

Cognitive Neuroscience Society

Annual Meeting Program 2009

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Cognitive Neuroscience Society
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Mark your calendars now...
the 17th Annual
Cognitive Neuroscience Society Meeting
will be held at the Hilton Bonaventure Hotel
in Montreal, Canada
April 17 - 20, 2010

Schedule of Events

Saturday, March 21

9:00 am - 5:00 pm	Satellites
12:00 - 5:00 pm	Exhibitor Check-In, <i>Pacific Concourse</i>
2:30 - 7:30 pm	Onsite & Pre-Registration Check In, <i>Grand Ballroom Foyer</i>
3:00 - 5:00 pm	Slide sessions 1 and 2, <i>Grand Ballrooms A & B</i>
5:00 - 6:00 pm	Reception, <i>Grand Ballroom Foyer</i>
5:00 - 7:30 pm	Exhibits on Display, <i>Pacific Concourse</i>
5:30 - 7:30 pm	Poster Session A, <i>Pacific Concourse</i>

Sunday, March 22

7:30 am - 7:00 pm	Onsite & Pre-Registration Check In, <i>Grand Ballroom Foyer</i>
8:00 am	Coffee Service, <i>Pacific Concourse</i>
8:00 - 10:00 am	Poster Session B, <i>Pacific Concourse</i>
8:00 am - 7:00 pm	Exhibits on Display, <i>Pacific Concourse</i>
10:00 am - 12:00 pm	Symposium Session 1, <i>Grand Ballroom A</i> Slide Session 3, <i>Grand Ballroom B</i>
12:00 - 1:00 pm	Lunch Break
1:00 - 3:00 pm	Poster Session C, <i>Pacific Concourse</i>
2:30 pm	Coffee Service, <i>Pacific Concourse</i>
3:00 - 4:00 pm	Announcement of the Young Investigator Awards, <i>Grand Ballroom</i>
	15th Annual George A. Miller Prize in Cognitive Neuroscience, <i>Grand Ballroom</i>
4:00 - 5:00 pm	GAM Reception, <i>Grand Ballroom Foyer</i>
5:00 - 7:00 pm	Poster Session D, <i>Pacific Concourse</i>

Monday, March 23

8:00 am - 7:00 pm	Onsite & Pre-Registration Check In, <i>Grand Ballroom Foyer</i>
8:00 am	Coffee Service, <i>Pacific Concourse</i>
8:00 - 10:00 am	Poster Session E, <i>Pacific Concourse</i>
8:00 am - 7:00 pm	Exhibits on Display, <i>Pacific Concourse</i>
9:00 - 9:40 am	YIA Special Lecture 1, <i>Grand Ballroom A</i>
10:00 am - 12:00 pm	Symposium Session 2, <i>Grand Ballroom A</i> Slide Session 4, <i>Grand Ballroom B</i>

12:00 - 1:00 pm	Lunch Break
1:00 - 3:00 pm	Poster Session F, <i>Pacific Concourse</i>
2:30 pm	Coffee Service, <i>Pacific Concourse</i>
3:00 - 5:00 pm	Symposium Session 3, <i>Grand Ballroom A</i> Slide Session 5, <i>Grand Ballroom B</i>
5:00 - 7:00 pm	Poster Session G, <i>Pacific Concourse</i>

Tuesday, March 24

8:00 am - 5:00 pm	Onsite & Pre-Registration Check In, <i>Grand Ballroom Foyer</i>
8:00 am	Coffee Service, <i>Pacific Concourse</i>
8:00 - 10:00 am	Poster Session H, <i>Pacific Concourse</i>
8:00 am - 7:00 pm	Exhibits on Display, <i>Pacific Concourse</i>
9:00 - 9.40 am	YIA Special Lecture 2, <i>Grand Ballroom A</i>
10:00 am - 12:00 pm	Symposium Session 4, <i>Grand Ballroom A</i> Slide Session 6, <i>Grand Ballroom B</i>
12:00 - 1:00 pm	Lunch Break
1:00 - 3:00 pm	Symposium Session 5, <i>Grand Ballroom A</i> Slide Session 7, <i>Grand Ballroom B</i>
2:30 pm	Coffee Service, <i>Pacific Concourse</i>
3:00 - 5:00 pm	Poster Session I, <i>Pacific Concourse</i>

Visit the CNS 2009 Exhibitors in the Pacific Concourse

ADInstruments	Elsevier	Oxford University Press
American Psychological Association	Hitachi Medical Corporation	Psychology Press
BIOPAC Systems, Inc.	Integragen	Psychology Software Tools, Inc.
Cambridge Electronic Design, Ltd.	Measurand Inc	Rogue Research, Inc.
Cedrus Corporation	Millisecond Software	SensoMotoric Instruments
Compumedics USA Ltd.	NeuroFocus, Inc	Sinauer Associates, Inc.
Cortech Solutions, Inc.	NITRC: Neuroimaging Informatics Tools and Resources Clearinghouse	The MIT Press
Electrical Geodesics, Inc.	Noldus Information Technology	W. W. Norton & Company
Electrode Arrays	Northern Digital Inc.	Wiley-Blackwell

15th Annual George A. Miller Prize in Cognitive Neuroscience

*Sunday, March 22, 2009, 3:00 - 4:00 pm, Grand Ballroom
Reception to follow, 4:00 - 5:00 pm, Grand Ballroom Foyer*

The Cognitive Neuroscience Society is pleased to announce the recipient of the 2009 George A. Miller Prize in Cognitive Neuroscience:

Marcus Raichle, Ph.D., Washington University School of Medicine in St. Louis

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.

