectively enhanced during sleep, most likely because reinstating the tone sequence reactivated corresponding representations of the visual cues and/or the learned motor sequence.

H30

FUNCTIONAL CONNECTIVITY BETWEEN PREMOTOR AND PRIMARY MOTOR CORTICES IS ENHANCED DURING INTERLEAVED PRACTICE OF MORTOR SEQUENCES Chien-Ho Lin[1], Barbara Knowlton[2], Ming-Chang Chiang[1], Thuy Dong[3], Parima Udompholkul[2], Allan Wu[2]; [1]Neurology, UCLA, [2]Psychology, UCLA, [3]Ecology and Evolution Biology, UCLA — Generally, practice of different tasks in an interleaved order induces superior retention compared to practicing in a repetitive order, a phenomenon known as the contextual-interference (CI) effect. Previous neuroimaging studies suggest increased corticomotor activity during interleaved over repetitive practice. Using functional imaging, we investigated whether the modulation from premotor (PM) to the primary motor cortex (M1) dur-

ing task practice is affected by CI. Ten adults practiced a serial reaction time task where a set of three 4-element sequences were arranged in a repetitive or in an interleaved order on 2 successive days. On Day 5, subjects were tested with practiced sequences to evaluate retention. A within-subjects design was used so that subjects practiced sequences in the other condition (repetitive or interleaved) 2-4 weeks later. Functional images were acquired online during practice and retention. Psychophysiological interaction analysis (PPI) was applied to determine the connectivity between PM and M1 during practice. We identified a CI effect in that while reaction times (RT) in the interleaved condition were slower than the repetitive condition during practice (effect size (ES)= 0.8) the reverse was true during retention on Day 5, with faster RT for sequences practiced under interleaved conditions (ES= 0.9). Between-condition differences in PM-M1 connectivity were found during practice (FDR, $p< 0.05$), with greater connectivity during interleaved practice. These results suggest that the CI effect can be demonstrated in a within-subject design. The results also suggest that interleaved practice is accompanied by increased PM-M1 connectivity, which may support the superior retention of practiced sequences.

H31

NEURAL CORRELATES OF MULTIPLE TIME SCALES DURING LONG-TERM MOTOR SEQUENCE LEARNING Nicholas F Wymbs[1], Scott T Grafton[1]; [1]UC Santa Barbara — Neuroimaging experiments have identified rapid neural changes with initial training, but few demonstrate plasticity for slower time scales that occur alongside extensive training. This experiment identified both fast and slow time scale regions. Participants trained for 30 days on 3 pairs of visually cued 10-element sequences that mapped 5 squares onto a keyboard. Training exposure varied between sequences, with two receiving minimal training (fast scale), two moderate training (intermediate scale), and two extensive training (slow scale). BOLD was acquired every 10 sessions, during which 50 trials of each sequence were presented. The repetition suppression (RS) effect was used to measure subtle changes by repeating pairs of sequences separately for each time scale group. Decreased RS sensitivity was found in motor cortex, vermis, putamen, temporal lobe, and fusiform cortex for fast time scales, along with increased sensitivity in the supplementary/cingulate motor areas and inferior frontal operculum. An inverse quadratic characterized regions showing changes at intermediate time scales, including dorsal premotor, supramarginal gyrus, posterior parietal cortex, and the right dorsolateral prefrontal cortex (DLPFC). Slow decreases in RS sensitivity were located in the left dominant hemisphere, including the intraparietal sulcus, lateral premotor cortex, precuneus, lateral cerebellum, and DLPFC. These results highlight the recruitment of a premotor-parietal network as one initially learns a sequential motor skill. DLPFC recruitment suggests that higher-level processing regions function at slower time scales, supporting the development of automaticity. Lastly, the lack of slow increasing sensitivity suggests that progression towards automaticity is characterized by increased efficiency within sensorimotor networks.

H32

DIFFERENTIAL EFFECTS OF FEEDBACK NOVELTY ON IMPLICIT VERSUS EXPLICIT CATEGORY LEARNING Benjamin O. Turner[1], Andrew Ross[1], F. Gregory Ashby[1]; [1]University of California, Santa Barbara — Novelty is a powerful salience cue, interacting with both the attention and dopamine systems. In particular, novelty can capture attention—thereby enhancing cognitive processing (e.g., Corbetta, 2002)—and can also cause dopaminergic neurons to fire (e.g., Horvitz, 2000). In the COVIS model of category learning (Ashby et al., 1998), the explicit system is only affected by dopamine in a tonic manner, but depends heavily on attentional processes, while the implicit system is largely attention-independent, relying instead on phasic dopaminergic signals to guide learning. Because positive and negative feedback play different roles in the two systems, we hypothesized that we would observe different patterns of behavior in the two systems when replacing either positive or negative feedback with novel images: in the implicit system, novel negative feedback should cause a small dopamine release, thereby strengthening the incorrect synapse and impairing learning, while novel positive feedback should have no such detrimental effect; and in the explicit system, negative feedback is logically more informative than positive feedback, so increasing the processing of negative feedback via novelty should lead to relatively better performance compared to doing so for positive feedback. The results of a behavioral study using this design support these predictions, such that for accuracy there is a significant interaction between category distribution (i.e., rule-based or information-integration) and feedback condition (i.e., whether positive or negative feedback is novel): subjects in the rule-based condition performed significantly better when negative feedback was novel compared to positive, while for subjects in the information-integration condition, this pattern was reversed.

H33

APATHY AND PERCEPTUAL CATEGORY LEARNING IN PARKINSON'S DISEASE: POSSIBLE ROLE OF THE VENTRAL STRIATUM J. Vincent Filoteo[1,2], W. Todd Maddox[3], David P. Salmon[1], Stephanie L. Lessig[1,2], David D. Song[1,2]; [1]UCSD, [2]VA San Diego Healthcare System, [3]University of Texas — Past evidence indicates that the ventral striatum plays an important role in reinforcement-based learning via dopamine signaling following reward. Recent studies have indicated that apathy, which reduces the ability to benefit from reinforcers in the environment, is highly prevalent in patients with Parkinson's disease (PD), and has been associated with ventral striatal dysfunction. Given this past work, we hypothesized that PD patients high in apathy (PD-HA) would be differentially impaired relative to PD patients low in apathy (PD-LA) on tasks that emphasize reinforcement-based learning. We examined 31 PD-HA and 39 PD-LA patients using an implicit, information-integration category learning task in which subjects were asked to classify individual stimuli into one of two categories and were given corrective feedback following each response. Results indicated that the PD-HA patients were impaired relative to both PD-LA and normal controls, whereas the latter two groups did not differ. Importantly, level of depression was not associated with performance on the implicit category learning task. To test whether the impact of apathy was specific to implicit learning, we examined the same group of PD patients on an explicit, rule-based task (for which verbal rules can be used to describe category membership) and found that apathy was not associated with performance, whereas PD patients with high levels of depression were impaired. These results suggest that possible ventral striatal dysfunction in PD-HA patients may be associated with impaired implicit but not explicit category learning, whereas levels of depression may have the opposite relationship.

H34

UNLEARNING AND EXTINCTION IN A PROCEDURAL-LEARNING CATEGORIZATION TASK Matthew J. Crossley[1], F. Gregory Ashby[1], Brian D. Glass[2], W. Todd Maddox[2]; [1]University of California, Santa Barbara, [2]University of Texas, Austin — Evidence suggests that information-integration category learning recruits procedural memory and requires reinforcement learning mediated within the striatum. However, virtually nothing is known about how this categorization knowledge can be "unlearned". We make a critical distinction between performance decrements that might suggest unlearning and true unlearning at the synaptic level. We report the results from two experiments designed to investigate the ability of random feedback to induce true unlearning of information-integration categories and to investigate the impact of training context on the learning and expression of information-integration categorization. Experiment 1 included an acquisition, extinction, and reacquisition phase. Participants learned information-integration categories using standard feedback-based training during the acquisition and reacquisition phases, and they received random feedback during the extinction phase. Results indicated that random feedback is sufficient to suppress the expression of procedural categorization but not to induce true unlearning of the category structures (because reacquisition was faster than initial acquisition). Experiment 2 included an acquisition phase and

two extinction phases that occurred in different contexts (i.e., different background colors). Results indicated that the expression of categorization knowledge after extinction can be briefly renewed by returning to the original training context. Taken together, the results from Experiments 1 and 2 echo some classic findings in instrumental conditioning (i.e., rapid reacquisition and renewal) and are inconsistent with many current category learning models. Finally, we propose a new neurobiologically detailed theory of information-integration category learning that accounts for these results.

H35

FUNCTIONAL CONNECTIVITY BETWEEN DORSAL LATERAL PREFRONTAL AND SUPPLEMENTARY MOTOR CORTICES IS ENHANCED DURING INTERLEAVED PRACTICE OF MOTOR SEQUENCES

Parima Udompholkul[1], Ming-Chang Chiang[1], Chien-Ho Lin[1], Allan Wu[1], Thuy Dong[2], Barbara Knowlton[3]; [1]Neurology, UCLA, [2]Ecology and Evolution Biology. UCLA, [3]Psychology, UCLA — Generally, practice of different tasks in an interleaved order induces superior retention compared to practicing in a repetitive order, a phenomenon known as the contextual-interference (CI) effect. Previous neuroimaging studies suggest increased corticomotor activity during interleaved over repetitive practice. Using functional imaging, we investigated whether the modulation from dorsal lateral prefrontal (DLPFC) to the supplementary motor cortex (SMA) during task practice is affected by CI. Ten adults practiced a serial reaction time task where a set of three 4-element sequences were arranged in a repetitive or in an interleaved order on 2 successive days. On Day 5, subjects were tested with practiced sequences to evaluate retention. A within-subjects design was used so that subjects practiced sequences in the other condition (repetitive or interleaved) 2-4 weeks later. Functional images were acquired online during practice and retention. Psychophysiological interaction analysis was applied to determine the connectivity between DLPFC and SMA during practice. We identified a CI effect in that while reaction times (RT) in the interleaved condition were slower than the repetitive condition during practice (effect size (ES)= 0.8) the reverse was true during retention on Day 5, with faster RT for sequences practiced under interleaved conditions (ES= 0.9). Between-condition differences in DLPFC-SMA connectivity were found during practice ($p < 0.05$), with greater connectivity during interleaved practice. These results suggest that the CI effect can be demonstrated in a within-subject design. The results also suggest that interleaved practice is accompanied by increased DLPFC-SMA connectivity, which may support the superior retention of practiced sequences.

H36

NEURAL MECHANISMS CONTRIBUTING TO CROSS-MODAL TRANSFER IN EXPLICIT AND IMPLICIT MOTOR LEARNING

Leighton Hinkley[1], John Houde[2], Kelly Westlake[1], Anne Findlay[1], Nancy Byl[3], Srikantan Nagarajan[1]; [1]Department of Radiology and Biomedical Imaging, University of California San Francisco, [2]Department of Otolaryngology, University of California, San Francisco, [3]Department of Physical Therapy and Rehabilitation Science, University of California, San Francisco — During both implicit and explicit sequence learning, the learnt sequence is encoded in a format that can be transferred across modalities. Sequences transferrable across disparate effector types are likely to be coded at a cortical level unbound to either stimulus or response modality. We examined cortical oscillations, with magnetoencephalography (MEG), during sequence learning and transfer while subjects performed a modified serial reaction time task in the manual (button press) and vocal (short vowels) response domains. Both implicit and explicit learning effects were explored. Five-dimensional neuroimaging was performed from whole-head MEG data using Nutmeg (nutmeg.berkeley.edu). Salient transfer effects were quantified by a reduction in reaction times to learned sequences produced by untrained effectors. Transfer effects were symmetric between manual and vocal learning and observed for both implicit and explicit learning. During training, we observed significant power changes in the beta-band (15-30Hz) over pre-frontal (PFC) and motor cortices. In the transfer phase, power increases in the high-gamma band (65-90Hz) were observed over dorsal pre-motor cortex (PMd) and the superior parietal lobe (SPL) during manual-to-vocal transfer. In contrast, during vocal to manual transfer, power increases in the high-gamma band were over dorsolateral PFC and the supplementary motor area (SMA). These results suggest that the process of translating a learned motor sequence pattern across effectors is mediated by high-frequency oscillatory activity in frontal cortex.

H37

PARSING THE EFFECT OF COMT GENOTYPES ON DIMENSION SELECTION AND CRITERION LEARNING IN RULE-BASED CATEGORIZATION

Sebastien Helie[1], Erick J. Paul[1], Benjamin O. Turner[1], Nicole C. Foley[1], Colin Gerber[1], Angela Chen[1], F. Gregory Ashby[1]; [1]University of California, Santa Barbara — Seger and Cincotta (Cerebral Cortex, 2006) showed that medial temporal lobe activation is negatively correlated with performance in rule-based categorization. More recently, Dennis and her colleagues (Cerebral Cortex, 2010) showed that participants homozygous for Val on the COMT gene had generally more activation in the prefrontal cortex and less activation in the medial temporal lobes, whereas participants homozygous for Met on the COMT gene had the opposite. Together, these results suggest that extracting participant genotypes on the COMT gene should allow us to predict their performance in a rule-based categorization task. Rule-based categorization involves at least two stages: (1) dimension selection and, (2) criterion learning. Thirty-seven participants were trained in two separate rule-based categorization tasks each focusing either on dimension selection or criterion learning. The results show that participants homozygous for Val were more accurate than participants with at least one Met allele in the criterion learning task. In addition, accuracy of participants homozygous for Met was worse than those with at least one Val allele in the criterion learning task. Similar results were found in the dimension selection task. Participants homozygous for Val could solve more problems in fewer trials than participants with at least one Met allele, who in turn could solve more problems in fewer trials than participants homozygous for Met. Hence, the Val allele seems to provide an advantage over the Met allele in rule-based perceptual category learning. These results are consistent with Seger & Cincotta (2006) and Dennis et al. (2010).

H38

DOPAMINERGIC EFFECTS ON BRAIN ACTIVATION DURING MOTOR SEQUENCE LEARNING IN PARKINSON'S DISEASE

Youngbin Kwak[1], Martijn Muller[1], Nicolaas Bohnen[1], Praveen Dayalu[1], Rachael Seidler[1]; [1]University of Michigan — We recently reported that the effect of dopaminergic medication varies across the time course of motor sequence learning in early stage Parkinson's (PD) patients (Kwak et al., 2010). We found a medication-associated impairment that was specific to the early phase of learning. In the current study, we investigated the neural substrate of this deleterious effect of L-DOPA on motor sequence learning. We hypothesized that L-DOPA would affect recruitment of the ventral striatal circuitry during the early phase of motor sequence learning. Seventeen early stage PD patients ON and OFF L-DOPA and 21 healthy control participants performed an explicit motor sequence learning task inside the MRI scanner. Paralleling our previous findings, we found an L-DOPA associated sequence learning impairment when learning was measured by error rate. We found sequence learning-specific activation during the early phase in the ventral putamen for controls and PD OFF but not for PD ON L-DOPA. A comparison of activation between PD OFF and PD ON within the ventral putamen showed that activation was decreased in PD ON compared to PD OFF. The degree of L-DOPA associated activation decrease was positively correlated with the degree of sequence learning impairment in the early phase of learning. These findings provide evidence for the differential effects of L-DOPA across the ventral and dorsal cortico-striatal loops involved in motor sequence learning in Parkinson's disease.

H39

INDIVIDUAL DIFFERENCES IN SPATIAL NAVIGATION: THE INFLUENCE OF COGNITIVE STYLES David J.M. Kraemer[1], Victor R. Schinazi[1], Philip B. Cawkwell[1], Russell A. Epstein[1], Sharon L. Thompson-Schill[1]; [1]University of Pennsylvania — Navigation in large-scale environments relies on integrating multiple information sources. Individuals differ in overall navigation ability and in choice of task strategies. One reliable, and potentially relevant, individual difference is preference for using visual or verbal information to complete a visual task – e.g., when recalling a previously seen picture, some tend to rely primarily on visual memory, while others focus on retrieving a verbal label. These separable preferences, visual and verbal cognitive styles, correlate with reasoning in visual and verbal domains. Recent neuroimaging evidence (Kraemer et al., 2009 JNeuroscience) linked these cognitive styles to separate task strategies associated with distinct brain regions. Specifically, left supramarginal gyrus activity was correlated with the verbal cognitive style labeling strategy, particularly during a visual task. Likewise, right fusiform gyrus activity during a verbal task was correlated with a visual cognitive strategy. Here, using novel large-scale virtual environments, we demonstrate that cognitive styles are differentially predictive of performance on navigation tasks that make use of different strategies. Specifically, landmark memory can rely on both visual and verbal strategies, while spatial integration measures, like judgments of relative direction (JRDs), rely primarily on visual strategies. Here, higher visual cognitive style predicted better performance on both landmark judgments and JRDs, while higher verbal style predicted performance for landmarks but not JRDs. Together, these results support the hypothesis that cognitive styles represent distinct strategies corresponding to differences in how individuals represent task-related information, in this case landmark memory and spatial position.

H40

DIFFERENT PATTERNS OF MATH LEARNING FOLLOWING DIFFERENCES IN TRAINING PROCEDURES Arava Y. Kallai[1], Christian D. Schunn[1], Julie A. Fiez[1,2]; [1]University of Pittsburgh, [2]Center for the Neural Basis of Cognition — Fluency in math has previously been conceptualized in terms of memorization of single-digit "math facts" (Resnick, 1983). The current study is part of an alternative effort, testing the influence of improving the quality of basic number representation on math fluency. In a recently completed neuroimaging study we found broad transfer for different math tasks following an arithmetic training program designed to engage procedural learning mechanisms. In an fMRI version of the training task, the basal ganglia showed characteristic activation for correct and incorrect trials. In the current study we sought to test the components of the training program that were considered essential for procedural learning, by manipulating three parameters between subjects: contingent feedback, incentive value of positive results, and uncertainty about outcomes. Eighty participants were behaviorally tested with variety of math-related tasks before and after a training program that consisted of rarely repeating addition and subtraction problems. The base group received trial-by-trial feedback, monetary rewards for correct answers, and short response-windows to increase uncertainty. Each of the other three groups lacked one of these parameters. Following training, participants in all groups improved in an SAT-like test, math-fact retrieval, and a Stroop-like task testing automaticity of double-digit numbers addition. However, unlike the other two groups, the Base and No-feedback groups also showed improvement in numerical representation (symbolic and non-symbolic). We conclude that although improvement in math fluency followed all training procedures, motivation to succeed and response pressure to change computational habits led to additional representational change.

Language: Syntax

H41

CHANGES IN THE NEURAL PATTERN OF L2 PROCESSING AFTER 3-6 MONTHS OF NON-EXPOSURE: ERP EVIDENCE FROM AN ARTIFICIAL LANGUAGE Sarah Grey[1], Kara Morgan-Short[2], Ingrid Finger[3], Michael Ullman[1]; [1]Georgetown University, [2]University of Illinois, Chicago, [3]Federal University of Rio Grande do Sul, Brazil — Although the neural bases of L2 processing have been increasingly well-studied, major empirical gaps remain. One issue that is still largely unexamined is whether and how the neurocognition of L2 changes after a period of non¬-exposure to the language, a situation that is not uncommon in L2 learning and use. Here we test whether and how the performance and brain bases of proficient L2 learners change after a period of non-exposure to the language, and how such changes may depend on the type of L2 training. We followed up on a recent ERP study of an artificial language that allowed us to control for the presence/absence as well as type of L2 exposure. In the initial study, subjects received either explicit (classroom-like) or implicit (immersion-like) training, and underwent behavioral and ERP testing at both low and high proficiency (Morgan-Short et al., 2010; under review). In response to grammatical violations, subjects showed natural language and other ERP components (LAN, P600, N400, late anterior negativity, early anterior positivity), though the exact pattern varied as a function of exposure type (explicit, implicit), proficiency (low, high) and grammatical violation (phrase-structure, agreement). In this follow-up study subjects returned 3 to 6 months later. Preliminary analyses suggest that this delay yielded no significant loss of proficiency, but changes in the ERP patterns, including the disappearance of components (e.g., anterior positivities), the appearance of new components (e.g., P600s), and the strengthening of components (e.g., anterior negativities). Explanatory hypotheses (consolidation in memory systems) and implications are discussed.

H42

BROCA'S AREA DOES NOT ONLY SUBSERVE VERBAL WORKING MEMORY Lars Meyer[1], Jonas Obleser[1], Angela D. Friederici[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany — Does Broca's Area only provide the neural substrate for verbal working memory during sentence comprehension? We challenged this vigorously discussed issue in language neuropsychology by crossing a syntactic processing factor (subject-first vs. object-first sentences) with a verbal working memory factor (short vs. long argument–verb dependencies). German syntax permits full crossing, unlike in English, where any contrast between object- and subject-first sentences is confounded with a difference in argument–verb dependency length. Presenting 24 participants with such sentences in an auditory fMRI study, the syntactic processing factor (= object-first vs. subject-first sentences) focally activated the left pars opercularis ($x = -57$, $y = 17$, $z = 10$, $z = 3.47$, $p < 0.005$), while the verbal working memory factor (= long vs. short argument–verb dependencies) activated the deep left supramarginal gyrus and planum temporale ($x = -42$, $y = -40$, $z = 10$, $z = 3.14$, $p < 0.005$). A negative correlation between this activation and digit span ($r = -0.55$, $p < 0.05$) suggests a central role in verbal working memory for the left supramarginal gyrus and planum temporale. Our results speak against Broca's Area only subserving verbal working memory. Rather, Broca's Area seems to support a computational faculty for syntactic processing, which operates on representations in verbal working memory as subserved by the left supramarginal gyus and planum temporale.

H43

DECODING PERCEPTION AND GRAMMAR: AN AUDITORY FMRI STUDY Björn Herrmann[1], Jonas Obleser[1], Christian Kalberlah[1,2], John-Dylan Haynes[1,2,3], Angela D. Friederici[1,3]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]Bernstein Center for Computational

Neuroscience, Berlin, Germany, [3]Graduate School of Mind and Brain, Berlin, Germany — Language processing is a higher cognitive function that requires syntactic operations in order to build a sentence structure. It has been suggested recently that local violations of such syntactic structures can modulate the activations in sensory cortex areas, while other studies found only regions outside the sensory cortices. The current event-related auditory fMRI study investigates the relative contributions of the auditory sensory cortices in syntactic processing. Two-word utterances were presented in a 2 x 2 stimulus design that varied the grammaticality (syntactically correct or incorrect) as well as the perceptual markedness (presence or absence of an overt word category marking "–t") of the utterances. A conventional univariate cognitive subtraction analysis was applied together with a multivariate pattern classification approach. Stronger activation was found for syntactically incorrect compared to correct utterances in the left inferior frontal gyrus (IFG), anterior superior temporal gyrus (aSTG), the superior temporal sulcus (STS) as well as in the right STS/STG. The information within local multivariate patterns indicated syntax-sensitivity to be strongest in the IFG, aSTG and STS of the left hemisphere. Importantly, the neural activation patterns of the auditory cortices were only modulated by the overt perceptual marking, but not by grammaticality. Thus, the present results speak against syntax-sensitive sensory cortex areas, but provide strong evidence for a distinction between regions involved in syntactic operations and regions involved in pure perceptual processes.

H44

ELECTROPHYSIOLOGICAL CORRELATES OF RULE-BASED ANOMALIES IN ARTIFICIAL GRAMMAR LEARNING Michelle Hendricks[1], Christopher Conway[1], John Purdy[1]; [1]Saint Louis University — We used event-related potentials (ERPs) to investigate the neural correlates of artificial grammar learning. Test items were divided into two categories based on superficial similarity (i.e. frequency of bigrams and trigrams) to training exemplars, such that low chunk test items were less superficially similar to training exemplars than high chunk test items (see Knowlton & Squire, 1996). Prior to recording the EEG, we trained participants (N=10) on letter strings generated from the grammar by requiring them to type each exemplar presented. The EEG was time-locked to the initial presentation of the test item, immediately prior to the grammaticality judgment. We recorded the EEG from 128 scalp electrodes using an EGI Geodesic Sensor Net; impedances were below 50 k?. Results indicated a robust P600-like component (with a centro-parietal distribution) for non-grammatical low chunk test items, but not for non-grammatical high chunk items, for which superficial similarity and grammaticality are confounded. The results are consistent with previous research finding a P600 (elicited in natural language tasks involving syntactic violations), but no LAN, for rule-based violations in artificial grammar learning tasks (Christiansen, Conway, & Onnis, 2007; Friederici, Steinhauer, & Pfeifer, 2002). The results are also consistent with research finding dissociable neural correlates for surface vs. rule processing, suggesting a specific role for the P600 in the detection of rule-based anomalies (Lelekov, Dominey, & Garica-Larrea, 2000; Nunez-Pena & Honrubia-Serrano, 2004). Finally, the results have implications for the generality of mechanisms underlying both the learning of artificial rule-based grammars and natural language processing.

H45

A GRATTON EFFECT ON THE SYNTACTIC P600: EVIDENCE THAT SYNTACTIC PROCESSING IS SUBJECT TO A DYNAMIC ADJUSTMENT OF EXECUTIVE CONTROL Liam Clegg[1], Ellen Lau[1,2], Gina Kuperberg[1,2]; [1]Tufts University, [2]Martinos Center for Biomedical Imaging, Mass General Hospital — It has been proposed that aspects of syntactic processing draw upon general executive processes which detect and resolve conflict between competing representations. A major feature of general conflict detection and resolution operations is their dynamic nature: increased conflict leads to the recruitment of additional cognitive resources, facilitating the resolution of subsequent conflicts. The present study aimed to determine whether the P600 – an event-related potential (ERP) associated with syntactic processing and conflict detection and resolution processes – is similarly subject to such a dynamic adjustment of control. In experimental paradigms of non-linguistic executive function, the dynamic adjustment of control manifests as the Gratton effect: a reduced cost in processing conflict trials preceded by other conflict trials, relative to those preceded by non-conflict trials. To determine whether a Gratton effect occurs in syntactic processing, we re-analyzed data from four ERP experiments in which syntactic violations in English sentences evoked robust P600 effects. We found clear effects of trial history on the P600 within and across experiments. When preceded by other syntactic violations, the amplitude of the P600 to syntactic violations was smaller than when preceded by non-violated sentences. In contrast, there was no effect of trial history on the N400 evoked by real-world violations in the same experiments. These findings suggest that aspects of syntactic processing are subject to similar dynamic control operations as classic tasks of executive function.

H46

DISTINCT NEURAL PROCESSES ENGAGED DURING TEMPORAL SEQUENCING AND COHERENCE BUILDING DURING DISCOURSE PROCESSING Wonja M. Fairbrother[1], Martin Paczynski[1], Eric. C. Fields[1,2], Gina R. Kuperberg[1,2]; [1]Tufts University, [2]Massachusetts General Hospital — In the real world, causes always come before effects, while in communication, events can be described in either this canonical temporal order using causal connectors such as "and so", or in non-canonical order using connectors like "because". Using event-related potentials (ERPs), we determined whether the canonical sequencing of events influences the establishment of causal coherence, or vice versa, during online discourse processing. Two-clause cause/effect sentences were created, in which we fully crossed temporal sequencing of events with discourse coherence, yielding four experimental conditions (example set: Fred was hungry [and so/*because] he ate…; Fred ate [*and so/because] he was hungry…"). 24 participants read these sentences, presented word-by-word (450ms, ISI: 100ms), and made acceptability judgments at the end of each sentence. At anterior electrode sites, ERPs to critical words ("ate/hungry") in clauses appearing in non-canonical sequence evoked a larger negativity between 350-450ms than in clauses appearing in canonical temporal sequence. This effect was particularly marked in the causally incoherent scenarios. At centro-parietal sites, ERPs to critical words in incoherent clauses evoked a larger negativity between 350-450ms (an N400 effect) and a larger positivity between 500-800ms (a P600 effect) than in coherent clauses. Together, these results suggest that during discourse comprehension, establishing the temporal sequencing of events and establishing their causal coherence are driven by distinct but interactive neural mechanisms.

H47

CROSS-LINGUISTIC VARIATIONS AND SIMILARITIES: AN ERP STUDY OF MANDARIN WH-CONSTRUCTIONS Ming Xiang[1], Fengqin Liu[2], Peiyao Chen[2], Taomei Guo[2]; [1]University of Chicago, [2]Beijing Normal University — Wh-dependencies are known to elicit extra processing cost since the parser needs to establish a long distance relationship between the fronted wh-phrase and its theta role position, as in the sentence "Emily wondered which pop star the performer in the concert had imitated…." (Kann et al, 2000; Phillips et al. 2005). However, many of the world languages exhibit a different syntactic pattern, such that the wh-phrases actually stay in their canonical theta position (literally in Mandarin, "Emily wondered the performer in the concert had imitated which pop star..."). To investigate whether this type of wh-constructions also evoke extra processing cost like their English counterparts, the current study recorded ERPs while native Mandarin speakers (n=24) read the following sentences (in Mandarin) and performed an acceptability judgment task: (1) declaratives "The teacher persuaded John (for his dreams) to apply for that school."; (2)interrogative wh-questions "The teacher persuaded John (for his dreams) to apply for which school?"; (3)embedded wh-questions "The teacher asked John (for his dreams) applied for which school.".

Another three "long" conditions were created by adding a prepositional phrase ("for his dreams") before the lowest verb. There were 30 trials/condition. An equal number (n=180) of unacceptable sentences served as fillers. The results indeed show an extra processing cost for wh-constructions. At the last noun phrase, the long (2) and (3) elicited a bigger P600 compared to the long (1); there was no difference between the former two. But this effect was not observed for the short conditions.

H48

LOCAL AND DISTANT MORPHOSYNTACTIC PROCESSING AT EARLY STAGES OF SECOND LANGUAGE ACQUISITION: AN EVENT-RELATED POTENTIAL STUDY Kara Morgan-Short[1], Laura Bartlett[1], Mandy Faretta Stutenberg[1], Kay E. González-Vilbazo[1]; [1]University of Illinois at Chicago — The acquisition of morphosyntactic aspects of second languages (L2s) is known to be particularly difficult for adult learners. The present study extends research on the acquisition of L2 morphosyntactic processing (e.g., Barber & Carreiras, 2005; Sabourin & Haverkort, 2003) by examining grammatical gender agreement between nouns and determiners (local), attributive adjectives (local) and predicative adjectives (distant) at different levels of L2 proficiency using event-related potentials (ERPs). Subjects were English native speakers enrolled in university-level Spanish basic language classes and were split into two proficiency groups—low and low-intermediate—based on the results of oral and written measures of proficiency. Subjects were asked to judge the acceptability of visually-presented Spanish sentences containing grammatical gender agreement violations on determiners and on attributive and predicative adjectives, along with matched correct sentences, plus distractor sentences. ERP data was collected as subjects judged each sentence. Behavioral results indicated that learners' acceptability judgments were above chance and that there were no differences between the low and low-intermediate groups. Preliminary analyses of the ERP results, however, suggest that processing differences exist. Whereas there was no clear evidence of ERP effects typical of linguistic processing in the low group, the low-intermediate group evidenced centro-parietal negativities for agreement on determiners and attributive adjectives, suggestive of N400 effects, although the effect was delayed for attributive adjectives. Predicative agreement elicited posterior positivities in low-intermediate learners, suggestive of P600 effects. These findings imply that morphosyntactic gender agreement begins to be processed at low-intermediate, not low, proficiency, despite a lack of behavioral differences between groups.

H49

NEURAL MECHANISMS SUPPORTING IMPLICIT ACQUISITION OF GRAMMAR IN A SECOND LANGUAGE Laura Batterink[1], Helen Neville[1]; [1]University of Oregon — Converging lines of evidence suggest that children and adults rely upon different neural mechanisms for the acquisition of grammatical information. While children acquiring their native grammar depend primarily on implicit memory systems, adults learning a new grammar appear to rely more heavily upon explicit memory systems. However, one caveat to these observations is that language acquisition in adulthood typically occurs through explicit, intentional learning strategies, as in a classroom setting. Surprisingly little attention has been directed towards investigating the neural mechanisms involved in second language learning when exposure to grammatical structure is incidental, as in native language acquisition. To examine this question, we presented adults with simple short stories in a foreign language, pairing each sentence with an accompanying picture to illustrate meaning. Following exposure, subjects completed a surprise grammaticality judgment task to assess learning. Based on performance on the grammaticality judgment task, subjects classified in the high proficiency group showed a late positivity to violations in the foreign grammar, similar in latency and distribution to the P600 effect. In contrast, low proficiency subjects showed no reliable ERP violation effects. These results suggest that adult learners who successfully acquire a foreign grammar system after implicit exposure may recruit some of the language-processing mechanisms similar to those employed by native language speakers. In line with previous findings, these mechanisms are primarily controlled in nature, while more automatic parsing mechanisms appear to be unavailable to adult second language learners, at least during early stages of acquisition, even when learning is incidental.

H50

EFFECTS OF TASK AND NARRATIVE CONTEXT ON SYNTACTIC PROCESSING: AN ERP-FMRI STUDY Eric Pakulak[1], Mark Dow[1], Helen J. Neville[1]; [1]University of Oregon — Many neuroimaging studies of syntactic processing use violation paradigms in which unrelated sentences are presented in isolation, and many of these paradigms also require participants to make grammaticality judgments. Here we compared the neural response to auditorily presented syntactic violations presented in unrelated sentences requiring a grammaticality judgment task (Grammaticality Judgment Condition; GJC) with the neural response to the same type of violations when presented in a more ecologically valid context featuring narrative context and no task (Narrative Context Condition; NCC). We acquired data from the same monolingual native English speakers in the different task conditions in two complementary methodologies: ERPs and functional magnetic resonance imaging (fMRI). In the ERP paradigm, syntactic violations in both conditions elicited both an early anterior negativity and a P600, though the P600 in the NCC was significantly reduced, consistent with some previous results (Gunter & Friederici, 1999; Hahne & Friederici, 2002). In the fMRI paradigm, syntactic violations in both conditions elicited robust activation in left perisylvian language areas. In the GJC activation was more left-lateralized and included more activation in parietal regions previously identified as likely generators of the P600 (Pakulak, Dow, & Neville, 2009). In the NCC activation was more bilateral in superior temporal regions and also in regions consistent with previous neuroimaging evidence on coherent text comprehension (Ferstl et al., 2008). The results suggest that processing syntactic violations recruits a core network of neural regions independent of task requirements, but that additional regions are recruited under different task and context conditions.

H51

SIMPLE BEAT GESTURES INFLUENCE THE SYNTACTIC ASPECT OF LANGUAGE COMPREHENSION Henning Holle[1], Jamie Ward[1], Christian Obermeier[2], Maren Schmidt-Kassow[3], Thomas Gunter[2]; [1]University of Sussex, [2]Max Planck Institute for Human Cognitive and Brain Sciences, [3]Goethe University Frankfurt — Gestures are a pervasive phenomenon of human communication and there is good evidence that these gestures convey additional information not found in speech, but it is unclear whether gestures and speech interact at the level of phonology, semantics or syntax. To date, the best evidence (derived from iconic gestures) suggests an interaction at the semantic level. We designed an EEG experiment to test whether beat gestures interact with the syntactic aspect of language. Stimuli consisted of German sentences that were temporarily ambiguous with respect to their syntactic structure (either Subject-Object-Verb SOV or OSV). German speakers have a preference for SOV, and a disambiguation towards the less preferred OSV structure elicits increased processing costs, including an increased P600 component in the Event Related Potential. In Experiment 1, we explored whether beat gestures can help to disambiguate syntactically ambiguous sentences, by presenting sentences either without a beat gesture, with a beat on the first (NP1) or with a beat on the second (NP2) ambiguous noun phrase. We found that a beat on NP2 abolishes the P600 effect usually found for OSV structures, suggesting that OSV structures become more plausible when the beat highlights the subject of a sentence. In a control experiment, we paired the auditory pitch accents resulting from making a beat with videos of a non-gesturing speaker, and found that the auditory accent did not abolish the P600 effect. Thus, the beat gestures of a speaker, but not their associated auditory pitch accents, interact with the syntactic aspect of language.

H52

LINGUISTIC DISTANCE AND SECOND LANGUAGE PROCESSING: ELECTROPHYSIOLOGICAL EVIDENCE FROM SPANISH/BASQUE BILINGUALS Adam Zawiszewski[1], Kepa Erdocia[1], Itziar Laka[1]; [1]University of the Basque Country — Several Event-Related Potentials (ERPs) studies on native versus non-native language processing argue that native/non-native differences result either from language proficiency, age of acquisition (AoA) or transfer from L1, but the relative impact of these and other factors in bilingual language representation and processing are still not well understood (Kotz 2009). In order to investigate these issues, we conducted a series of experiments in Basque language with native Basque speakers and highly proficient Spanish/Basque bilinguals (AoA=3). The experimental conditions were (i) linearization (verb-before-object (VO) in Spanish and object-before-verb (OV) in Basque), (ii) verb agreement (only with subject in Spanish, with subject and object in Basque) and (iii) argument alignment (accusative in Spanish versus ergative in Basque). Our results show that both groups behaved differently with regard to (iii) ergative case, but similarly when dealing with (i) different linearizations (OV/VO) and with (ii) subject and object verb agreement violations. Spanish/Basque bilinguals displayed a smaller P600 component, and more errors in the grammaticality judgment task for ergative case compared to Basque/Spanish bilinguals. A similar ERP pattern and comparable behavioral measures obtained for non-canonical word-orders (frontal negativities+P600) and verb agreement violations (N400-P600) in both groups. These results indicate that some aspects of language-variation have a deeper impact in bilingual processing even at high proficiency and early AoA, than others. Our findings suggest that not all cross-linguistic differences are equivalent regarding bilingual processing (McLaughin et al. 2010), an issue that is relevant to fully understand the neural underpinnings of linguistic structure.