Young Investigator Award in Cognitive Neuroscience

*Sunday, March 22, 2009, 3:00 - 4:00 pm, Grand Ballroom
(Immediately prior to the George A. Miller Award in Cognitive Neuroscience Lecture)*

The Cognitive Neuroscience Society is pleased to announce the recipients of the 2009 Young Investigator Awards:

Lila Davachi, Ph.D., New York University

Clayton Curtis, Ph.D., New York University

The Young Investigator Awards in Cognitive Neuroscience recognizes outstanding contributions by scientists early in their careers. Two awardees are named each year by the Award Committee, and are honored at the Annual meeting of the Cognitive Neuroscience Society. Each award includes \$500 to be used by the awardees toward travel costs to the meeting, or for any other purpose.

In addition to the ceremony, this year, the recipients will be giving a 30 minute talk at the CNS meeting.

YIA Special Lecture 1 – Dr. Lila Davachi

Monday, March 23, 2009, 9:00 - 9:40 am, Grand Ballroom A

FUNCTIONAL ARCHITECTURE OF THE HUMAN MEDIAL TEMPORAL LOBE MEMORY SYSTEM

How are memories formed? Approaches to this question have been based on distinctions between kinds of conscious experience or on psychological processes. While each of these approaches has its merits, it is also important to consider the anatomical inputs to and connectivity within the medial temporal lobe (MTL). Animal studies suggest that distinct regions of MTL cortex receive differential input from neocortical input structures that are associated with divergent roles in object and spatial cognition. This suggests a different viewpoint on the functional organization of the MTL such that distinct MTL cortical regions may participate in the encoding of domain-specific information while the hippocampus proper, which receives convergent input from these MTL cortical structures, contributes to the mnemonic binding of this input. In this talk, I will describe a series of studies that integrates anatomical and psychological theories to support a hybrid model of MTL function.

YIA Special Lecture 2 – Dr. Clayton Curtis

Tuesday, March 24, 2009, 9:00 - 9:40 am, Grand Ballroom A

A SINGLE CLASSIFIER PREDICTS THE DIRECTION OF SPATIAL ATTENTION, WORKING MEMORY, AND MOTOR INTENTIONS

We recently demonstrated that neural activity in the same frontal and parietal cortical areas persists when humans 1) maintain a location in working memory, 2) covertly maintain attention peripherally, and 3) maintain a spatially directed motor intention. We concluded that spatial working memory, attention, and intentions share a common neural mechanism that is implemented in these areas. To further test these conclusions, here, we use multivoxel pattern classification of fMRI data to test two hypotheses. First, we can predict the location of a working memory representation, the direction of covert attention, and the target of a motor intention based on the multivariate pattern of delay period activity. Indeed, we find that frontal and parietal cortex activity can correctly classify whether subjects are remembering, attending, and planning a movement to the right or left hemifields. Second, we show that the classifiers generalize across tasks. We trained classifiers on one task (e.g., working memory) and tested its predictive validity on the other tasks (e.g., spatial attention and motor intention). Remarkably, despite that subjects were performing a different task, we observe robust cross-task classification. A classifier trained to discriminate the position of a working memory representation can predict the direction of one's attention and the goal of one's motor intentions. These results suggest that the information contained within these areas during delay periods is not dependent on working memory, attention, or intentions. Instead, it argues that these areas implement a common mechanism that supports a variety of spatial cognitions.

CNSSA Social Night

Come and meet other students from the Cognitive Neuroscience Society and let's explore the city!

All students of the Cognitive Neuroscience Society are welcome to join us at the Hyatt Hotel Bar - The Eclipse Lounge at 7:30 p.m. on Saturday March 21st (after the poster session). Please wear your name-tags so other students can easily identify you. We will introduce everyone to each other and get acquainted, and around 8:30 p.m. we will head out to two local bar/restaurants:

Gordon Biersch

2 Harrison Street
San Francisco, CA 94105
Phone: (415) 243-8246
www.gordonbiersch.com

Palomino

345 Spear Street
San Francisco, CA 94105
Phone:(415) 512-7400
www.palomino.com

Both bars are walking distance from the hotel and from each other.

Please note that this is not a funded event and although there is no entrance fee for any of the places we are going to, you will have to pay for your own drinks and/or dinner.

Looking forward to you meeting you in San Francisco!