H53

NUMBER ATTRACTION EFFECTS ON OBJECT-CLITIC AGREEMENT IN SPANISH: BEHAVIORAL AND ELECTROPHYSIOLOGICAL EVIDENCE Mikel Santesteban[1], Adam Zawiszewski[1], Erdocia Kepa[1], Laka Itziar[1]; [1]University of the Basque Country — Number attraction phenomenon in subject-verb agreement relations has been widely studied in language production and comprehension (e.g., Vigliocco, & Hartsuiker, 2002). However, only two studies have explored the neurophysiological mechanisms underlying these effects, and they have reported N400 and P600 components associated to the number attraction effects in subject-verb agreement (Kaan, 2002; Severens & Hartsuiker, 2008). Here we explored the electrophysiological responses of number attraction effects on object-clitic pronouns in Spanish. In a grammaticality judgment task, 46 Spanish native speakers were presented (word-by-word) with sentences containing a singular object-NP with a local noun that matched or mismatched in number with the head noun. Sentences were either grammatical or ungrammatical, depending of whether they contained an object-clitic pronoun that agreed or disagreed in number with the preceding object-NP (e.g., La pastora dijo que la casa de la(s) montaña(s) la/*las visitó en invierno [The shepherdess said that the house in the mountain(s), she visited it/*them in winter]). Clear number attraction effects were found. In the grammaticality judgment task, participants were significantly slower and less accurate in number mismatch than match conditions. More interestingly, at the critical word position (la vs. *las), different ERP patterns related to grammaticality effects were reported for number match (a fronto-central N400 followed by a P600) and mismatch (only a P600 component) conditions. The absence of N400 components in number mismatch conditions indicates that number attraction effects have a deep impact on early (considered automatic) stages of agreement computation, whereas later comprehension processes seem to remain unaffected.

H54

COMPARING RULES OF AGREEMENT IN NATIVE SPEAKERS: AN APPLICATION OF THE EVENT-RELATED POTENTIAL ADDITIVITY INDEX TO GENDER, NUMBER AND PHONOLOGY IN ITALIAN Elliot Collins[1], Geoffrey DC Valentine[1], Lee Osterhout[1]; [1]University of Washington — Additive Event-Related Potential (ERP) methodologies allow for the determination of the relative independence of the neural activity which underlies stimulus feature processing. Using these methodologies we compared ERP waveforms elicited by singly anomalous stimuli to those elicited by doubly anomalous stimuli. Applied to the linguistic domain, the ERP additivity index provides a measure of the degree to which grammatical rules share similar or separate neural generators. We conducted two experiments in which ERPs were recorded from native speakers of Italian as they read sentences containing article noun pairs. The article noun pairs were well or ill formed with respect to agreement in either number and phonology, or both, (experiment 1), or gender and number (experiment 2). Each of three singly anomalous stimuli and the two doubly anomalous stimuli elicited a P600 deflection of the ERP waveform. Ill formed article-noun pairs with respect to gender or phonology elicited a P600 component with greater amplitude than those elicited by ones anomalous with respect to number. In experiments 1 and 2, the waveforms resulting from double violations more closely resembled those from phonology and gender single violations, respectively, than they did those from number violations. The ERP additivity index describes the percentage of overlap between the amplitudes of the waveforms elicited by the doubly anomalous stimuli and those of the sums of singly anomalous stimuli, and hence, their relative neural independence.

H55

THE TIME COURSE OF FEATURE INTERFERENCE AND DECAY IN AGREEMENT PROCESSING: EVIDENCE FROM EVENT-RELATED POTENTIALS Darren Tanner[1], Lee Osterhout[1], Janet Nicol[2]; [1]University of Washington, [2]University of Arizona — Language processing in English requires the agreement of grammatical number features between the subject noun phrase (NP) and verb inflections. Behavioral studies have shown that native English speakers have difficulty processing this agreement when the subject NP contains conflicting cues about grammatical number (Nicol et al, 1997). Here we report results from two experiments investigating the time course of grammatical number interference during comprehension using event-related potentials. In Experiment 1 participants read sentences which contained a complex subject NP where the two nouns either matched or mismatched in number feature, and which contained a verb that either agreed or disagreed with subject ("The key to the cabinet/cabinets is/*are very rusty"). Results show that the verb in ungrammatical sentences elicited a P600 effect that was greater in the match than mismatch conditions. Grammatical sentences showed a P600 effect for number mismatches, but only at the sentence-final word. Experiment 2 used similar materials, but linearly separated the verb and preceding noun with a sentential adverb, allowing the grammatical features of the local noun to decay before subject-verb agreement is processed. Results showed robust effects of ungrammaticality but no interference from mismatching number features. These studies suggest a working memory account of grammatical interference in agreement processing, where cue-based search works in tandem with predictive mechanisms for agreement checking at the verb (Wagers et al, 2009). Mismatch interference occurs in grammatical sentences during sentence-final wrap-up processes, not during agreement checking processes as has previously been suggested (Pearlmutter, et al, 1999).

H56

ELECTROPHYSIOLOGICAL CORRELATES OF CUE-BASED RETRIEVAL IN SENTENCE COMPREHENSION: EVIDENCE FROM NOUN PHRASE ELLIPSIS Andrea E. Martin[1], Mante S. Nieuwland[1], Manuel Carreiras[1]; [1]Basque Center on Cognition, Brain, and Language — Language comprehension often requires retrieval of recently processed linguistic representations from memory. How is missing information recovered during

online sentence comprehension and what factors affect its retrieval? During ellipsis (the interpretation of unpronounced material), retrieval cues at the ellipsis site may make direct contact with the antecedent in memory (Martin & McElree, 2008, 2009). To study this process, we examined the electrophysiological response during retrieval of elided noun phrases in Castilian Spanish. Tracking the online processing of ellipsis in a language with morphological gender agreement allows the observation of retrieval as a function of the relevant representations (cues and recently processed constituents). Participants read 4 sentence conditions ("Marta se compró la camiseta que estaba al lado de la falda/el vestido y Miren cogió otra/*otro igual para salir de fiesta."), where the determiner ('otro'/'otra') cued the retrieval of the antecedent ('la camiseta'), which occurred in the context of a matching or mismatching local agreement attractor ('la falda'/'el vestido'). Data from 18 native speakers showed ungrammatical sentences evoked a sustained anterior negativity compared to grammatical ones from 300 milliseconds onwards; this negativity was reduced in the context of a matching local agreement attractor. Interestingly, in contrast to our predictions and inconsistent with ERP results on agreement errors (Silva-Pereyra & Carreiras, 2007), no P600 effect was observed. However, consonant with ERP results on referential processing (Van Berkum, Brown, & Hagoort, 1999), we take this anterior negativity to reflect the degree of cue diagnosticity to linguistically relevant representations during retrieval in sentence comprehension.

Language: Other

H57

A CONCURRENT TRANSCRANIAL MAGNETIC STIMULATION (TMS) AND FMRI INVESTIGATION OF CORTICAL ADAPTATION AND BEHAVIORAL IMPROVEMENT DURING SENTENCE COMPREHENSION Robert A. Mason[1], Chantel S. Prat[2], Marcel Adam Just[1]; [1]Carnegie Mellon University, [2]University of Washington — A concurrent repetitive transcranial magnetic stimulation (rTMS) and fMRI investigation of sentence comprehension was conducted to assess changes in behavior and brain function following down regulation of Wernicke's area. Readers were found to have improved performance on a language comprehension task following rTMS to Wernicke's area as compared to no change when the right hemisphere (RH) homologue received rTMS. This improved performance following left hemisphere rTMS was accompanied by an increase in efficiency, resulting in reduced activation in a bilaterally distributed language comprehension network. This demonstrates adaptability of the language network and suggests that the brain became more efficient due to the focal down-regulation of Wernicke's area. The brain activation measures (fMRI) and behavioral performance (accuracy and speed of responses to comprehension probes) were obtained as participants read a set of cognitively demanding sentences , either a subject-relative construction (The doctor that sued the man retained an attorney.) or an object-relative construction (The hippie that the drummer visited poured the wine.). fMRI activation was acquired before, during and after rTMS was applied to Wernicke's area (the Left Superior Temporal Gyrus) in the scanner. Behavioral data was also acquired outside the scanner when rTMS was applied to the RH. The improvement in performance as a result of this adaptive recruitment of cortex may indicate that rTMS actually led to a better processing strategy than the default strategy when the typical mode of processing was not available. This offers a promising new direction for the investigation of cognitive methods that enhance performance.

H58

HETEROGENEITY IN MODALITY-GENERAL AND MODALITY-SPECIFIC RESPONSES TO INPUT-ORDER Samuel Nastase[1], Vittorio Iacovella[1], Uri Hasson[1]; [1]CIMeC - Center for Mind/Brain Sciences, University of Trento, Italy — Prior work suggests that experience with monitoring auditory transitions scaffolds order perception and that lateral temporal cortex (Wernicke's area) mediates a general order perception function. We investigated whether regions associated with language comprehension are sensitive to sequence-order (entropy) across different modalities. Participants were presented with 8sec, 32-element series composed of four tokens. Series were presented in three modalities: auditory, visual, and audiovisual, and varied across four levels of order ranging from random to highly structured. Order was manipulated by varying the entropy of a 1st-order Markov process. The proportion of self-repetitions and relative token frequency (25%) were constant across levels of order. Functional images were acquired using a 4 Tesla scanner and the hemodynamic response function was estimated for each condition in a fast event-related design. A main effect of order, independent of modality, was found in right anterior temporal (aTemp) and left anterior cingulate cortex (ACC). Several regions showed interaction effects, indicating different sensitivity to order as a function of modality. Finally, response profiles to levels of order varied across regions: a linear relation between order and BOLD magnitude was found in ACC and aTemp, whereas lateral temporal regions exhibited U-shaped and inverse U-shaped response profiles in the audiovisual modality but not in the auditory modality. Our results demonstrate that order sensitivity is mediated by domain-general and domain-specific systems, which show heterogeneous response profiles to levels of order. These findings provide little support for the notion that lateral temporal regions perform a general function of modality-independent order-coding.

H59

BRAIN DYNAMICS OF COGNITIVE CONTROL DURING LEXICAL SELECTION IN OVERT SPEECH Stephanie Ries[1], Boris Burle[1], F.-Xavier Alario[1]; [1]CNRS & Aix-Marseille Université — Lexical selection is the process by which we select words for producing language. Neuropsychological and functional neuroimaging investigations have associated two frontal areas with the control of this process: the left inferior frontal cortex and medial frontal regions. Whether or not these regions play similar roles in word selection remains unclear. We addressed this issue by studying the spatio-temporal dynamics of word selection in overt speech with spatially improved electro-encephalography. We used a picture naming task which included a semantic interference effect believed to reflect the competitive nature of lexical selection. With the same materials, we tested a verbal version of the Simon task, involving arbitrary stimulus-response associations. As early as 100 ms after stimulus presentation, left and medial frontal activities were differentially affected by the task performed but not by within-task manipulations. These activities were interpreted as alert signals to the structure that would later be involved in the selection process. An activity starting 250/300 ms after stimulus presentation could be specifically associated with lexical selection, in agreement with recent findings. This activity was recorded over the left frontal cortex and reached its maximum when the execution of the response started. Finally, a medial frontal activity peaking about 250 ms before vocal onset was present in both tasks and was associated with response selection irrespective of the type of stimulus-response association. Together these findings suggest that word selection in overt speech is under both specific and domain-general control mechanisms, differentially involving lateral and medial frontal regions.

H60

A LINGUISTIC MULTI-FEATURE MMN PARADIGM AND ITS' APPLICATIONS Eino Partanen[1,2], Teija Kujala[2], Mari Tervaniemi[1,2], Minna Huotilainen[1,2,3]; [1]Finnish Center of Excellence in Interdisciplinary Music Research, University of Jyväskylä, [2]Cognitive Brain Research Unit, University of Helsinki, [3]Finnish Institute of Occupational Health — While effort is needed for understanding the contents of speech, the discrimination of speech sounds normally occurs in an automatic and effortless fashion. This is based on the existence of long-term memory traces for the native language phonemes. These traces can be investigated with the mismatch negativity (MMN), a component of event-related brain potentials (ERPs). We studied whether a multi-feature MMN paradigm, which contains several parallel sound changes (deviants), using naturally produced speech stimuli is feasible for studies of auditory discrimination accuracy of adult, child and infant participants. A naturally produced trisyllabic

pseudo word [tatata] was used in the paradigm and MMNs were recorded to changes that were acoustic (changes in fundamental frequency or intensity) or potentially phonological (changes in vowel identity or either vowel or consonant duration). All the different changes were presented in three different word segments (initial, middle, or final syllable) for adult participants or the middle position for child and infant participants. All changes elicited an MMN response in adults and most changes elicited responses in children but vowel duration change elicited a different response pattern than the other deviant types in adult participants. Changes in vowel duration and identity also had an effect on MMN lateralization in adult participants. Infants were only capable of discriminating the changes after training. Our results show that assessing speech sound discrimination of several features in word context is possible in a short recording time (30 minutes) with the multi-feature paradigm.

H61

THE NEURAL BASIS OF THE INTEGRATION OF WRITTEN AND HEARD SYLLABLES IN FLUENT AND DYSLEXIC READERS Maria Mittag[1], Rika Takegata[1], Paula Thesleff[1], Marja Laasonen[2,3], Teija Kujala[1]; [1]Cognitive Brain Research Unit, University of Helsinki, Helsinki, Finland, [2]Department of Psychology, Institute of Behavioral Sciences, University of Helsinki, Helsinki, Finland, [3]Department of Phoniatrics, Helsinki University Central Hospital, Helsinki, Finland — Learning to read requires the mapping of speech sounds (phonemes) with letters (graphemes). In individuals with reading impairments, such mapping is considered to be deficient. Recent studies suggest that the integration of letters and speech sounds takes place automatically and is dependent on temporal synchrony. In the present studies, we examined the integration of written and heard syllables in 1) fluent adult readers and 2) compared them with dyslexic adult readers. The mismatch negativity (MMN), an index of automatic change detection in the brain, was recorded. Subjects were presented with consonant-vowel syllable sounds together with visual stimuli, which differed between conditions. The auditory stimuli included vowel or consonant changes, or changes in syllable intensity, frequency, or vowel duration. As visual material, written syllables or scrambled images of the written syllables were used. The auditory stimuli were presented either synchronously with the visual stimuli or with a time delay. 1) In fluent readers, MMN amplitudes for consonant and frequency changes were larger in the syllable than control condition, and time delay diminished the MMN for all deviants. Results suggested a modulation of speech sound processing when sounds are presented with letters versus non-linguistic visual stimuli, and further that letter-speech sound integration depends on temporal synchrony. 2) MMNs were smaller in dyslexic than fluent readers in the syllable but not the symbol condition. MMNs of dyslexic readers were reduced by time delay and delayed for simultaneously presented stimuli. Our results indicate a deficient and delayed letter-speech sound integration in dyslexic individuals.

H62

MMN RESPONSES IN ACQUIRED AND DEVELOPMENTAL APRAXIA OF SPEECH: EVIDENCE FOR PHONOLOGICAL INVOLVEMENT Karen Froud[1], Reem Khamis-Dakwar[2], Melissa Randazzo Wagner[1]; [1]Teachers College, Columbia University, [2]Adelphi University — It is unknown to what extent developmental childhood apraxia of speech (CAS) and acquired apraxia of speech (AOS) may be associated with similar underlying mechanisms. It has been suggested that AOS may be associated with overspecification in the phonological domain (Dogil & Mayer, 1988; Dogil, Mayer, & Vollmer, 1996). Similarly some evidence suggests that children with CAS have disordered phonological representations (e.g. Moriarty & Gillon, 2006). To evaluate this hypothesis, we investigated auditory MMN responses from adults with AOS and children with CAS and healthy age-matched controls. CV syllables were presented in passive-listening oddball paradigms: phonemic (/ba/, /pa/), allophonic (/pa/, /pha/), and nonspeech (FM sounds) contrasts. MMN was derived from high-density EEG recordings by averaging and subtraction of averaged standard responses from averaged deviant responses within each condition. For all participants, the nonspeech condition resulted in MMN enhancement to deviant presentations. In children, MMN enhancement was observed in the phonemic contrast condition for controls only. The allophonic condition was not associated with MMN for children, but those with CAS showed a positivity throughout the epoch (up to 400 msec), which may index an immature pattern of responding (Rivera-Gaxiola, Silva-Pereyra, & Kuhl, 2005). In adults with AOS, MMN enhancement was evident in both the phonemic and allophonic conditions; however, the MMN component showed a greater right-lateralized scalp distribution compared to controls, which likely indexes lesion-related functional redistribution. We propose that these preliminary findings are consistent with a view of CAS and AOS as disorders affecting underlying phonological representations.

H63

FROM SOUND TO MEANING: CHANGES IN EEG SOURCE-LOCALIZED BRAIN ACTIVITY WITH FOREIGN-LANGUAGE TRAINING Catherine Poulsen[1], Phan Luu[1], Colin Davey[1], Don Tucker[1], Joey Nelson[1]; [1]Electrical Geodesics, Inc., Eugene, OR — When acquiring a foreign language, a stream of initially unintelligible sounds slowly emerges into distinct words and meaningful phrases. We aimed to track this process by measuring changes in brain activity across language training sessions. Twenty native English speakers attended two 50-minute sessions of computer-assisted, virtual-reality Dari language instruction, separated by a day without instruction. Immediately before and after each training session, subjects actively listened to 76 mini-dialogues while their electrical brain activity (EEG) was recorded from 256 scalp electrodes. Half the dialogues were composed of phrases from the trained lesson, and half were from an untrained lesson. Following each dialogue, subjects rated their comprehension on a scale from 1 through 4. The EEG was averaged off-line into event-related potentials (ERPs), time-locked to the onset of each word. Linear-inverse source analysis (sLORETA) with a realistic head model was applied to localize the scalp ERPs to the cortical surface. Training-specific changes in neural activity were observed in both articulatory-motor and semantic processing regions, including increases in left posterior inferior temporal gyrus, left temporal pole, and left lateral inferior frontal regions for the trained words. Also observed, was increasing left lateralization, and an increase in mediotemporal regions suggestive of memory reconsolidation during the one-day break between training sessions. These findings illustrate the ability to track changes with training in recognized language-processing brain regions using source-localized EEG recorded while listening to continuous, naturalistic speech. Subsequent research will explore individual differences and the development of adaptive training based on neural indices.

H64

COMPREHENDING ACTION VERBS WITH THE MOTOR SYSTEM Karen D. I. Schuil[1], Marion Smits[2], Rolf A. Zwaan[1]; [1]Erasmus University Rotterdam, The Netherlands, [2]Erasmus Medical Centre, The Netherlands — Theories of embodied cognition propose that higher order mental processes, such as language, are fundamentally based on perceptual and motor processes. More specifically, it has been hypothesized that the neural substrates for processing verbs describing bodily actions show considerable overlap with the neural substrates for performing the corresponding physical actions. A competing view proposes that the language-induced activation of the neural substrates for action is modulated by context. Recent studies have shown that action verbs in literal sentences activate the motor system, while mixed results have been observed for action verbs in idiomatic sentences. Thus, whether the recruitment of motor regions is automatic or context dependent remains elusive. We investigated functional magnetic resonance imaging activation to idiomatic and literal sentences including arm- and leg related actions. The Dutch language is highly suitable for this purpose, because all of the context can be presented before the verb in the subordinate clause. After scanning, idiomatic sentence comprehension was tested. Our results show that action verbs in both idiomatic and literal sentences recruit the fronto-temporal

regions, associated with language processing. Region of interest analyses show that literal action verbs engage the motor regions to a greater extent than idiomatic action verbs. Taken together, these results indicate that during comprehension, the nature of the semantic context influences the degree to which other modalities are recruited, such as in our case, the motor regions.

H65

EFFECTS OF SUBTHALAMIC NUCLEUS DEEP BRAIN STIMULATION ON LANGUAGE IN PARKINSON'S DISEASE Kaitlyn A. Litcofsky[1], Lara Hershcovitch[2], Michael Pelster[2], Matthew Gelfand[1], P. David Charles[2], Michael T. Ullman[1]; [1]Georgetown University, [2]Vanderbilt University — While deep brain stimulation (DBS) of the subthalamic nucleus (STN) has become an increasingly common therapy to treat Parkinson's disease (PD) motor symptoms, its effects on cognition, particularly on language, remain unclear. Such effects may elucidate not only the nature of DBS, but also the neural organization of language. This study investigates the effects of DBS on tasks probing aspects of both language and motor function. Ten early PD patients undergoing DBS treatment were compared to 10 early PD patients on medication alone, and 24 healthy controls. All subjects were tested twice; PD patients were tested first on and then off DBS or medication. To assess language, subjects were asked to produce the past-tenses of regular and irregular verbs; evidence suggests that regular past-tenses (and aspects of grammar more generally) depend on procedural memory and frontal/basal-ganglia circuits, and thus may be particularly affected by DBS. To assess motor function, subjects named objects that are or are not commonly manipulated (e.g., hammer, elephant); evidence suggests that naming manipulated objects depends on motor circuits, and thus should be especially affected by DBS. DBS, but not medication alone, affected performance on both regular past-tenses and manipulated objects, but in opposite directions. On-DBS yielded better performance at naming manipulated (but not non-manipulated) objects than off-DBS. In contrast, on-DBS yielded worse performance at producing regular (but not irregular) past-tenses than off-DBS. These contrasting effects elucidate language outcomes that may be expected from STN DBS, and the nature of motor and language circuits in the basal-ganglia.

H66

FOSTERING FLUENCY: TRANSCRANIAL MAGNETIC STIMULATION IMPROVES FLUENCY IN SUBJECTS WITH CHRONIC NONFLUENT APHASIA Catherine Norise[1], Jared Medina[2], H. Branch Coslett[2], Roy Hamilton[2]; [1]Haverford College, [2]University of Pennsylvania — Repetitive transcranial magnetic stimulation (rTMS) administered to the right inferior frontal gyrus (IFG) has been shown induce improvements in naming ability in patients with chronic left hemisphere stroke and nonfluent aphasia. We previously reported (Hamilton et al., 2010) the case of single patient in whom rTMS also led to improvements in spontaneous elicited speech, a measure of fluency. We sought to elucidate whether similar improvement in fluency can be induced in a larger cohort of patients with chronic nonfluent aphasia. We report eight subjects who demonstrated deficits in fluency as assessed using the Cookie Theft picture description task of the Boston Diagnostic Aphasia Examination. In the treatment condition, subjects received 1200 pulses of 1 Hz rTMS daily for 10 days at a site that had previously been shown to elicit a patient-dependent optimal response to rTMS. They were then tested one day and two months after treatment. In the sham condition, a subset of these subjects was tested on the same protocol with sham instead of real TMS. For measures of fluency, including the usage of closed-class words and speech rate, subjects improved in picture description 2 months after rTMS. However, these improvements were not observed in the sham stimulation condition. The results suggest that rTMS of the right IFG of patients with chronic non-fluent aphasia may improve language fluency, and that these benefits may persist after discontinuation of TMS treatment.

H67

CASE-INVARIANT LETTER REPRESENTATIONS REVEALED THROUGH MULTI-VOXEL SIMILARITY ANALYSIS David Rothlein[1], Brenda Rapp[1]; [1]Johns Hopkins University — Literate adults effortlessly recognize that r and R refer to the same letter. A common explanation is to assume a representational level that encodes a letter's abstract letter identity (ALI) in a manner that is case and font-invariant. Previous fMRI studies have investigated case-invariance by identifying regions exhibiting cross-case word priming (e.g. dog facilitating DOG) (Dehaene et al., 2001; 2004), or by comparing brain responses for alternating and single-case words (e.g. OrAnGe vs. orange) (Polk and Farah, 2002). Their findings indicated case-invariant responses in the left mid-fusiform gyrus. However, since the alphabetic stimuli used in these studies consisted of words and pseudowords, these studies did not directly test for ALIs. We addressed this in an fMRI study in which participants viewed single letters in an event-related design. For data analysis we used a multivariate representational similarity approach (Kriegeskorte et al., 2008). Specifically, we assumed that regions encoding ALIs should show greater similarity in their activation patterns for identical (yet visually dissimilar) cross-case pairs (a and A) than for non-identical cross-case pairs (a and B). Analyses revealed clusters of voxels in the left mid-fusiform gyrus and the left IFG/IFJ that showed greater similarity in their response patterns for identical cross-case letter pairs than for non-identical pairs. These results provide both a more nuanced understanding of ALIs in the left mid-fusiform gyrus and converging evidence for the importance of this region and the left IFG/IFJ in the literate brain (Rapp and Lipka, 2010).

H68

THE EFFECT OF GENDER AND HANDEDNESS ON THE HEMISPHERIC SPECIALIZATION OF PHONOLOGICAL AND SEMANTIC PROCESSING. FUNCTIONAL MRI EVIDENCE IN HEALTHY SUBJECTS Marcela Perrone-Bertolotti[1], Rachel Zoubrinetzky[2], Gaëtan Yvert[1], Cédric Pichat[1], Jean François Le Bas[3], Monica Baciu[1]; [1]Laboratoire de Psychologie et Neurocognition, UMR CNRS 5105, Université Pierre Mendès-France, Grenoble, [2]Centre Référent de Diagnostic des Troubles du Langage, Pôle Couple-Enfant, CHU de Grenoble, [3]IFR 1/SFR « RMN Biomédicale et Neurosciences », Unité IRM 3T CHU Grenoble, France — The present study aims to assess the effect of gender and handedness on the hemispheric lateralization patterns in healthy subjects during phonological (phoneme detection, PD) and semantic (living categorization, LC) processing, compared to a visuo-attentional control (C) task. Twenty four healthy volunteers participated at the experiment, 12 were right-handed (half females) and 12 left-handed (half females). Experimental conditions were implemented into a pseudo-randomized event-related fMRI paradigm. Two separate scans have been measured, one for PD and another one for LC. A 3T MR scanner (Bruker MedSpec S300) has been used for MR acquisitions. After fMRI spatial pre-processing steps, individual statistical analyses have been performed first (PD vs C; LC vs. C). Subsequently, a random-effect group analysis using one-sample t-test was performed for the same contrasts ($p < .001$, $k = 20$, $T = 3.50$). Based on the activation resulting from the group analysis, we defined symmetrical (left/right) regions of interest (ROI). For each task, each subject and each ROI, the % of MR signal intensity variation has been extracted and included in two ANOVA analyses one for each task (Gender and Handedness were between-subject factors and Hemisphere was within-subject factor). Our results showed left hemisphere predominance for both tasks. The effect of gender and handedness was observed only for PD. Specifically, left-handed females were not hemisphere lateralized. This result suggests that several variables may affect the hemispheric specialization for language

H69

ON THE ROLE OF CATEGORICAL PERCEPTION IN THE NEURAL PROCESSING OF WORDS VERSUS SEGMENTS: EVIDENCE FROM GRANGER ANALYSIS OF MULTIMODAL IMAGING DATA David Gow[1,2,3], Ricky Sachdeva[1]; [1]Massachusetts General Hospital, [2]Athinoula A. Martinos Center for Biomedical Imaging, [3]Salem State University — For over 50 years, evidence for the categorical perception of speech sounds (CP) has created a disconnection between the study of speech perception and the study of word recognition. The goal of the current study is to use 40 Hz phase locking and Granger analysis of high spatiotemporal resolution MRI-constrained MEG/EEG movies to identify the networks and network dynamics that support CP, and to determine what role if any these play in word recognition. Two experiments are presented. The first involves the explicit categorization of synthetic place and voicing continua in CV contexts. The second employs a word-picture matching task using CV and CVC continua that draw on the same continua. In the explicit categorization task causal interactions between the left superior temporal sulcus (STS) and the angular gyrus (AG) are found for tokens that straddle phonetic categories. In the word-picture matching task tokens with the same phonetic characteristics did not engage the STS or AG, but instead engaged strong bidirectional interactions between the supramarginal gyrus and superior temporal gyrus. We will review converging evidence from BOLD imaging and correlations between vocabulary development and grey matter neuronal density suggest that the SMG stores abstract representations of wordform. These results imply that: (1) the networks and processes that produce CP in explicit categorization tasks do not play a major role in word recognition and (2) word recognition involves an interactive direct mapping between sound and wordform.

H70

ERP EFFECTS OF PUNCTUATION: EVIDENCE FROM EVENT-RELATED POTENTIALS Hyekyung Hwang[1], Shari R. Baum[1], John E. Drury[2], Hope Valeriote[1], Karsten Steinhauer[1]; [1]McGill University, [2]Stony Brook University — This study used ERPs to investigate the real-time use of punctuation in processing ambiguous sentence structures. Previous ERP work in German suggested that commas activate implicit prosodic boundaries that locally elicit the closure positive shift (CPS) and help disambiguate syntactic structures in the same way as overt prosodic boundaries in speech (Steinhauer & Friederici, 2001). However, since this notion remains controversial (Kerkhofs et al, 2008), the present study was designed to contribute cross-linguistic evidence from a variety of English structures. Twenty-eight participants read sentences that were ambiguous either between (a) parenthetical (1) and subordinate clause (2) readings or (b) between early closure (3) and late closure (4) structures, and that either contained commas or not. (1) Mary(,) said John(,) was the nicest girl. (2) John(,) said Mary(,) was the nicest girl. (3) Since Jay always jogs(,) a mile seems a short distance to him. (4) Since Jay always jogs(,) a mile, this seems a short distance to him. ERP data revealed the following significant effects: (A) CPS components were elicited at all comma positions. (B) Incongruent comma use in (1) and (2) resulted in N400 effects on the critical noun phrase ('girl'). (C) Replicating a recent auditory ERP study, we found prosody-driven garden path effects in (3) and (4), the strength of which depended on whether commas had to be mentally deleted or inserted. These data provide further support for the direct correspondence of (punctuation-driven) implicit and overt prosody and for the Boundary Deletion Hypothesis (Pauker et al., in press).

H71

FUNCTIONAL PARCELLATION OF THE SUPERIOR TEMPORAL SULCUS USING RESTING STATE CONNECTIVITY Jeffrey Binder[1], Benjamin Stengel[1], Colin Humphries[1], Rutvik Desai[1]; [1]Medical College of Wisconsin — The human superior temporal sulcus (STS) is implicated in a wide range of perceptual and cognitive processes, yet the functional organization of this region is unclear. We used low frequency resting-state BOLD fluctuations to characterize the functional connectivity of 16 equal subdivisions of the left STS. Analysis of these connectivity maps suggests a subdivision of the STS into 3 main functional groups: 1) a semantic group including cortex in the angular gyrus, anterior temporal lobe, and lower bank of the mid-STS; (2) a posterior temporal group involved in speech production, with connections to the posterior superior temporal plane, supramarginal gyrus, and posterior inferior frontal cortex; and (3) an upper bank group in the mid-STS with connections to the superior temporal plane, parietal operculum, and primary sensory-motor cortex, likely involved in speech perception and monitoring speech production. Functional connectivity with ventral visual areas was confined to one lower bank region in the posterior temporal STS. In addition to connections with the semantic system, anterior temporal regions showed widespread connectivity with frontal opercular, sensory-motor, and medial temporal cortex, suggesting a "hub" role in integrating and encoding diverse sources of information. Consistent with studies of the monkey STS, marked differences in connectivity were observed between upper and lower bank regions in the mid-portion of the sulcus. These data provide new evidence on the functional organization of the human STS and illustrate a powerful method of functional parcellation that can be applied to other large, functionally heterogeneous regions.

H72

ANOMALOUS PATTERNS OF CEREBRAL DOMINANCE FOR LANGUAGE IN CHILDREN WITH ASD Karen Cooper[1], Timothy Lavicki[2], Kaitlyn DePlonty[1,2], Carly Demopoulous[2], Brandon Kopald[2], Lindsey Felix[2], Mona Stepansky[2], Nitin Bangera[2], Jeffrey Lewine[1,2]; [1]Mind Research Network, [2]Alexian Brothers Medical Center — Objective: To evaluate patterns of cerebral dominance for language in children with autism spectrum disorders. Participants and Methods: Magnetoencephalography was used to evaluate cerebral dominance in thirty-six children with an autism spectrum disorder and 23 neurotypical children. Whole-head MEG data were recorded during a dichotic listening paradigm. On each trial of the paradigm, the subject was presented a pair of words, one to each ear. Word pairs were semantically related [e.g., hot/cold, day/night] or unrelated [e.g., hot/moon, earth/sad], and subjects were instructed to listen to the words. The critical MEG response occurs between 350 and 750 milliseconds, post-stimulus, with the side of greatest response being language dominant as previously validated in 33 of 35 neurosurgical patients that underwent sodium amytal (Wada) testing. Results: Most neurotypical children showed the expected pattern of left hemisphere dominance [83%]. 13% of neurotypical children showed bilateral profiles and 4% were right hemisphere dominant. In marked contrast, only 23% of children with an ASD were left hemisphere dominant for language77% of children with ASD showed right (46%) or bilateral (31%) dominance, whereas 83% of the neurotypical controls showed left dominance, 13% showed bilateral and 4% showed right dominance. Conclusion: The data indicate that children with ASDs show anomalous profiles of langauge dominance. This may have important implications for directing neuromodulatory strategies [transcranial magnetic stimulation and transcranial direct current stimulation] that are being explored to improve language skills.

H73

NEURAL CORRELATES OF READING FLUENCY DEVELOPMENT Stephanie N. Del Tufo[1], Joanna A. Christodoulou[1], Patricia Saxler[1,2], John Lymberis[1], John D. E. Gabrieli[1]; [1]Brain and Cognitive Sciences, Massachusetts Institute of Technology, [2]Harvard Graduate School of Education — The functional neuroanatomy of reading fluency has yet to be explored using functional magnetic resonance imaging (fMRI). We investigated reading fluency in adolescent (n=11, 11-17 years) and adult readers (n=11, 18-35 years) using an event-related fMRI design with a 3.0T Tim Trio Siemens System. We administered behavioral tests that sampled cognitive abilities and reading fluency. Adolescent and adult readers were matched on non-verbal cognitive ability and reading fluency performance based on standardized measures. For the reading fluency fMRI task, participants were asked to judge the semantic plausibility of sentences shown word-by-word. Preliminary fMRI analyses show developmental differences in

functional activations. For adolescent readers, increased presentation rate corresponded to increased activation in the left cingulate gyrus and left precentral gyrus. For adult readers, increased presentation rate corresponded to increased activation in bilateral inferior frontal gyri, left fusiform gyrus, left superior temporal region, left parietal region, and bilateral occipital regions. A comparison of adult readers and adolescent readers revealed that the left inferior parietal lobule was recruited by adult readers but not by adolescent readers. Neural correlates of fluent reading showed developmental trends as age increased and reading proficiency improved.

H74

NEURAL SYSTEMS SUPPORTING TEXT READING FLUENCY IN DYSLEXIA Joanna Christodoulou[1], Stephanie N. Del Tufo[1], John Lymberis[1], Patricia Saxler[1,2], John D.E. Gabrieli[1]; [1]Dept. of Brain and Cognitive Sciences, Massachusetts Institute of Technology, [2]Harvard Graduate School of Education — Adult readers with dyslexia have often compensate for word reading difficulties, but their reading fluency remains slow. This study identifies the neural correlates of reading fluency using functional magnetic resonance imaging (fMRI) in adult readers with dyslexia. Behavioral performance and functional brain activity were analyzed for adults with dyslexia (n=12, 18-34 years). The fMRI task required participants to view sentences (word-by-word) and judge the semantic plausibility. Sentence presentation rate was manipulated as the independent variable in three conditions of slow, medium, and fast, which corresponded to minimal, moderate, and challenging speeds. Adults with dyslexia performed below average on standardized measures of word and text reading fluency while demonstrating average or higher nonverbal cognitive ability. Parametric modulation of sentence presentation speed (fast>medium>slow) yielded significant activations in the left hemisphere (inferior occipital gyrus, middle frontal gyrus, superior parietal lobule) as well as the right hemisphere (superior, middle, and inferior frontal gyrus, superior parietal lobule) in regions associated with compensatory reading systems (cluster-level corrected, $p<.05$, FWE). These findings provide novel insights underscoring a marked signature for dysfluent reading in the brain for adults with dyslexia.

H75

THE TEMPORAL DYNAMICS OF THE CODE-SWITCHING EFFECT BETWEEN ALPHABETIC AND LOGOGRAPHIC LANGUAGES IN UNBALANCED CHINESE-ENGLISH BILINGUALS Yu-Ning Chien[1,3], Yi-Hui Hung[2,3], Daisy Hung[1,3], Denise H. Wu[1,3]; [1]Institute of Cognitive Neuroscience, National Central University, Taiwan, [2]Institute of Neuroscience, National Yang-Ming University, Taiwan, [3]Laboratories for Cognitive Neuroscience, National Yang-Ming University, Taiwan — How two languages are represented and how the code switching between the two languages are enabled in the bilingual brain are intensively investigated in recent literature. The present study aimed to reveal the temporal dynamics of the code-switching effect between one alphabetic and one logographic language with the priming paradigm in 20 unbalanced Chinese-English bilinguals. A prime in one of three languages (Chinese, English or Korean) appeared for 100ms, and a target word in either Chinese or English was presented for participants to make a semantic judgment. Event-related potentials (ERPs) elicited by the target following a same-language, different-language, or non-linguistic prime (i.e., Korean) were recorded via a 64-channel electrophotography. Regardless the target language, only English primes that are visually distinct from participants' native language elicited a stronger N1 component of the target, while only Korean primes that are non-linguistic to participants elicited a stronger N2 component of the target. The code-switching effect was revealed from 250 ms after the target onset, as a prime in the same language with the target elicited a smaller P3 component than the other two kinds of primes. The prime in the same language with the target, as well as the nonlinguistic prime, was also associated with a smaller N400 component of the target than the prime in a different language. The neurophysiological findings suggested that the effect of code-switching between alphabetic and logographic languages occur from an early stage of lexical access and continues to be present during semantic processing.