CNSSA Executives

Graduate Students Present

Eight to ten abstracts are chosen each year for CNS's Graduate Students Present (GSP) Award. The recipients are awarded a \$500 travel award and present their 15 minute discussion on their research findings during the Cognitive Neuroscience Society Annual Meeting.

The GSP sessions will be scheduled and presented with the topically organized slide session that corresponds to the topic of their abstract. Presenters/ Attendees are to check the Slide Presentation Schedule for complete presentation.

The Cognitive Neuroscience Society is pleased to announce the 2009 GSP Award Recipients:

Simon van Gaal, *University of Amsterdam, The Netherlands*

Jaap Munneke, *VU University, Amsterdam*

Andrew Butler, *Indiana University*

Gerrit Hirschfeld, *University of Muenster*

Dominique Vuvar, *University of Toronto, Canada*

Antonio Lara, *University of California, Berkeley*

Bradford Mahon, *Harvard University*

Amitai Shenhav, *Harvard University*

Julie L. Hall, *University of Michigan*

CNS Symposia

Symposia
Session 1

Vertically Integrating Molecular-genetics, Cognitive Neuroscience, and Psychology

Sunday, March 22, 10:00 am - 12:00 pm, Grand Ballroom A

Chair: **Adam Green**

Speakers: **John A. Fossella, Andreas Papassotiropoulos, Joseph H. Callicott, Colin G. DeYoung**

Summary: Using cognitive neuroscience techniques to investigate neural expression of genetic variants is not only relevant for disease, it also has the potential to inform models of healthy cognitive function. The goal of this "cognitive neurogenetic" research is to integrate genes and their protein products with brain-based intermediate phenotypes and behavioral phenotypes. While the promise is considerable, so are the theoretical, statistical, and interpretive hazards. Psychological theory will be an indispensable pillar for building an understanding of gene-brain-behavior relationships, including rigorous development and validation of behavioral tasks. Another pillar will be the use of a systems approach that engages the complexity and non-specificity of gene effects as well as the interactions between and among genetic polymorphisms and brain systems. A third pillar is detailed molecular-genetic characterization of the effects of polymorphisms on gene expression. Fitting gene-(intermediate) phenotype associations to constraints established by molecular genetic data can help weed out spurious associations and provide the link to molecular-biological mechanisms that build and guide neural systems. This symposium will review vertically integrative approaches that help delineate the causal chain from gene to protein to brain to behavior, as well as statistical and methodological measures that help ensure meaningfully interpretable data.

A B S T R A C T S

RECONCILING THE DEVELOPMENT OF EXECUTIVE CONTROL WITH MOLECULAR CHANGE *John A. Fossella, Mount Sinai School of Medicine* – It is well-known that children show gradual and protracted improvement in an array of behaviors involved in the conscious control of thought and emotion. Non-invasive neuroimaging in developing populations shows that activity in the developing cingulate cortex and fronto-striatal circuits are correlated with dissociable aspects of executive control. These brain regions, themselves, undergo protracted cellular, synaptic and molecular change in the first two decades of human development and, as such, have been implicated in mechanisms that link the development of brain and behavior. One approach to better understanding age-dependent changes in cognition is to consider the role of molecular genetic change. When developmental changes in gene expression are known, it is reasonable to begin to ask whether such changes contribute to observable correlates in brain structure, activity and behavior. A so-called imaging-genetic approach has been validated and replicated in paradigms that measure aspects of executive control in adults and is now well poised for studies on the development of executive control in children. We present a research strategy, based on a child-friendly version of the attention network task (ANT) that exploits evidence converging on the development of the anterior cingulate cortex (ACC) at the psychological, anatomical and molecular levels. The approach supports ongoing imaging-genetic experiments that are driven by explicit hypotheses.

GENETICS OF HUMAN MEMORY: UNDERSTANDING COMPLEXITY *Andreas Papassotiropoulos, Division of Molecular Psychology, University of Basel, Switzerland* – Experimental work in animals has shown that memory formation depends on a cascade of molecular events. In humans, heritability estimates of ~50% suggest that genetic factors have an important impact on this fundamental brain function. Therefore, our research aims at identifying memory-related genes and gene-clusters in humans and at translating the findings to memory-related disorders. Gene identification is done by combining unbiased genome-wide association studies, candidate gene approaches and gene clustering, and functional MRI (fMRI) in populations which are carefully tested for memory performance and for the presence or absence of diseases related to

impaired memory function. We show that variability of human memory performance is related to variability in genes encoding proteins of a core molecular signaling cascade. Functional magnetic resonance imaging reveals that this genetic profile correlates with activations in memory-related brain regions. The genome-wide association studies reveal the existence of novel genes significantly related to human memory performance, brain activation and to the risk for developing diseases related to memory impairment. The search for genes related to human memory processes provides new insights into the genetic basis of this cognitive ability and will ultimately promote the targeted treatment of memory disorders by identifying relevant genetic pathways in humans.