H76

NARRATIVE IMPROVISATION IS ASSOCIATED WITH A UNIQUE PATTERN OF CEREBRAL ACTIVITY Nuria AbdulSabur[1], Michael Erkkinen[1,2], Yisheng Xu[1], Allen Braun[1]; [1]National Institutes of Health, National Institute on Deafness and Other Communication Disorders, [2]Howard Hughes Medical Institute — An ecologically valid model of discourse-level language production must account for a speaker's ability to spontaneously generate novel utterances in complex social contexts. To identify the neural basis underlying these processes, we collected blood oxygen level-dependent functional magnetic resonance images while subjects produced different types of narrative: rehearsed fictional stories, improvised fictional stories, and autobiographical stories. Stories included either one character or more than one. As a control, subjects recited nursery rhymes. Brain activity during production of rehearsed stories (compared to nursery rhymes) demonstrated strongly left lateralized activation of classical language areas and extrasylvian areas recruited at the discourse level. Conversely, improvised fictional narratives (compared to rehearsed stories) revealed bilateral activity which was most pronounced in the medial prefrontal cortex, posterior cingulate/retrosplenial cortices and inferior parietal lobules – the so-called default-mode network (DMN). Improvisational fiction involving social interaction (two vs. one characters) was associated with selective increases in the posterior portions of the DMN. The patterns associated with autobiographical narratives were strikingly similar to those seen for improvisational fiction, differing only in that they more robustly activated the left parahippocampal gyrus. Our results illustrate unique patterns of brain activity during production of different types of narrative. Importantly, the DMN appears to be selectively activated when subjects produce either improvised fictional stories or autobiographical narratives. Furthermore, we demonstrate enhanced activity of the posterior regions of the DMN during improvisational production of fiction involving more than a single character, suggesting a possible role for these regions in creating representations depicting social interactions.

H77

RESIDUAL DISCOURSE-LEVEL IMPAIRMENT IN WELL-RECOVERED POST-STROKE APHASIA Suraji Wagage[1], Jennifer Ryder[2], Beth Solomon[2], Allen Braun[1]; [1]The National Institute on Deafness and Other Communication Disorders, The National Institutes of Health, [2]Rehabilitation Medicine, The National Institutes of Health — Discourse production and comprehension are synonymous with successful real-world communication, one of the most critical aspects of daily life, yet are largely understudied and underexamined in assessment of post-stroke aphasia. Indeed, the classic tests by which aphasia is assessed—the Western Aphasia Battery (WAB), Psycholinguistic Assessments of Language Processing in Aphasia (PALPA), etc—rely on assessing linguistic ability on lexical and sentential levels, though recovered aphasics are anecdotally troubled by difficulties at the discourse level. This study compared the performance of 21 "well-recovered" (as defined by an Aphasia Quotient of 88 or greater on the WAB) aphasic subjects ranging in age from 34-81 years old with left-sided lesions in varying locations to that of age-matched controls on an array of discourse tasks including the Discourse Comprehension Test, picture description, proverb interpretation, conversation, procedural discourse, story generation, story retelling and story comprehension. Data were analyzed using analysis of variance. Controls performed at ceiling on the discourse tasks, while aphasic subjects were significantly impaired relative to controls despite their strong performance on tests that are considered standard measures of language ability. Overall, production was more significantly impaired than comprehension. Additionally, results show no correlation between performance on the standard battery of tests and performance on the discourse battery, indicating that discourse performance can't be predicted from the degree of residual language impairment on standard tests. These findings suggest a recon-

sideration of standard lexical and sentential tests as benchmarks of recovery in aphasia.

H78

THE INTERPLAY BETWEEN ATTENTION AND LANGUAGE IN HIGH-FUNCTIONING ADULTS WITH AUTISM: EVIDENCE FROM REACTION TIMES Sophieke Koolen[1], Constance Th.W.M. Vissers[2,3], Angelique W.C.J. Hendriks[1], Jos I.M. Egger[1,2,3], Ludo T.W. Verhoeven[1]; [1]Behavioural Science Institute, Radboud University Nijmegen, The Netherlands, [2]Centre of Excellence for Neuropsychiatry, Vincent van Gogh Institute for Psychiatry, Venray, The Netherlands, [3]Donders Institute for Brain, Cognition and Behaviour, Centre for Cognition, Radboud University Nijmegen, The Netherlands — Language problems are among the most profound deficits in autism spectrum disorders (ASD). Individuals with ASD often show increased performance on low level tasks, whereas high level processing seems reduced. Leading theories ascribe these language atypicalities to superior perceptual functioning (e.g. Frith, 1989; Mottron & Burack, 2001). Alternatively, as we propose, language problems might not result from language (in)competency as such, but from a different interaction between attention and language. The goal of the present study was to investigate the role of attention during processing of different levels of language. A dual-task experiment was designed, in which participants were exposed to sentences in three different conditions: I) a low level condition with attentional focus on orthographic errors, II) a high level condition with attentional focus on syntactic errors, and III) a dual level condition with attentional focus on both orthographic and syntactic errors. Reaction times for error detection were measured from 16 high-functioning adults with autism, and 16 IQ- and age-matched controls. Repeated measures analyses were conducted to compare performance in the dual level and the single level conditions. For controls, as expected, there was an attentional cost of dual level processing for low level performance but not for high level performance. For ASD participants, however, there was an attentional cost both for low level and for high level performance, as shown by significant increases in reaction times. These results suggest a strategic use of attention during language processing in ASD, rather than a difference in ability to process language.

H79

DIFFERENCES IN SENSORY AND COMPLEX VISUAL PROCESSING IN NON-VERBAL CHILDREN WITH ASD AND AGE-MATCHED CONTROLS: A VISUAL ERP STUDY Naseem Choudhury[1,2], Cecylia Chojnowska[1], Yan Yu[3], Judy Flax[1], Valerie Shafer[3], April A. Benasich[1]; [1]Center for Molecular & Behavioral Neuroscience, Rutgers University, [2]Ramapo College of New Jersey, [3]The Graduate Center, CUNY — Children with Autism Spectrum Disorder (ASD) present as a heterogeneous group, with underlying deficits in communication, social relatedness, restricted and repetitive behaviors, and sensory sensitivities. Studies of children with ASD suggest that deficits in these areas may be characterized as difficulty with "complexities", where performance on tasks requiring simple processing is spared, while performance on more complex tasks may show deficits. Hence, ASD children seem to be superior in processing fine visual detail but poorer in processing global structure. This study assessed visual event-related potentials of 6 non-verbal children with ASD and age-matched controls (mean age = 5.6 years) to photographs of common objects followed 500ms later by a matched or mismatched verbal label (e.g., picture of book followed by the word "book" or "duck"). Results suggest group differences in the latency of the first positive peak, C1. For children with ASD, the C1 peaked at approximately 200ms (maximal at occipital areas) compared to 150 ms for controls. No group differences in amplitude were seen, however, controls also showed a robust second positive peak, a P1 (350ms), which was missing in the ASD group. While C1 is thought to index sensory processing, P1 has a top-down component and is affected by attention shifting and focus. These findings are consistent with prior literature suggesting that children with ASD, while showing relatively intact sensory processing, may have disrupted complex processing abilities. Furthermore they may have difficulty focusing on, and attaching meaning to a visual stimulus even before a verbal stimulus is presented.

H80

COMPUTERIZED AUDITORY TRAINING ACCELERATES THE N200 RESPONSE IN 7-MONTH OLD INFANTS Cynthia Roesler[1], Naseem Choudhury[1,2], Teresa Realpe-Bonilla[1], April A Benasich[1]; [1]Center for Molecular & Behavioral Neuroscience, Rutgers University, [2]Ramapo College of New Jersey — The ability to efficiently process rapid changes (RAP) in auditory signals in the millisecond range is related to differences in language acquisition. Early deficits in RAP are predictive of later language disorders, such as Specific Language Impairment and dyslexia. In this study, we evaluate changes in the morphology of high density scalp event-related potentials (ERPs) from 14 typically developing 7-month-old infants before and after completing a computerized training task designed to sharpen auditory discrimination abilities. ERPs were passively elicited in an oddball paradigm (standard stimulus = 800-800Hz tone pair [85%]; deviant = 800-1200Hz) using fast- and slow-rate complex tone-pairs. ERPs were assessed at pretest (4-months) and then after completing a 6-week active training program (7-months). ERPs from the experimental group were compared to age-matched naïve controls (n=10). Preliminary analysis showed a P100-N200-P300 complex to standard and deviant waveforms, and a mismatch response (MMR) from the difference waveform (deviant-standard), at 4- and 7-months in both groups. There were no group differences in latency/amplitude at pretest. At posttest, however, latencies for the P100-N200-P300 complex for fast-rate stimuli were shorter as compared to pretest, and the N200 appeared significantly earlier in the experimental group as compared to controls (standard: 260 versus 330 ms, deviant: 250 ms versus 280ms). In previous studies, individual differences in N200 latencies were robustly associated with later language outcomes. The experimental group showed additional negative components not typically observed until 12 months-of-age. Findings suggest that early auditory training may accelerate efficient auditory processing abilities in infants.

H81

SIMULATING DYSLEXIA IN NORMAL READERS: BEHAVIOURAL AND FMRI DATA FROM A NOVEL PARADIGM Stefan Heim[1,2,3], Ann-Christin von Overheidt[1,2], Nicole Tholen[1], Marion Grande[1,3], Ralph Weidner[2], Katrin Amunts[1,2,3]; [1]RWTH Aachen University, [2]Research Centre Juelich, [3]JARA-Brain — Reading deficits in developmental dyslexia often result from phonological or visuo-magnocellular deficits. Here, we report a novel technique to simulate dyslexic symptoms in normal readers during visual lexical word-pseudoword decisions, and the underlying neurofunctional mechanisms. Grapheme-to-phoneme mapping was impaired by manipulating the identifiability of letters via familiar or unfamiliar letter shapes. Visuo-magnocellular processing was impaired by presenting letters in a moving, non-stationary manner. Lexical decision times were systematically higher for both types of simulation, which did not interact. Pseudowords elicited higher reaction times than words in all simulations, thus implying that the lexical advantage for words was maintained despite increasing processing difficulty. Moreover, pseudoword processing was extra difficult in the phonological simulation, as indicated by a significant interaction of word-type and letter shape. The simulation replicates earlier findings in the literature on "real dyslexics". Using fMRI, the phonological simulation recruited predominantly left and right IFG, whereas the magnocellular simulation involved bilateral V5/MT+. These findings demonstrate that dyslexic reading may be caused by phonological vs. magnocellular deficits with distinct neural pathways. The experimental simulation may help testing novel hypotheses about dyslexia first with normal readers as "models" before recruiting dyslexic participants only for the final examinations.

H82

FUNCTIONAL MRI AND NEUROPSYCHOLOGICAL EVIDENCES FOR LANGUAGE PLASTICITY IN TEMPORAL LOBE EPILEPSY, BEFORE AND AFTER SURGERY. A CASE REPORT. Rachel Zoubrinetzky[1,3], Marcela Perrone-Bertolotti[1,2], Gaëtan Yvert[1,2], Jean-François Le Bas[4], Monica Baciu[1,2]; [1]SFR « Santé et Société», Université Pierre Mendès-France, Grenoble, France, [2]Laboratoire de Psychologie et Neurocognition, UMR CNRS 5105, Université Pierre Mendès-France, Grenoble, France, [3]Centre Référent de Diagnostic des Troubles du Langage, Pôle Couple-Enfant, CHU de Grenoble, France, [4]IFR 1/ SFR « RMN Biomédicale et Neurosciences », Unité IRM 3T CHU, Grenoble, France — This study aims to assess the plasticity of language before (BS) and after surgery (AS) in a right-handed 55y old female patient with left temporal epilepsy. The neuropsychological assessment showed BS phonological fluency impairment (Cardebat et al., 1990) (Standard Deviation SD = -1.93) which was improved AS (SD = +.18). The fMRI examination explored three tasks (phonological, semantic and prosodic). Based on the activation obtained in control, specific task-related regions of interest were defined. Modified t-test analyses (Crawford & Howell, 1998) allowed the comparison of the mean parameter estimates between patient and control group. Compared to control, the results for phonological task showed deficit of activation BS, within Broca's area and left lingual gyrus and additional activation of right superior temporal and left supramarginal gyri as well as of bilateral precuneus. Compared to BS, additional activation of left middle temporal (around the excised region), fusiform, lingual, occipital inferior, supramarginal gyri and bilateral precuneus, has been revealed AS. BS and AS, the performance during phonological fMRI task was above the chance level. Moreover, the performance was significantly higher AS than BS. BS, the temporal epileptic focus induced cerebral reorganization of phonological substrate (illustrated by homologue activation of Wernicke's area). However, this plasticity pattern was functionally insufficient as the patient had phonological deficits. AS, another pattern of reorganization was described with supplementary activation of ipsilateral (to surgery) language and visuo-attentional regions. This pattern was functional because it was associated with improvement of phonological abilities.

H83

CROSS-LANGUAGE NEIGHBORHOOD DENSITY EFFECTS IN LATE ENGLISH-WELSH BILINGUALS: AN ERP STUDY Giordana Grossi[1], Nicola Savill[2], Enlli Thomas[2,3], Guillaume Thierry[2,3]; [1]State University of New York, New Paltz, [2]Bangor University, [3]Centre for Research on Bilingualism in Theory and Practice, Bangor University — Behavioral studies with proficient late bilinguals have revealed the existence of orthographic neighborhood density effects across languages for both the first (L1) and the second (L2) language (e.g., van Heuven et al., 1998). Electrophysiological evidence for cross-language activation comes from Midgley et al. (2008) who found an enhanced N400 for words with many cross-language neighbors compared to words with few cross-language neighbors. The authors also found an early effect (175-275 ms) only for L2 words, which they explained in terms of differential connection strength between L1 and L2 words depending on frequency of exposure (higher for L1). In this study, 14 late English-Welsh bilinguals performed a semantic categorization task on English and Welsh words presented in separate blocks. Words in the two languages were matched on orthographic and lexical measures. Fifty percent of words in each language had many cross-language neighbors and 50% had few cross-language neighbors. Similar early ERP cross-language neighborhood density effects (175-300 ms) were found for both L1 and L2 words, suggesting similar orthographic activation mechanisms for the two languages in proficient late bilinguals. In contrast, significant cross-language neighborhood density effects in the 300-600 ms were observed only for L1 words. These findings support the non-selective access view of single word recognition, at least in terms of orthographic processing, and suggest that proficiency with a language is what shapes the development of cognitive and neural orthographic processes.

H84

A BEHAVIORAL INVESTIGATION OF THE ROLE OF NON-ADJACENT LETTER BIGRAMS IN LETTER IDENTIFICATION Brenna Fearey[1], Nolan Conaway[1], Denise Donatien-Coder[1], Jesse Siegel[1], Viviana Quinones[1], Giordana Grossi[1]; [1]State University of New York at New Paltz — According to some theories, word recognition involves the activation of both adjacent and non-adjacent letter bigrams. Evidence mainly hinges on masked priming experiments. We sought to more directly test these models by investigating the role of non-adjacent letter bigrams in letter recognition. Adjacent letter bigram frequency and non-adjacent letter bigram frequency were orthogonally manipulated in a series of forced-choice letter identification experiments. Four types of stimuli were developed: nonwords with low adjacent and low non-adjacent bigram frequency (e.g., JBRWO), nonwords with low adjacent and high non-adjacent bigram frequency (e.g., DBRWY), pseudowords with high adjacent and low non-adjacent bigram frequency (e.g., JURSO), and pseudowords with high adjacent and high non-adjacent bigram frequency (e.g., DURSY). In the first experiment, letters in the central position were identified more accurately when embedded in pseudowords than nonwords (pseudoword superiority effect, PSE). Furthermore, the PSE increased for stimuli with high non-adjacent bigram frequency. These results were replicated in a second experiment where we controlled for the masking effect of the central fixation point. A third study was conducted in order to control for the pronounceability of the nonwords. We replicated the PSE, but the previously observed interaction between the two types of bigram frequency disappeared. These results suggest that the bigram frequency of adjacent letters strongly impacts letter identification, whereas the bigram frequency of non-adjacent letters may not. We are currently investigating whether phonology modulates these orthographic effects.

H85

ELECTROPHYSIOLOGICAL REPRESENTATION OF ACTION VERBS IN THE FIRST LANGUAGE AND THE SECOND LANGUAGE ON THE PRIMARY MOTOR CORTEX Sungbong Kim[1], Peter Gordon[1]; [1]Teachers College, Columbia University — This study investigated cortical electrophysiological responses to visually presented different types of words (action verbs and abstract words) and different types of action verbs (Face-, Hand-, and Foot-related verbs) to examine how action verbs from both the first language (L1: Korean) and the second language (L2: English) are represented on primary motor area of cortex (PMA) by comparing cortical event-related potentials (ERPs). A 128-channel electroencephalography system collected scalp voltages of five native Korean adults at 250Hz rate. The mean amplitudes of ERPs at the three early time-windows (90~160ms(N1), 160~230ms(P2), and 230~300ms(P3)) were computed to test word type effect at PMA montage, and effect of action verbs on the four selected electrodes of left PMA (Cz, C1, C3, and C5). Larger P2 for action verbs than abstract words (1.483 vs. 0.692) was observed at PMA, $F(1, 4)=5.100$, $p=.087$. Within L2 condition, verb type effect was observed in the first time window, $F(2, 8)=3.598$, $e=.798$, $p=.095$. Further analysis with individual electrodes revealed that foot-related words elicited significantly bigger N1 than face-related words at the two electrodes, Cz and C1, which locate above leg-movement cortical area of motor homunculus, $F(1, 4)=16.452$, $p<.05$, and $F(1, 4)=7.328$, $p=.054$, respectively. L2 words had consistently larger amplitude than L1 words. The results of current study found the effect of word types and the effect of verb types, and confirm the claim of distributed semantic processing of brain and neural level ground of action verbs, though this conclusion was more obvious with ERPs for L2 comparing to L1.

H86

ERP MISMATCH NEGATIVITY PREDICTS READING FLUENCY IN YOUNG CHILDREN Elizabeth S. Norton[1,2], Marianna D. Eddy[1], Tyler K. Perrachione[1], Abigail B. Cyr[2], Maryanne Wolf[2], John D. E. Gabrieli[1]; [1]Massachusetts Institute of Technology, [2]Center for Reading and Language Research, Tufts University — The mismatch negativity (MMN), a pre-attentive electrophysiological response to a deviant item within a series of identical stimuli, is a strong

longitudinal predictor of reading ability beyond behavioral measures across languages. However, it remains unclear which reading-related processes (phonological awareness, accuracy, fluency) are concurrently related to the MMN. In this study, children ages 5-8 heard natural speech syllables /ba/ and /da/ through earphones while attending to a silent cartoon during EEG recording. All participants had typical language and hearing, and nonverbal IQ and vocabulary standard scores above 90. We analyzed event-related potentials for 3,000 trials (10% deviants) and calculated the mean amplitude of the difference between standard and deviant trials 200-500msec after stimulus onset. Analyses revealed that the mean amplitude of individuals' MMN response was significantly related to standardized measures of reading fluency at the connected text, word, and subword levels (WJ-III Tests of Achievement Reading Fluency, Test of Word Reading Efficiency, Rapid Automatized Naming), but not to other measures of untimed reading or phonological awareness. The higher-amplitude mismatch response to deviant stimuli might reflect automaticity of processing that is required for fluent reading. These findings support the notion that cognitive neuroscience techniques could be useful in efforts to identify children who will have reading difficulties, especially in the crucial domain of fluency, which is often overlooked in assessments of reading ability.

H87

NEURAL SENSITIVITY TO SUB-PHONEMIC FEATURES: AN FMRI ADAPTATION STUDY Laurel A. Lawyer[1], Lewis C. Lawyer[1], David P. Corina[1]; [1]University of California Davis — Goal. fMRI adaptation paradigms have been commonly used to explore the featural composition of visual processing in humans (Grill-Spector and Malach (2001)). In auditory perception, speech sounds may also be composed of hierarchical featural representations. However, the methods of fMRI adaptation have not been widely applied to speech processing. Methods. This study uses adaptation effects to investigate featural differentiation of English CV syllables. Subjects (n=7) listened to a single syllable repeated 8-14 times, followed by a test item which differed in 0-3 phonetic features (as defined by Hayes (2009)). A region of interest analysis was used to define voxels that were sensitive to speech compared to noise (Marsbar, Brett et al. (2002)). Data was analyzed both on a group level using standard SPM methods, and on an individual level using a time-course sensitive pattern classification algorithm (TClass, Kadous (2002)). Results. Initial results show differential activation for test items based on the degree of feature similarity to preceding adaptation strings. The temporal pattern classification technique demonstrates the ability to reliably classify these neural responses based on auditory form. Conclusion. These data suggest that regions in auditory cortex are sensitive to featural content of speech below the level of the segment. This level of encoding may represent articulatory or acoustic features in speech.

H88

ICONIC GESTURES FACILITATE WORD AND MESSAGE PROCESSING Ying Choon Wu[1], Marguerite McQuire[1], Seana Coulson[2]; [1]Center for Research in Language, UCSD, [2]Department of Cognitive Science, UCSD — This study assessed how iconic gestures impact the brain's real-time response both to speech in spontaneous, multi-modal discourse about concrete topics, and to pictures of the objects discussed. EEG was recorded as 24 healthy adults viewed descriptive discourse involving both speech and iconic gestures. Videos were followed by related or unrelated picture probes. Incongruent control trials were constructed by swapping audio and video files such that gestures no longer matched the meaning of utterances. After EEG recording, participants classified the speech-gesture congruency of each trial offline, and were divided into two groups based on their performance: super-integrators, who tended to judge most videos as congruent, and conservative integrators, who exhibited a bias towards incongruent judgments. Overall, ERPs time-locked to speech in the videos were less negative 400-875 ms when accompanied by congruent versus incongruent gestures. In conservative integrators, the congruency effect had a posterior topography, not unlike that of the well-known N400 effect. In super-integrators, congruency effects were frontally focussed, consistent with ERP concreteness effects. In both groups, brain response to related picture probes differed from unrelated, suggesting a facilitative effect of discourse. However, ERPs to picture probes revealed that only the super-integrators were sensitive to the speech-gesture congruency in the discourse prime. Findings suggest that super-integrators engaged image-based processes to construct a representation of speaker meaning that combined information from both his words and gestures. Conservative integrators utilized congruent gestures to facilitate semantic processing of concurrent speech, but do not appear to have engaged imagistic processes.

H89

LISTENERS DIRECT ATTENTION TO UNPREDICTABLE MOMENTS IN CONTINUOUS SPEECH: EVIDENCE FROM EARLY LATENCY EVENT-RELATED POTENTIALS Lori Astheimer[1], Lisa Sanders[1]; [1]University of Massachusetts Amherst — Several lines of research demonstrate that listeners attend to word onsets in continuous speech, but the reason for this preferential processing is unknown. Attending to all word onsets may be necessary for word recognition, or listeners may attend to the initial portions of most words because these segments cannot be predicted from context. To test the hypothesis that predictability modulates attention during speech processing, we compared event-related potentials (ERPs) elicited by attention probes presented concurrently with word onsets following highly constraining (e.g., The woman took the warm cake out of the …) and unconstraining (e.g., The man walked over to the …) contexts. The completion of both sentences was a word that, based on the constraining context, was either expected (e.g., oven) or unexpected (e.g., pantry). Each participant heard both contexts with only one completion for each to avoid repeating items and to balance all other factors across participants. Probes presented concurrently with word onsets in unconstraining sentences elicited a larger first negative peak (N1) than the same words in constraining sentences. As expected, unpredictable words in constraining contexts and both types of words in the unconstraining contexts elicited a larger N400 than predictable words in constraining contexts. These results indicate that listeners direct more attention, as indexed by N1 amplitude, to word onsets that cannot be predicted from the preceding context. Unexpected words capture processing resources later, as indexed by the N400. This suggests that temporally selective attention is used to preferentially process the most informative segments of speech.

H90

SEMANTIC AND PHONOLOGICAL PROCESSING IN THE VISUOSPATIAL DOMAIN: EVIDENCE FROM SWEDISH SIGN LANGUAGE Eleni Orfanidou[1], Lena Kästner[2], Cheryl M. Capek[3], Velia Cardin[4], Bencie Woll[1], Mary Rudner[5], Jerker Rönnberg[5]; [1]Deafness, Cognition and Language Research Centre, University College London, UK, [2]Department of Philosophy II, Ruhr-University Bochum, Germany, [3]School of Psychological Sciences, University Of Manchester, UK, [4]Department of Psychology, Royal Holloway, University of London, UK, [5]Linnaeus Centre HEAD, Swedish Institute for Disability Research, Department of Behavioural Sciences and Learning, Linköping University, Sweden — Signed language (SL) processing (phonological, semantic) is supported by classical left-hemisphere areas that support spoken language processing (Rönnberg et al., 2000). Previous work has been unable to distinguish experimentally the neural correlates of semantic and phonological SL processing, however. In the present experiment we isolate phonological and semantic processing in a single fMRI study by manipulating the semantic and phonological characteristics of the stimulus material. 11 native signers of Swedish Sign Language (SSL) were scanned while performing monitoring tasks for specific components of (a) familiar SSL signs (phonology and semantics), (b) foreign signs from British Sign Language (BSL) (phonology only), and (c) non-signs (non-existing signs violating phonological rules; neither phonology nor semantics). Preliminary analyses reveal greater activation for SSL signs compared to BSL signs (semantic processing) in frontal (left superior MFG, IFG bilaterally but mainly on the left, SFG) and temporal areas

(left superior and middle temporal pole, inferior temporal gyrus, left MTG and angular gyrus). Contrasting activation for BSL signs and non-signs (phonological processing) reveals activations in left IFG, the pre- and postcentral gyri, MFG and insula bilaterally, middle cingulate, right putamen and right supramarginal gyrus (bilaterally, more pronounced on the left). These results indicate that semantic and phonological processing in SL are supported by distinct yet overlapping networks that at least partly match those suggested for spoken language processing. In the first neurolinguistic endeavour to explore SLs crosslinguistically, data from native BSL signers will be collected and analysed to establish the cross-linguistic generality of these results.

H91

LISTENING TO INTELLIGIBLE BUT DEGRADED SPEECH INCREASES THE STRENGTH OF FEED FORWARD AND FEED BACKWARD CONNECTIONS BETWEEN THE LEFT ANTERIOR AND POSTERIOR SUPERIOR TEMPORAL SULCUS Samuel Evans[1], Carolyn McGettigan[1], Alex P Leff[1], Stuart Rosen[1], Zarinah K Agnew[1], Poonam Shah[1], Sophie K Scott[1]; [1]University College London — Studies in human and non-human primates suggest that auditory information is processed hierarchically, with regions lateral to primary auditory cortex responding selectively to stimuli of increasing complexity. Accurate speech perception requires the integration of lower level, acoustic processes with higher-order, linguistic processes, with the demands increased on this system when individuals listen to degraded speech. We wanted to understand how the effective connectivity within the temporal lobes was modulated by listening to degraded but intelligible speech. In this study we demonstrate with functional magnetic resonance imaging (fMRI) and Dynamic Causal Modelling (DCM) that listening to degraded speech increases the strength of both feed forward and feed backward connections between left anterior and left posterior STS. Furthermore, we show that stimulus-dependent activity within the left hemisphere causes dynamic changes in activity within the right hemisphere, but not vice versa. These results suggest that the left anterior STS, a region previously implicated in the processing of intelligible speech, may be involved in top down modulation of left posterior STS when individuals listen to degraded speech signals. Furthermore the results provide an alternative approach in demonstrating left hemisphere dominance in language processing.

H92

THE EFFECT OF VARIED PROPORTIONS OF WORD TYPES IN A READING TASK ON FMRI BOLD ACTIVATION IN THE VENTRAL AND DORSAL VISUAL PROCESSING STREAM Crystal Zhou[1], Brea Chouinard[1], Stan Hrybouski[1], Jacqueline Cummine[1]; [1]University of Alberta — Background: Two processing streams are associated with reading tasks: a dorsal route employing serial reading and a ventral route involved in whole-word reading. The extent to which each stream is active while reading different proportions of different word types is still under investigation. Purpose: Using functional Magnetic Resonance Imaging (fMRI), we explored activation in ventral and dorsal visual processing streams for exception words (EXC) and regular words (REG), during three variations of a reading task: 1) 25% EXC and 75% REG (25EXC-75REG), 2) 75% EXC and 25% REG (75EXC-25REG), and 3) 50% EXC and 50% REG (50EXC-50REG). The 25EXC-75REG should evoke both ventral and dorsal activation, the 75EXC-25REG should evoke primarily ventral activation, and the 50EXC-50REG condition should evoke a pattern between those of the first two conditions. Method: Participants (N=10) read lists in which proportions of EXC and REG words were manipulated. Maps for unique versus shared regions of activation were created and reaction times (RTs) were collected. Results: Changes in activation along ventral and dorsal stream corresponded to changes in RT from behavioural data. Individuals were fastest in 25EXC-75REG and activation was found in both ventral and dorsal systems. The 50EXC-50REG condition produced the slowest RTs and showed shared activation along both the ventral and dorsal systems. In the 75EXC-25REG condition, participants monitored their responses for EXCs, as shown by slowed RTs and activation in BA6. Conclusion: Manipulating the proportion of EXC and REG influences the extent to which individuals employ serial reading and/or whole-word reading processes.

H93

NEURAL SYNCHRONIZATION SUPPORTS MISMATCH NEGATIVITY HIERARCHICAL NETWORK FOR DISCRIMINATING MEANINGFUL PHONEMIC CONTRASTS Shannon E. MacLean[1], Lawrence Ward[1]; [1]University of British Columbia — Several cortical regions appear active when the mismatch negativity (MMN) scalp potential is evoked automatically in response to detectable auditory changes. It remains debatable whether the activation of multiple regions beyond the auditory cortex is coincidental or functionally significant to the MMN response. To investigate the functional relationship between brain regions active during the MMN response, high density EEG was separated into sources using independent component analysis (ICA) and source spatiotemporal properties were examined. For a group of healthy young adults (n=14) passively listening to infrequent changes in speech syllables (Ba vs Da), cross-coherence analysis showed that during the MMN response synchronous interactions occurred among sources located in the left and right STG (BA42), the left and right SFG (BA10), R IFG (BA45), and the L IFG (BA47) and Broca's area (BA45). In a related task, this same group attended to the syllables, responding to deviants and standards with a different button press. During the MMN response synchronous interactions occurred among sources located in the left and right STG (BA22), the left IFG (BA10), the R IFG (BA47), Broca's area (BA44) and the R CING (BA32). These findings demonstrate consistent synchronous interaction between the STG and specialized regions in the frontal cortex during the time period when the MMN response is evoked at the scalp. This study provides evidence for a hierarchical functional organization to change detection in the human auditory system. Nodes in speech processing regions provide support for the role of long term memory in the MMN network.

H94

FUNCTIONAL NEUROANATOMY OF SKILLED AND NON-SKILLED DEAF READERS: DATA FROM WORD AND SIGN PROCESSING David Corina[1], Laurel Lawyer[1], Elizabeth Hirshorn[2], Peter Hauser[3]; [1]U.C. Davis, [2]Univ. of Rochester, [3]Rochester Institute of Technology — Goals. How profoundly deaf individuals acquire competencies in the processing of written orthographic forms is poorly understood. This study compares the functional activation in skilled and non-skilled deaf readers during single word and single sign processing. Methods. fMRI was used to document the BOLD response while subjects performed implicit reading (Price et al. 1996) and implicit sign recognition (Corina et al. 2010) tasks. Subjects were segregated into two groups on the basis of independently administered tests of written English comprehension (PIAT) and were judged for ASL competency (ASL-SRT, Hauser et al. 2010). Results. Initial findings from adult signers (n=15) indicate word and sign language processing produce activation in regions associated with lexical processing, including the left middle and superior temporal regions and left inferior frontal regions. During word reading, skilled deaf readers activated left middle and inferior frontal regions and bilateral mid-temporal lobe regions. Less-skilled readers showed widespread activity including left-temporal and ventral visual regions, which were not seen in the skilled readers. Unexpectedly, deaf signers who scored lower on the English reading test showed activation for ASL that was largely limited to bilateral frontal regions. This pattern of activation contrasts with other reports in the literature, which typically reveal bilateral middle temporal gyrus activation that includes left posterior Wernicke's territory. This unexpected pattern may be reflective of strategic responding in the implicit sign task. Conclusions. These data provide new evidence for neural systems that enable the acquisition of English orthographic knowledge in the face of severe auditory deprivation.

H95

DETERMINING THE SUITABILITY OF PARKINSON'S DISEASE AS A PARALLEL DISEASE MODEL FOR GULF WAR SYNDROME 2. Kristin Moffett[1], Ilana Levy[1], Vikram Smith[3], Virginia Buhl[2], Kimberly Case[1], John Hart[2], Anna Moore[3], Robert Haley[2], Bruce Crosson[1]; [1]University of Florida, [2]University of Texas Southwestern Medical Center, [3]Emory University School of Medicine — Following the 1991 Gulf War, at least one quarter of the returning veterans developed physiological and psychological symptoms not attributed to post-traumatic stress disorder. While three unique syndrome subtypes have been identified to describe the groupings of these symptoms, Syndrome 2 (Syn2) veterans are recognized as the most cognitively impaired group. The neurological basis of Syn2 impairments is suspected to involve the basal ganglia, and previous research has linked basal ganglia damage to impairments in complex verbal and verbal executive functions. Hence, this study assessed participants' performance in these cognitive domains. Parkinson's disease (PD) was chosen as a parallel disease model for Syn2 because of the basal ganglia's fundamental involvement in PD. For this study, 22 Syn2 veterans and their matched control group, and 25 PD civilians and their matched control group completed cognitive testing. Relative to their controls, PD patients were impaired at $p < .05$ on a verbal working memory measure. Relative to their controls, Syn2 patients were impaired on complex language, verbal fluency, and verbal working memory measures. Further, patterns of semantic priming relative to their respective controls were dissimilar for PD and Syn2. Contrary to our hypothesis, the Syn2 group's pattern of performance was different from that of the PD group, aside from performance on the measure of verbal working memory. Overall, these findings suggest PD is not an appropriate disease model for Syn2. Future research should explore similarities between Syn2 and additional subcortical disease models in order to identify the neurological mechanism behind Syndrome 2.

H96

NEURAL SUBSTRATES UNDERLYING NEW WORD LEARNING IN ADULT MONOLINGUALS AND EARLY SPANISH-ENGLISH BILINGUALS Kailyn Lipowski[1], Kelly E. King[1], Elizabeth A. Woods[1], Arturo E. Hernandez[1]; [1]University of Houston — The purpose of this study was to evaluate the neural substrates underlying the early stages of word learning in monolinguals and bilinguals. In particular, we wanted to determine if monolinguals and bilinguals show differences in neural processing of newly learned words that share orthographic similarity to their English translations. English monolingual and early Spanish-English bilingual participants learned 100 German words, 50-cognates and 50-non-cognates. Using an event-related design 100 German words and matched English controls were presented one at a time in an fMRI scanner, and subjects were asked to perform a semantic task after each word was presented. In both monolinguals and bilinguals, fewer, more localized regions were active in the English vs. German condition (i.e. middle temporal gyrus), suggesting a process of simple semantic retrieval as opposed to the active translation involved in recalling new German words. In the German vs. English condition, monolinguals showed robust activation across a wide set of language-related areas (i.e. inferior frontal gyrus, middle temporal gyrus), suggesting difficulty with lexical, phonological, and articulatory processing. Bilinguals had markedly less activation in the same condition, with bilateral activity in inferior parietal lobules, suggesting translation is much less difficult in individuals that have experience with another language. Results also revealed that bilinguals but not monolinguals showed brain activity that depended on orthographic similarity. Taken together these results suggest that bilingual's experience may help them with novel word learning.

H97

ONLINE PROCESSING OF SCALAR IMPLICATURES IN CHINESE AS REVEALED BY EVENT-RELATED POTENTIALS Stephen Politzer-Ahles[1], Robert Fiorentino[1], Xiaoming Jiang[2], Xiaolin Zhou[2]; [1]University of Kansas, [2]Peking University — In sentence processing, whether pragmatic information is integrated immediately and automatically or at a delay is a subject of debate in experimental pragmatics. One test case is that of scalar implicatures, which occur in propositions like "some cats are animals", when actually all cats are animals: the quantifier "some" is logically correct here (because at least two cats are animals) but pragmatically underinformative (because all cats should be animals). Previous event-related potential studies on scalar implicatures typically investigated critical words downstream of the quantifier and were thus not able to address the possibility of immediate construction of scalar interpretations at the moment the quantifier is encountered. The present study adopts a picture-sentence design to make the violation immediately detectable when the quantifier is read. Participants saw pictures in which several characters are either performing the same activity or different activities, followed by sentences using "some" or "all", yielding a 2x2 design including both scalar violations ("some" sentences after "all" pictures") with matched controls, and purely incorrect assertions ("all" sentences after "some" pictures) with matched controls. Preliminary results of electrode-level and by-region analyses for the critical scalar violation, about which alternative theories make distinct predictions, suggest that a broadly distributed negativity emerges over posterior electrodes in the 300-600ms time window for the scalar violation case, relative to its control, immediately when the quantifier is read. This finding is consistent with a view in which pragmatic expectations, which are necessary for the construction of scalar implicatures, are integrated immediately during sentence processing.