THE GENETIC UNDERPINNINGS OF PREFRONTAL NEURONAL INFORMATION PROCESSING: MECHANISTIC PROMISES AND METHODOLOGICAL PITFALLS *Joseph H. Callicott, National Institute of Mental Health* – Imaging genetics evolved from candidate gene studies demonstrating in-vivo effects of allelic variation tied to increased risk for complex heritable illnesses like schizophrenia. Following findings linking alterations in prefrontal cortex (PFC) information processing efficiency during working memory to allelic variations in healthy individuals, we pursued two questions related to future investigations, namely: 1) Do findings relating genes like COMT to PFC function generalize to all PFC-linked cognitive tasks or do task characteristics (e.g., cognitive demand, task complexity, or network relationships) influence these relationships? and 2) Are analyses that ignore multiple, related genetic variants (i.e., pathways) sufficient? Using fMRI data collected during two PFC tasks (Nback and DSST) in healthy subjects, we contrasted the information processing efficiency effects of a gene dependent on cognitive load (COMT) and one with general effects (the potassium channel gene KCNH2). We also contrasted gene interactions emerging in a predicted fashion from risk conferred by both genes (COMT x KCNH2) as opposed to those only evident when conditioned on risk in an interacting partner (RGS4 x COMT, GAD1 x COMT). Analyses incorporating metabolic pathway interactions and measured at differing cognitive loads should foster adaptation from candidate gene to GWAS and beyond.

EXTERNALIZING BEHAVIOR AND COGNITION: DOPAMINE GENES AND COMPLEX ASSOCIATIONS *Colin G. DeYoung, University of Minnesota* – Externalizing behavior (encompassing aggression, antisocial behavior, impulsivity, and drug abuse) has been shown through studies of heritability to have a strong genetic basis. Molecular genetics and neuroimaging are crucial to understanding how genetic factors, interacting with environmental influences, shape the brain in ways that lead to the expression of externalizing behavior. A panel of genes related to the dopaminergic system has been associated with externalizing behavior and cognitive function. Here, we focus on the dopamine D4 receptor gene (DRD4) and the catechol-O-methyltransferase gene (COMT). The products of these two genes have strong influences on dopaminergic function in the prefrontal cortex, a key brain region for higher cognition and cognitive control. The research presented highlights the complexity of molecular genetic effects. For example, three studies show that variation in DRD4 moderates the typically negative association of externalizing behavior with IQ. Cognitive ability is strongly associated with working memory, and the neural circuits underlying working memory are influenced by variation in DRD4 and COMT. A large fMRI study (N =100) shows that genetic variation influences brain activity related to working memory and cognitive control and explores the relation of these effects to individual differences in externalizing behavior.

Symposia Session 2

Neurobiology of human language and its evolution: Primate perspectives

Monday, March 23, 10:00 am - 12:00 pm, Grand Ballroom A

Chair: **William D. Marslen-Wilson**

Speakers: **James K. Rilling, Angela D. Friederici, Asif A. Ghazanfar, William D. Marslen-Wilson**

Summary: The last decade has seen dramatic developments in our understanding of the neural and functional architecture of non-human primate systems that support the processing of complex auditory objects in general, and of conspecific vocal calls in particular. These developments are having an increasing influence on research into human language, making it possible to situate this work in a genuinely neurobiological and evolutionary context. This symposium explores these exciting developments in four presentations. Two speakers come from the non-human primate research community. The first speaker will discuss evolutionary changes in the neural pathways connecting frontal and temporal cortices in the macaque, chimpanzee and human brain, in areas critical for key human linguistic capacities. The second

speaker will focus on the multi-modal functional architecture underlying vocal communication in the macaque, and the implications of this for models of language evolution and function. Two further speakers come from human research exploring the cognitive neuroscience of language. The first focuses on left-hemisphere pathways supporting syntax, a faculty specific to humans, and combines research with adults and with children learning language. The second will focus on bi-hemispheric substrates for human language functions, placed in a broader primate perspective.

A B S T R A C T S

THE ARCUATE FASCICULUS IN HUMANS, CHIMPANZEES AND MACAQUES: IMPLICATIONS FOR THE EVOLUTION OF HUMAN LANGUAGE *James K. Rilling, Emory University, Anthropology* – The cognitive attribute that most obviously distinguishes humans from other primates is our capacity for language. Human language is supported by typically left hemisphere regions of temporal and frontal cortex that are connected by a white matter fiber tract known as the arcuate fasciculus. The objective of our research was to identify possible language-related specializations of the human brain by comparing human, chimpanzee and rhesus macaque brains in the region of the arcuate fasciculus with diffusion tensor imaging (DTI). Post-mortem and in vivo DTI scans were acquired from human, chimpanzee, and macaque subjects. Probabilistic tractography software (FSL) was used to reconstruct the arcuate pathway or its homologue in all three species. Tractography results suggest that connections linking the posterior superior temporal gyrus (Wernicke's region) and left inferior frontal cortex (Broca's region) exist in all three species. However, connections linking semantic processing areas of the middle temporal gyrus (BA 21, 37, 39) with Broca's area are only present in humans and chimpanzees, and are much more extensive in humans. These differences in the arcuate fasciculus language pathway between humans and chimpanzees may be relevant to the evolution of the neural substrates supporting human language.