H98

WINDOWS INTO THE VISUAL PROCESSING OF LANGUAGE: EVIDENCE FROM COMPRESSED AND LOCALLY-REVERSED ASL So-One Hwang[1], Clifton Langdon[2], Concetta Pucci[2], Gaurav Mathur[2], William Idsardi[1]; [1]University of Maryland, [2]Gallaudet University — The goal of this study is to demonstrate the contributions of both modality and language-dependent processing in determining the time-window of integrating the linguistic input. The phenomenon of cognitive restoration of locally-reversed speech has provided insight into integration windows (Saberi & Perrott, 1999). While intelligibility for speech is high at smaller intervals of reversals, intelligibility falls drastically at reversals of ~60 ms, (Greenberg & Arai, 2001). Furthermore, using the novel combination of compressed and locally-reversed speech, Figueroa et al. (2009) shows that these windows are not absolute properties of auditory processing but relative to the time-length of linguistic units; with 2x compressed speech, intelligibility falls proportionally at reversals of ~30 ms. Following this work, Hwang et al. (2010) find that intelligibility falls drastically at ~300 ms for American Sign Language played at the normal rate, demonstrating a modality effect for linguistic processing. Participants (deaf ASL users) were instructed to repeat back all signs they were able to detect after each video, and percent accuracy was measured. In the present study, by using 2x compressed ASL, where twice the amount of linguistic information is contained in a specific time frame, we find that the window is proportionally reduced to ~150 ms, demonstrating that the window for the visual modality is also language-dependent. These psychophysical results from a sign language have implications for our understanding of how we integrate incoming language input and how these may be related to frequencies of inherent cortical rhythms, as has been proposed for speech (Poeppel 2003).

H99

LATERALIZING STIMULATION OF THE POSTERIOR TEMPORAL LOBES IMPROVES READING EFFICIENCY Peter Turkeltaub[1], Jennifer Benson[1], Roy Hamilton[1], Abhishek Datta[2], Marom Bikson[2], H. Branch Coslett[1]; [1]University of Pennsylvania, [2]City College of New York — Poor reading efficiency is the most persistent problem for adults with developmental dyslexia. Previous research has demonstrated a relationship between left posterior temporal cortex (pTC) function and reading competence, regardless of dyslexia status. Here, we demonstrate that enhancing left lateralization of pTC using transcranial direct current stimulation (tDCS) improves reading efficiency in adults without dyslexia. 25 right-handed adults with no history of learning disorder participated. TDCS was applied with the anode over the left pTC and the cathode over the right. Subjects completed two sessions: (1) real tDCS (1.5mA for 20 min), and (2) sham tDCS. Standardized word and nonword reading tests were given immediately afterwards. Modeling of the induced electrical field confirmed that the direction of current flow facilitated left pTC function, and inhibited right pTC as intended. Relative to sham, real tDCS induced improvements in word reading efficiency (Test of Word Reading Efficiency Sight Reading Efficiency subtest; P = .034). Every subject that scored below average on this test improved with tDCS (P=.0005). Such short-term gains could amplify the effect of appropriate reading interventions when performed in conjunction with them. Further research will be needed to investigate the cognitive locus of effect, whether the behavior performed during stimulation alters the outcome, whether multiple sessions result in long-lasting improvement, and whether the effects extend to adults with persistent difficulties due to developmental dyslexia.

H100

COMPLEMENTARITY OF LINGUISTIC AND MUSICAL PROCESSING Victoria Harms[1], Lorin Elias[1]; [1]University of Saskatchewan — The two hemispheres of the brain are commonly thought play complementary roles in cognitive processing. Prior research demonstrates that linguistic processing relies predominantly on the left hemisphere whereas music-related processing in non-musicians, such as unfamiliar melody recognition, relies predominantly on the right hemisphere. The question remains whether these hemispheric asymmetries reflect a causal relationship between the lateralized functions, a bias in the underlying neural architecture of the hemispheres, or independent processes governing the lateralization of cognitive functioning. There is clear evidence of population-level hemispheric biases for each of these functions when measured separately, but little research has examined whether a causal pattern of hemispheric asymmetry holds when both functions are assessed with a within-subjects design (Elias, Bulman-Fleming & Guylee, 1999). Using 47 healthy, right-handed participants without formal musical training, we examined whether the degree of lateralization in a linguistic task is correlated with the degree of lateralization in an unfamiliar melody recognition task at the level of the individual using the dichotic listening method. When laterality scores for the two tasks are compared within individuals only 38% of participants demonstrate a complementary pattern of lateralization. The laterality quotients for the two tasks are positively correlated providing evidence against the commonly assumed causal relationship and instead providing support for Bryden's bias model of complementarity (Bryden, 1990).

H101

NEURAL SUBSTRATES OF GESTURE RECOGNITION Nicole White[1,2], Hazlin Zaini[1], Aaron Newman[1]; [1]Dalhousie University, [2]University of Toronto — Viewing human movements, compared to non-biological motion, engages a network of brain regions including V5, the posterior superior temporal sulcus (STSp), the fusiform gyri, and frontal and parietal structures comprising the putative human mirror neuron system (MNS). Interestingly, deaf and hearing native learners of sign language show selective activation of the MNS for sign language but not non-communicative gesture, whereas normally hearing, non-signing individuals show MNS activation for gesture and other types of human motion. However, it is unknown how deaf individuals who do not use sign language, but may rely on nonverbal cues for communication, process human movements. We measured brain activation using fMRI in post-lingually deaf non-signers and hearing individuals, who viewed point-light movies of non-communicative movements involving the body (e.g. walking) or hand (e.g., playing piano), and communicative, emblematic gestures (e.g. thumbs-up) In all subjects, compared to scrambled point-light animations, all movements engaged bilateral occipitotemporal regions (including STSp, LOC, MTG, ITG). Hand movements engaged the MNS to a greater extent than body movements in hearing but not deaf individuals, suggesting a similar filtering of biological motion in deaf non-signers and signers. Contrasting communicative and non-communicative movements revealed right STSp and parietal activation in hearing people, but exclusively left hemisphere middle and posterior STS activation in deaf participants. These results suggest that even in the absence of sign language knowledge, deaf but not hearing people engage left hemisphere temporal structures when processing potentially communicative gestural information.

H102

NEURAL SYSTEMS SENSITIVE TO CONTEXT RELEVANCE AND CONSISTENCY IN DISCOURSE INTEGRATION Giovanna Egidi[1], Alfonso Caramazza[1,2]; [1]University of Trento, [2]Harvard University — Discourse comprehension entails integration of incoming information with prior context. Behavioral research has shown that incoming information is perceived as consistent with prior context if it can be integrated with the immediately preceding context (local integration) or with more distal information (global integration). This fMRI experiment identifies the neural systems sensitive to the amount of contextual information being integrated and the consistency of incoming information with prior context. Participants listened to stories whose final sentence was either consistent or inconsistent with the local context. The global context of these stories was either relevant or irrelevant for the integration of this final sentence: when global context was irrelevant, the consistency of the final sentence was determined only by local context, but when global context was relevant, the consistency of the final sentence was a function of both local and global context. Several regions demonstrated only a main effect of local consistency, indicating that they integrate discourse information locally. Other regions showed sensitivity to the relevance of global context suggesting that they mediate information integration, but are not sensitive to local context. Finally, the left intraparietal sulcus and the superior parietal cortex (bilaterally) showed an interaction pattern demonstrating that the effect of local consistency was reduced when a local inconsistent ending could be explained by global context. These results show that discourse comprehension results from the cooperation of different brain systems each concerned with different aspects of information integration.

H103

A NOVEL METHOD FOR COMPARING THE RECRUITMENT OF NEUROCOGNITIVE RESOURCES: AN INDEX OF ADDITIVITY IN EVENT-RELATED POTENTIALS AND ITS APPLICATION Geoffrey Valentine[1], Lee Osterhout[1]; [1]University of Washington — The Event-Related Potential (ERP) technique is poorly suited to spatially localizing the sources of the electrophysiological signal it measures. Establishing whether waveforms elicited by differing stimuli reflect activity generated by the same or independent neural processes is therefore problematic. By measuring the additivity of individual, relative to composite, waveforms, we have developed an index which measures the independence of the neural substrates underlying multiple ERP signals. Using a linguistic double anomaly paradigm, in which subjects read sentences containing individual or co-occurring violations of expectancy, we carried out three experiments in which we systematically varied the similarity of the two expectancy violations. Comparing the waveform resulting from the double violation to the composite waveform created by mathematically summing waveforms resulting from the individual violations, we computed an index of the

amount of additivity in the signal, which, in turn, mirrors the independence of the neural processes underlying the individual anomalies. The ERP additivity index therefore provides a graded measurement of the independence of the neural substrates underlying the processing of the multiple stimuli, ranging from complete independence, reflected in perfect ERP additivity, to complete overlap, reflected in zero additivity. Although it provides no information on the spatial location of the sources of particular ERP components, the graded nature of the additivity index allows a meaningful comparison of the ratio of independence of the neural resources elicited by various stimuli which can be applied between experiments.

H104

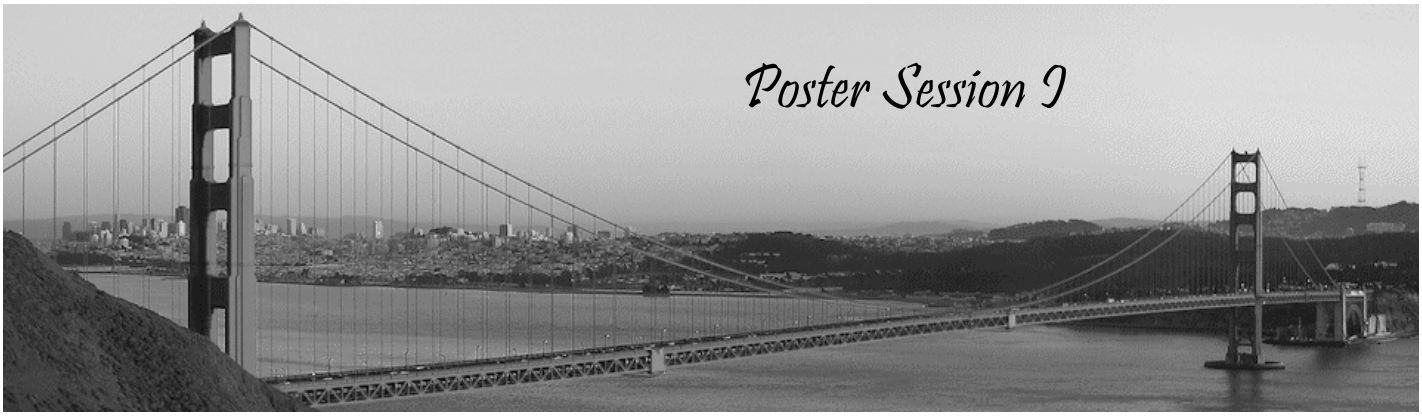
AN ERP INVESTIGATION OF TONAL VERSUS PHONEMIC INFLUENCES ON SPOKEN WORD RECOGNITION IN MANDARIN CHINESE Jeffrey Malins[1], Marc Joanisse[1]; [1]University of Western Ontario — Tonal languages like Mandarin Chinese use both phonemic and tonal features to differentiate words. In this study we compared the neural underpinnings of these two types of information in processing auditory speech. Event related potentials were recorded while adult native speakers of Mandarin (N = 19) judged whether auditory words matched or mismatched visually presented pictures. Mismatching words were of the following nature: segmental (e.g., picture: hua1 'flower'; sound: hua4 'painting'); cohort (e.g., picture: hua1 'flower'; sound: hui1 'grey'); rhyme (e.g., picture: hua1 'flower'; sound: gua1 'melon'); tonal (e.g., picture: hua1 'flower'; sound: jing1 'whale'); unrelated (e.g., picture: hua1 'flower'; sound: lang2 'wolf'). Expectancy violations in the segmental and cohort conditions were detected at a similar onset, marked by a similar latency of modulation of the phonological mapping negativity (PMN). This result suggests that tonal and phonemic information are accessed in parallel; however, effects were less persistent and more left-lateralized in the segmental versus cohort condition, suggesting different mechanisms underlie tonal versus phonemic processing. We also observed evidence for effects of word-final overlap in both the rhyme and tonal conditions, marked by an attenuated late N400 component compared to unrelated mismatches. This is suggestive of feedback from lexical to sublexical levels of spoken word processing, resulting in facilitated recognition of word-final phonemes or tone. Together, the results suggest key modifications are needed for existing models of speech processing to accommodate the tonal languages spoken by a large proportion of the world's speakers.

H105

PRESERVED MID-FUSIFORM ACTIVATION FOR FAMILIAR WORDS IN A PATIENT WITH PURE ALEXIA Suzanne Welcome[1], Adrian Pasquarella[2], Xi Chen[2], David Olson[2], Marc F. Joanisse[1]; [1]University of Western Ontario, [2]University of Toronto — We explored activation in the left fusiform gyrus in H.E., a published author with pure alexia as a result of a stroke. H.E.'s lesion is localized to the left inferior temporal lobe and restricted primarily to white matter. His word identification remains dysfluent and laborious despite therapy. We used fMRI to examine cortical activity as H.E. viewed a variety of orthographic stimuli (words, nonwords, consonant strings) as well as non-orthographic objects. Surprisingly, H.E. showed cortical activation in the mid-fusiform area during the processing of words and word-like stimuli, suggesting that this region's role in processing visual words is intact despite his severely impaired reading. A portion of the left inferior occipital cortex showed greater activation to words, nonwords and consonant strings than to non-orthographic stimuli. However, H.E. showed abnormally little activation in other portions of the temporal lobes while viewing words. We suggest that H.E.'s alexia results from a functional disconnection between the mid-fusiform region and other parts of the reading network rather than dysfunction of the mid-fusiform region itself. These findings are discussed in terms of current models of reading, and in particular the role that mid-fusiform gyrus plays in word recognition vs. production.

H106

THE TIMECOURSE OF IMPLICIT SINGLE-LETTER PROCESSING: N170 AND RHYME EFFECTS Courtney Stevens[1], Autumn McIlraith[1]; [1]Willamette University — Previous event-related brain potential (ERP) studies report a left-lateralized enhancement of the N170 over posterior brain areas to words as compared to other classes of visual stimuli (e.g., Bentin et al, 1999). This effect, apparent even during implicit processing tasks, is proposed to index automatic phonological processing emerging from the repeated pairing of words with left-lateralized language systems (Maurer et al, 2010). However, it is unclear whether similar effects are observed with single-letter stimuli, although individual letters represent the initial unit of literacy learning for most children and may be particularly useful in developmental neuroimaging studies. The goal of the present study was to assess whether adult fluent readers show similar left-lateralized N170 effects during implicit processing of single-letter stimuli, as well as whether such stimuli automatically engage phonological processing. Adult participants completed a one-back task in separate blocks with single-letter (LT) or false-font (FF) stimuli. Within the LT blocks, half of the letters rhymed with 'e' and the other half were nonrhyming. ERPs were recorded to the LT and FF stimuli. Results indicated that over posterior regions, the N170 was larger to LT than FF stimuli, but this effect was bilateral as opposed to left-lateralized. This bilateral effect was related to level of implicit phonological processing of letters, as indexed by the effect of rhyming vs nonrhyming letters in LT blocks. Taken together, these data suggest that whereas single-letters are distinguished from non-letter stimuli during implicit processing tasks, they lack the strong left-lateralized bias observed with whole word stimuli.



Tuesday, April 5, 3:00 - 5:00 pm, Pacific Concourse

Language: Lexicon

I1

CONTRARY ACTIVATION PATTERNS OF ANTERIOR AND POSTERIOR BRAIN REGIONS WITH INCREASING READING ABILITY: FMRI EVIDENCE FROM CHINESE SCHOOL CHILDREN Meixia Song[1], Zhengke Wang[2], Jie Jian[2], Hanlin You[2], Na Wei[1], Alice Cheng Lai[3], Xiangzhi Meng[2], Guosheng Ding[1]; [1]State Key Laboratory for Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, P.R. China, [2]Department of psychology, Peiking University, Beijing, P.R. China, [3]Department of Applied Social Sciences, Hong Kong Polytechnic University — Using functional magnetic resonance imaging (fMRI), the present study investigated how reading ability modulates the brain activation when Chinese school children performed phonological and orthographic judgment task. Twenty-seven children aged 8-11 years old were recruited and divided into three groups according to their Chinese reading performance, and were labeled as High, Medium, Low level group respectively. One-way ANOVA showed a main effect of reading ability in several brain regions, including posterior regions in bilateral calcarine, right fusiform gyrus, left lingual gyrus and anterior regions primarily in left middle frontal gyrus. With the increasing of reading ability, brain activations in the posterior regions, especially the primary visual cortex, was more activated in both the phonological and orthographic tasks. On the contrary, the anterior region of left middle fontal gyrus was significantly stronger activated in readers with low reading ability, demonstrating that compared with high level readers, low level readers rely more on the anterior regions when performing both tasks. The results were further confirmed by Regions of Interest (ROIs) analysis in posterior site of right fusiform gyrus and anterior site of left middle frontal gyrus. We propose that while readers with high reading ability benefit from intact activity in the posterior visual system for the development of reading, their peers with low reading ability, instead, recruit anterior regions as a compensation for the underdevelopment of posterior systems.

I2

THE ROLES OF ORTHOGRAPHY, PHONOLOGY, AND MORPHEME IN CHINESE SPOKEN COMPOUND WORD RECOGNITION: AN ERP STUDY Lijuan Zou[1], Youyi Liu[1], Hua Shu[1]; [1]State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, China — The constraints from phonology and orthography have been broadly investigated in spoken word recognition, whereas the role of morpheme awaits more attention, especially for a language with the majority of compound words consist of two or more morphemes like Chinese. The property that the large number of homophones and homographs in Chinese could make the differentiation of orthography and morpheme have a prominent role during the time course of Chinese spoken word recognition. This study aims to investigate the effects of phonology, orthography, and morpheme on Chinese spoken compound word recognition. Using an auditory priming paradigm, two experiments, with the relations between the first syllable of prime and that of target words varying along orthography, phonology or morpheme, were conducted. 21 subjects participated the experiments. Subjects were asked to judge whether the target word they heard was a real word or a pseudo-word, while ignoring the prime word. Results showed that the N400 amplitude increased as sharing phonology between prime and target words, but decreased as sharing orthography. Sharing morpheme induced largest N400 amplitude especially for semantic unrelated words. In addition, morpheme effect is different from semantic priming effect on the topographic analysis, i.e., N400 for morpheme effect mainly distributed on anterior-central whereas semantic N400 had a maximum at central-posterior areas. These data suggested that orthography was accessed quickly and, reversely, facilitated the processing of spoken word recognition, and morpheme had a prominent role in Chinese compound word recognition and the framework of spoken word recognition should catch this feature.

I3

CROSS-LINGUAL PHONOLOGICAL SIMILARITY INFLUENCES RECOGNITION OF WORDS IN FLUENT SPEECH: EVIDENCE FROM AN ERP-STUDY WITH EARLY BILINGUALS Nicole Altvater-Mackensen[1], Nivedita Mani[1]; [1]Georg-Elias-Müller-Institute for Psychology, Georg-August-University Göttingen — An increasing number of studies suggest that lexical access in bilinguals is not language-selective but that bilinguals activate words from both their languages when processing speech. Yet, most of these studies investigated (visual) recognition of isolated words. The current study examined whether word recognition in fluent sentences presented in the first language is influenced by the phonological similarity of the words to words from the second language. While early German-English bilinguals listened to German sentences, we measured subjects' ERPs. Target words in the sentences were either German-English homophones (eagle – Igel 'hedgehog'), German words that are phonologically closely related to English words (kitten – Kittel 'smock') or German words that had no phonological relation to English words. Results show a difference in the N400-effect between words that have a cross-lingual relation and words that are not related across languages. Between 200 and 500 ms after word onset, subjects show a more positive waveform for homophones and German words that are related to English than for German words that have no relation to English, suggesting that lexical activation is influenced by the cross-lingual relation. This result is in line with earlier studies showing that bilinguals activate words from both languages in word recognition, but extends the results in demonstrating that this effect is neither bound to homophones, nor to visual recognition. Importantly, we show that the effect is not only found when recognizing words in isolation but also while processing words in fluent speech in the bilingual's dominant language.

I4

PHONOLOGICAL CO-ACTIVATION OF BOTH LANGUAGES IN BILINGUAL SPEECH PRODUCTION Katharina Spalek[1], Noriko Hoshino[2], Markus Damian[3], Guillaume Thierry[2]; [1]Humboldt-University Berlin, [2]Bangor University, [3]University of Bristol — One question in bilingual language production is whether the language not currently spoken is activated during speech planning. We collected event-related potentials (ERPs) in late German-English bilinguals while they named coloured line drawings using adjective–noun dyads exclusively in English, e.g., blue bird. The onset of adjectives and nouns could overlap in English (L2-overlap, e.g. blue bird vs. green bird) or in German, the speakers' native language, which was not produced during the experiment (L1-overlap, e.g., red skirt –'roter Rock' vs. blue skirt –'blauer Rock'). In both cases of overlap we observed a more positive going waveform at frontocentral electrodes in the N400 range (280 to 500 ms), even though, behaviourally, L1-overlap has been previously shown to cause inhibition and L2-overlap to cause facilitation (cf. Spalek & Damian, in prep.). Strikingly, ERPs in the related and unrelated conditions in L1 diverged about 60 ms earlier (~290 ms after stimulus onset) than ERPs in the related and unrelated conditions in L2. In sum, the data not only show that L1 phonology is activated during L2 speech production, but they also show that L1 is available earlier than L2 phonological information, even in the case of proficient speakers and even when only L2 production is required in the course of the experiment. This finding is compatible with a model of bilingual language production in which activation cascades from an activated concept to the phonological representation of both languages.

I5

ERP EVIDENCE FOR THE ROLE OF SECOND LANGUAGE (L2) KNOWLEDGE ON READING ALOUD IN THE FIRST LANGUAGE (L1) Niels Schiller[1], Ilse Ceusters[1], Kalinka Timmer[1]; [1]LUCL & LIBC, Leiden University — Previous research has shown that words of the second language (L2) can be primed with homophonic words of the first language (L1; Brysbaert et al., 1999) indicating phonological priming from L1 to L2. The Masked Onset Priming Effect (MOPE) is considered to have a phonological basis and has often been reported in reading aloud L1 words (e.g. Forster & Davis, 1991; Kinoshita, 2000; Schiller, 2007). Using the MOPE, we investigated whether L2 phonology also influences reading aloud L1 words, even when speakers are in their native monolingual L1 environment. In the present study, bilingual Dutch (L1) participants read aloud English (L2) target words primed visually by onset-related L2 words using four conditions: 1) graphemic and phonemic match (O+P+; e.g. kettle – KNAAP), 2) phonemic mismatch (O+P–; e.g. knife – KNAAP), 3) graphemic mismatch (O–P+; e.g. curve – KNAAP), 4) graphemic and phonemic mismatch (O–P–; e.g. bush – KNAAP). Orthographically related primes did not lead to faster response times, but event-related brain potentials (ERPs) revealed orthographic priming. Phonologically related L2 primes decreased the response times. ERPs supported these phonological priming effects. The results demonstrate that English phonology is also activated in Dutch participants, even when they are in their native monolingual environment and are less familiar with the orthography of the L2.

I6

A NEURONAL INDEX OF CONNECTION STRENGTH IN LEXICAL MEMORY CIRCUITS: EARLY ELECTROPHYSIOLOGICAL RESPONSES REFLECT FREQUENCY OF UNATTENDED SPOKEN WORDS Yury Shtyrov[1], Lilli Kimppa[2], Friedemann Pulvermüller[1], Teija Kujala[2]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK, [2]Cognitive Brain Research Unit, University of Helsinki, Finland — How are words represented in the brain and can these representations be qualitatively assessed? Recent research demonstrates that neurophysiological signatures of individual words can be measured when subjects do not focus their attention on speech. These automatic activations, manifest as negative deflections of ERPs, can appear surprisingly early (within ~200 ms) and are based on robust connections within neuronal circuits encoding individual words that ignite even when attentional resources are scarce. A critical prediction of this framework is that words with high frequency of occurrence have especially strongly connected underlying memory circuits and should thus yield more negative ERPs compared with rarer words. We tested this prediction by presenting our subjects, in passive non-attend conditions, with acoustically matched high- and low-frequency words and pseudo-word controls. Using factorial and correlation analyses, we found that already at 120 ms after the stimulus information was available response amplitude was modulated by the words' lexical frequency. Topographic mapping and source analysis suggested that this early automatic frequency effect originates from the left inferior-frontal cortices. While, at ~120ms, lexical differences between words and pseudo-words were seen only for the most frequent words, later-on (~270 ms), a more global lexicality effect with bilateral perisylvian sources was found for all stimuli, suggesting faster access to more frequent lexical entries. Our results support the account of word memory traces as interconnected neuronal circuits, and suggest that speed and magnitude of their activation are determined by their internal connection strength, which, in turn, is determined by everyday language use.

I7

BEHAVIOURAL AND EEG+MEG EVIDENCE FOR EARLY RETRIEVAL OF LEXICO-SEMANTIC INFORMATION IN VISUAL WORD RECOGNITION Olaf Hauk[1], Caroline Coutout[1], Anneka Holden[2], Yuanyuan Chen[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, [2]Department of Experimental Psychology, University of Oxford — Timing information from electrophysiological data is becoming increasingly relevant for models of visual word recognition. It is also important for the comparison of specific stages of the word recognition process among healthy participant or patient groups. In this study, we attempted to 1) provide a lower limit for the earliest latencies of lexical and semantic information retrieval; 2) separate stimulus- from response-related brain responses; 3) test for serial or parallel retrieval of lexical and semantic information. Participants performed 2 different types of Go/NoGo tasks: lexical decision (LD) and semantic decision (SD). In experiment 1 (E1), button press latencies as well as 64-channel ERP data were recorded. Statistical analysis of ERP data was performed using SensorSPMs in SPM5. In experiment 2 (E2), participants responded by eye blinks while 306-channel MEG and 70-channel EEG were recorded. Reaction times around 375 ms in E1 and around 300 ms in E2 reliably distinguished stimulus categories in both LD and SD, reflected in the onset of positive d-prime distributions. In the ERP data, a reliable difference between Go and NoGo conditions was observed around 200 ms. Region-of-interest analysis of minimum norm source estimates derived from EEG+MEG data showed that left perisylvian brain areas distinguished words from pseudowords already before 200 ms. Our results demonstrate that brain responses around 200 ms already reflect target detection or response preparation. We conclude that earliest retrieval of lexical and semantic information affecting behavioural responses occurs in parallel before 200 ms.

I8

DISSOCIATING INFLECTIONAL AND DERIVATIONAL MORPHOLOGY: EVIDENCE FROM POLISH Zanna Szlachta[1], Mirjana Bozic[1], William Marslen-Wilson[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK — Different types of lexical complexity in English modulate the involvement of different fronto-temporal language networks during language comprehension (Bozic et al., 2010). Morphologically complex inflected verbs (jumped, agreed) selectively activate left fronto-temporal areas, while derivationally complex words (bravely, darkness) show more distributed bi-hemispheric effects which do not include left frontal cortex, consistent with a whole word processing account. In this study we ask whether Polish, a language with much richer inflectional and derivational paradigms, shows a similar dissociation between inflectional and derivational morphology. We use aspectual verb pairs that allow for an elegant comparison between these two types of complexity in a passive listening efMRI experiment. Polish aspectual prefixes can either be purely inflectional (e.g. the prefix na- changes the imperfective verb stem

pisac' – to write, to the perfective form napisac' – to write, perf, with no change in meaning) or mixed inflectional/derivational (e.g. the prefix prze- can change both aspect and meaning of the stem, as in przepisac' – to rewrite/copy, perf). We compared neural responses to each type of affix (and to unprefixed verb stems) in a design adapted to multivariate analysis techniques. Using Representational Similarity Analysis we found that purely inflectional affixes show coherent patterns of activation in inferior frontal areas bilaterally, while inflectional/derivational affixes are much more heterogeneous. This is cross-linguistic evidence to support the claim that inflectional and derivational morphemes support qualitatively different neurocognitive processing functions, with only inflectional morphology fully engaging key combinatorial linguistic processing functions associated with left perisylvian cortex.

I9

EARLIEST BRAIN SIGNATURES OF LEXICAL ACCESS TO SPOKEN WORDS: MEG EVIDENCE Lucy J MacGregor[1], Friedemann Pulvermüller[1], Maarten van Casteren[1], Yury Shtyrov[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge — How quickly can the listener's brain access information about perceived words in the mental lexicon? Previous research has demonstrated a neurophysiological distinction between passively presented spoken words and pseudo-words as soon as 100-150ms after they could be identified, which has been used as evidence for automatic lexical access within the same time frame. However, one criticism of these studies is that they used the oddball paradigm and the mismatch negativity brain response, which require unnatural repetition of a small number of stimuli. Here we address this issue by directly comparing listeners' neuromagnetic brain responses to multiple (N>100) distinct words (monosyllabic CVC) with phonologically and psycholinguistically matched pseudo-words. Each stimulus was auditorily presented only once in a random sequence, whilst volunteers were engaged in a distracter task (watching a film) used to minimise the influence of attention on brain responses. MEG was recorded using a high-density whole-head sensor array (Elekta-Neuromag). Event-related fields and their gradients were calculated relative to the onset of the word uniqueness point, determined in a behavioural gating study, which coincided with the onset of stimulus-final consonants. Significantly greater activity for words compared to pseudo-words – a putative index of lexical access – was observed as early as 60ms, with later effects also occurring at ~110-180 ms and ~300-400 ms. Minimum Norm Estimation revealed that left perisylvian sources underpinned the early lexical enhancement of the brain response. The results offer support for automatic rapid activation of neural memory circuits for spoken words within less than 1/5 second.

I10

AUTOMATIC PROCESSING OF DERIVATIONAL AND INFLECTIONAL FORMS IN SPOKEN WORD COMPREHENSION: COMBINED MEG-EEG EVIDENCE Caroline M. Whiting[1], Yury Shtyrov[1], William D. Marslen-Wilson[1]; [1]MRC Cognition & Brain Sciences Unit, Cambridge UK — Extensive research now suggests that the presence of a potential stem and affix within a word (e.g. corn-er) is sufficient to trigger attempts at morphological decomposition, regardless of word meaning. Using combined magneto- and electroencephalography, we investigated how the processing of spoken words is modulated by such morpho-phonological cues. The mismatch negativity (MMN), an index of long-term linguistic memory traces, was recorded to examine the spatiotemporal dynamics elicited by words of varied complexity: transparent derivational affixation (baker), pseudo-affixation (beaker), inflectional affixation (bakes, beaks) and non-affixed forms, in the absence of focused attention. Matched pseudowords were used as acoustic and phonological controls. A critical variable was semantic transparency within the derivational forms, where the embedded stem was related or unrelated to the meaning of the whole form (baker vs. beaker). Results revealed an initial peak 150-200 ms after the deviation point, primarily localized to left superior temporal cortex. This early component was sensitive both to lexicality - showing a larger response to real words than to pseudowords - and to morphological structure, showing increased activity for a potential but invalid segmentation (beak-er) in left fronto-temporal cortex. Effects for inflected forms appeared later, with a significant dissociation at 300 ms reflecting a more left-lateralized response to the verbal deviant. A further component emerging at 315 ms revealed differential processing of non-affixed forms within bilateral inferior frontal gyrus. These results support recent theories pointing to early and automatic processing based on the presence of phonological cues to morphological structure.

I11

SEARCHLIGHT REPRESENTATIONAL SIMILARITY ANALYSIS OF NEUROCOGNITIVE PROCESSES SUPPORTING SPEECH COMPREHENSION Li Su[1], Elisabeth Fonteneau[1], Cai Wingfield[1], William Marslen-Wilson[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK — Although the neural basis of speech comprehension has been a growing focus for neuroimaging research, detailed neural models of morpho-lexical processing are notably absent. Here we explore how the underlying properties of lexical constituents are computed in neural networks situated in bilateral fronto-temporal brain regions. A novel method that reveals the fine grained structure of neural computation (with centimetre and millisecond precision) has been developed based on the Representational Similarity Analysis (RSA) of MEG/EEG data in source space using searchlight techniques. Specifically, we search the data in time and space for neurocomputational signatures that are correlated to five theoretical models. These models describe different dimensions of lexical complexity, and form a hierarchical structure with basic models progressively evolving into complex models. The three basic models (Simple Suffix, Stem and IRP) capture single dimensions respectively, regular inflectional morphology, general processing demands and phonological cues to the presence of inflection. The more complex Suffix model captures the critical process of interpreting the acoustic information carried by the potential inflection (the IRP model), while the Word model integrates the Suffix model and the Stem model to reflect the dynamic interaction between stem and inflectional morphemes. Searchlight RSA analyses show weak and diffused activation patterns for the basic models, while the complex models (Suffix and Word) result in stronger and more focal activation in both inferior frontal areas and the temporal lobes. This supports a hierarchical view of morpholexical processing and potentially provides a system level account of dynamic neural processing for speech comprehension.

I12

THE EFFECT OF MEANING ENTROPY DURING AUDITORY HOMOPHONE RECOGNITION: MEG EVIDENCE FOR AMODAL LEXICAL ENTRIES Gwyneth Lewis[1], Alec Marantz[1]; [1]New York University — Several MEG studies report correlations between ~350 ms superior temporal (ST) activation (the MEG M350) and lexical properties of visually presented words (Solomyak & Marantz, 2009, 2010; Lewis et al., in press; Simon et al., in press). The latest of these studies found meaning entropy effects at the M350 during visual recognition of homographic homophones (orthographically and phonetically identical words with distinct meanings). Entropy reflects the relative frequencies of meanings for each homophone, estimated from the number of senses for each meaning. If each meaning has a distinct lexical entry, higher entropy implies greater competition among entries for recognition (compare high entropy "pawn" with low entropy "bank"). To test whether representations accessed at the M350 are amodal, we exploited the meaning entropy effect and replicated the homophone result in the auditory modality by employing Simon's 500 homophones as speech stimuli in an MEG lexical decision experiment involving 10 subjects. Analyses were in source space using MNE and structural MRIs. Transverse temporal regions of interest (ROIs) yielded negative ST activation (as in Simon et al.). Activation from these temporal ROIs correlated significantly with the entropy variable at ~300 ms, similar to the latency and direction of Simon's effect, and in the same ROI -- greater entropy yielded greater activation, consistent with the lexical competition model. The M350 reflects similar resolution stages in auditory and visual word recognition whereby amodal

lexical entries compete for access, comparable to the parallel auditory and visual N400m ST responses seen in MEG (Helenius et al., 2002).

I13

NEURAL CORRELATES OF AMBIGUOUS AND UNAMBIGUOUS VERB PROCESSING Aya Meltzer Asscher[1], Julia Schuchard[1], Dirk-Bart den Ouden[2], Cynthia K. Thompson[1]; [1]Northwestern University, [2]University of South Carolina, Columbia, SC — Verbs differ with regard to their argument structure, i.e. the number and type of arguments they select, and studies have shown that differences in argument structure complexity map onto the brain. The present study examines the neural correlates of an instantiation of argument structure complexity not explicitly targeted before: argument structure ambiguity. In English, many lexical entries (e.g. break, close) denote two different verbal alternates, a transitive and an intransitive one. The processing of these entries thus entails accessing two thematic grids. In contrast, other verbs (e.g. laugh, wander) are unambiguous, and have only the intransitive argument structure. The present study used fMRI to compare neural activation induced by processing the two types of verbs. 14 healthy monolingual English speakers performed a lexical decision task in response to ambiguous verbs, unambiguous verbs and pseudowords. Participants exhibited enhanced activations for ambiguous relative to unambiguous verbs in regions previously implicated in the processing of complex verb argument structure: middle and superior temporal gyri, as well as the angular and supramarginal gyri bilaterally. An additional cluster was observed in the left middle and superior frontal gyri (BA 9). The present results corroborate previous studies of argument structure processing, implicating a posterior network of activation involved in processing complex argument structure representations. The study also contributes to what is known about the neural mechanisms associated with processing lexical ambiguity, and is compatible with previous results showing involvement of left middle and superior frontal regions in ambiguity processing.

I14

MEG EVIDENCE FOR RECOMBINATION STAGE IN FULL DECOMPOSITION MODEL OF VISUAL WORD RECOGNITION Joseph Fruchter[1], Alec Marantz[1]; [1]New York University — During visual word recognition, the MEG response ~300-400ms post-stimulus onset from the middle and superior temporal lobe displays many of the hallmarks of lexical access (Pylkkänen & Marantz, 2003), while the Anterior Midline Field (AMF) reflects semantic properties of the combination of words (Pylkkänen & McElree, 2007). Here we developed a statistical measure of the semantic coherence of suffixed words based on the residuals from a regression model involving surface frequency, base frequency, and biphone transition probability. We also investigated the influence of derivational family entropy (Moscoso del Prado Martin, Kostic, & Baayen, 2004). Full decomposition models of complex word recognition predict correlations with family entropy at stem access, followed by correlations with surface frequency and semantic coherence during the recombination stage. MEG data was obtained from 10 subjects performing a visual lexical decision task on 200 words composed of a monomorphemic stem and suffix ("-er," "-ness," "-ly," "-able"). We used MNE and FreeSurfer to generate cortically-constrained minimum norm estimates for analysis of activity in source space. Using automatically parcellated anatomical regions of interest (ROIs), we investigated the correlation of neural activity in left temporal and orbitofrontal ROIs with stimulus variables. The left temporal activity correlated with derivational family entropy (~240-390ms) followed by surface frequency (~430-500ms), suggesting an earlier stage of lexical access for a stem followed by recombination of stem and suffix, as predicted by full decomposition models. The left orbitofrontal activity (AMF) correlated with semantic coherence (~350-500ms), suggesting an equivalence of semantic composition between words and between morphemes.