NEURAL PATHWAYS RELEVANT FOR SYNTAX *Angela D. Friederici, Max Planck Institute for Human Cognitive and Brain Sciences* – Language has evolved from non-human to human primates and it develops in the child under external input in a predetermined manner. Both phylogenetic and ontogenetic findings indicate a strong biological foundation of language. Language functions are known to be based on the gray matter in circumscribed brain regions in the frontal and the temporal cortex. Recent findings, moreover, suggest that the white matter fibre tracts connecting these regions are of major importance for language. A number of different connections between the frontal and temporal have been identified, one of which appears to be particularly weak in non-human primates when compared to human adults. Here we show that this pathway, which connects the frontal and temporal cortex dorsally, is functionally relevant for the processing of syntactically complex sentences in the adult and that it develops only late during ontogeny. Moreover, the data indicate that children's comprehension, behaviorally not adult-like until the age of 7 years, relies on an alternative pathway. The dorsal pathway thus appears to be crucial for the adult human ability to comprehend syntactically complex sentences.

THE EMBODIED NATURE OF PRIMATE VOCAL COMMUNICATION *Asif A. Ghazanfar, Neuroscience Institute & Department of Psychology* – We are studying the neurobiology and vocal behavior of monkey agents as way of understanding the evolution and neurobiology of human communication. There are three principles that we use to guide our investigations. The first principle is that a primate's experience is profoundly multimodal and that multiple over-lapping and time-locked sensory systems enable it to learn, perceive and act in the vocal domain. Second, these communication-related sensory systems develop incrementally and their initial prematurity, and the particular trajectory they take during development, are critical to their final structure. The third principle is that sensory and motor systems will be coupled; that is, stable features of the brain, body and/or environment will be exploited to simplify vocal communication. Using these principles, our data suggest that vocal communication arises through the coupling of multiple oscillations that operate on different timescales. The facial dynamics and vocal acoustics of the signaler are linked and take the form of a coupled slow oscillation. These signals, in turn, couple with on-going oscillations in the receiver's auditory cortex. These auditory cortical oscillations then modulate faster oscillations, which in turn couple to parallel oscillations in other brain regions (including the frontal cortex and the superior temporal sulcus). We hypothesize that the oscillatory structure present in the facial dynamics and vocal acoustics exploit the structure of neural oscillations and that vocal communication emerges from these multiple oscillatory couplings. As each locus of coupling is a putative substrate for the evolution of language in humans, it is unlikely that language evolved solely through changes in key brain structures or the development of new ones.

BI-HEMISPHERIC FOUNDATIONS FOR HUMAN SPEECH AND LANGUAGE *William D. Marslen-Wilson, MRC Cognition and Brain Sciences Unit* – Current research into the biological foundations for human language emphasises the evolutionary development of specialised left hemisphere (LH) perisylvian networks, that seem to be unique to humans. This has led to undue neglect of the role of more general purpose bi-hemispheric processing capacities in supporting human spoken communication, even in the absence of syntax. In fact, functional neuro-imaging studies generally report significant RH as well as LH activity in spoken communication. Behavioral and neuro-imaging research on patients with major damage to LH perisylvian cortex reveals surprisingly effective RH capacities for lexical access from speech and for semantic-pragmatic interpretation. Recent neuro-imaging research in healthy populations, targeted at non-linguistic sources of processing complexity in lexical access shows parallel RH and LH fronto-temporal activity in response to increased perceptual complexity (for example, under conditions of increased word-internal competition between cohort competitors). These co-occur with strongly left-lateralised patterns of activation elicited by specifically linguistic sources of processing complexity (such as the presence of inflectional morphemes). These bi-hemispheric capacities for supporting vocal communication are likely to be closely related to cognate capacities that have evolved in non-human primates.

**Symposia
Session 3**

The key to prevent the return of fear memories - extinction versus reconsolidation

Monday, March 23, 3:00 - 5:00 pm, Grand Ballroom A

Chairs: **Daniela Schiller and Karim Nader**

Speakers: **Mohammed R. Milad, Karim Nader, Marie-H. Monfils, Daniela Schiller**

Summary: The ability to modulate, suppress, or erase, fear memories is crucial for adaptive function in everyday life. Without such mechanisms, fear memories could abnormally persist and gain control over behavior. To date, two seemingly opposing mechanisms are suggested to block the return of old fear memories: 1) Extinction, where fear is suppressed by safe exposure to the fear-eliciting stimuli in the absence of the harmful outcome; 2) Reconsolidation, a phase where fear memories are labile upon retrieval, presumably in order to be strengthened or updated, but their re-storage can be dampened by pharmacological manipulations. Although both mechanisms are based on triggering the fear memory, extinction leads to new safety learning, leaving the fear memory intact, while reconsolidation results in modification of the original trace. In this symposium we will cover seminal research investigating the neural mechanisms and theoretical conceptualizations of these phenomena. The speakers will cover a wide range of topics on the neuroscience of extinction and reconsolidation from rats, to humans, to psychopathology. We will discuss recent evidence for a potentially groundbreaking technique to erase emotional memories, by combining extinction and reconsolidation. Discovering the brain mechanisms for these phenomena is enhancing our understanding of emotion systems in the brain, and has important clinical implications.