I15

BILINGUAL LEXICAL ACTIVATION IS MODULATED BY FACIAL CUES OF THE LISTENER'S LINGUISTIC IDENTITY Ping Li[1], Yunqing Li[1], Jing Yang[1], Qing X. Yang[1]; [1]Pennsylvania State University — It is widely accepted that proficient bilingual speakers non-selectively activate items from both languages in the mental lexicon during speech comprehension or production. Given this non-selectivity the question arises as to how bilinguals, while speaking in one language, avoid significant interference from the other, non-intended language. In this study we presented participants with faces that prompt the linguistic identity of the listener (Asian vs. Caucasian faces) and asked the participants to perform a picture-naming task inside and outside the scanner. Chinese-English bilingual participants saw a fixation cross, a face with a picture frame (red or blue, as cue to the naming language), and named the picture in either their first language (L1: Chinese) or second language (L2: English). Behavioral results indicate that naming was facilitated when the naming language and the linguistic identity of the faces were consistent (i.e., naming in L1 while seeing Asian face, or naming in L2 seeing Caucasian face), compared with conditions when these were inconsistent. fMRI results revealed that when the naming language and the linguistic identity of the faces were consistent, stronger activation was seen in the right insula and bilateral anterolateral frontal gyrus, but when these were inconsistent, stronger activation was seen in the inferior frontal gyrus and the left middle frontal gyrus. These results suggest that naming in the weaker L2 requires greater involvement of the PFC, and that facial cues of the listener's linguistic identity modulate the activation of the naming language, leading to increased left frontal activities during conflict resolution.

I16

THE ROLE OF WHITE MATTER PATHWAYS IN MAPPING WORDS TO MEANING Denise Y Harvey[1], Timothy M Ellmore[2], A. Cris Hamilton[1], Tatiana T Schnur[1]; [1]Rice University, [2]University of Texas Medical School — Understanding a word requires decoding auditory or visual information, and access to semantic knowledge (Hillis, Rapp, Romani, & Caramazza, 1990). The posterior temporal cortex mediates both visual and spoken abstract word form processing (Price, 2000), and the anterior temporal lobes serve as an amodal semantic store (Patterson, Nestor, & Rogers, 2007). However, it is unclear how information is transmitted between these disparate regions. We hypothesize that a white matter pathway, the inferior longitudinal fasciculus (ILF) mediates lexical semantic processing by connecting the temporal-occipital junction with the anterior temporal lobe. We collected diffusion tensor imaging (DTI) data from participants with varying degrees of word comprehension impairments as a result of left hemisphere stroke. Deterministic tractography methods were used to isolate the ILF in both hemispheres. Accuracy on a single word, single picture matching task (Hillis et al., 1990) significantly correlated with both left and right ILF integrity (as measured by fractional anisotropy (FA)) such that lower FA values were related to poorer performance. The results suggest that the ILF is important for understanding the meaning of a word as it carries information from regions specialized for decoding presemantic word form information to stored semantic knowledge. The finding that the right ILF also correlates with performance may suggest that although single word comprehension is weakly left lateralized, it may be compensated for by the right hemisphere (Hickok & Poeppel, 2007; Bozic, Tyler, Ives, Randall, & Marslen-Wilson, 2010).

I17

MAPPING WORD READING CIRCUITRY FOR SKILLED DEAF READERS Karen Emmorey[1], Stephen McCullough[2], Jennifer Petrich[2], Jill Weisberg[2]; [1]San Diego State University, [2]San Diego State University Research Foundation — Many deaf individuals read in a language they cannot hear and do not speak, and the neural circuits that support reading in this population are poorly understood. We examined word-level semantic and phonological processing in skilled deaf readers (mean PIAT scores above college level)

who use American Sign Language as their primary language. Participants (mean age = 29.4 years; education = 17 years) performed a yes/no semantic decision (concrete concept?) and a phonological decision (two syllables?) for separate blocks of printed English words (10 words per block, ITI = 3s) while undergoing fMRI (3T GE scanner, 40 3.5mm axial slices, TR = 2s, FOV = 22.4mm, 240 volumes). Across two runs, six blocks of each task were interspersed with control blocks during which participants decided whether or not false font strings were underlined. Data collection for a matched group of hearing readers is currently underway. Preliminary analyses of data from nine deaf readers revealed that syllable counting, relative to semantic decision, elicited increased activity in left hemisphere regions typically reported for phonological processing in hearing readers (e.g., inferior frontal gyrus; inferior parietal cortex). However, deaf readers also showed heightened activity in right hemisphere homologues of these regions. We also observed a different distribution of neural activity for phonological (more dorsal) and semantic (more ventral) processing within left inferior frontal cortex (cf. Poldrack et al., 1999). Thus, skilled deaf readers may rely on left hemisphere circuits for reading single words, but require additional right hemisphere regions to make explicit phonological decisions.

I18

PHONOLOGICAL UNDERSPECIFICATION IN THE MENTAL LEXICON AND NASAL CONFUSABILITY Noriko Tanigawa[1], Ramin Rahni[1], John J. Kim[1], Mark W. Geisler[1]; [1]San Francisco State University — The purpose of the present study is to determine the extent to which predictable abstract information about speech sounds is stored in the mental lexicon and how it is processed, using electrophysiology. Past studies investigated this question by contrasting the processing of coronals (/n /, /d/) that have alternating surface forms (e.g., /n/ pronounced as [n] in rain, [m] in rainbow) with that of non-coronals (/m/, /b/) that do not. To tease out the Lexicality (real vs. pseudo) x Place (coronal vs. non-coronal) interaction, we added Manner (nasal /n/, /m/ vs. oral /d/, /b/) and Quantity (neutralized geminate vs. singleton, e.g., nn vs. n). Following Friedrich et al.'s (2006) auditory lexical decision paradigm, monomorphemic English nouns were selected that had a uniqueness point with a coronal or a non-coronal as the first phoneme of the second syllable. A pseudoword was created from each real word by switching the place of articulation between coronal and non-coronal (e.g., picnic to *picmic; helmet to *helnet). Event-related potentials (n = 10) were time-locked to the uniqueness/deviation points. Preliminary results show an asymmetric pseudoword effect on the N400 amplitude driven by nasals, suggesting increased processing load by Nasal Confusability. Centroid latency differences became significant earlier in the NonCoronal condition but later in the Coronal condition, in which latency was shorter for pseudowords among geminates but longer for pseudowords among singletons. These processing speed differences suggest that the place feature might be un(der)specified for coronals but specified for neutralized geminates (Ghini, 2002) in the mental lexicon.

I19

ERP MASKED PRIMING INVESTIGATION ON THE RADICAL DECOMPOSITION OF SINGLE CHARACTER KANJI Kana Okano[1], Jonathan Grainger[2,3], Phillip J. Holcomb[1]; [1]Tufts University, [2]Aix-Marseille University Marseille, [3]CNRS — ERP research on the decomposition of morphologically complex words in English have provided evidence suggesting that not only are complex words decomposed into their constituent morphemes, but words with pseudomorphemes (i.e., corner) are also decomposed. In the present study, a similar investigation using Japanese Kanji was conducted. Radicals in Kanji are the smallest component of a character that still carry meaning and are thought to play a similar role to morphemes in alphabetic languages. The current experiment used masked morphological priming to look for evidence of radical decomposition of single character Kanji. We used the three priming conditions that have been investigated in the field of morphological decomposition. These were prime-target pairs that are 1) semantically and orthographically related (Transparent condition), 2) semantically and orthographically opaque (Opaque condition), and 3) semantically unrelated but orthographically related (Orthographic condition). The results showed a significant priming effect in the N250 component for Transparent and Opaque conditions but not the Orthographic condition, indicating that single character Kanji are decomposed as a function of the transparency of the semantic radicals.

I20

AN ELECTROPHYSIOLOGICAL STUDY OF AUDITORY LANGUAGE SWITCHING IN SECOND LANGUAGE LEARNERS Katherine J. Midgley[1,2], Phillip J. Holcomb[1], Jonathan Grainger[2]; [1]Tufts University, [2]LPC, CNRS Marseille, France — Whether in production or comprehension, bilinguals can and do freely switch between their two languages. What are the processing costs and underlying neural mechanisms associated with these language switches? We investigated this by presenting, in the auditory modality, common, single-word non-cognates in English and French to 24 native French speakers who were learning English. Critical items were either "switch" items, for which the language differed from the two previously presented words (CLAVIER - POMME - BEACH) or they were "non-switch" items, in which case the language remained the same across the previously presented items (WINDOW - FIGHT - DRINK). Event-related potentials were recorded from 32 scalp electrodes to each critical, final item (BEACH compared to DRINK). Consistent with previous research by our group we found a widespread language effect with larger negativities to words in L1 relative to L2 in an extended epoch starting at 150ms and continuing through 600ms. For language switching we also found L1 items showed early effects of switching between 150 and 250ms as well as later effects between 400 to 600ms. No effects of switching were found for L2 items. These results appear to be consistent with theories postulating a greater inhibition of the dominant L1 during L2 processing followed by a need for greater reactivation of L1 after a switch. The findings will be discussed within the framework of current models of bilingual language control.

I21

DISSOCIATING ROOTS AND WORD PATTERNS IN ARABIC: EVIDENCE FROM APHASIA Sami Boudelaa[1], Ali Idrissi[1], Renee Beland[2], William Marslen-Wilson[3]; [1]United Arab Emirates University, [2]University of Montreal, Canada, [3]MRC Cognition and Brain Sciences Unit, UK — There are currently two opposing views of the internal morphological structure of words in Semitic languages. One view argues for a linguistically universal stem-based account. The other claims that Semitic morphology is characterized by a non-concatenative morphological structure whereby a tri-consonantal root conveying semantics is interleaved with a word pattern that conveys morphosyntactic and phonological information. On this view, roots and word patterns have an independent status in language processing and can be selectively impaired and spared. Here we provide evidence for a dissociation between these two morphemic elements in the brain. We use the auditory-auditory priming task to assess the performance of an Arabic speaking aphasic with left perisylvian damage, known from previous production studies to have specific problems with the consonantal root. Word pairs sharing a root and either a transparent (e.g., [ri>Asah]-[ra>ys] presidency-president) or an opaque (e.g., [miTraqah]-[Taryq] hammer-road) semantic relationship do not show the facilitation normally observed. Two further control conditions, a semantic condition (e.g., [SAHib]-[rafyq] friend-comrade) and a phonological condition (e.g., [niSf] –[naSr] half-victory) also fail to show any facilitation. In contrast, prime and target pairs sharing a word pattern (e.g., [Axraj]-[AElam] take out-inform) show significant facilitation both in latencies and error rates. Consistent with this, linear mixed-effect analyses show that the family size of the word pattern but not of the root modulates priming. These results suggest that processes extracting a word pattern can remain intact even when root processing is impaired, consistent with a decompositional account separating root and word pattern morphemes.

I22

BILINGUAL PHONOLOGICAL PRIMING: WORD-WORD RELATIONSHIPS BETWEEN LANGUAGES AND ACROSS DEVELOPMENT Katie Von Holzen[1], Nivedita Mani[1]; [1]Georg-August-Universität Göttingen — Phonological priming effects operate across the two languages of a bilingual – words in one language can prime words in the other language (Van Wijnendaele and Brysbaert; 2002). These results point to the interconnectivity of the bilingual's two lexicons. However, these results are based on studies which present subjects with orthographic or auditory stimuli from both languages (van Wijnendaele & Brysbaert, 2002; Phillips et al., 2006). It is unsurprising then that words in both languages are activated. The current study presents subjects with images of name-known objects as primes followed by auditorily presented target words which were phonologically related, unrelated or identical to the label for the prime image. ERPs to targets were measured to determine differences in activation across the different conditions. In the rhyming conditions, phonological similarity between prime images and target labels was manipulated within (i.e. German prime, German target) and across (i.e. English prime, German target) languages. Importantly, since the prime is an image whose label subjects can generate in either of their languages, and the targets were only German words, this study presents subjects with auditory stimuli from only one language. Nevertheless, adult N400 amplitude revealed no differences in activation from prime image-target labels that were related within and across languages. However, child N400 amplitude showed a differentiation of the rhyming conditions, although both conditions differed from the unrelated condition. This provides strong evidence of interconnectivity of a bilingual's two lexicons as it develops, despite the study presenting subjects with stimuli from only one language.

I23

LANGUAGE PROFICIENCY MODULATES THE RECRUITMENT OF NON-CLASSICAL LANGUAGE AREAS IN BILINGUALS Matthew K. Leonard[1], Christina Torres[1], Katherine E. Travis[1], Timothy T. Brown[1], Donald J. Hagler Jr.[1], Anders M. Dale[1], Jeffrey L. Elman[1], Eric Halgren[1]; [1]University of California, San Diego — In a previous study, we used magnetoencephalography (MEG) constrained with MRI to study the organization of the first (L1) and second (L2) languages within the brains of bilinguals. We found that, compared to L1, L2 words evoke greater activity in right hemisphere and bilateral posterior visual areas as early as ~135 ms, and that this activity persists through lexico-semantic processing at ~400 ms (Leonard et al., 2010). However, although these subjects began learning L2 at around 6 years old, they remained more proficient in L1, and it was unclear whether proficiency or order of acquisition determined the extent of bilateral posterior activity. Additionally, the occipito-temporal location of the activity to L2 words could be related to the fact that words were presented in a written form. In the present study, MEG was recorded in 16 Spanish-English bilinguals while they either read or listened to single words and performed a size judgment task. The subjects were all dominant in English, which they began acquiring around age 6. Anatomical MRI scans were acquired and used to constrain the MEG inverse solution to the cortical surface. Visual words evoked similar activity as in the previous study, in that the less proficient language evoked greater activity in bilateral occipito-temporal secondary visual areas ~400 ms after a word was shown. A similar pattern was observed for auditory words. These findings suggest that proficiency plays a dominant role in the recruitment of non-classical language areas, which appear to have supramodal responses to linguistic stimuli.

I24

SPATIOTEMPORAL DYNAMICS OF MORPHOLOGICAL PROCESSING IN SPOKEN DERIVED AND INFLECTED WORDS Alina Leminen[1], Miika Leminen[1], Minna Lehtonen[1,2], Päivi Nevalainen[3], Sari Ylinen[1], Lilli Kimppa[1], Christian Sannemann[1], Jyrki P. Mäkelä[3], Teija Kujala[1]; [1]University of Helsinki, [2]Aalto University, [3]Helsinki University Central Hospital — The present study examined the temporal course and the neural sources of spoken morphologically complex words. The aim was also to compare the neural processing of derived (e.g., sense+less) and inflected (e.g., sense+s) words. Ten participants (native speakers) listened to morphologically simple and complex Finnish words and judged their acceptability while their electroencephalography (EEG) and magnetoencephalography (MEG) responses were recorded simultaneously. The event-related potential (ERP) results showed that inflected words elicited a larger LAN-type of negativity than derived and monomorphemic words approximately 200 ms after the critical point (suffix onset or uniqueness point). Equivalent current dipole (ECD) modeling of MEG data showed that this negativity was explained by two bilateral sources (four dipoles) in the temporal cortex, with inflected words showing larger source amplitudes than derived words. There were also significant differences in the dipole locations between inflected and derived words. The current results provide electrophysiological evidence for distinct neural sources of spoken inflected and derived words. In general, the results support the models of morphological processing that suggest that during the recognition of inflected words, the constituent morphemes are accessed separately. The stem and suffix combination undergoes simultaneous syntactic licensing and semantic integration of the morphemes. Regarding derived words, stem and suffix morphemes might be at least initially activated along with the whole word representation.

I25

ON THE INTERFACE OF PHONOLOGY AND MORPHOLOGY IN PROCESSING OF COMPLEX WORDS Natalia Bekemeier[1], Aditi Lahiri[2], Carsten Eulitz[1]; [1]University of Konstanz, Germany, [2]University of Oxford — How much detail on word forms is stored in mental lexicon? The current EEG study asked whether there is morphological decomposition of semantically transparent complex nouns (stem + derivational suffix). To explore this, we used a fine-grained phonologically motivated violation of a stem vowel as well as presence/absence of sentence context. The hypothesis was that violation-related brain responses should depend on the type of stem violation and the presence of context. A set of spoken German nouns of the type 'adjectival stem + fronting + {ung}' (e.g. Stark~Stärkung) was tested in a word list experiment and a sentence context experiment with critical items in final position. In the related derived (RD) condition, we preserved the adjectival stem (e.g. *Starkung), in the unrelated derived (UD) condition a non-existing stem (e.g. *Sturkung) was used. Both violation conditions elicited similar L(eft) A(nterior) N(egativity) and P600 effects in the context experiment. Similar results were found in a cross-linguistic comparison using English nouns of the type 'adjectival stem + change of height/tenseness + {ity}' (e.g. sane~sanity). The word list experiment showed a significant gradient brain response (control > RD > UD) in the latency and topography of N400. This gradual pattern of N400 effect gives evidence for morphological decomposition of complex words. Moreover, our findings in the context experiments imply that contextually driven expectations induce repair mechanisms that convert violated items into semantically meaningful strings. Thus, the LAN/P600 effects support the idea that these repair mechanisms are purely morphosyntactic, i.e. morphological decomposition takes place.

I26

COMBINED ERP/FMRI EVIDENCE FOR LEXICAL EFFECTS IN THE LANGUAGE FORMULATION AREA Joseph Dien[1], Eric Brian[2], Dennis Molfese[3], Brian Gold[4]; [1]University of Maryland at College Park, [2]University of Louisville, [3]University of Nebraska at Lincoln, [4]University of Kentucky at Lexington — The Recognition Potential (Rudell, 1991), a left-lateralized negativity that peaks at about 200-250 ms, is one of the most interesting of the early latency ERP reading components. It is the first to consistently display lexicality effects (larger for words vs. non-words) and possibly semantic effects. It has therefore been suggested to reflect an early confluence of lexical and semantic processing (Martín-Loeches, 2007). The lexicality effect seems to be largely invisible unless the stimuli are temporally flanked by masks at an SOA of about 250 ms (Iglesias et al., 2004). It has been suggested that its generator is either the Visual Word Form Area (Martín-Loeches, Hinojosa, Gómez-Jarabo, & Rubia, 2001) or

the Language Formulation Area (Dien, 2009), a portion of the posterior inferior temporal gyrus (Nielsen, 1946) that has been reported to respond to cloze probability of sentence stimuli (Dien et al., 2008). In this experiment, twenty-three participants underwent the task while having high-density 129-channel ERP data collected and a separate sample of fifteen participants underwent the task while having fMRI data collected in a 3T scanner. Examination of the ERP data confirmed that a standard Recognition Potential effect was produced. The only corresponding effect in the fMRI data was in the Language Formulation Area, confirming it as a more likely source for the Recognition Potential. Based on the neuroanatomical location and the temporal information, it is suggested that it may be a primary convergence point between the orthographic and phonological pathways of reading comprehension.

I27

ACOUSTIC AND CATEGORICAL EFFECTS OF AMERICAN ENGLISH FRONT VOWEL PERCEPTION Mathias Scharinger[1,3], Philip Monahan[2,3], William Idsardi[3]; [1]Max-Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]Basque Center on Cognition, Brain, and Language, Spain, [3]University of Maryland — The classification of vowels can rely on gradient-acoustic distinctions (e.g. spectral characteristics) or on abstract-categorical distinctions (i.e. high vs. low vowels). We present data from a MEG mismatch negativity (MMN) study that assesses both the processing of gradient acoustic and categorical phonological information. Thus, we tested the American English low, mid, and high front vowels [?], [?] and [?], recording the neuromagnetic response to deviant vowels preceded by a series of standard vowels. Based on previous work, we expect the MMN amplitude to reflect categorical rather than acoustic differences between standards and deviants. 15 participants passively listened to multiple, acoustically distinct tokens of the front vowels, naturally produced by a female native speaker of American English. Brain activity was recorded by a 157 channel whole-head axial gradiometer MEG system (KIT, Japan). We compared the brain responses to the low-mid pair (i.e., [?]/[?] and [?]/[?]) and to the low-high pair (i.e., [?]/[?] and [?]/[?]), assuming that the low-high pair should not elicit larger MMNs if the response is dependent on categorical differences. In fact, the magnitude of the MMN did not differ in amplitude between the contrast of low and mid, and low and high vowels ($t = 1.61$, $p = 0.11$). Further, we found a directional MMN asymmetry for the low-mid comparison, supporting underspecification of the feature [mid]. Differences in N1m dipole sources, on the other hand, preserved acoustic distances in vowel space. We conclude that initial, more acoustic-based processing is rapidly followed by the evaluation of categorical vowel differences.

I28

THE RIGHT TO NAME ACTIONS Eileen Cardillo[1], Gwenda Schmidt[2], Matthew Lehet[1], Anjan Chatterjee[1]; [1]University of Pennsylvania, [2]Hope College — By most accounts, the critical contribution of the right hemisphere to language processing is restricted to complex interpretive tasks that require extending meaning beyond the literal senses of individual words or sentences (e.g. figurative language, narratives, inferences, and emotional tone). Neuropsychological studies consistently reveal impairments in these high-level language skills following right hemisphere injury while reports of comprehension or production deficits at the level of single words are exceedingly rare. The report of Neininger and Pulvermuller (2003) then that damage to right frontal cortex results in significantly impaired verb processing is especially surprising. The purpose of the present study was to re-examine the assumption that the language-dominant left hemisphere is necessary and sufficient for normal naming abilities by following up on this study with a more sensitive and rigorous approach. We tested thirty-four focal lesion patients (half with unilateral left hemisphere injury and half with unilateral right hemisphere injury) on the Object and Action Naming Battery (Druks, 1992) and conducted Voxel-based Lesion Symptom Mapping (VLSM; Bates et al, 2003) analysis to identify areas where damage significantly impaired naming accuracy. Results of the VLSM analysis confirm that an intact left hemisphere is insufficient for accurate action naming. Even in the absence of clinical aphasia, lesions to the right prefrontal and premotor cortex were associated with mild but significant impairments in the ability to accurately name everyday actions. Results are discussed in terms of possible deficits at the level of verb retrieval or semantics.

Language: Development & Aging

I29

THE MISMATCH NEGATIVITY TO THE ENDING VOWEL CHANGE OF PSEUDOSYLLABLES IN ADULTS AND PRESCHOOLERS Pei-wen Yeh[1,2], Yu-lin Tzeng[1], Chia-Ying Lee[1,2]; [1]Institute of Linguistics, Academia Sinica, Taipei, Taiwan, [2]National Yang Ming University, Taiwan — Mismatch negativity (MMN) is an ERP component that reflects a process of automatic discrimination of auditory information. In our previous study, MMN to ending vowel (rime) changing in Mandarin syllable elicited in 100-250 ms in adults. However, the MMN can be replaced by the positive mismatch responses (P-MMR) in 4- to 5-year-old preschoolers. It is still unclear whether the developmental transition from a positive wave to an adult-like negative mismatch is affected by the neural maturation or by the stimulus-related factor, such as the size of deviance. In addition, the influence of meaning syllable could enhance the magnitude of MMN (MMN enhancement; Pulvermüller et al., 2001). Therefore, the present study aims to examine the mismatch responses to three meaningless syllables: tsi1, tsu1 and tse1, that share the same initial consonant /ts/ and high level tone T1 but differ in the place of articulation of the ending vowel in adults and preschoolers from 4 to 6 years old. The "tsi" serves as the common standard and the "tsu" and "tse" were smaller and larger deviants in the multiple oddball paradigm. The results showed that typical MMNs elicited in 150-250 ms in adults, but P-MMRs instead in 4- to 6-year-old preschoolers. The data suggested that both stimulus-related and biological criteria affected the presence of P-MMR.

I30

NEURAL CORRELATES OF LANGUAGE ACQUISITION IN INTERNATIONALLY ADOPTED CHILDREN Reem Khamis-Dakwar[1], Kathleen Scott[2]; [1]Adelphi University, [2]Hofstra University — The effects of immersing an internationally adopted (IA) child into the new language of the environment (LE) while ceasing his/her exposure to his/her first language, the language of adoption (LA), are not fully understood. A recent meta-analytic examination of language skills in IA children reveals that IA children show poorer language performances during the school-age years (and beyond) as opposed to their non-adopted peers (Scott et al., in submission). To evaluate whether later language difficulties can be related to differences in phonemic system organization, we investigated auditory MMN responses from five IA children (3 -5 years old) adopted from China and exposed to LE for at least 2 years, and five matched non-adopted monolingual English speaking children .Words were presented in randomized order in passive listening oddball paradigms in three conditions. Chinese only phonemic feature (/maai5/ (buy) & /maai6/(sell))based on tonal differences present in Mandarin and not in English, English only phonemic feature not represented in Mandarin (/mad/ vs. /mat/), and phonemic contrast evident in both languages (/mad/ and /man/). MMN was derived from 32 channel EEG recordings by averaging and montaging to fronto-central sensors and subtraction of averaged standard responses from averaged deviant responses within each condition. Enhanced MMN responses were observed for tonal differences in IA children and not for the control group. The English phonemic contrasts were associated with delayed MMN responses for the IA group and not the control group. We propose that these preliminary findings reveal differences in the phonological representations in IA children.

I31

IMPAIRED LEXICAL PROCESSING IN CHILDREN WITH AUTISM SPECTRUM DISORDERS AS REVEALED BY MISMATCH NEGATIVITY

Bettina Mohr[1,2], Whitmore Antony[1], Garagnani Max[2], Pulvermuller Friedemann[2], Ludlow Amanda[1]; [1]Anglia Ruskin University, Cambridge, UK, [2]Medical Research Council, Cognition and Brain Sciences Unit, Cambridge, UK — Semantic processing problems are often seen among individuals with a diagnosis of autism spectrum disorders (ASD). However, it is still unclear whether these deficits reflect impairments in language processing per se or whether they may be linked to or caused by problems in auditory sensory processing, such as hyper- or hyposensitivity to sounds and speech. This question was addressed in a multi-feature passive mismatch negativity paradigm (MMN) using speech standards as well as frequency, loudness, length, word and pseudo-word deviants. 11 high functioning children with a diagnosis of autism spectrum disorders (mean age 13.1 years) and 11 typically developing children (mean age 13.7 years) were matched for IQ and handedness. Behavioural correlates of sensory perception were assessed with the Adolescence Sensory Profile. In ASD children, compared with typically developing children, we found significantly reduced MMN amplitudes to loudness and word deviants, but not to pseudo-word, frequency and length deviants. Further analyses showed that only word evoked MMN responses significantly correlated with impaired sensory processing in the ASD group. As word-elicited MMN responses have previously been suggested to reflect the activation of cortical memory circuits, we interpret the reduced word-MMN as an indicator of weakened memory traces in ASD, leading to impaired top-down processing.

I32

SEGMENTING WORDS IN TWO LANGUAGES: ERP EVIDENCE FROM MONOLINGUAL AND BILINGUAL INFANTS

Debra Mills[1], Caroline Junge[2], Theresa Wildegger[1], Emily Guilhem[1], Laura Talbot[1], Natalie Ebanks[1]; [1]Bangor University, [2]Max Planck Institute for Psycholinguistics, Nijmegen — An important predictor of early language development is the ability to recognize words from continuous speech. This is a non-trivial task even for infants exposed to only one language. Infants learning trochaic languages use the statistical regularities of the stress patterns of their native language to facilitate word segmentation. Here, we examine the effects of learning one or two trochaic languages, English and/or Welsh, which differ in the salience of the first syllable on ERP indices of word segmentation. Although both languages are stress-based, the difference between stressed and unstressed syllables is more salient in English. Welsh typically has a short first vowel and a lengthened second syllable, providing a syllable-based cue, and initial stress is a less reliable predictor of word onset. In the present study, 32 10-month-olds exposed to only English or both English and Welsh participated in the study. Infants were familiarized to 4 blocks of 8 English sentences containing a stress-initial bi-syllabic word followed by a test phase of 4 unique sentences, half containing the familiarized word. Monolingual infants showed a left-negativity at 400ms, followed by a late negative component (Nc). Similarly, bilinguals show a larger negativity to familiarized than unfamiliarized words over left frontal regions, but the onset of the ERP effect was later. The results suggest that exposure to two languages with minimally different rhythmic structures increases the difficulty of finding words in the speech stream. Although bilinguals are capable of finding words in continuous speech, they make take more time to do so.

I33

SEMANTIC PRIMING AND WORKING MEMORY IN MONOLINGUAL AND BILINGUAL INFANTS

Natalie Ebanks[1], Debra Mills[1], Caroline Junge[2], Catherine Rowe[1], Theresa Wildegger[1], Emily Guilhem[1], Laura Talbot[1]; [1]Bangor University, [2]Max Planck Institute for Psycholinguistics, Nijmegen — The extent to which domain general processes contribute to language development is a central question in developmental science. Behavioral research suggests that memory development plays an important role in the rapid vocabulary changes typically observed between 13- and 20-months. It has been suggested that bilingual adults have improved working memory abilities compared to monolinguals as a function of increased frontal lobe function. The present study tests the hypothesis that bilingual infants will show enhanced sematic priming effects compared to monolingual infants as a result of improved working memory abilities. An event-related potential (ERP) semantic priming paradigm was adapted for use with infants to elicit the N400 component. Infant participants 14-, 17-, 20- and 30-months of age heard a word that was immediately followed by a picture. The word prime either named the subsequent picture (match) or was the name for another picture (mismatch). This paradigm requires the infant to hold the word in mind and compare it to the subsequent picture to show a priming effect. A larger N400 was expected in trials where there was a mismatch between the word-picture pair. Consistent with previous findings, the size of the N400 effect in monolingual infants was linked to vocabulary size. That is, only more experienced word learners showed an N400 effect. When holding vocabulary size constant, the bilingual infants showed a more mature N400 effect than monolingual infants across all ages. This enhanced N400 word-picture effect is interpreted as the result of increased working memory abilities in bilingual infants.

I34

EXPERIENCE-INDUCED CHANGES IN BRAIN STRUCTURES AND FUNCTIONS: INFLUENCE OF LIFELONG BILINGUALISM

Gigi Luk[1], Ellen Bialystok[1,3], Fergus Craik[1,2], Cheryl Grady[1,2]; [1]Rotman Research Institute at Baycrest, [2]University of Toronto, [3]York University — Structural and functional brain changes have been reported as a result of behavioral training but less research has examined the relation between such neurological change and life experience. To examine one such experience, bilingualism, we studied 24 older adults with structural and functional MRI. Half of the participants had lifelong bilingual experience on a daily basis since childhood and the others were monolingual speakers of English. Participants in the two groups had comparable background, neuropsychological performance and gray matter volume. Using diffusion tensor imaging, bilingual participants showed increased white matter integrity, measured by fractional anisotropy (FA), in corpus callosum and parts of the bilateral superior longitudinal fasciculi. This FA difference was primarily driven by lower radial diffusivity, indicating more intact myelination in the bilinguals. Resting-state functional data in these participants were analyzed with seed connectivity using partial least squares (seed-PLS), a multivariate technique that correlates brain activity in a seed voxel with activity in the rest of the brain. The seed was in the left caudate, chosen from a meta-analysis examining bilingual language switching. Results revealed common and distinct regions showing correlated brain activity with left caudate for monolinguals and bilinguals. The distinct regions uniquely expressed in bilinguals included left hemisphere pre-SMA, middle cingulate cortex, and inferior parietal lobule. These findings show that lifelong bilingualism maintains white matter integrity in older adults and reveal different functional neural networks at rest. These structural and functional changes may be the neural underpinnings of the reported bilingual behavioral advantage in executive functions.

I35

PICTURE-SENTENCE VERIFICATION IN OLDER ADULTS: EVIDENCE FROM ERPS

Pia Knoeferle[1], Marta Kutas[2]; [1]Bielefeld University, [2]University of California San Diego — In a recent study, sentences implied the shape of an object, which matched (vs. mismatched) the shape of an object on a subsequent picture. Participants verified whether the sentence mentioned the object. Shape-matching (vs. mismatching) trials elicited faster responses; mismatch effects were more pronounced, and response latencies delayed for older relative to younger adults. These results were interpreted as older (vs. younger) adults constructing stronger situation models (Dijkstra et al., 2004). We collected event-related brain potentials (ERPs) as older participants (60-90 yrs) read subject-verb-object sentences, and sentence final response times (RTs) indicating whether or not the verb matched a previously depicted action (e.g., gymnast-punching

vs. applauding). For mismatches (vs matches), RTs were longer, verb N400s over centro-parietal scalp larger, and ERPs to the object noun more negative, replicating findings on verb-action congruence in younger adults (18-31 yrs, Knoeferle, Urbach, & Kutas, in press). In older (-0.55) vs. younger (-1.51) adults, verb-action congruence N400 effects were less pronounced. Reliable N400 congruence effects in older adults were delayed and only reliable between 400-500 ms, and not - like for younger adults - from 300-400 ms post verb onset. Sentence-finally, only young adults showed a reliable congruence effect. Thus, in our task, too older adults were slower to respond to mismatches, though their online N400 effects were less pronounced than in the younger adults, undermining a simple account of strong situation models in the elderly.

I36

MISMATCH RESPONSES TO MANDARIN LEXICAL TONE IN CHILDREN WITH OR WITHOUT SPECIFIC LANGUAGE IMPAIRMENT Hsin-Chi Wu[1,2], Huei-Ling Yen[1,2], Pei-Wen Yeh[3], Yu-Lin Tzeng[3], Chia-Ying Lee[3]; [1]Department of Physical Medicine and Rehabilitation, Buddhist Tzu Chi General Hospital, Taipei branch, Taipei, Taiwan, [2]School of Medicine, Tzu Chi University, Hualien, Taiwan, [3]Institute of Linguistics, Academia Sinica, Taipei, Taiwan — An issue still in debate is whether the children with specific language impairment (SLI) have deficit in speech processing. This study aims to address this question by using mismatch negativity (MMN) to index their ability in discriminating lexical tones of Mandarin CV syllables in a multiple-deviant oddball paradigm. In which, T1 (yi1; high level contour, 10%) serves a large deviants and T2 (yi2; high rising contour, 10%) serves as a small deviant, were contrasted to a common standard T3 (yi3; low falling rising contour, 80%). Twelve children with SLI aged from 4 to 6 years old and their age-matched controls participated in this study. The control group exhibited an adult-like MMN between 100-250 msec to large deviant (T1/T3) and an attenuated and delayed MMN from 150 to 200 msec to small deviant (T2/T3). However, children with SLI showed a delayed MMN to large deviant (T1/T3) from 200 to 250 msec and a positive mismatch response to the small deviant (T2/T3) from 250 to 350 msec. The data suggested children with SLI display a deficit in lexical tone discrimination, especially for the acoustic similar contrast, such as T2/T3. It might serve as a neurophysiological marker for the early identification of children with language or reading deficits.

I37

DOES BEING BILINGUAL LEAD TO AN ADVANTAGE AT DECLARATIVE MEMORY? Ingrid Finger[1], Johanna Dagort Billig[1], Laura Babcock[2], Michael T. Ullman[2]; [1]Federal University of Rio Grande do Sul, Brazil, [2]Georgetown University — Previous studies have generally shown bilingual advantages in executive function over the lifespan. However, few studies have examined the effects of bilingualism on other cognitive domains. Declarative memory is one domain that might be expected to show bilingual/monolingual differences. Evidence suggests that this memory system plays important roles in both first and second language (Ullman, 2001; 2005). The use of this memory system in two languages in bilinguals, as compared to one in monolinguals, might thus possibly lead to the greater development of declarative memory in bilinguals, due to their greater language experience. To test this hypothesis, we examined declarative memory with a recognition memory task in middle-aged and elderly Brazilian monolingual speakers of Portuguese, and age- and education-matched Brazilian bilingual speakers of Portuguese and Hunsrückisch (a German dialect). In the encoding phase, subjects saw pictures of real and made-up objects, and indicated whether or not each was real. To test recognition, several minutes later they saw the same items and matched foils, and indicated whether they had seen each item earlier. To test longer-term retention, one day later subjects were again presented with the target items, together with new matched foils, and indicated whether they had seen each item the previous day. Preliminary analyses suggest that bilinguals were more accurate than monolinguals in both the recognition and retention phases, that is, at recognizing the target items and rejecting the foils. The data suggest that cognitive advantages of bilingualism may extend beyond executive function to aspects of declarative memory.

I38

AGE-RELATED DIFFERENCES IN INTRA-INDIVIDUAL SPEECH PROCESSING VARIABILITY Brian Taylor[1], Daniel Roberts[1], Carryl Baldwin[1]; [1]George Mason University — Event-related potentials (ERPs) have frequently been used to assess age-related changes in the neurophysiological processing of language. Specifically, the amplitude of the ERP is often compared between conditions or groups of interest. In constructing ERPs, many recorded neurophysiologic responses are averaged together to reduce the contribution of uncorrelated background EEG. However, if variability in the timing of each potential on a trial-by-trial basis (i.e., "latency jitter") is confounded with a variable of interest, then the presence of amplitude differences observed in the average ERP might not be the result of genuine amplitude differences, but timing variability. We examined what role latency jitter may play in the well-established observation of age-related changes in the processing of natural speech as indexed by the N400. Older and younger adults were presented with sentences that ended in either expected or unexpected final words. In agreement with previous findings, a reduction in N400 amplitude was observed in the older adults compared with the younger adults in response to the unexpected final words. However, analyzing ERPs on a single trial basis reveals the older adults to have significantly greater within subject variability in N400 latency, in comparison to younger adults. This increased intra-individual latency variability may contribute to the smaller N400 amplitudes observed in each subject's average ERP. Age-related reductions in N400 amplitudes may indicate less precise timing of neurological processes. Conversely, they may indicate that the older brain exhibits greater specificity in the processing of individual sentence stimuli. Future research will examine this issue.