A B S T R A C T S

TRANSLATIONAL RESEARCH IN THE NEUROSCIENCE OF EXTINCTION: FROM RATS TO HEALTHY HUMANS TO PSYCHOPATHOLOGY *Mohammed R. Milad, Harvard Medical School* – Some people adapt well in the aftermath of traumatic events and are quickly able to inhibit their fear responses to trauma-associated stimuli. Fear responses, however, persist for longer periods of time for others to the point where they reach a pathological state. Why are some people more resilient to trauma while others are not? What are the neural substrates that underlie fear inhibition and extinction? Are these circuits deficient in patients with anxiety disorders? In my talk, I will focus on presenting translational data from the rat and human brain with the objective of trying to provide some preliminary answers to the above stated questions. Specifically, I will review human studies indicating that prefrontal areas homologous to those critical for extinction in rats. Furthermore, I will present some data to show that those brain regions in the rat brain appear to be structurally and functionally homologous to specific brain regions in the human brain. I will also show some data suggesting that these brain regions, the ventromedial prefrontal cortex (vmPFC) and the dorsal anterior cingulate cortex (dACC), appear to be deficient in patients with posttraumatic stress disorder (PTSD). I will present some structural and functional neuroimaging and psychophysiological studies done in our lab that focused on the neural mechanisms of fear extinction, particularly extinction recall and the contextual modulation of extinction recall. These recent studies suggest that: 1) human

vmPFC is involved in the recall of extinction memory; 2) the size of the vmPFC might explain individual differences in the ability to modulate fear among humans; 3) hippocampal activation is observed during the recall of extinction memory in a context where extinction training took place but not in the initial conditioning context; 4) and the dACC may be involved in the expression of fear responses. I will also present recent neuroimaging and psychophysiological data from PTSD patients suggesting that 1) the retention of extinction memory is impaired in PTSD, and 2) the function of the vmPFC and dACC (measured by fMRI) appears to be impaired in PTSD in the context of fear extinction. Implications of these findings to the pathophysiology of anxiety disorders such as PTSD and current extinction-based behavioral therapies for anxiety disorders will be discussed.

CONSOLIDATION AND RECONSOLIDATION OF EMOTIONAL MEMORIES *Karim Nader, McGill University* – For over a hundred years memories were thought to be stored in our brain as a one time process called consolidation. They are thought to be stored as changes in the strength of connections between neurons. The molecular machinery required for memory consolidation have been relatively well described. Recently, we rediscovered that when you remember a memory that is already stored in your brain, it can become un-stored and has to be re-consolidated. If you block the memory from being restored it seems to be lost. This means that, in theory, we could manipulate the strength of memories therapeutically. I will talk about the brain mechanisms thought to be involved in memory consolidation and reconsolidation, and discuss some of the first clinical trials attempting to manipulate our memories therapeutically in patients with chronic post-traumatic stress disorder (PTSD).

RECONSOLIDATION-EXTINCTION BOUNDARIES MAY HOLD THE KEY TO PREVENT THE RETURN OF FEAR *Marie-H Monfils, University of Texas at Austin* – In the process of reconsolidation, a retrieved memory transiently returns to a structurally-labile state, during which time it is open to enhancement or disruption. This period of instability, termed the reconsolidation window, is known to persist for several hours following retrieval. Its adaptive purpose might be to enable the integration of new information present at the time of retrieval into an updated memory representation, and numerous studies have demonstrated that the blockade of this updating process, usually via pharmacological intervention within the lability window, prevents memory re-storage and produces amnesia (loss of the specific memory that was reactivated in the presence of the drug). Thus, blocking reconsolidation weakens the emotional impact of a stimulus by altering the molecular composition of the memory itself. The clinical efficacy of reconsolidation blockade is limited, since it typically requires toxic drugs. My talk will focus on a paradigm we have recently devised, in rats, that capitalizes on the mechanistic differences between reconsolidation and extinction, and provides an effective, drug-free alternative to permanently target and reduce learned fear. We show that destabilizing a memory by presenting an isolated retrieval trial prior to an extinction session leads to de-phosphorylation of GluR1, facilitates a re-interpretation of the conditioned stimulus as safe, and prevents the return of fear memories. Our results suggest that subtle modifications to a common treatment (exposure therapy) could improve clinical outcome.

PREVENTING THE RETURN OF FEAR MEMORIES IN HUMANS - INVASIVE AND NON-INVASIVE TECHNIQUE *Daniela Schiller, New York University* – Nearly all forms of behavioral therapy rely, at least partially, on extinction learning through exposure to fear arousing stimuli in a safe context. Although extinction provides a relief from fear, this relief is temporary, as extinguished fear responses often reemerge with the passage of time or following re-exposure to the original context or the original stress, or even an irrelevant stress. The fact that extinguished fear can be recovered has been taken to mean that the fear memory is not erased but rather suppressed by extinction. In recent years, research in non-human animals has attempted to erase old memories by targeting a particular phase, called reconsolidation, in which memories are rendered labile by being retrieved. Pharmacological manipulations at this stage result in an inability to retrieve the memories at later times, suggest that they are either erased or persistently inhibited. While this has important implications for the treatment of traumatic memory in humans there has yet to be convincing evidence that reconsolidation can be impaired in humans. This is in part due to obvious limitations in the use of invasive manipulations, such as drugs, and the risk of side effects. Thus, there is a critical need to develop drug-free behavioral manipulations to achieve blockade of fear recovery. In the talk, I will describe current research on human reconsolidation of emotional memories. In particular, I will describe a series of experiments on reconsolidation of fear using pharmacological and behavioral manipulations, and the initial attempts to translate animal findings to humans.

Symposia
Session 4**The fluidity of preferences: effects of choice and context***Tuesday, March 24, 10:00 am - 12:00 pm, Grand Ballroom A*Chair: **Ray Dolan**Speakers: **Laurie Santos, Tali Sharot, Antonio Rangel, Paul Glimcher**

Summary: Modern society presents individuals with more choices than ever before. We can select from a near-infinite number of possibilities where to live, who to marry, what to eat, and how to spend our leisure time. Traditional decision making theories assume that these choices are based on relatively stable preferences. In this symposium we argue that preferences are in fact highly unstable and susceptible to the context in which alternatives are presented. The focus of the symposium is on findings that begin to describe the cognitive and neural mechanisms mediating preference generation and their modulation by context. Santos and Sharot demonstrate how the mere act of choosing modifies our preferences; describing both the origins of this intriguing phenomenon in children and monkeys (Santos) and the underlying neural mechanisms in human adults (Sharot). Rangel will discuss how marketing strategies affect neural representations of experienced pleasure. Finally, Glimcher will present data from single LIP neurons that help explain how, and why, preferences are altered by changing choice sets. This diverse data all converge to one underlying theme: context-dependent preference volatility is a robust effect reflected in brain regions tracking subjective value (including striatum and OFC), and appears to be conserved across primate evolution.

A B S T R A C T S**HOW UNKNOWN DECISIONS AFFECT PREFERENCES: EVIDENCE FROM HUMAN CHILDREN AND CAPUCHIN MONKEYS**

Laurie Santos, Yale University – Common wisdom suggests that we make decisions based on our preferences. In contrast, a growing body of behavioral evidence suggests that our decisions can sometimes affect our preferences. In three studies, we explore the origin of this phenomenon in children and monkeys (*Cebus apella*). We first demonstrate that, like adults, children and monkeys change their preferences based on their decisions. We then explore whether decisions can affect preferences even when participants are unaware of their own choices. Children and monkeys made choices between similar alternatives while ignorant of the identities of these alternatives. Both groups then subsequently chose between the rejected alternative and a third similar alternative. Both populations preferred the third alternative to the blindly rejected alternative, indicating that they devalued the unchosen alternative even though they were unaware of its identity. These results demonstrate that choices can affect preferences even when the stimulus attributes of particular choices are unknown. In this way, our results provide the first evidence that choice-based preference changes are independent of stimulus factors. Our discovery of choice-based preference changes in these populations also provides further evidence that these preference changes may operate even in the absence of high-level cognitive processes.

CHOICE REVEALS AND SHAPES EXPECTED HEDONIC OUTCOME

Tali Sharot, University College London – Humans tend to modify their attitudes to align with past action. For example, after choosing between similarly valued alternatives, people rate the selected option as better than they originally did, and the rejected option as worse. However, it is unknown whether these modifications in evaluation reflect an underlying change in the physiological representation of a stimulus' hedonic value and our emotional response to it. In two studies we addressed this question by combining participants' estimations of the pleasure (Experiment I) and pain (Experiment II) they will derive from future events, with brain imaging data recorded while they imagined those events, both before, and after, choosing between them. Participants rated the selected alternatives as better after the decision stage relative to before, while discarded alternatives were valued less. Our fMRI findings reveal that post-choice changes in preference are tracked in caudate nucleus activity. Specifically, the difference in BOLD signal associated with the selected and rejected stimuli was enhanced after a decision was taken, reflecting the choice that had just been made. This finding suggests that the physiological representation of a stimulus' hedonic value is altered by a commitment to it. Furthermore, prior to any revaluation induced by the decision process, our data show that BOLD signal in the striatum reflects the choices we are likely to make at a later time, even when an explicit valuation of the options does not.