I39

A NEUROCOGNITIVE PERSPECTIVE ON SPECIFIC LANGUAGE IMPAIRMENT: NEW EVIDENCE AND THE PROCEDURAL DEFICIT HYPOTHESIS Mariel Y. Pullman[1], Elizabeth I. Pierpont[2], Michael T. Ullman[1]; [1]Georgetown University, [2]University of Wisconsin-Madison — In 2005 we advanced a brain-based conceptualization of Specific Language Impairment (SLI), a developmental disorder affecting language that occurs in about 5% of children. We proposed that SLI can be largely explained by abnormalities of brain structures underlying the procedural memory system, in particular frontal/basal-ganglia circuits, especially in Broca's region and the caudate nucleus (Ullman & Pierpont, 2005). We argued that this pattern of brain abnormalities, which may be caused by various etiologies, results in deficits of the diverse language and non-language functions that depend on these neural substrates – including procedural memory, working memory, motor function, grammar, and lexical retrieval – but that declarative memory and its neural substrates remain largely unaffected. We also suggested that heterogeneity in the exact locus and extent of the neural abnormalities leads to much of the behavioral heterogeneity observed in SLI. Since 2005, a new body of brain and behavioral research has emerged that tests this Procedural Deficit Hypothesis (PDH). Here, we present a review of this recent evidence, focusing on neuroimaging and ERP studies, as well as a range of behavioral experiments examining procedural memory, declarative memory and other functions. We present a quantitative analysis of the proportion of SLI samples, across all studies, that have shown abnormalities of major cortical and subcortical brain structures. Overall, the evidence supports the PDH and suggests further theoretical refinements as well as avenues for future research. We discuss implications for behavioral heterogeneity, co-morbidity with ADHD and other disorders, and therapeutic interventions.

I40

ADHD AND LANGUAGE IMPAIRMENT: A NEW PERSPECTIVE ON COMORBIDITY Kaitlyn M. Tagarelli[1], Mariel Y. Pullman[1], Michael T. Ullman[1]; [1]Georgetown University — Attention-deficit/hyperactivity disorder (ADHD), the most common developmental disorder in children, co-occurs with language deficits at rates as high as 90%. Various accounts have been posited for the high comorbidity of ADHD with language impairments (including Specific Language Impairment; SLI), such as a lack of causality between the disorders, and language problems being caused by attention problems. While these and other explanations may help partially account for the comorbidity, we argue that they are not sufficient. We suggest a new hypothesis: abnormalities in frontal/basal-ganglia and/or frontal/cerebellar circuits in ADHD not only affect those portions of the circuitry responsible for the core deficits of ADHD, but also tend to extend to other, parallel, portions of the circuitry, including those involved in language – specifically, those portions involved in grammar (posited to depend on the circuitry underlying procedural memory) and those parts underlying lexical retrieval (thought to depend on nearby circuitry). That is, just as Ullman and Pierpont (2005) posit that SLI is not specific to language, we posit that ADHD is not necessarily specific to attention or hyperactivity. To test this hypothesis, we present a review of evidence from a wide range of neural and behavioral studies of ADHD. Overall, the evidence supports the predictions of this novel hypothesis for ADHD, which can be viewed as an extension of the Procedural Deficit Hypothesis (PDH) proposed for SLI. Finally, we make a number of testable predictions for future research, and suggest that the PDH is a useful paradigm for the further study of ADHD.

I41

MATURATION OF MISMATCH RESPONSES TO MANDARIN LEXICAL TONES IN PRIMARY SCHOOL CHILDREN En-ju Lin[1], Wan-hsuan Lin[1], Yu-lin Tzeng[1], Pei-wen Yeh[1], Chia-ying Lee[1]; [1]Institute of Linguistics, Academia Sinica — Mismatch negativity (MMN) is a change-specific component of auditory event-related potentials (ERPs) elicited in passive oddball paradigm. In adults, MMN is generally a frontocentral negativity elicited between 150 and 250ms after the onset of the deviant stimuli. However, it was also found that MMN could be replaced by a frontal positive response when measured in infants and preschool children. The change of the polarity of the mismatch responses has been suggested a developmental transition affected by both neuronal maturation and the stimulus-related factors such as the size of deviance. As follow-up, present study further examined whether the turning point of the polarity could be found during elementary school stage with regard to lexical tone changes. With the participation of more than 80 native Chinese students across 6 grades (aged from 7 to 13 years old), two deviants, high level T1 and high rising T2 (10% each), were contrasted with a common low falling-rising standard T3 (80%) in a multi-deviants oddball paradigm. In consistent with previous observation, the mismatch responses for the acoustically dissimilar contrast of T1/T3 showed an adult-like MMN across the grades. As for the acoustically similar contrast of T2/T3, a positive mismatch response was observed in the case of lower grades whereas data from higher grade students started to show a smaller in amplitude yet negative response. Furthermore, the transition in polarity was clearer when grouping the participants according to literacy, suggesting that the maturation of MMN might also be affected by the familiarity of the language.

I42

POSTERIOR PERISYLVIAN PARIETAL ANATOMY IN BOYS WITH AUTISM SPECTRUM DISORDER Tracey Knaus[1], Helen Tager-Flusberg[2], Anne Foundas[1]; [1]Louisisana State University Health Sciences Center, [2]Boston University — The right hemisphere is specialized for spatial attention, emotion and pragmatics; the left hemisphere is specialized for tool use and expressive language functions. The anterior (APR) and posterior (PPR) parietal regions, demarcated by the end of the horizontal ramus of the Sylvian fissure are asymmetric: larger left APR, and larger right PPR. Disrupted lobar volume and asymmetry in individuals with autism spectrum disorder (ASD) may be associated with aberrant inter-hemispheric specialization. This deficit may be associated with aberrant morphology in these posterior perisylvian parietal regions. To examine this hypothesis, 30 right-handed boys with ASD and 30 typically developing boys, matched on age (7-14 years), handedness, and non-verbal IQ, were studied. The APR was larger in the left hemisphere ($F1,58 = 19.08$, $p < .001$) and the PPR was larger in the right hemisphere ($F1,58 = 5.23$, $p = .022$), with no group differences. Structure-function relationships differed between the groups. In controls, there was a negative correlation between right PPR volume and verbal IQ ($r = -.377$, $p = .040$). In the ASD group, there was a negative correlation of the APR asymmetry quotient with verbal IQ ($r = -.411$, $p = .024$) and a positive correlation between right and left APR volumes ($r = .403$, $p = .033$). These results suggest that there are different inter- and intra-hemispheric anatomical-behavioral relationships in boys with ASD. These results support the hypothesis that differential development of the cerebral hemispheres in ASD may be associated with aberrant inter-hemispheric specializations that reflect different processing strategies.

I43

PRELEXICAL REGULARITY DETECTION DURING EARLY INFANCY: A COMBINED EEG AND FNIRS STUDY Sonja Rossi[1,2], Silke Telkemeyer[2,3,4], Isabell Wartenburger[2,4], Hellmuth Obrig[1,2,5]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]Charité University Medicine, Berlin, Germany, [3]Free University Berlin, Germany, [4]University of Potsdam, Germany, [5]University Hospital, Leipzig, Germany — At birth newborns already possess the universal ability to discriminate phonemes of different languages. With increasing exposure to those phonemes relevant for their native language this universal ability decreases in the course of language acquisition. The present study aimed at investigating the development of this discrimination ability in the first six months of life by means of neuroscientific methods. The focus was set on phonotactic regularities. These are prelexical cues which describe the possible combination of phonemes in a specific language. They are important for segmenting an acoustic speech stream and play a crucial role during word learning. We studied newborns, 3 and 6 months old infants by means of the simultaneous measurement of the electroencephalogram (EEG) and the functional near infrared spectroscopy (fNIRS). Results showed that already at 3 months of age - but also at 6 months - infants are able to distinguish native from non-native phonotactic rules. This was observable in the EEG in a stronger frontal negativity and in the fNIRS in a stronger activation for native in contrast to non-native phonotactic rules. The fNIRS effect was bilaterally distributed over frontal areas at that age. This latter finding indicates that neuronal lateralization may establish at a later time during language development.

I44

LEARNING OBJECT NAMES ACTIVATES THE VISUAL WORD FORM AREA MORE THAN LEARNING TO READ: EVIDENCE FROM FMRI Jo S H Taylor[1], Kathleen Rastle[2], Matthew H Davis[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK, [2]Royal Holloway University of London, London, UK — Dehaene and colleagues propose that the left fusiform gyrus (LFG) contains a specialised visual word form area (VWFA) representing abstract orthographic units. Conversely, Price and others argue that the LFG processes visual objects as well as words, attributing word-specific responses to task-related top-down modulation. Differences between these two tasks should be greatest during learning: words must be decoded using systematic spelling-sound mappings whereas objects must be arbitrarily associated with their names. We combine an artificial language paradigm with fMRI, providing a unique opportunity to explore ventral-temporal specialisation whilst learning novel words and objects. Twenty healthy adults learned new names for 24 novel objects and to read 24 new words written in novel symbols, whilst in an MRI scanner. Learning consisted of interleaved phases of training (paired visual and spoken forms) and testing (read words/name objects). Participants learned the

trained items (words-69% correct, objects-68% correct) and generalized their orthographic knowledge to untrained words (62% correct). Relative to unimodal listening or viewing, cross-modal associative learning of spoken words paired with objects and novel written words activated bilateral superior parietal cortices, fusiform gyri and left hippocampus ($p<.01$ whole-brain corrected). The LFG (overlapping with VWFA) was more active when learning object-name associations than when learning to read words. The reverse contrast revealed activation in bilateral superior parietal cortices. The fact that the LFG was less involved in learning a new orthography than in learning new object-label associations challenges the idea that this region is specialised for word reading.

I45

ERP MASKED REPETITION PRIMING EFFECTS IN CHILDREN Marianna Eddy[1], Priya Mitra[2], John Gabrieli[1], Jonathan Grainger[3], Phillip Holcomb[2]; [1]Massachusetts Institute of Technology, [2]Tufts University, [3]CNRS and Aix-Marseille University — Masked priming is the "gold-standard" paradigm for examining visual word recognition in adult readers. Previous behavioral studies have demonstrated reliable masked repetition priming effects can be obtained in children, suggesting that this approach might be useful for probing visual word recognition developmentally. Recently our group has enhanced the temporal resolution of the masked priming paradigm in adults by combining it with the recording of event-related potentials (ERPs). However, to date, ERP studies have not examined the neural time course of these effects in children. The current study examined masked repetition priming in a group of children 8 to 12 years old, manipulating stimulus repetition and duration of prime stimulus presentation. The prime stimulus was presented for 53, 80 or 107 ms with a constant stimulus onset asynchrony of 120 ms. Consistent with adult masked repetition priming ERP literature, we found a cascade of priming effects including the N250 and N400, with effects tending to be stronger at the longer prime duration. These results suggest in proficient, young readers, a similar mechanism to that of adults is used access orthographic and semantic information. However, the priming effects were less robust at shorter priming durations suggesting some developmental differences in proficient reading children compared to adults.

I46

EMERGENCE OF VISUAL CORTEX PLASTICITY IN CONGENITALLY BLIND CHILDREN Marina Bedny[1], Hilary Richardson[1], Lindsay Yazzolino[2], Helen Pu[1], Rebecca Saxe[1]; [1]Massachusetts Institute of Technology, [2]Brown University — Congenitally blind adults activate left visual cortices during language comprehension. This occipital activation extends into primary visual cortex (pericalcarine cortex). We asked when during the course of development visual brain regions take on language functions. Ten totally blind children between the ages of four and sixteen took part in an fMRI study. Nine of the children were blind from birth and one participant became totally blind at age five. Fifteen age-matched sighted children also took part in the study as control participants. During the study, participants listened to brief stories (20 seconds). After each story, children were asked: "Does this come next?" Then the child either heard a sentence describing the completion of that story or an unrelated sentence from a different story (3 seconds). Participants made a yes or no response (6.5 seconds). In two control conditions children performed the same task based on sound similarity with 1) stories in foreign languages and 2) music sequences. In congenitally blind children, we observed increased occipital activity for stories relative to music. However, relative to our prior studies with blind adults, occipital activity was reduced in extent and predominantly found in secondary visual regions in the fusiform gyrus and later occipitotemporal cortex, rather than in the primary visual cortex. These data suggest that occipital areas are recruited for higher cognitive functions in early childhood, possibly beginning with higher-order visual areas.

I47

ERP MASKED PRIMING EFFECTS CORRELATE WITH READING PROFICIENCY IN CHILDREN AND ADULTS Priya Mitra[1], Marianna Eddy[2], John Gabrieli[2], Jonathan Grainger[3,4], Phillip Holcomb[1]; [1]Tufts University, [2]Massachusetts Institute of Technology, [3]CNRS, [4]Aix-Marseille University — Previous research investigating event-related potential (ERP) masked priming effects has provided unique insight into the time-course of automatic visual word recognition. Masked priming produces robust sublexical (N250) and lexico-semantic (N400) effects in the ERPs of fluent adult readers. Since reading is a learned skill, these priming effects must develop over time as the brain acquires the ability to read. Here we explored developmental and individual differences resulting from different levels of reading expertise. Electrophysiological data from college- and elementary-aged typical readers were recorded in a forward- and backward-masked repetition priming paradigm. Standardized behavioral reading measures were also administered to determine individual proficiency in reading-related skills. Correlations between behavioral and ERP priming measures revealed that the amplitude of N250 priming effect was largest at posterior midline sites in adults who had higher scores on one measure of phonological awareness. Analyses of data from developing readers revealed a similar relationship with the size of N250 priming showing a significant positive correlation with phonological awareness at central and posterior sites. The N400 priming effect showed significant positive correlations with number naming speed in both groups. Together these data suggest that ERP masked priming measures may be a sensitive predictor of reading-related subskills in both children and adults.

I48

THE ROLE OF AGE OF ACQUISITION AND LANGUAGE PROFICIENCY DURING L2 SOUND DETECTION IN BILINGUALS: AN FMRI STUDY Aurora I Ramos Nuñez[1], Pilar Archila[1], Jason Zevin[2], Arturo E Hernandez[1]; [1]Department of Psychology, University of Houston, [2]Sackler Institute for Developmental Psychobiology, Weill Medical College of Cornell University — While exemplars of the same speech token cluster into a single category (i.e., within-category), exemplars of different speech tokens cluster into separate categories (i.e., between-categories). A previous study in our lab found that bilinguals' age of acquisition (AOA) and proficiency level (PL) differentially predict the discrimination of within- and between-categories in a second language. The current fMRI study is an extension of our behavioral findings. The main goal is to investigate how AOA and PL predict the detection of sounds in second language (L2) when these are discriminated as same (within-category) or different (between-category). A total of 83 subjects participated in this study (17 monolinguals and 66 Spanish-English bilinguals – 34 early and 32 late). In a passive listening task, participants watched a muted movie clip of "planet earth" while pairs of L2 syllables (saf, sof, suf) played through the MRI headphones. Proficiency scores were obtained in each language. The results from a multiple regression analysis showed that early acquisition activates brain areas associated with categorization of speech and early-auditory processing, including the inferior frontal gyrus and superior temporal gyrus. On the other hand, high proficiency activates brain areas involved in sensory integration, monitoring, and novelty response detection including the superior and inferior parietal lobule, the posterior cingulate gyrus and the supramarginal gyrus. Our data indicates that different neural systems play a role in the detection of non-native within- or between- category sounds depending on the age of acquisition and proficiency level.

I49

AN ANALYSIS OF THE ABILITY OF DIFFERENT NEURAL MARKERS TO PREDICT READING PERFORMANCE Cheng Wang[1], Joonkoo Park[1], Agnes Jasinska[1], Joanne Carlisle[1], Holly Craig[1], Stephanie Hensel[1], Sarah Leitman[1], Fred Morrison[1], Steven Nair[1], Jilly Plonsker[1], Thad A. Polk[1]; [1]University of Michigan — Previous neuroimaging studies have identified a number of different neural markers that predict reading ability, but these markers

have not been systematically compared in the same subjects. We recruited participants with a wide range of reading abilities (from dyslexics to very good readers) and used fMRI to measure a variety of neural markers that have previously been shown to predict reading ability (e.g., right cerebellar activity during a motor sequence task, left occipito-temporal and left temporoparietal activity during phonological processing, activity in area MT/MT+ during a motion processing task). We then correlated each neural marker with reading ability as assessed by the Woodcock-Johnson III Reading Inventory (WJ-III) and the Test of Word Reading Efficiency (TOWRE) in order to evaluate the predictive power of each marker. Preliminary data suggest that cerebellum activation during motor sequence execution and activation in the reading network during phonological processing are good neural predictors of reading fluency and word decoding, whereas MT/MT+ activation during motion processing is a good neural predictor of passage comprehension. Complete results from a larger sample of subjects will be presented and discussed. Supported by NIH grant R21HD064983 to T.A.P.

I50

AGE-RELATED CHANGES IN DECISION-MAKING INFLUENCE OPTIMAL COMMUNICATION Corey McMillan[1], Robin Clark[1], Michael Dreyfuss[1], Murray Grossman[1]; [1]University of Pennsylvania — Individuals can optimize communication by minimizing ambiguities. For example, instead of speaking a homonym (e.g., "pen") individuals can use an unambiguous alternative (e.g., "animal cage"). McMillan et al (submitted) observed that young adults who optimize communication recruit a decision-making network that includes a probabilistic mechanism ("what is the likely meaning of 'pen'?") in dorsolateral prefrontal cortex (DLFPC), a risk-evaluation mechanism (will 'pen' be misinterpreted?") in orbitofrontal cortex (OFC), and an integration mechanism in inferior parietal cortex (IPC). Healthy seniors have limitations with decision-making due to age-related cortical changes in DLPFC and OFC. In this study we used fMRI in young adults (YNG) and healthy seniors (HS) to investigate how changes in decision-making mechanisms influence optimal communication. Participants performed a sentence-completion task ("He needed a __.") by choosing a homophone ("pen") or an unambiguous synonym ("cage") after reading a sentence biased toward the dominant ("Tony has ink") or subordinate meaning ("Tony has pigs"). YNG chose more unambiguous synonyms than HS in both the dominant and subordinate contexts ($p<0.05$); YNG chose more unambiguous synonyms in the subordinate than the dominant context while HS selections did not differ across contexts. An fMRI analysis revealed that YNG recruited a decision-making network relative to HS, including DLPFC, OFC and IPC, while HS only recruited anterior cingulate relative to YNG. These behavioral results suggest that HS have limitations optimizing communication, and fMRI evidence suggests this limitation is due to reduced recruitment of a decision-making network. We conclude that decision-making mechanisms contribute importantly to optimizing communication.

I51

PROCEDURAL MEMORY DEFICITS IN SPECIFIC LANGUAGE IMPAIRMENT: EVIDENCE FROM AN ALTERNATING SERIAL REACTION TIME TASK Martina Hedenius[1,2], Esther Adi-Japha[3], Antoine Tremblay[2], Cristina D. Dye[2,4], Margareta Jennische[1], Jonas Persson[5], Per Alm[1], J. Bruce Tomblin[6], Michael T. Ullman[2]; [1]Department of Neuroscience, Uppsala University, Sweden, [2]Brain and Language Lab, Georgetown University, [3]Bar-Ilan University, Israel, [4]University of Salford, United Kingdom, [5]Department of Psychology, Stockholm University, [6]Child Language Research Center, University of Iowa — Specific Language Impairment (SLI) is a developmental disorder that affects language, especially grammar. However, SLI is also associated with deficits of non-linguistic functions such as motor skills. The Procedural Deficit Hypothesis (PDH; Ullman & Pierpont, 2005) proposes that SLI can be largely explained by abnormalities of brain structures in the procedural memory system. This system, which is rooted in frontal/basal-ganglia circuits, may be specialized for the implicit learning of rules and sequences, in both motor and cognitive domains, including grammar. The PDH predicts procedural learning deficits. To test this, we gave the Alternating Serial Reaction Time task (ASRT; Howard & Howard, 1997) to 27 language-impaired (mean age 10) and 22 age-matched typically-developing children, none of whom had ADHD or other co-morbid developmental disorders. Subjects performed the task for four epochs (each 5 blocks of 80 trials) on one day. Retention was examined on a subsequent day with a single epoch. Learning was operationalized as a two-way interaction between Epoch (1-5) and Triplet-Frequency (high/low): learning should be reflected by an increasing difference in performance between high- and low-frequency triplet-sequences. Holding performance IQ constant in an ANCOVA, group differences in learning were observed (Epoch x Triplet-Frequency x Group interaction), due to learning between epochs 1 and 5 in the typically-developing but not the language-impaired children. The data suggest that procedural learning deficits in language-impaired children might in some cases be apparent only after a delay, perhaps due to consolidation differences. The results support the PDH, and suggest further refinements to the hypothesis.

I52

ATTENTIONAL FOCUS DURING LEARNING IMPACTS N170 LATERALIZATION TO NOVEL VISUAL WORD FORMS Yuliya Yoncheva[1], Jessica Wise[1], Bruce McCandliss[1]; [1]Vanderbilt University — Reading instruction can highlight different unit sizes in print-to-speech mappings, ranging from whole words to grapheme-phoneme relationships within words. Thus, attentional focus on specific unit sizes during learning might influence the neural mechanisms recruited later in skilled reading, as indexed by the characteristically left-lateralized N170 event-related potential (ERP) response. The present study tested this hypothesis by training literate adults in an artificial writing system consisting of word characters (glyphs) containing embedded letters. Subjects learned to associate sets of auditory English words with corresponding glyphs under two instruction conditions. For one set, participants were instructed to focus on linking entire characters to whole auditory words (whole-word focus); for another set, they were instructed to focus on linking the embedded letters to the vowels and consonants within the auditory words (grapheme-phoneme focus). Following training, ERPs to both sets of glyphs were recorded during a reading verification task. Glyphs trained under grapheme-phoneme focus elicited a more left-lateralized N170 topography relative to the right-lateralized N170 topography observed in response to glyphs trained under whole-word focus. These results demonstrate that focusing learners' attention on certain unit size mappings can impact the neural circuitry subsequently recruited by specific stimuli during reading. The current findings support the notion that attentional focus plays a key role in early reading acquisition.

Language: Semantic

I53

ELECTROPHYSIOLOGICAL CORRELATES OF THE COMPREHENSION OF NOVEL MEANINGS: CONTRASTING OXYMORA AND PLEONASMS Nicola Molinaro[1], Manuel Carreiras[1,2], Jon Andoni Duñabeitia[1]; [1]BCBL, Basque center on Cognition, Brain and Language, [2]Ikerbasque, Basque Foundation for Science — In this study we evaluate novel meanings comprehension processes. Oxymora are figures of speech in which two words whose meaning is paradoxical are merged. The most common form of oxymoron involves adjective-noun combinations (e.g. cold fire or real dream). While oxymora are literally paradoxical, pleonasms are noun-adjective pairs in which similar meanings are redundantly expressed (burning fire). In a first ERP experiment 20 participants were visually presented with word by word Spanish sentences containing noun-adjectives Oxymora (Estaba completamente confusa por el sueño real de la noche anterior. - I was completely confused by the real dream from last night), compared to literally Neuter sentences (funny dream) and semantic Vio-

lations (!expert dream). The Violation condition elicited an enhanced N400 compared to the other two conditions, that did not differ around 400 ms. The Oxymoron condition elicited a larger frontal positive effect (500-900 ms) compared to the other conditions. In a second experiment 20 Spanish speakers read sentences containing Pleonasms (unreal dream; plus Neuter and Violation). While Pleonasms and Neuter sentences did not differ around 400 ms the Violation caused a N400 effect. The Pleonasm elicited a short-living (500-650 ms) increased frontal positive component compared the other conditions. The two experiments suggest that understanding oxymora requires more than the simple activation and combination of semantic features (mirrored in the N400). Only after this initial semantic analysis, related concepts are integrated in activating novel meanings: while pleonasms trigger short-living late positivities, oxymora trigger long-lasting positivities.

I54

CEREBRAL ASYMMETRIES IN THE GENERATION OF LITERAL VERSUS FIGURATIVE MEANINGS Natalie A. Kacinik[1], Rita El-Haddad[1], Benjamin A. Cooley[1]; [1]Brooklyn College and the Graduate Center, City University of New York — There are indications that the right hemisphere (RH) is preferentially involved in processing figurative language (e.g., Anaki et al., 1998; Klepousniotou & Baum, 2005; Schmidt et al., 2007), but many studies have failed to find evidence of this preferential RH involvement (e.g., Coulson & Van Petten, 2007; Kacinik & Chiarello, 2007; Rapp et al., 2004). In normal, non brain-injured participants, the vast majority of this research has investigated the processing of figurative expressions, particularly the activation and integration of their meaning, using comprehension paradigms. The present study used visual half-field presentation and a word generation procedure to examine hemispheric differences in the generation and production of literally versus figuratively related nouns in response to adjectives with a literal and figurative sense. The typically robust processing advantage for words presented to the right visual field left hemisphere (RVF/LH) was not obtained, in accordance with previous work by Chiarello et al. (2006) suggesting that the RH may be important for generating and maintaining the activation of potential word responses. Furthermore, classification of these responses indicated that participants were more likely to generate figuratively related words in response to stimuli in the LVF/RH, whereas words presented to the RVF/LH were more likely to result in literal responses. These findings thus support the RH figurative language hypothesis because, although the RH may not be the preferred substrate for understanding figurative expressions, it does appear to be important in generating, and hence ultimately producing, figuratively related words.

I55

"FOR TO EVERYONE WHO HAS, MORE SHALL BE GIVEN": SEMANTIC RICHNESS ENHANCES IMPLICIT WORD LEARNING Milena Rabovsky[1], Werner Sommer[1], Rasha Abdel Rahman[1]; [1]Humboldt University (Berlin) — Words differ considerably in the amount of associated semantic information. Despite the crucial role of meaning in language, it is still unclear whether and how this variability modulates language learning. Here, we provide initial evidence demonstrating that the amount of semantic features associated with a given word influences implicit learning in repetition priming. Electroencephalographic recordings were obtained while participants performed a visual lexical decision task; the complete stimulus set was repeated once. Repetition priming effects on performance accuracy and the N400 component of the event-related brain potential were enhanced for words with many semantic features. These findings suggest a novel and important impact of the richness of semantic representations on learning and plasticity within the lexical-conceptual system.

I56

AUDITORY CORTICAL ACTIVITY DURING SUSTAINED AUDITORY ATTENTION Novraj Dhanjal[1], Jane Warren[1], Richard Wise[1]; [1]Imperial College London — Successful encoding of heard factual sentences depends on sustained auditory attention while listening to an entire sentence. This results in greater understanding of the meaning of messages conveyed, strengthening encoding to episodic memory. Studies of selective auditory attention in both humans and animals have attributed enhancement of activity in auditory cortex to attention. However, studies of sustained auditory attention in rats have demonstrated suppression of activity in primary auditory cortex. Using functional magnetic resonance imaging on 31 healthy adults, we investigated the response of human auditory cortex during sentence encoding. Subsequent recall performance was used as a marker of sustained auditory attention during encoding. Sentences that were most accurately recalled were associated with relative suppression of activity in primary auditory cortex during encoding. This was accompanied by greater activity in cortical regions associated with processing for verbal meaning (semantics). By contrast, the greatest auditory activity was associated with task-dependent focused attention on single words during a task designed to prevent subvocal rehearsal of sentences, despite lower rates of presentation of auditory stimuli than in sentence encoding task. We have therefore demonstrated that although focused attention to individual verbal stimuli enhances activity in early auditory cortex, different levels of sustained auditory attention when understanding sentences have counterintuitive modulatory influences on auditory cortical function. These findings have implications for research on patients with diffuse neurodegenerative diseases, whose verbal memory impairment may be consequential to an inability to sustain auditory attention across sentences, in addition to disordered language and memory systems.

I57

SPATIO-TEMPORAL INTEGRATION OF WRITTEN WORDS DURING PHONOLOGICAL AND SEMANTIC TASKS. HIGH RESOLUTION EEG SOURCES RECONSTRUCTION ASSESSMENT Gaetan Yvert[1,2], Marcela Perrone-Bertolotti[1], Olivier David[2], Monica Baciu[1]; [1]Laboratoire de Psychologie et Neurocognition, UMR CNRS 5105, Université Pierre Mendès-France, Grenoble, [2]Inserm, U836, Grenoble Institut des Neurosciences, Grenoble, Université Joseph Fourier, Grenoble, France — The goal of this study was to assess the spatio-temporal integration of written word using EEG source localization. The temporal lobe is the main candidate for the integration of written words, from shape analysis to lexicality discrimination. EEG and MEG studies have shown that the workflow of information processing occurs between 150 and 400 ms after stimulus onset. Here, fifteen healthy subjects performed phoneme detection and semantic categorization tasks. EEG activity was recorded with 96 active electrodes. Reconstruction of sources was subsequently performed on the event-related potentials (ERP) using SPM8. To limit inter-individual variability, we used a group-based reconstruction scheme that constrains the sources to be identical for all subjects. ERP showed significant task-related differences on left temporal electrodes between 200 ms and 300 ms peri-stimulus time, ERP amplitude for semantic task being stronger than for phonological task. After source localization, it was possible to identify two cortical regions responsible for ERP differences: the infero-posterior temporal gyrus (BA 37) from 200 to 250 ms and the anterior temporal gyrus from 250 to 300 ms. Our results confirm that spatio-temporal integration of word processing involves the left temporal lobe. They also suggest that activation of word processing moves from posterior (lexicality access) to anterior (semantic retrieval) regions of the left temporal lobe.

I58

CONTEXT EFFECTS IN LANGUAGE COMPREHENSION: ACTIVE PREDICTION OR PASSIVE PRIMING? Ellen Lau[1,2], Phillip Holcomb[2], Gina Kuperberg[1,2]; [1]Massachusetts General Hospital, [2]Tufts University — The N400 component of the ERP is reduced in amplitude between ~200-500 ms

when a word is preceded by a supportive context such as a semantically associated word or a predictive sentence frame. An ongoing question is the degree to which this reduction reflects passive memory mechanisms as opposed to active predictions about upcoming material. To address this question, we used a priming paradigm that made it possible to modulate prediction without changing the critical context. Semantically associated prime-target pairs were embedded within an experimental context that differentially encouraged active prediction. In the first block of the experiment, only 10% of prime-target pairs were semantically associated, while in the second block, 50% were associated. Participants monitored filler probe words (always preceded by an unrelated prime) for a particular semantic category. If the N400 priming effect is partially driven by active prediction, the effect should be larger in the 50% context. Indeed, we found a larger N400 reduction for associated targets in predictive than non-predictive blocks. The N400 to non-associated targets was not modulated by contextual prediction. These results are consistent with the view that N400 modulation can reflect active predictions about upcoming stimuli, but that its modulation is driven primarily by predictive facilitation, rather than costs of unfulfilled prediction. However, longer reaction times and a larger late posterior positivity were observed on probe words in predictive relative to non-predictive blocks, i.e. in cases of response conflict. These findings suggest that the benefits and costs of semantic prediction are partially independent.

I59

SEMANTIC NEIGHBORHOOD EFFECTS FOR CONCRETE AND ABSTRACT WORDS Rutvik Desai[1], Usha Tadimeti[2], Jeffrey Binder[1]; [1]Medical College of Wisconsin, [2]Marquette University — We examined semantic neighborhood effects on word recognition in an fMRI study, using both association and similarity measures of neighborhood. Twenty-two subjects performed a lexical decision task for fifty concrete and abstract words. We examined the following variables obtained from the Florida Free Association Norms and Latent Semantic Analysis (LSA): Set Size (SS – number of associated words), Mean Connectivity (MC – mean association between the neighbors), Probability of Resonance (PR – probability of mutual connectivity between the word and its neighbors), Semantic Density (SD – average distance to the closest 50 words in the LSA space). For concrete words, SS was positively correlated with activation in the left (L) middle and inferior temporal (MTG/ITG) and angular gyri. MC was positively correlated with L MTG/ITG, and negatively with right supramarginal gyrus (SMG) and inferior precentral gyrus activation. PR was positively correlated with L SMG and postcentral gyrus, posterior superior temporal sulcus (STS), cuneus, pars opercularis, and dorsal anterior temporal lobe (ATL) activation. SD was positively correlated with L pars triangularis/orbitalis and posterior superior temporal gyrus activation. For abstract words, MC was positively correlated with L mid/anterior STS, and SD was positively correlated with L dorsal ATL activation. The results suggest partially distinct networks involved in processing semantic associations for concrete and abstract words, with involvement of the ATL in both. Involvement of anterior inferior parietal regions previously associated with action planning suggests automatic activation of action associations for concrete words.

I60

TOOL, FOOD, OR ANIMAL? FMRI INDEXES OF SEMANTIC NOUN CATEGORIES Francesca Carota[1], Rachel Moseley[1], Bettina Mohr[1], Olaf Hauk[1], Friedemann Pulvermüller[1]; [1]MRC-Cognition and Brain Science Unit — As most words are used to speak about objects in the world, the processing of word meaning is typically related to the ventral visual stream of object processing in temporal cortex, where previous studies have shown general along with category-specific semantic activation, for example distinguishing between animals and tools. We here compare event-related fMRI responses to three different object-related word categories, namely tool, food and animal words, which were closely matched for psycholinguistic properties and carefully evaluated with regard to sensorimotor and abstract semantic dimensions. Food and tool words, but not animal words, imply semantic knowledge about actions performed on referent objects; correspondingly, left-precentral activation of the motor system was found for these items, dominating in face and hand areas for food and tool words, respectively. This result is reminiscent of semantic somatotopy shown earlier for action verbs. Consistent with their motor connotations, tool words also activated right cerebellar areas. Food words sparked left-orbitofrontal cortex, possibly reflecting aspects of their emotional-affective meaning, along with left–inferior-temporal and –fusiform cortex. Activity to animal words tended to dominate in dorsolateral prefrontal cortex and in a right-inferior-temporal (or possibly cerebellar) area. These results provide evidence for both dorsal and ventral stream activation in cortex, along with cerebellar dynamics, for objet-related words, documenting general word-elicited along with category-specific semantic processes. Category-specific semantic foci can, in part, be understood as brain manifestations of aspects of referential word meaning. Supported by MRC

I61

SELECTIVE REDUCTION OF VERBAL ASSOCIATIONS IN PRIMARY PROGRESSIVE APHASIA: AN ERP STUDY Robert S. Hurley[1], Ken A. Paller[1], Christina A. Wieneke[1], Joseph F. Boyle[1], M. Marsel Mesulam[1]; [1]Northwestern University — A number of neurodegenerative diseases result in language impairment. When this impairment is the salient aspect of the disease, and is initially not accompanied by decline in other cognitive domains, a diagnosis of Primary Progressive Aphasia (PPA) is applied. Aphasia in a subset of these patients is characterized by deficits in comprehension of nouns, usually accompanied by selective atrophy in the temporal pole. There is current debate as to whether these semantic PPA (PPA-S) patients have a core impairment in an amodal system underlying both object and word knowledge, or whether impairment resides primarily in the language system. In the current experiment, 24 controls and 7 PPA-S patients were shown picture primes followed by either picture or word targets, and were asked to make match/nonmatch judgments in response to each pair. Event-related potentials (ERPs) reveal the extent of predictive encoding of targets as set up by the degree of semantic congruity with the preceding prime. Controls and PPA-S patients showed P250 and N400 ERPs to target items. Whereas P250/N400 effects were equivalent between groups on picture-to-picture trials, effects were diminished in PPA-S patients on picture-to-word trials. These results demonstrate that dysfunction in PPA-S is selectively greater in verbal compared to non-verbal modalities, inconsistent with the view of an amodal conceptual deficit. It is unknown whether patients with the closely-related syndrome of semantic dementia, who may have more prominent object recognition deficits (agnosia), would also show abnormal ERPs on picture-to-picture trials.

I62

CONNECTIVITY WITHIN LANGUAGE NETWORK WAS MODULATED BY LANGUAGE TASK Zude Zhu[1], Gangyi Feng[1], Peter Hagoort[2,3], Hsuan-Chih Chen[4], Marcel Bastiaansen[2,3], Suiping Wang[1]; [1]South China Normal University, [2]Radboud University Nijmegen, [3]Max Planck Institute for Psycholinguistics, [4]Chinese University of Hong Kong — Connectivity among language-related brain regions during resting state has consistently been observed in previous studies. The current study investigates whether and how this connectivity is altered by a language task. Twenty-four native Dutch speakers were asked to read sentences for comprehension (i.e., a 50 min. language comprehension task), and resting state fMRI data were collected before and after the task. In accordance with previous similar work (Xiang, Fonteijn, Norris, & Hagoort. (2010). Topographical functional connectivity pattern in the perisylvian language networks. Cerebral Cortex, 20, 549-560.), ROIs in left BA44, BA45 and BA47 were used as seed regions. Functional connectivity (fc) of the seed regions with left parietal and temporal areas was found, in line with Xiang et al's observations. Moreover, comparing fc's before and after the task, we found that the task altered fc patterns. After the task, for ROI BA44 and BA45, reduced connectivity with middle and posterior temporal regions as well as with the parietal lobule were found. In contrast, we

observed increased connectivity with medial frontal and superior frontal gyrus. For BA47, increased connectivity with anterior temporal lobe and bilateral precentral gyrus, and reduced connectivity with visual cortex were observed. Together the results suggest that language tasks modulate the resting-state connectivity within the brain's language network, in line with previous work (Waites, Stanislavsky, Abbott, & Jackson. (2005) Effect of prior cognitive state on resting state networks measured with functional connectivity. Human Brain Mapping, 24, 59-68.).

I63

THE USE OF STEREOTYPICAL GENDER INFORMATION IS MODULATED BY WORKING MEMORY AND ATTENTION DURING PRONOUN RESOLUTION Lijing Qiu[1], Suiping Wang[1], Tamara Y. Swaab[2], Hsuan-Chih Chen[3]; [1]South China Normal University, [2]University of California at Davis, [3]Chinese University of Hong Kong — Previous studies have consistently demonstrated that stereotypical gender information is used to resolve pronouns. But it is controversial how this information is used during real-time language processing. For example, when pronouns violate the gender of antecedents, some ERP studies revealed an N400, others a P600, and in some studies both were elicited. We suggest that working memory and attention may have contributed to these paradoxical findings. The present study was therefore conducted to investigate whether or not working memory (WM) and attention could affect stereotypical gender processing in Chinese sentences about persons. As in previous studies gender congruency was manipulated. To assess potential effects of WM, we manipulated the distance between pronouns and their antecedents. To assess potential effects of attention, we manipulated the task of subjects in two experiments. In Experiment 1, participants read sentences in the context of non-direct attention to pronoun processing. In Experiment 2, participants read sentences in the context of direct attention to pronouns. Results of Experiment 1 showed an N400-like effect for incongruent compared to congruent pronouns in the short distance condition, while a P600-like effect in the long distance condition was found. Results of Experiment 2 demonstrated a P600 for both distance conditions. However, the effects differed with distance in topography; a centro-occipital distribution was found in the short distance condition and a parietal distribution in the long distance condition. These results suggest that the effects of gender stereotype on Chinese pronoun comprehension can be modulated by working memory load and attention.

I64

A SHIFT IN TIME: NEURAL PROCESSING COSTS ASSOCIATED WITH SHIFTS IN ASPECTUAL INTERPRETATION Martin Paczynski[1], Tali Ditman-Brunye[2], Arim Choi[3], Ray Jackendoff[1], Gina Kuperberg[1,2]; [1]Tufts University, [2]Massachusetts General Hospital, [3]Northwestern University — People readily understand sentences such as "For several minutes the cat pounced…' as describing a cat performing multiple pounces, despite the fact that this information is never explicitly specified. Such interpretation has been proposed to rely on a type of enriched semantic composition known as "aspectual coercion." Previous research has indicated that aspectual coercion carries an online processing cost (Piñango et al., 1999; Brennan & Pylkkänen, 2008). Using Event-Related Potentials (ERPs), we explored several alternative mechanisms which could explain the source of these costs. We create three sentences discourse scenarios, in which the critical manipulation always appeared in the second sentence. For each scenario, we chose a contextually appropriate punctive (e.g. "pounce") and durative (e.g. "prowl") verb which was preceded by one of three adverbial modifier phrases: punctive (e.g. "After several minutes"), durative (e.g. "For several minutes") or frequentative (e.g. "Several times"), thus yielding a total of six conditions. Consistent with previous studies, we found costs to punctive verbs preceded by durative adverbial phrases. These evoked a widespread negativity between 400 and 700msec. Importantly, we observed a similar negativity for punctive verbs proceeded by frequentative adverbial modifiers. Adverbial phrase type failed to modulate ERPs to durative verbs. Taken together, our results suggest that previously observed costs of aspectual coercion may instead have been driven by a need to shift interpretation from a punctive, instantaneous event to an ongoing activity, rather than semantic coercion itself.

I65

LAUGH AT A FUNERAL: DISTINCT ROLES OF VALENCE AND SEMANTIC CONGRUITY IN DISCOURSE Gina R. Kuperberg[1,2], Kana Okano[1], Nathaniel Delaney-Busch[1]; [1]Tufts University, [2]Martinos Center for Biomedical Imaging, Mass General Hospital — Though the neural mechanisms engaged in computing semantic congruity have been extensively studied, we know very little about how emotional meaning is integrated into linguistic context. The N400 event-related potential (ERP) is attenuated to words that are semantically congruous (versus incongruous) with their preceding discourse context, reflecting a facilitation of lexico-semantic processing. We asked whether an analogous N400 facilitation would be observed to words that were valence congruous (versus incongruous) with their preceding context. ERPs were measured as 24 participants read two-sentence scenarios with critical words that varied by emotional valence (pleasant, neutral, or unpleasant) and congruence (congruent or incongruent). In each scenario, the second sentence varied at a single critical word (pleasant, unpleasant or neutral) that was either congruous or incongruous with the preceding context (eg "Peggy smiled/gagged as she walked into the basement. Something in that room was emanating a wonderful/awful smell."; eg neutral critical word: "Peggy sneezed … was emanating a peppery/fruity smell"). Congruous critical words were matched on cloze, and all incongruous critical words had zero cloze. Though the neutral incongruous (vs. congruous) scenarios elicited a large N400 effect, no N400 congruity effect was observed for either pleasant or unpleasant incongruous (vs. congruous) critical words. The incongruous emotional critical words elicited an attenuated N400, despite their unpredictability.These findings suggest that valence congruity and semantic congruity are treated differently by the brain during online discourse processing. Congruity of emotional salience appears to facilitate lexico-semantic processing regardless of whether or not valence was consistent across the scenario.

I66

AN EVENT-RELATED POTENTIAL INVESTIGATION OF REPAIRING CAUSAL COHERENCE GAPS Tristan S. Davenport[1], Seana Coulson[1]; [1]UC San Diego — Although causal inference generation and lexico-semantic association are both important factors in language processing, few studies have directly compared their effects on word processing. Till, Mross & Kintsch (1988) obtained behavioral evidence that separate lexical and inferential relationships facilitate distinct phases of word processing. But recent ERP work (Kuperberg, Paczynski & Ditman, 2010) shows that the degree of a word's causal relatedness to its context affects the N400 - a component linked to aspects of lexical activation - but no later ERP components. The present ERP study directly compares lexical and causal inference facilitation of word processing. Sixteen subjects each heard 160 short vignettes containing causal coherence gaps, necessitating a causal bridging inference. 400ms after the end of each vignette, one of four visual probe words was presented: causally related to the coherence gap, lexically related to the vignette's final word, or one of two unrelated conditions drawn from the lists of causal and lexical words to serve as controls. Causally and lexically related probes each elicited smaller N400s than their unrelated controls. This effect was larger for the causal comparison than for the lexical. Causally related probes also elicited a late positivity compared to their associated controls. The ERP data indicate that constructing a causal bridging inference has a larger facilitatory effect on subsequent word processing than lexico-semantic association. Lexical and causal information facilitate word processing along similar timecourses, although causally related words also elicited a late positivity, indicating extended processing of words related to repairing causal coherence gaps.

I67

SPANISH BLUES ACROSS TWO DIFFERENT SPANISH-SPEAKING POPULATIONS Fernando Gonzalez-Perilli[1,2], Analía Arévalo[4], Ignacio Rebollo[3], Nicolasa Morales[3], Alejandro M Maiche[3]; [1]Laboratorio de Percepción y Psicofísica, Universidad Autónoma de Barcelona, Spain, [2]Grupo Transmedia Catalonia, UAB, Spain, [3]Centro de Investigación Básica en Psicología, Universidad de la República, Uruguay, [4]VA Northern California, Martinez, CA — Does a language's way of categorizing colors affect the way its speakers think about and mentally organize color, even in the absence of an explicitly linguistic task? (e.g., Whorf, 1956, 1940) One special case – that of the color blue -- has been studied across several languages, including Japanese, Greek, Korean, and Russian. Unlike English, these languages divide the color blue into two distinct linguistic categories. Interestingly, different populations of Spanish speakers differ in the way they implement this distinction: in some South American countries, the term 'celeste' is used on its own to depict light blue, while in Spain, it is used only as a compound word which includes the supraordinate category of blue, i.e., 'azul celeste'. In this study, we tested the blues question in the Spanish language, and also incorporated a cross-cultural within-language comparison by testing two groups of native Spanish-speakers, one from Uruguay and one from Spain. Participants were asked to decide which of two color squares matched a third square. Distracter squares were either from the same or different linguistic category. As in Winawer et al.'s (2007) work comparing Russian and English speakers, Uruguayan participants were more accurate when presented with cross-category distracters. Contrary to prediction, Spanish participants also showed a cross-category facilitation effect. We discuss how cultural as well as linguistic differences have been used to explain Whorfian effects across populations. This work contributes to our understanding of the interaction between language and thought.

I68

INDIVIDUAL DIFFERENCES IN EFFECTS OF LEXICAL ASSOCIATION IN AUDITORY SENTENCE CONTEXTS: AN ERP STUDY Megan A. Boudewyn[1], Debra L. Long[1,2], Tamara Y. Swaab[1]; [1]University of California, Davis, [2]University of Central Lancashire, England — We investigated individual differences in effects of associative relations between words in sentences. Previous studies of lexical associations in sentences have found mixed results (Carroll & Slowiaczek, 1986; Morris, 1994; Traxler et al., 2000). However, Van Petten et al. (1997) showed that such effects may vary with WM span, with low span subjects relying more on word-level meaning relations. Individual differences in language processing have also been attributed to other factors, including cognitive control and conceptual memory (e.g., Long et al., 2006, Haarmann et al, 2003). We used ERPs, digit, listening, and conceptual span tasks, the Stroop task, and a verbal ability test to further explore individual variability in sensitivity to lexical associations during spoken sentence processing. Results show a robust N400 effect of lexical association across all participants in the typical 300-500ms time window. However, the latency and topographical distribution of this effect were variable and significantly correlated with cognitive control and conceptual span. Specifically, good control participants showed a relatively late and more frontally distributed effect than did poor control participants, who showed an earlier and more classically distributed centro-posterior effect. In contrast, high conceptual span participants showed a very early and classically distributed N400 effect; this effect was later for low conceptual span participants. These results suggest that there are multiple overlapping processes contributing to the N400 effect: the early centro-posterior effects seen here suggest more automatic lexical processing, while more controlled integrative processing may lead to the later, more frontal effects seen in high control participants.

I69

EXPERIMENTAL DESIGN MODULATES LANGUAGE-PERCEPTION INTERACTIONS Jennifer Collins[1], Seana Coulson[1]; [1]UC San Diego — Consistent with grounded approaches to meaning (Barsalou, 2008) prior research has shown that verbs of motion activate motion processing areas MT+ (Saygin et al., 2010) and influence tasks of motion perception (Meteyard et al., 2007). However, the possibility remains that effects might reflect strategic factors engendered by blocked designs. Three experiments tested whether motion verbs affect sensitivity to motion using randomized (E1 and E2) and blocked (E3) presentation paradigms. In all three experiments, participants were presented with random dot kinematograms (RDKs) following Meteyard et al. (2007). They were instructed to determine if motion was random or vertical. Vertical motion was divided between upward and downward motion, randomized in E1 and E2, organized into blocks in E3. Concurrent verbs described either upward, downward or horizontal motion, such as "rise", "plummet" or "glide". Verbs were always randomized and were classified by congruency (congruent/incongruent/control) depending on whether the motion of the verb and RDK were in the same or different directions. Verbs were presented 300ms later in E1 than E2 and E3. The influence of verb type on motion perception varied by trial arrangement. In both E1 and E2 verbal stimuli affected neither perceptual sensitivity (d') nor decision criterion (C). In E3, when RDK direction was separated by block, d' was greater and C was lower for the congruent condition than incongruent or control conditions. The facilitative influence of motion verbs on perception found in previous studies might include a strategic component because blocked perceptual organization, but not blocked verb stimuli, influences performance.

I70

N400 TO P600: DISCOURSE CONTEXT MODULATES THE "SEMANTIC P600" Les Sikos[1], Albert Kim[1]; [1]University of Colorado — Several language-processing ERP studies report P600 effects for semantically-anomalous verb-argument combinations under various conditions (Hoeks et al., 2004; Kim & Osterhout, 2005; Kolk et al., 2003; Kuperberg et al., 2003), apparently deviating from earlier findings that semantic anomaly enhances N400. Eliciting factors for these so-called "semantic P600" effects are poorly understood and seemingly contradictory results have been reported. For example, Kuperberg et al. (2003; 2007) found P600 effects for two-clause sentences ("Every morning at breakfast the eggs would eat…") while Kim & Sikos (submitted) reported LAN effects for otherwise similar one-clause sentences ("The hearty meal would devour…"). It is possible that contextual information carried in a preceding clause modulates the syntax-semantics interactions during these anomalies. We propose that the appearance of particular content words in discourse may generate a bias to treat future appearances of those words as contextually appropriate, even if they are locally anomalous. Such a bias may encourage structural (syntactic) reprocessing rather than semantic reanalysis in response to the anomaly. This discourse-context hypothesis may also explain temporary "semantic illusion" effects reported by Nieuwland & Van Berkum (2005) for animacy-violating nouns, linking those findings with semantic P600s. We tested the discourse hypothesis using ERPs while participants read short stories that varied in context and found that sentences with local semantic anomalies elicited classic N400 effects when preceded by a "light" context but P600 effects when preceded by a "rich" context. This is the first direct evidence of semantic P600 effects being modulated by discourse context within subjects.

I71

FLEXIBLE IMPLEMENTATION OF ANTICIPATORY LANGUAGE COMPREHENSION MECHANISMS Edward Wlotko[1], Kara Federmeier[1]; [1]University of Illinois — Mechanisms of language comprehension can be flexibly implemented dependent upon situational context. In a series of studies, event-related brain potentials have revealed anticipatory comprehension mechanisms that can be dampened when predications are made unreliable (by including in the experiment plausible but unexpected sentence completions semantically related, often synonymous with, the most expected completion). In order to determine the scope of the effect of experimental context on comprehension modes, ending type was blocked in the experimental design. When participants read synony-

mous endings in the first half of the experiment, no effect of predictability for unexpected items was observed in the second half, concordant with results from the mixed design. Brain responses to the related endings themselves were drastically affected by the manipulation of experimental context. When read in the first half of the experiment, related endings elicited a late left-lateralized frontal negativity previously observed for expected endings, and linked to reinterpretation of contextual material when the context leads to multiple interpretations. When presented in the second half of the experiment, related endings elicited brain responses similar instead to the unrelated endings. These results suggest that the success of a predictive mode of comprehension is evaluated on the fly vis-a-vis situational context and resources are allocated accordingly in a particular communicative setting to most effectively achieve comprehension goals.

I72

WORD ASSOCIATIONS INVOLVE MODALITY-SPECIFIC CORTICES Amy Price[1], Michael Bonner[1], Murray Grossman[1]; [1]University of Pennsylvania — OBJECTIVE: How are the processes that we use during the retrieval of semantic associations related to our sensory perceptions of the world? Our study aims to investigate whether semantic associations involve perceptual-motor recruitment. We used an fMRI word matching experiment to examine the role of visual, motor and auditory features involved in word associations. METHODS: During a BOLD fMRI study, young healthy participants (n=6) viewed three words on a screen and responded by button press to indicate which of the two word choices on the bottom matched the word on top, in a paradigm similar to Pyramids and Palm Trees. Word sets had strongly associated features (determined by norming study) in one of three modalities: Motor (e.g., fork: chopsticks or drumstick; n=22), Visual (e.g., carrot: potato or lightbulb; n=22), and Auditory (e.g., thunder: rocket or downpour; n=22). An Abstract word condition (e.g., saga: epic or proxy; n=22) served as a baseline. Conditions were matched for word length and frequency. Functional localizers identified visual, motor and auditory regions within participants. RESULTS: Motor words activate regions associated with motor planning and execution (including primary motor cortex). Visual words recruit regions associated with visual perception in ventral temporal cortex. Auditory words do not reach a statistically significant level of activation in regions of auditory perception in these preliminary results. CONCLUSION: These results support the hypothesis that word meanings involve motor and visual feature knowledge in modality-specific association cortices.

I73

DO SENSORY AND MOTOR REGIONS OF CORTEX CONTRIBUTE TO WORD MEANING? AN FMRI STUDY OF FEATURE REPRESENTATIONS IN WORD MEANING Michael Bonner[1], Murray Grossman[1]; [1]University of Pennsylvania — OBJECTIVE: fMRI studies demonstrate that perceptual and motor regions of cortex are recruited when participants think about the features of objects and actions. Few studies examine whether such feature representations contribute to word meaning. We investigate the role of auditory, visual and motor features in word recognition. METHODS: In BOLD fMRI, participants (n=20) viewed single words on a screen and responded by button press to indicate if each word was real or fake. Stimuli included words with strongly associated features (determined in a norming study) in three modalities: Auditory (e.g., thunder; n=40), Visuomotor (e.g., handshake; n=40) and Visual (e.g., goldfish; n=40). Conditions were matched for word length and lexical frequency. Foils were pronounceable pseudowords (n=120). Functional localizers identified visual, auditory and motor cortical regions. RESULTS: For all three word conditions, we observed activity within or adjacent to the corresponding perceptual or motor region: Auditory words recruited superior temporal cortex (BA 22) associated with auditory perception; Visuomotor words recruited frontal regions (BA 6) associated with motor planning and execution and ventral temporal and occipital regions (BA 37, 7) associated with visual perception and visuomotor integration; and Visual words recruited ventral temporal regions (BA 37, 20) associated with visual perception. CONCLUSIONS: In a lexical decision task, sensory and motor association cortices are selectively recruited, consistent with the hypothesis that word meanings rely in part on feature representations in sensory and motor cortical regions.

I74

IN A MANNER OF SPEAKING: NARRATION IN FRONTOTEMPORAL DEMENTIA Tilbe Goksun[1], Sharon Ash[1], Murray Grossman[1], Anjan Chatterjee[1]; [1]University of Pennsylvania — How do patients with frontotemporal dementia (FTD) describe motion when narrating a story? We analyzed the linguistic production of motion event components, the path (where a figure moves) and manner (how a figure moves) of motion in discourse in FTD patients. In the sentence "The boy runs into a room," RUNNING describes the manner and INTO THE ROOM describes the path of the motion. Previous research suggests that the manner involves posterolateral temporal lobes, whereas the path involves superior parietal and frontal eye fields (Wu et al., 2008). We predict that degenerative conditions affecting different parts of the brain would affect different aspects of event descriptions. Patients with semantic dementia (SD, n=9), nonaphasic patients with a behavioral variant of FTD (bvFTD, n= 14), patients with progressive nonfluent aphasia (PNFA, n= 16), and elderly controls (n= 19) narrated a story from a wordless picture book. As expected, PNFA patients produced fewer words and utterances than controls ($p<.05$). Although patients with SD produced fewer nouns compared to other groups ($p<.05$), no difference was found for verb production. PNFA and SD groups produced fewer manner verbs than bvFTD and controls, but they produced more path verbs without manner like EXIT, ESCAPE. Patients with SD replaced manner verbs with simple path verbs like GO, COME. These findings suggest that degenerative conditions lead to qualitative differences in describing motion events. Due to neuronal pathology in the left temporal lobe, patients with SD and PNFA would have difficulties retrieving verbs that precisely describe manners of motion.

I75

FMRI EVIDENCE FOR A PHONOLOGICAL EXCITATION ACCOUNT OF ASSOCIATIVE FACILITATION IN PICTURE NAMING Greig de Zubicaray[1], Kori Johnson[2], Niels Schiller[3], Katie McMahon[2]; [1]School of Psychology, University of Queensland, [2]Centre for Advanced Imaging, University of Queensland, [3]Leiden Institute of Brain and Cognition — Recent accounts of associative facilitation in the picture word interference (PWI) paradigm have attributed the effect to semantic priming (e.g., Abdel Rahman & Mellinger, 2009; Costa et al., 2005). However, an earlier phonological account attributed the effect to activation spreading between excitatory links at the word form level, due to the co-occurrence of associates in language use (Cutting & Ferreira, 1999). In an fMRI study, we contrasted hypotheses from these rival accounts by presenting written distractors that were either associatively related (e.g., hive) or unrelated (e.g., moth) to the target object (e.g., BEE) 150 ms prior to picture presentation. We also examined the effect of categorically related distractors (e.g., fish) in an attempt to determine whether interference and facilitation effects, although of opposite polarity, are attributable to the same processing level. An additional naming only condition was employed to isolate distractor effects. Overall, pairing distractor words with target pictures during naming elicited fMRI activity in a predominantly left hemisphere cortical network when compared to naming alone. Associates resulted in significantly faster naming latencies than unrelated distractor-target pairs and elicited a significant increase in activity solely in the left posterior temporal cortex. However, categorically related distractors produced only marginally slower naming latencies compared to unrelated words and no significant differences in activity. We interpret the results as supporting a phonological excitation account of associative facilitation, and discuss the implications for some recently proposed models of lexical selection in speech production.

I76

FMRI CORRELATES OF WORD-FINDING DEFICITS IN GULF WAR ILLNESS Virginia Buhl[1], Clifford Calley[1], Tim Green[1], Gail Tillman[1], John Hart[1], Mike Kraut[2], Robert Haley[3]; [1]University of Texas at Dallas, [2]Johns Hopkins University, [3]University of Texas at Southwestern Medical Center — The Gulf War Syndrome, observed in veterans deployed during operation Desert Storm, has been characterized as having three distinct sub-divisions: Haley Syndrome 1 (HS1); Haley Syndrome 2 (HS2); and Haley Syndrome 3 (HS3). Haley Syndrome 2 and to a lesser degree HS1 have reported difficulties in cognitive domains, including memory and word finding difficulties. We employed a task of semantic object retrieval (SORT) during fMRI to determine if there were any correlates to these reported impairments. Previously, this task in normal controls has been shown to engage medial BA6, caudate, and thalamus. A total of 97 subjects where tested; 30 subjects comprising a group of controls while the remaining 67 subjects were divided into the respective HS syndromes. Subjects performed that SORT task in the scanner where they were presented two words that were features of objects (e.g., 'desert' 'humps') to see if they combined to activate a specific object memory. Region of interest results showed significant differences between groups for percent signal change (PSC) were found in BA6 for HS2 ($p < .01$). HS2 also showed a trend towards decreased levels of % correct responses when compared to controls at 75% correct ($p=.06$) correct. These findings show that HS2 patients have a clear behavioral performance decrement in a task of semantic memory retrieval that appears to be associated with decrease signal changes in medial BA6, a region shown to be engaged in both semantic memory retrieval and verbal production.

I77

LIFG RESOLVES COMPETITION BETWEEN REPRESENTATIONS OF AN OBJECT BEFORE AND AFTER AN EVENT Gerry T.M. Altmann[1], Nicholas C. Hindy[2], Emily Kalenik[2], Sharon L. Thompson-Schill[2]; [1]University of York, UK., [2]University of Pennsylvania — When an object is described as changing state during the course of an event, the representations of those states (the 'before' and 'after') compete; the distinct states they represent cannot co-exist at any one moment yet each such representation must be retrievable (at the cost of suppressing the other). On reading "the squirrel will crack the acorn", we must keep track of multiple representational instantiations of the acorn –before it was cracked, and after– and retrieve just the right one if the acorn is subsequently referred to. Conversely, reading "the squirrel will sniff the acorn" requires only a single (unchanged) instantiation of the acorn. We used fMRI to test the hypothesis that such competition recruits the same brain regions that are involved in other forms of conflict resolution. Parts of the left inferior frontal gyrus (LIFG) have previously been demonstrated to be central in resolving competition amongst incompatible representations of a single stimulus (e.g., an ambiguous word or a garden-path sentence). We found that increased activation in posterior LIFG (BA44) during sentence reading correlated with the rated degree to which the mentioned object changed in state; this change-related activation co-localized with conflict-dependent activation during color naming in a Stroop task. In contrast, activation in mid LIFG (BA45), which co-localized with increased activation during a distinct sentence comprehension task, negatively correlated with the rated imageability of the described action, but did not correlate with rated change. These results suggest that, when representing change, multiple representational instantiations of an object do compete.

I78

DO SENTENCE PRODUCTION AND COMPREHENSION SHARE COGNITIVE CONTROL MECHANISMS? Gina Humphreys[1], Silvia Gennari[1]; [1]Psychology Department - University of York, UK — Previous research suggests that language production and comprehension share a common knowledge base, e.g., lexical and grammatical rules but that they engage different processes, e.g., word retrieval vs. word recognition. Yet, the extent to which producing and comprehending recruit common mechanisms is not well understood. Here, we hypothesized that sentence production and comprehension, and specifically, determining who is doing what to whom in the sentence, recruit similar semantic control mechanisms, particularly when alternative semantic roles (agent vs. patient) compete. To this end, we compared sentences that differ in the degree of semantic roles' competition both in production and comprehension. Using event-related fMRI, three tasks were completed: sentence comprehension, sentence completion, and a colour Stroop task, which was used to identify regions sensitive to conflict/competition in semantic representations. In the comprehension task, visually presented sentences were occasionally followed by comprehension questions (catch trials). In the sentence completion task, participants were given the first phrase of the sentence to covertly complete. The reading portion of this task was distinguished from the production/completion portion. The results showed that within a region of the left inferior frontal gyrus that was activated by the Stroop task, activity was modulated by the degree of semantic competition in a similar manner for both the comprehension and the production tasks. This suggests that semantic competition processes modulate brain responses common to both tasks, and are therefore shared by production and comprehension. More generally, the results suggest that language processing shares mechanisms and resources with other cognitive tasks.

I79

THE NEURAL ARCHITECTURE OF THE LANGUAGE COMPREHENSION NETWORK: CONVERGING EVIDENCE FROM LESION AND CONNECTIVITY ANALYSES And Turken[1], Nina Dronkers[1,2]; [1]VA Northern California Health Care System, [2]UC Davis Neurology Department — In an earlier investigation, we assessed the brain areas necessary for auditory sentence comprehension using a voxel-based lesion-symptom mapping analysis with 64 aphasic patients (Dronkers et al., 2004). In the present study, we extended these findings by using diffusion tensor imaging (DTI) and resting-state functional magnetic resonance imaging (RS-fMRI) datasets from healthy subjects to assess the connectional anatomy of these previously-identified regions. Tractography and functional connectivity analysis results indicated that the left posterior middle temporal gyrus (MTG) and underlying white matter, the anterior superior temporal gyrus and BA22, inferior frontal gyrus pars orbitalis (BA47), the anterior middle frontal gyrus (BA46), the posterior superior temporal sulcus (STS) and BA39, and white matter underlying the STS are part of a richly interconnected network that extends to additional frontal, parietal and temporal regions in the two hemispheres. The major white matter pathways implicated in this network were the inferior occipito-frontal fasciculus (IOFF), the arcuate fasciculus (AF), the middle and inferior longitudinal fasciculi (MdLF, ILF), the uncinate fasciculus (UF), and transcallosal projections via the tapetum. The posterior MTG showed a particularly extensive functional connectivity pattern and was associated with five major pathways. These observations might explain the severe language comprehension impairments produced by lesions affecting the MTG, and are consistent with the notion that this region plays a role in core lexical-semantic processes. Further analyses also revealed subregions with distinct structural and functional connectivity patterns and showing a differentiation along the rostro-caudal axis, suggesting functional heterogeneity within the MTG.

I80

THE SUBJECTIVE NATURE OF MEANING Gina Grimshaw[1], Jessica Stewart[1], Jan Lauwereyns[2]; [1]Victoria University of Wellington, [2]Kyushu University — Although we often dichotomise information as meaningful or meaningless, meaning exists in the mind of the perceiver; it is not an inherent property of the stimulus. Thus the threshold between meaningful and meaningless may be dynamic, shifting with contextual variables. We present a series of behavioural studies in which participants made meaningfulness judgments of random adjective-noun word pairs (e.g., brave slipper), presented in different experimental contexts. When the experiment included a number of clearly related word pairs (either literal pairs such as tall building, or conventional metaphors such as lost soul), participants judged very few of the random word pairs as meaningful. However, when only random word pairs were presented, rates of

meaningfulness judgments increased dramatically. Across participants, similar word pairs were rated as meaningful, suggesting that participants were not simply responding randomly to meet some criterion level of response. Instead, findings suggest that in the absence of a clear standard for meaning, participants either increased their conceptual effort to help them find meaning, lowered their criterion for reporting meaningfulness, or both. A follow-up ERP study tested both of these hypotheses, using the N400 to index conceptual effort and the lateralized readiness potential (LRP) to index response preparation. Although the N400 did not show clear evidence of a shift in conceptual processing across conditions, the LRP clearly demonstrated an increased preparedness for meaningful responses when random word pairs were presented in isolation. Findings are consistent with a shifting criterion for meaningfulness.

I81

CAUSAL INFERENCE PROCESSING Connie Shears[1], Matthew Baker[1], Jessica Green[1]; [1]Chapman University — The left hemisphere is dominant for processing language (Beeman & Chiarello, 1998) but when emotions come into play inthere appears to be hemispheric differences. Previous research suggests a right-hemisphere advantage in processing both causal inferences and emotional language. Borod (1992) found that there is right hemisphere dominance regardless of emotional valence. Other researchers have argued against this theory, finding that the left hemisphere processes language faster than the right hemisphere (Miller, n.d.) and that negative emotion is often processed in the right hemisphere, while positive emotion does not elicit hemispheric asymmetries (Smith & Bulman-Fleming, 2006). In the current study, we sought to investigate how causal inferences were processed differentially between hemispheres across emotional valences. Sixty-four participants completed a computer-based word recognition task that involved identification of the presence of target words in sentence pairs. Target words were drawn either from the sentence text or from inferential information and were presented to either the left or right visual field. Sentence pairs were classified as either inference-supporting or non-inference-supporting, and as having either a positive, neutral, or negative emotional valence. Results suggested a left-hemisphere bias for processing negative inferences, and a right-hemisphere bias for processing neutral inferences. This conflicts with theories that attribute emotional language processing to only the right hemisphere, and supports the important role of the right hemisphere in the formation of causal inferences for non-emotional language.

I82

EVIDENCE OF CONTEXT-SENSITIVE SEMANTIC PROCESSING IN THE BRAIN Colleen Crangle[1,2], Marcos Perreau-Guimaraes[1], Patrick Suppes[1]; [1]Stanford University, [2]Converspeech LLC, California — The goal of this work is to detect evidence of semantic processing in brain waves using the high temporal resolution of EEG. The semantic framework is given by WordNet, a lexical database of English organized around sets of cognitive synonyms, and a probability-based method that extracts word relations from text on the web. The EEG data derive from experiments in which statements about commonly known geographic facts of Europe were presented to participants who were asked to determine their truth or falsity. Using ten geography words, T=640 brain data samples time-locked to the presentation of the words and extracted from the EEG recordings are classified into the N=10 classes associated with the words 'London', 'Moscow', 'Paris', 'north', 'south', 'east', 'west', 'Germany', 'Poland', and 'Russia'. Ordinal relations of similarity differences are derived for the brain and semantic data, with one set of semantic data restricted to be contextually relevant and the other not. Spearman rank correlations are computed across the ordinal relations of similarity differences, comparing the brain and semantic data to find those relations that are invariant with respect to both (rho?0.8; p<0.0014). The results from 120 classifications of the brain data are compared with the context-relevant and semantically-unrestricted data. The results show that statistically significant structural similarities can be found between the brain and semantic data restricted to be contextually relevant. But without contextual restrictions, the brain and semantic data fail to exhibit statistically significant structural similarities. These results provide new evidence of context-sensitive semantic processing in the brain.

I83

NOUN OBJECT DISCRIMINATION IN LEFT INFERIOR TEMPORAL CORTEX Melissa M Rundle[1], Andrew C Connolly[1], Richard H Granger[1]; [1]Dartmouth College — Previous work demonstrated that pictures of objects elicited object-specific voxel patterns in inferior temporal cortex. We wanted to determine whether words alone would also give rise to selective pattern responses. Participants (5M, 10F; right-handed; mean age: 23±3) were given a recall task for nouns while undergoing fMRI. 360 trials each consisted of three serially presented single words (560msec each), selected from one of six categories: birds, mammals, fruits, vegetables, musical instruments, and hand tools. Subjects were periodically asked to recall having seen a given set of words; accuracy was 91% ± 4%. Multivariate pattern analysis within a searchlight identified voxel clusters that accurately distinguished among object words for the six categories. A group analysis of the searchlight results revealed a region of high sensitivity for noun object categories in left temporal cortex (x,y,z: -48,-45,-18; p<.005). We examined the dissimilarity structure -- one minus correlation distance between activation patterns for different categories. Multidimensional scaling analysis showed three groups of two elements each: i) birds and mammals; ii) fruits and vegetables; iii) musical instruments and hand tools. Inter-subject correlation for dissimilarity matrices in this region was modest (mean = .21) but significantly higher than chance. Although there was more inter-subject variability within the ROI than found in prior findings for object pictures, the present results indicate that a left temporal neural population is capable of semantic noun category discrimination.

I84

DIFFERENTIAL EFFECTS OF THE TRANSPARENCY OF IDIOMATIC ADJECTIVE-NOUN COMBINATIONS ON N400 Robert Schreuder[1], Karly Van Gorp[1], Nan Van de Meerendonk[1], Dorothee J. Chwilla[1]; [1]Donders Centre for Cognition, Radboud University, Nijmegen — Idiomatic expressions occur frequently in language. We investigated the processing of adjective-noun (A-N) combinations varying in semantic transparency (opaque/specialized). In a lexical decision task the same target word was preceded by an idiom or by an unrelated A-N (ISI 115 ms). For an opaque A-N the target "unimportant" was preceded by the idiomatic "ivory tower" or an unrelated A-N "full plate". For the specialized items the target "politics" was preceded by the specialized idiom "iron curtain" or the unrelated A-N: "light blouse". Reaction time (RT) priming occurred both for specialized and opaque items and for related control conditions. In contrast, for N400 priming occurred for specialized items (and the related control condition), but not for the opaque items. An effect of transparency thus was found for N400 but not for RT. In Experiment 2 we used the same procedure and materials but inflected the idiomatic A-N, creating an unexpected form of the A-N. Inflection led to a disappearance of the RT effect to opaque, specialized, and even related items. In contrast, for N400 again a priming effect was found for specialized items and related items, but not for the opaque items. Flexibility in idiom processing and dissociation between N400 and RT results present a challenge for current models of idiom processing. The dissociation may be explained by the low form frequency of the inflected idioms which could induce too much noise in pattern recognition (no RT effect) while the processing of the meaning is preserved (N400 effect).

I85

VISUAL SEMANTIC PRIMING STRENGTHENS THE AUDITORY TEMPLATE OF A LEXICAL TONE: AN MMN STUDY Suksun Itthipanyanan[1], Ulrike Zimmer[1], Marty Woldorff[1]; [1]Center of Cognitive Neuroscience, Duke University — In tonal languages such as Mandarin Chinese, the tonal characteristics of speech sounds impart different semantic meanings to those sounds (e.g., /hu/ with a rising tone means 'teapot' but /hu/ with a dipping tone means 'tiger'). The close association between tones and meanings in tonal languages has been evidenced in pure auditory para-

digms at both early sensory and later semantic levels (e.g. Brown-Schmidt, 2004; Chandrasekaran et al., 2007). So far, however, whether and how tone/meaning integration might occur across visual and auditory modalities has not been examined. To address how visual semantic priming might influence lexical tone perception, the present event-related potential (ERP) study employed a visual-priming auditory-oddball paradigm, in which a TEAPOT or a TIGER picture preceded an auditory speech stimulus by 300 ms. The auditory stream consisted of Chinese word sounds that could be either "teapot" or "tiger" (standard, 70%) or an artificial sound (deviant, 15%) whose tone structure fell in between those of 'teapot' and 'tiger' sounds. On the deviant-sound trials where the priming visual stimulus had the same meaning (congruent) versus different meaning (incongruent) as the repeated standard sound, the extracted auditory mismatch negativity (MMN) was significantly larger from 130-450 ms. This finding demonstrates that the crossmodal influence of visual semantic priming input on lexical tone perception can occur very early in processing. Moreover, this MMN increase suggests that the congruent visual priming strengthened the template of the repeated standard sounds, leading to a cross-modally induced amplification of the detection of deviancy in lexical tone structure.

I86

WHEN DO YOU GRASP THE IDEA? MEG EVIDENCE FOR INSTANTANEOUS IDIOM UNDERSTANDING Veronique Boulenger[1,2], Yury Shtyrov[2], Friedemann Pulvermüller[2]; [1]Laboratoire Dynamique du Langage, CNRS, Lyon, France, [2]MRC Cognitive and Brain Sciences Unit, Cambridge, UK — We investigated the time-course of cortical activation during comprehension of concrete and figurative language using MEG and anatomically guided distributed source analysis. Previous fMRI work showed that the comprehension of sentences including action-related words elicits somatotopic semantic activation along the motor strip, reflecting meaning aspects of the constituent words. Furthermore, idioms more strongly activated temporal pole and prefrontal cortex than literal sentences. We here show that idiom reading modulated anterior frontotemporal activation very early, already 150 ms after sentence critical disambiguating words ("kick the habit"). In parallel, the meaning of action words embedded in sentences was reflected by activation of precentral motor systems. As neural reflections of constituent parts of abstract sentences were manifest at the same early latencies as more general indexes of abstract vs. concrete meaning processing, we conclude that within ¼ of a second, compositional and abstract context-driven processes in parallel contribute to abstract sentence meaning computation.

I87

LANGUAGE IN ACTION OR ACTION IN LANGUAGE? AN EEG+MEG STUDY ON INTERACTION BETWEEN LANGUAGE AND THE MOTOR SYSTEM Giovanna Mollo[1], Friedemann Pulvermüller[2], Olaf Hauk[2]; [1]Institute for Advanced Biomedical Technologies G D'Annunzio University, Chieti, Italy, [2]Medical Research Council Cognition and Brain Sciences Unit, Cambridge, UK. — Several studies has shown activation in motor cortex during the processing of action-related words or sentences. However, brain activation measures are correlational, and thus motor cortex activation does not automatically imply that motor cortex is crucial for these processes. Our study therefore addressed the question whether activation in motor cortex affects activation in non-motor language areas. In the experiment, participants started trials by pressing a button either with their index finger or foot (effector type, Fg or Ft). They kept the button pressed until a letter string appeared on the screen. If the letter string was a word, they had to release the button as quickly as possible, or otherwise wait until the end of the trial (lexical decision, LD). In another task, participants had to respond quickly to concrete words, and delay for abstract ones (semantic decision, SD). The (concrete) words were subdivided into arm-related and leg-related action-words. We hypothesized that if motor cortex is part of cell assemblies representing the words' semantics, the congruency between effector type for the button press should interact with word category in motor as well as non-motor brain areas. We measured 306-channel MEG and 70-channel EEG and applied ROI analysis on MNE source estimates to test this prediction. A congruency motor effect is present for motor areas [$p<.05$] and Superior Temporal Gyrus (classical language region) [$p<.05$] within the first 150 msec from the word presentation This is a crucial evidence that the motor system is part of the semantic brain networks for action-words.

I88

COMPREHENSION AND REPETITION OF SENTENCES NEED BOTH DORSAL AND VENTRAL FIBER TRACTS Sarah M. E. Gierhan[1,2], Alfred Anwander[1], Angela D. Friederici[1]; [1]MPI for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]Berlin School of Mind and Brain, Humboldt University of Berlin, Germany — During language processing white matter fiber bundles are used for information propagation between the temporal and frontal lobes. Potential candidates for fiber tracts dorsally connecting the two lobes are the arcuate fascicle (AF) and the superior longitudinal fascicle (SLF). Candidates for a ventral connection are the external capsule (ExC), the extreme capsule (EmC) and the uncinate fascicle (UF). Still controversial, however, is which specific linguistic information is processed via which specific fiber tract (e.g., Saur et al. 2008, Friederici 2009). Our study aimed to elucidate the fiber tracts involved in a) comprehension and b) repetition of meaningful and meaningless spoken German sentences. Therefore, we conducted within-subject functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) on healthy volunteers. The results show that for both repetition and comprehension, brain regions are needed that are connected by dorsal and ventral fiber tracts. Dorsally, the information is propagated via the AF/SLF, terminating in postero-medial temporal regions and parietal regions. Ventrally, there is a differentiation between comprehension and repetition: comprehension of meaningful sentence information appears to be propagated via the ExC/EmC and the UF, whereas sentences consisting of meaningless words are repeated only via the ExC/EmC. We conclude: 1) Not only regions connected via ventral fiber tracts, but also regions connected via dorsal fiber tracts are needed for comprehending lexical and combinatorial meaning of sentences. 2) Mapping a newly heard word form onto an unfamiliar articulation not only needs regions connected via dorsal fiber tracts, but also regions connected via ventral fiber tracts.

I89

ACTIVATION AND INHIBITION OF CONTEXTS WHILE READING; AN ERP STUDY Heather MacLaren[1], J. Bruno Debruille[1,2]; [1]McGill University, [2]Douglas Institute Research Center — In order to follow a story or novel, it seems that content words have to activate the context in which they previously occurred. However, if a word appears in a new context this activation may be inappropriate. The present study aimed to test whether the N400 event-related potential (ERP) indexes the inhibition of these inappropriate contexts or the activation of semantic representations corresponding to the word. ERPs were recorded during sentence reading. There were 28 series of 3 blocks. Block 1 included seven sentences. Block 2 included seven new sentence contexts using the same final words as the block 1 sentences. In block 3, the seven final words occurred in isolation and participants were asked to recall the two contexts. ERPs elicited by the block 2 sentence endings were examined. Those obtained when the block 1 context was remembered at block 3 were compared to those obtained when the block 1 was not remembered. Consistent with the inhibition hypothesis, the early part of the N400s were larger when the first context was forgotten. Unexpectedly, the P600s were larger when both contexts were remembered. These results suggest that 2 related stages of processing occur after the preconscious activation of previous contexts. First, some of these contexts could be inhibited, which would be indexed by larger N400s. Second, the number (and importance) of remaining contexts being placed in working memory would be positively correlated with P600 amplitudes.

I90

N400 AS AN INDEX OF INHIBITION: A STUDY WITH HIGHLY REPEATED STIMULI Miles Shang[1], J. Bruno Debruille[1]; [1]McGill University — The N400 is an event-related potential (ERP) that indexes semantic processing. It is modulated by semantic priming and repetition, amongst other factors. A recent study using a three-word paradigm has suggested that the N400 represents a semantic inhibition rather than an activation. However, questions were raised as to whether the results of this study could be related to the contingent negative variation (CNV) or the P600 ERPs rather than to the N400. To address this issue, we capitalized on studies showing that the N400 is discernable even with massive repetition. Indeed, these studies produced N400s that were easier to discern from CNVs and P600s. Here, we thus used this repetition technique, along with the three-word paradigm, to further test the inhibition hypothesis. In one block, participants judged whether the second word was semantically related to the third word. In another block, they did the same regarding the first and third words, thus ignoring the second. The classic semantic match N400 effect was found for the third words (but not for the second), further confirming previous studies showing that genuine N400 effects can be found with massive repetition. As predicted by the inhibition hypothesis, the amplitudes of the N400 elicited by the second words were greater when participants had to ignore them than when they had to use them. Most surprisingly, N100s were also found to be larger for the actively ignored words. Our conclusion pertains to the mechanisms by which we ignore the meaning of words that have our focus.

I91

MEMORY DEFICITS FOR ARM- AND LEG-RELATED WORDS INDUCED BY DRUMMING EXERCISES Friedemann Pulvermuller[1], Zubaida Shebani[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge — Language and action systems of the human brain are functionally interwoven. Speaking about actions and understanding action-related speech sparks the motor system of the human brain and, conversely, motor system activation has an influence on the comprehension of action words and sentences. Although previous research has shown that motor systems become active when we understand language, a major question still remains whether these motor system activations are necessary for processing action words. We here report that complex rhythmic drumming exercises, so-called paradiddles, performed using either the hands or the feet, lead to a differential impairment of working memory for concordant arm- and leg-related action words. Moving the arms more strongly impairs working memory for words typically used to speak about arm actions, whereas leg movements impair leg word memory more severely. In documenting a motor locus of working memory for specific action-related word categories, these results demonstrate that processing resources in specific parts of the cortical motor system are critical for action word processing, more specifically for keeping action words in working memory.

I92

FROM WORDS TO EMOTION VIA BODY MOTION: A ROLE FOR THE MOTOR SYSTEM IN BINDING ABSTRACT MEANING Rachel Moseley[1], Francesca Carota[1], Olaf Hauk[1], Bettina Mohr[1,2], Friedemann Pulvermüller[1]; [1]MRC Cognition and Brain Sciences Unit, Cambridge, UK, [2]Anglia Ruskin University, Cambridge, UK — Contemporary theories of semantics suggest that word meaning is embodied in the brain in the connections between word form circuits in language areas and perceptual object representations in the ventral stream. This view, however, fails to explain representation of abstract concepts, including emotion words such as 'hope' or 'loathing'. Whilst their meaning relates to emotional brain systems in the limbic system, it is unclear how the link between an internal body state and a word form can be learnt. In one view, motor activities expressing emotion (e.g. scowling) are crucial for learning correspondences between emotional body states and word forms. This hypothesis predicts that emotion words activate brain systems for emotion-expressing body parts: the face and arm motor and premotor cortex in the dorsal stream. To test this hypothesis, we compared the brain activation evoked by emotion words to that brought about by face- and arm-related action words in a tachistoscopic silent reading task during fMRI scanning. Semantic networks for emotion words were found to include classical limbic areas such as the cingulate, orbitofrontal cortex, insula and basal ganglia, and to overlap strongly with arm- and face-related words in activating effector-specific areas in motor and premotor cortex. These results were confirmed for highly abstract emotion words with low imageability and without overt action connotations. We conclude that, similar to their role in action verb processing, activation of frontocentral motor systems reflects the semantic binding of sign and meaning of abstract words denoting internal emotional states.

I93

HEMISPHERIC INFERENCE PRIMING DURING COMPREHENSION OF CONVERSATION Chivon Powers[1], Mark Beeman[1]; [1]Northwestern University — Understanding conversational language emphasizes different processes than understanding narrative, and may result in a distinct pattern of lateralized processing during comprehension. This study investigates lateralization of comprehension processes while people listen to conversations that promote causal inferences at coherence inference points, when inferential information must be incorporated in order to maintain coherence about the conversation. Some evidence for inference generation during comprehension comes from studies showing priming for inferences, that is, faster recognition for inference-related than –unrelated words when inferences are generated during comprehension. Our objective was to examine hemispheric contributions to priming for inferences embedded in conversation. We tested 21 undergraduates listening to 36 conversations promoting 100 total inferences. Target words were presented to the left visual field-right hemisphere (lvf-RH) or to the right visual field-left hemisphere (rvf-LH) at coherence inference points. Targets were piloted to ensure their strong relatedness to the promoted inferences, but no strong semantic relation to any individual words in the dialogue up to the inference points. Participants showed stronger inference priming for lvf-RH target words than for rvf-LH target word, which suggests drawing inferences from conversation heavily relies on RH integration processes. Ultimately, we demonstrate that inferences can be promoted within conversation and highlight a potentially important lateralization distinction for comprehension of conversational language.

I94

BEHAVIORAL PATTERNS AND LESION SITES ASSOCIATED WITH IMPAIRED PROCESSING OF LEXICAL AND CONCEPTUAL KNOWLEDGE OF ACTIONS David Kemmerer[1,2], David Rudrauf[1], Ken Manzel[1], Daniel Tranel[1]; [1]University of Iowa, [2]Purdue University — We administered to 226 brain-damaged patients a battery of 6 tasks that probe lexical and conceptual knowledge of actions in a variety of verbal and non-verbal ways, including naming, word-picture matching, attribute judgments involving both words and pictures, and associative comparisons involving both words and pictures. 61 patients failed one or more of the tasks, with 4 patients being impaired on the entire battery, and varied numbers of patients being impaired on varied combinations of tasks. The lesion sites of 147 patients were also investigated, using formal methods for lesion-deficit statistical mapping and power analysis of lesion overlap maps. Significant effects for all 6 tasks were found in the following left-hemisphere regions: the inferior frontal gyrus; the ventral precentral gyrus, extending superiorly into what are likely to be hand-related primary motor and premotor areas; and the anterior insula. In addition, significant effects for 4-5 tasks were found in not only the regions just mentioned, but also in several other left-hemisphere areas: the ventral postcentral gyrus; the supramarginal gyrus; and the posterior middle temporal gyrus. These results converge with previous research on the neural underpinnings of action words and concepts. However, the current study goes considerably beyond most previous investigations by providing extensive behavioral and lesion data for an unusually large and diverse sample of brain-

damaged patients, and by incorporating multiple measures of verb comprehension. Regarding theoretical implications, the study provides new support for the Embodied Cognition Framework, which maintains that conceptual knowledge is grounded in sensorimotor systems.

I95

ELECTROPHYSIOLOGICAL CORRELATES OF SPOKEN WORD PROCESSING IN THREE-TO-SEVEN YEAR OLD NON-VERBAL CHILDREN WITH AUTISM Yan Yu[1], Michelle MacRoy-Higgins[2], Sarita Austin[1], April Benasich[3], Judy Flax[3], Richard Schwartz[1], Valerie Shafer[1]; [1]Ph.D program in Speech-Language-Hearing Sciences, The Graduate Center, City University of New York, [2]Hunter College, City University of New York, [3]Center for Molecular & Behavioral Neuroscience, Rutgers, The State University of New Jersey — Very few studies have investigated the language processing skills in nonverbal (NV) children with Autism Spectrum Disorders (ASD) due to the reliance of overt behavioral responses in traditional behavioral methods. The purpose of this study was to use electrophysiology to assess semantic processing in NV children with ASD. We recorded event-related potentials (ERPs) to auditory words paired with a preceding picture that matched the word ("duck" and picture of a duck) or was unrelated to the picture ("duck" with picture of a bowl) from 3 years of age to adults in a passive task. Adults showed an expected superior-posterior increase in negativity (N400) to the unrelated picture-word pairs around 300 ms following word onset. Typically developing children showed a significant increased negativity to the unrelated word beginning 420 ms following word onset at sites near the vertex (CZ) rather than at more posterior sites. Two of the NV ASD children showed similar patterns to the TD groups. The remaining four ASD children showed attenuated responses or reversed superior-inferior polarity to the words and no evidence of increased vertex negativity to the mismatched words. These peliminary data suggest that this passive design can be used to inform our understanding of language processing in non-verbal children with ASD.

I96

N200 AND N400 MODULATIONS ELICITED BY PHONOLOGICAL AND SEMANTIC REPRESENTATIONS OF AMERICAN SIGN LANGUAGE Eva Gutierrez[1], Deborah Williams[1], Mike Grosvald[1], Sarah Hafer[1], David Corina[1]; [1]Center for Mind and Brain. University of California, Davis — Goal: The notion that language forms (phonology) are arbitrarily related to meaning (semantics) is often considered a central tenet of the properties of human languages. Spoken languages overwhelmingly exhibit a clear separation between properties of language form and language meaning. In signed languages this separation of form and meaning may not apply to the same degree. Methods: EEG was recorded while 17 native signers of American Sign Language (ASL) watched ASL sentences for comprehension in which semantic(S) expectancy and phonological(P) form was systematically manipulated. Analysis of ERP components revealed a modulation of the N200 and N400 to semantically and phonologically related signs. Results: As expected, and consistent with previous research, a classic N400 effect was observed in the UNRELATED(-S-P) condition. Unexpectedly, N200 components were modulated in cases of shared (congruent) semantics and/or shared phonological information. This may indicate that both semantic and phonological features of the expected sign are activated and cause competition effects during the lexical selection process. In addition, latency differences of the onset of the N400 were observed; N400 elicited by both, the semantically (+S-P) and the phonologically (-S+P) related conditions, had an earlier onset than the elicited by the UNRELATED(-S-P). Conclusion: These findings provide evidence that access to semantic and phonological properties are present early during ASL lexical access, and incur similar on-line processing costs. These data provide evidence for an intimate relationship between form and meaning during natural language processing of ASL signs.

I97

AMERICAN SIGN LANGUAGE AND GESTURE PROCESSING IN DEAF SIGNERS: AN EVENT-RELATED POTENTIALS STUDY Michael Grosvald[1], Eva Gutierrez[1], David Corina[1]; [1]University of California, Davis — A fundamental advance in our understanding of human language would come from a detailed account of how non-linguistic and linguistic manual actions are differentiated in real time by language users. We targeted the N400, a well-established component known to be sensitive to lexical-semantic integration, to investigate deaf signers' brain response when processing signed sentences incorporating target items of varying linguistic status. Forty deaf signers took part. Each saw a sequence of 120 sign sentences, consisting of a "frame" (a sentence without the last word; e.g. BOY SLEEP IN HIS) followed by a "last item" belonging to one of four categories: a high-cloze-probability sign (a "semantically reasonable" completion to the sentence; e.g. BED), a low-cloze-probability sign (a real sign that is nonetheless a "semantically odd" completion to the sentence; e.g. LEMON), a non-sign (phonologically legal but non-occurring form, created here by articulating an existing sign with a different handshape), or a non-linguistic grooming gesture (e.g. the performer scratching behind her ear). Significant N400-like responses occurred in the "semantically odd" and non-sign contexts, with stronger such responses in the non-sign condition. In contrast, the non-linguistic gesture context was associated with a consistently positive response rather than an N400. These findings suggest that deaf signers can quickly detect and reject non-linguistic manual actions during real-time language processing. Moreover, our findings represent an important step in understanding the relationship between the processing of language and that of human actions in general, and offer information about the time-course and neural topography of these effects.

I98

REMEMBERING WALK, JUMP, KICK, AND STROLL: BRAIN-INDICES OF WORKING MEMORY FOR ACTION-RELATED WORDS Zubaida Shebani[1], Francesca Carota[1], Olaf Hauk[1], James Rowe[1], Friedemann Pulvermüller[1]; [1]Medical Research Council Cognition and Brain Sciences Unit — The recognition of action-related words activates specific motor areas of the human brain and this activation has been interpreted as a correlate of the meaning of these words. An alternative suggestion is that such motor system activation is epiphenomenal reflecting a process following semantic processing, but not intrinsically related to it. We therefore used fMRI to study performance in a task where subjects had to fully engage in action word processing in order to be successful. In a high-load memory condition, they had to keep in working memory four closely related action words. In a low-load control task that still allowed for some epiphenomenal mental activity, only one such item had to be memorized. Results replicated activation in areas known to be linked to verbal working memory, including inferior-frontal and superior/middle-temporal cortex. Critically, the most strongly active region in the high memory load condition (versus low load) was the left premotor and supplementary motor cortex. Further analyses showed differential activation between encoding and memory maintenance in temporal and parietal areas, but equally strong engagement of prefrontal and motor systems. A degree of category specificity emerged in the comparison between memory conditions; working memory for arm- vs. leg-related action words differentially activated superior vs. inferior frontocentral areas. These results confirm the general role of the frontotemporal articulatory loop in verbal working memory and rule out an epiphenomenal role of motor systems in action word processing. In action-word memory, body-part related action-perception loops may complement the function of the articulatory loop.

I99

ON-LINE PROCESSING OF IDIOMATIC EXPRESSIONS: A CROSS-MODAL EEG PRIMING STUDY Verena Braunstein[1], Anja Ischebeck[1], Christa Neuper[1]; [1]University of Graz, Austria — Previous EEG priming studies comparing idiomatic vs. literal language indicated that both types are pro-

cessed differently in the brain: Primes related to the figurative meaning of an idiomatic expression elicited larger amplitude responses in event-related brain potentials (ERPs) like the N400 and the P600 compared to primes related to the expression's literal meaning. In these studies, however, idioms were presented first and ERPs were measured from the onset of a probe word presented later. It is unclear in how far the observed results relate to early stages in idiom processing. In the current study, an auditory prime was presented before an idiomatic sentence was displayed to assess on-line processing. EEG responses were measured from the onset of the last phrase of an idiomatic sentence (e.g., 'Er beißt / ins Gras.' He bites / the dust.). The prime word was related to the literal or the figurative meaning of the idiomatic sentence (e.g., 'essen' eat and 'sterben' die). Unrelated primes as well as ordinary sentences served as a control condition. A simple verification task assured that participants read the sentence. Preliminary results showed a larger P600 for figuratively primed compared to literally primed idioms, most pronounced at fronto-central electrode sites. A larger posterior N400 was observed bilaterally for figuratively-primed idioms and idioms primed with an unrelated word compared to idioms primed for their literal meaning. Our findings indicate that the literal as well as the figurative meaning of an idiomatic expression are semantically integrated already at an early processing stage.

I100

SCHEMAS MAKE SPATIAL RELATIONS VISIBLE FOR A PATIENT WITH SIMULTAGNOSIA Alexander Kranjec[1], Geena Ianni[1], Anjan Chatterjee[1]; [1]University of Pennsylvania — Maps, graphs and diagrams compact a more complex spatial reality into an easier-to-use model of the world by using simplified graphic forms, like lines and blobs, to represent basic relations, like boundaries and enclosures. As such, a SCHEMA is an iconic representation where perceptual detail has been abstracted away from reality in order to provide a more flexible structure for cognition. Unlike truly symbolic representations of spatial relations (i.e. prepositions) a schema preserves some of the analog spatial qualities of the thing it stands for. We tested the efficacy of schemas in facilitating the perception and understanding of spatial relations in a patient with bilateral occipitoparietal damage and resulting simultagnosia. Patient EE555 performed six matching tasks involving WORDS (in, on, above, below), photographic PICTURES of objects, and/or SCHEMAS depicting the same spatial relations. For each task, EE555 was instructed to match a single spatial relation to a corresponding image (picture or schema) from an array of four choices. On the two tasks that did not include matching to, or from, schemas (word-to-picture; picture-to-picture) EE555 performed at chance levels. For the tasks with schemas (schema-to-picture; word-to-schema; schema-to-schema; picture-to-schema) performance was significantly better, indicating that abstract analog representations make spatial relations visible in a manner that symbols and complex images do not. The results provide general insight as to how schemas facilitate spatial reasoning when used in graphic depictions, and how such theoretically intermediate representational structures could serve to link perceptual and verbal representations of spatial relations in the brain.

I101

EXAMINING THE PROCESSING OF ACTION-RELATED EMBODIED LANGUAGE IN TWO INDIVIDUALS POST RIGHT AND POST LEFT HEMISPHERECTOMY Carrie Esopenko[1], Crossley Crossley[1], Nicole Haugrud[1], Borowsky Ron[1]; [1]Department of Psychology, University of Saskatchewan — Previous neuroimaging research has shown left hemisphere (LH) dominance during the processing of language and semantic information. Additionally, our lab has demonstrated that in a semantic generation task, where participants verbalize how they would interact with action-related stimuli, arm stimuli are processed bilaterally for both pictures and words, whereas leg stimuli show LH dominance for pictures and words. The goal of our research was to examine how action-related language is processed in individuals post right or post left hemispherectomy. Based on this previous research we predicted better performance in the individual with the intact LH, and better performance with leg stimuli specifically during the semantic generation task. S.M. (right hemispherectomy), J.H. (left hemispherectomy) and normal control participants completed naming and semantic generation tasks with pictures and words. Our results showed evidence of a double dissociation. Specifically, the naming of picture leg stimuli showed that, relative to controls, S.M. (intact LH) is severely impaired both in terms of response times and accuracy, whereas J.H. (intact RH) shows performance that is close to that of the controls. For the semantic generation of picture leg stimuli, relative to controls, J.H. (intact RH) is severely impaired, whereas S.M. (intact LH) is close to the performance of controls. As such, we provide evidence regarding the necessity of the right and left hemispheres for picture naming and semantic generation respectively, whereby the right hemisphere is of critical importance for picture naming, and the left hemisphere is of critical importance for the semantic generation of action-related knowledge.

I102

FMRI-BASED DECODING OF ABSTRACT AND CONCRETE CONCEPT REPRESENTATION Jing Wang[1], Laura Baucom[1], Svetlana Shinkareva[1]; [1]University of South Carolina — Previously, multi-voxel pattern analysis has been used to decode words referring to concrete object categories (Just, et al., 2010; Shinkareva, et al., In press). In this work we investigated if single trial-based brain activity was sufficient to distinguish abstract (e.g., mercy) vs. concrete (e.g., barn) concept representations. Multiple neuroimaging studies have identified differences in the processing of abstract vs. concrete concepts based on the averaged activity across time by using univariate method (Wang, et al., 2010). Here we used multi-voxel pattern analysis to decode functional magnetic resonance imaging (fMRI) data when participants perform a semantic similarity judgment task (Breedin, et al., 1994). During event-related fMRI scans, 13 participants performed the similarity judgment task on triplets of words with similar meanings. Classifiers were trained to identify individual trials as concrete or abstract. Cross-validated accuracies for classifying trials as abstract or concrete were significantly above chance ($p = .05$) for all participants. Discriminating information was distributed in multiple brain regions. Moreover, accuracy of identifying single trial data for any one participant as abstract or concrete was also reliably above chance ($p = .05$) when the classifier was trained solely on data from other participants. These results suggest abstract and concrete concepts differ in representations in terms of neural activity patterns during a short period of time across the whole brain.

I103

USING BRAIN LESION DATA AND VLSM TO EXPLORE EMBODIED SEMANTICS AND THE HUMAN MIRROR NEURON SYSTEM Analia Arevalo[1], Juliana Baldo[1], Nina Dronkers[1,2,3]; [1]VA Northern California Martinez, [2]UC Davis, [3]UCSD — The notion of embodied semantics suggests that processing linguistic stimuli referring to motor-related concepts recruits the same sensorimotor regions of cortex involved in the execution and observation of motor acts or the objects associated with those acts. Twenty-seven patients with left-hemisphere lesions due to stroke and 10 matched controls were presented with pictures and words representing objects and actions typically associated with the use of the hand, mouth, foot or no body part at all (i.e., neutral). Picture-sound pairs were presented simultaneously, and participants were required to press a space bar only when the item pairs matched (i.e., congruent trials). We conducted two different analyses: 1) we compared task performance of patients with and without lesions in several key areas previously implicated in the putative human mirror neuron system (i.e., Brodmann areas 4/6, 1/2/3, 21 and 44/45), and 2) we conducted Voxel-based Lesion-Symptom Mapping analyses (VLSM) to identify additional regions associated with the processing of effector-related versus neutral stimuli. Processing of effector-related stimuli was associated with several regions across the left hemisphere, and not solely with premotor/motor or somatosensory regions. We also did not find support for a somatotopically-organized distribution of effector-specific regions. We suggest that,

rather than following the strict interpretation of homuncular somatotopy for embodied semantics, these findings support theories proposing the presence of a greater motor-language network which is associated with, but not perfectly matched to, the network responsible for action execution and observation.

Language: Development & Aging

I104

USING BRAIN LESION DATA AND VLSM TO EXPLORE EMBODIED SEMANTICS AND THE HUMAN MIRROR NEURON SYSTEM Analia Arevalo[1], Juliana Baldo[1], Nina Dronkers[1,2,3]; [1]VA Northern California Martinez, [2]UC Davis, [3]UCSD — The notion of embodied semantics suggests that processing linguistic stimuli referring to motor-related concepts recruits the same sensorimotor regions of cortex involved in the execution and observation of motor acts or the objects associated with those acts. Twenty-seven patients with left-hemisphere lesions due to stroke and 10 matched controls were presented with pictures and words representing objects and actions typically associated with the use of the hand, mouth, foot or no body part at all (i.e., neutral). Picture-sound pairs were presented simultaneously, and participants were required to press a space bar only when the item pairs matched (i.e., congruent trials). We conducted two different analyses: 1) we compared task performance of patients with and without lesions in several key areas previously implicated in the putative human mirror neuron system (i.e., Brodmann areas 4/6, 1/2/3, 21 and 44/45), and 2) we conducted Voxel-based Lesion-Symptom Mapping analyses (VLSM) to identify additional regions associated with the processing of effector-related versus neutral stimuli. Processing of effector-related stimuli was associated with several regions across the left hemisphere, and not solely with premotor/motor or somatosensory regions. We also did not find support for a somatotopically-organized distribution of effector-specific regions. We suggest that, rather than following the strict interpretation of homuncular somatotopy for embodied semantics, these findings support theories proposing the presence of a greater motor-language network which is associated with, but not perfectly matched to, the network responsible for action execution and observation.

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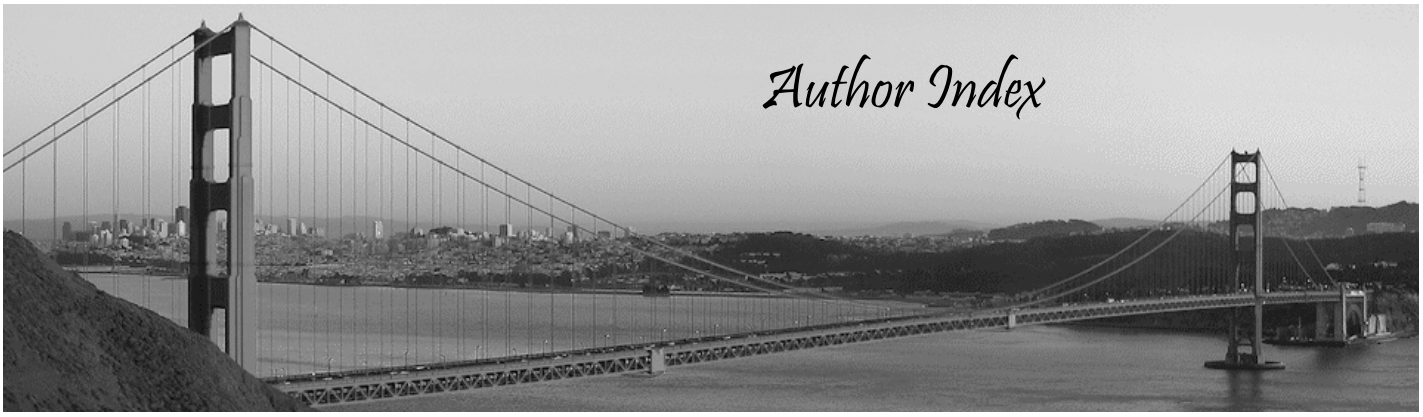

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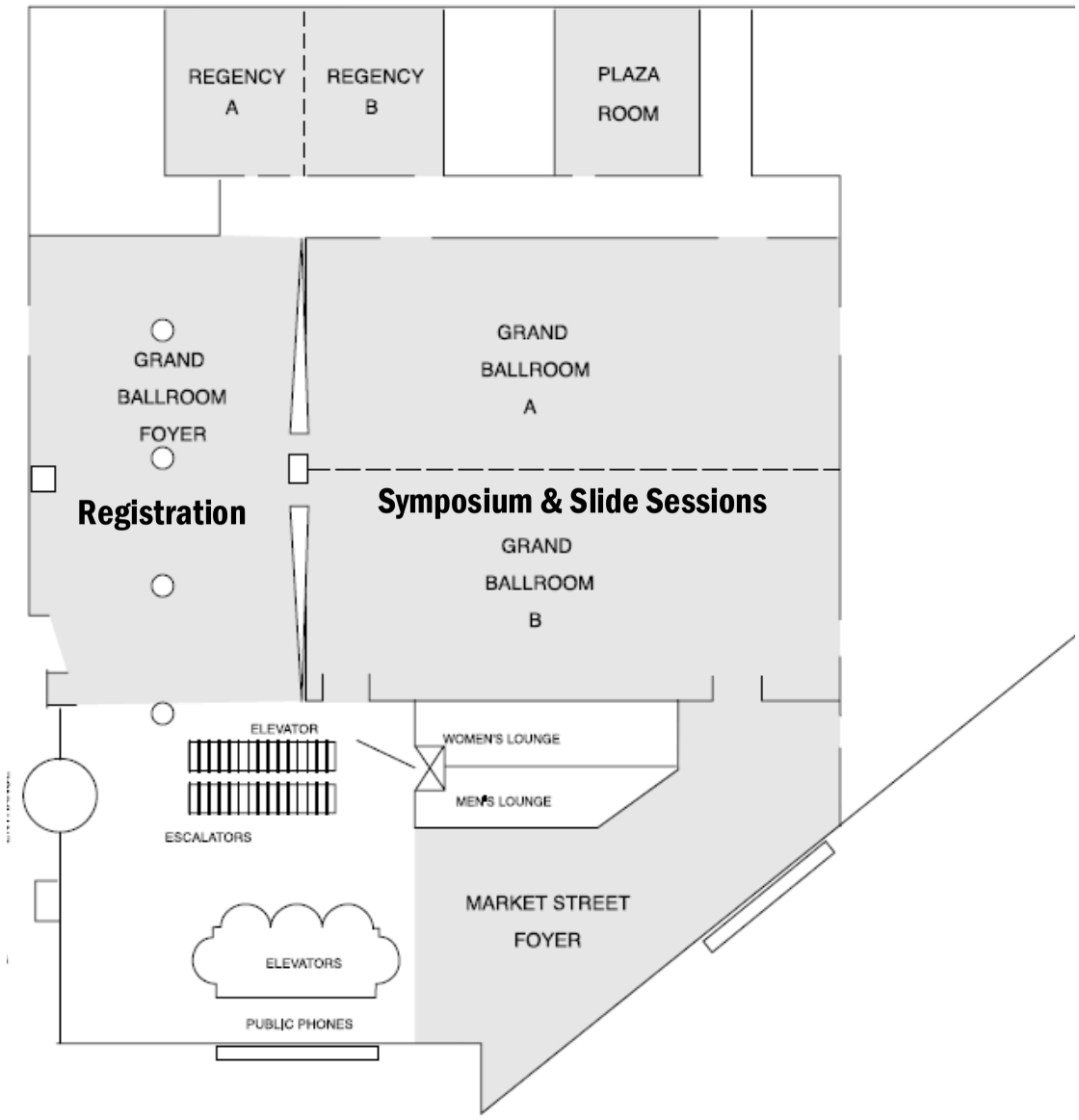

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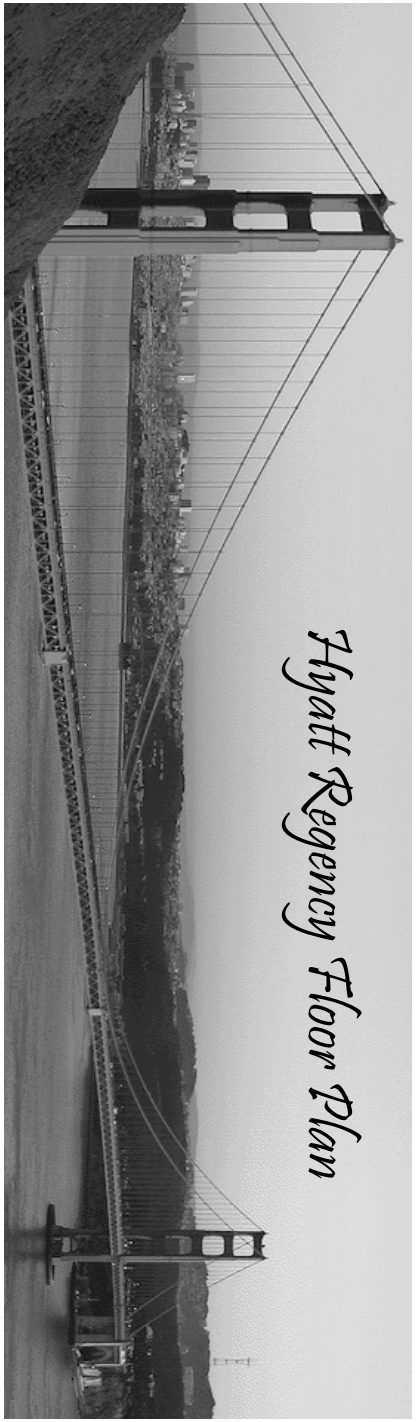

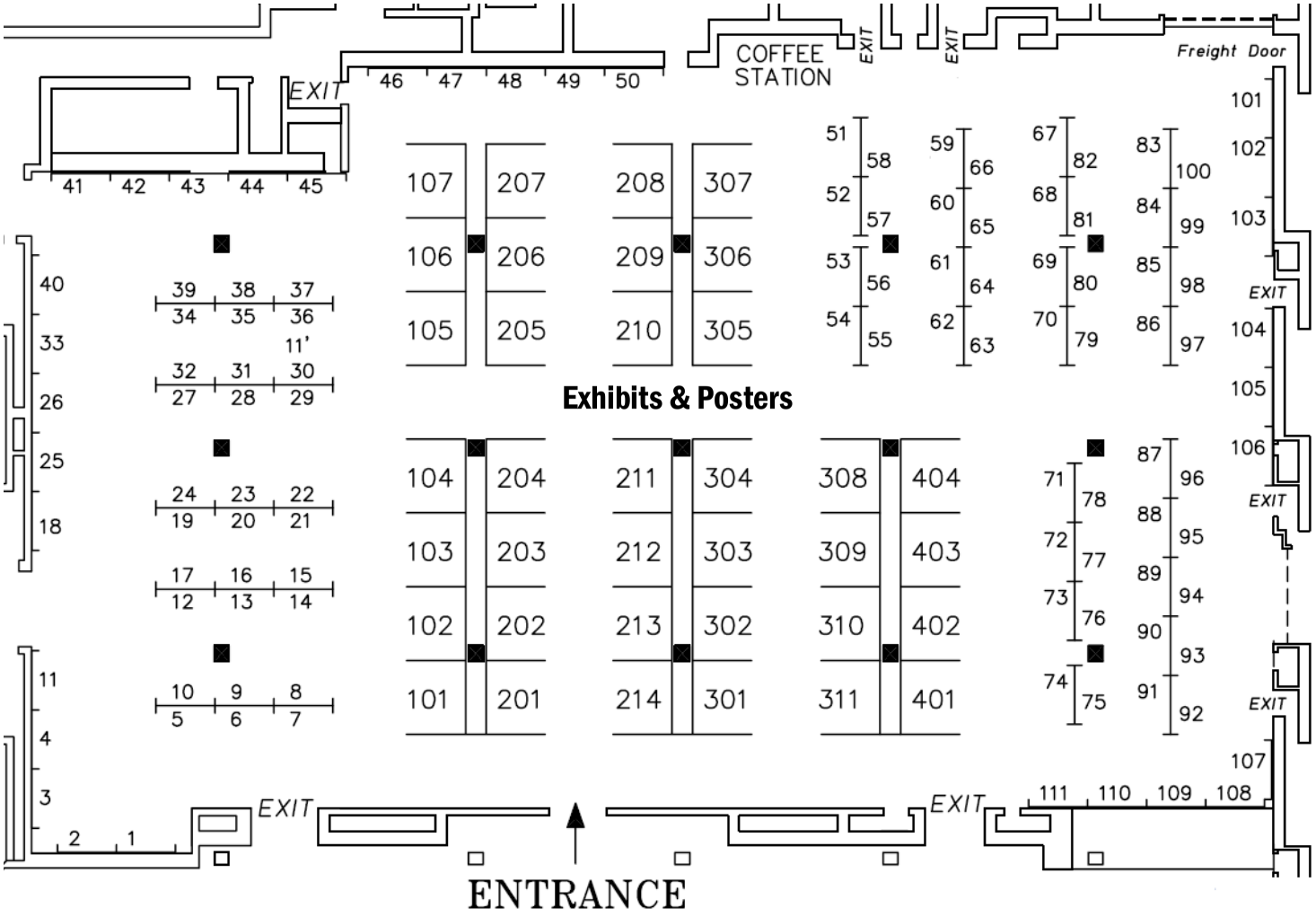

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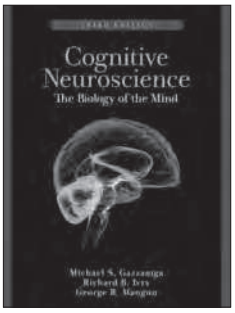
Hyatt Regency - Pacific Concourse



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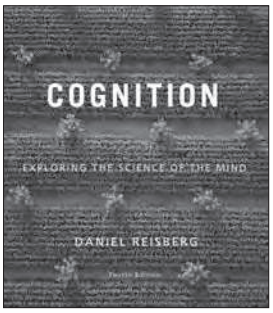

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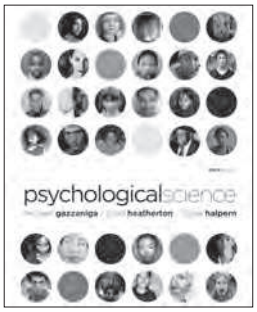

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