BIASES IN THE NEURAL REPRESENTATIONS OF EXPERIENCED UTILITY

Antonio Rangel, California Institute of Technology – Experienced utility signals provide a measure of the quality of the outcomes generated by our choices, thus providing the necessary feedback to improve future decision-making. Although multiple

human neuroimaging studies have shown that activity in the medial orbitofrontal cortex (mOFC) is correlated with reports of subjective pleasantness, little is known about which variables affect this signal. Here we report on the results of two studies investigating this question. In the first study we explored the extent to which changes in prior expectations about the quality of an experience, such as changes in the price of a product, can affect neural representations of experienced pleasantness. We tested this hypothesis by scanning human subjects using functional magnetic resonance imaging (fMRI) while they tasted wines which, contrary to reality, they believed to be different and sold at different prices. Our results show that increasing the price of a wine increases subjective reports of flavor pleasantness as well as BOLD activity in medial orbitofrontal cortex (mOFC). In a second study we showed that random events unrelated to the experience of tasting a wine, such as the payoff of a random lottery, also affect subjective reports of taste pleasantness and activity in the mOFC. Together, these results suggest that the putative experienced utility signal encoded in the mOFC is contaminated by variables that are unrelated to the objective quality of the experience being measured. These "experiential biases" might contribute to some of the "choice biases" that have been identified by behavioral economists, as well as to the efficacy of some marketing practices.

CHOICE SET EFFECTS: RELATIVE REWARD REPRESENTATION IN PARIETAL CORTEX *Paul Glimcher, New York University* – One of the hallmarks of rational choice theory is the desirability of choice options - the more alternatives a decision-maker can choose from, the better off he will be. However, a growing literature suggests that when choice set size grows too large, decisions become difficult and people fare significantly worse. We hypothesize that such choice effects arise from how the values of alternative actions are represented in neural decision-making circuits. In the lateral intraparietal area (LIP), visuomotor neurons are strongly modulated by reward variables such as expected gain, prior probability, and reward income, suggesting that individual LIP neurons represent the subjective value of specific saccades. We recorded monkey LIP neurons during a multiple option choice task and show that the value of an action is represented in a relative form, normalized by the total value of all available alternatives. These results are well-characterized by the divisive normalization model previously proposed to explain responses in early sensory cortices, suggesting that divisive normalization may represent a canonical mechanism of cortical operation. Furthermore, such a relative value representation can be shown to modify preferences in the face of increasing numbers of alternatives, and may explain how actual choice behavior responds to multiple options and changing choice sets.

Symposia Session 5

Representational similarity analysis - characterizing visual population codes for shapes, objects, and faces

Tuesday, March 24, 1:00 - 3:00 pm, Grand Ballroom A

Chair: **Nikolaus Kriegeskorte and Geoffrey K. Aguirre**

Speakers: **James V. Haxby, Hans Op de Beeck, Nikolaus Kriegeskorte, Geoffrey K. Aguirre**

Summary: The characterization of neuronal codes in terms of their representational content constitutes a challenge fundamental to cognitive neuroscience. One promising approach that has recently gained momentum is to characterize a neuronal population code by means of a representational dissimilarity matrix. For each pair of experimental conditions (e.g. each pair of stimuli), the representational dissimilarity matrix contains an entry reflecting the dissimilarity of the activity patterns associated with the two conditions. Intuitively, the representational dissimilarity matrix encapsulates the information carried by a given representation in a brain region or computational model. Representational similarity analysis (RSA) provides data-driven characterizations of representational content and allows us to quantitatively relate the three major branches of cognitive neuroscience - behavioral experimentation, brain-activity experimentation, and computational modeling - by comparing representational dissimilarity matrices. This symposium presents a series of novel findings on high-level visual representations at the interface between perception and cognition that have been obtained by means of RSA. These studies demonstrate the power of RSA to bridge fundamental divides of our science so as to relate human to monkey representations, cell-recordings to fMRI, and brain-activity data to behavioral measures and computational theory in an information-rich, quantitative framework that is well-motivated by cognitive theory.

A B S T R A C T S
CHARACTERIZING LOCAL NEURAL REPRESENTATION AS A MULTIDIMENSIONAL SIMILARITY SPACE

James V. Haxby, Dartmouth College, Psychological & Brain Sciences – Whereas conventional univariate analysis of functional brain imaging data characterized the function of a region in terms of the conditions that activate that region, multivariate pattern (MVP) analysis characterizes local function in terms of the conditions that evoke distinct patterns of activity. Moreover, the dissimilarities of the patterns of activity for different conditions can be quantified. Thus, local neural representation can be analyzed in terms of a high-dimensional similarity structure rather than as a (short) list of functions. Functional differences among brain regions can similarly be analyzed as differences in the neural representational space rather than as different functional labels. For example, different categories of visual stimuli - faces and objects - activate and evoke distinct patterns of activity in medial occipital, inferior lateral occipital (LO), and ventral temporal (VT) cortex, including when analysis is restricted to subregions that respond maximally to faces (FFA) and places (PPA). The similarity structure of the responses to categories, however, differs significantly among these brain regions. Whereas LO demonstrates larger distinctions than does VT within animate (faces of different species) and inanimate domains (houses, chairs, and shoes), VT demonstrates larger distinctions between the animate and inanimate domains. Medial occipital cortex, on the other hand, demonstrates a similarity structure that is not dominated by the animate-inanimate distinction at all. MVP analysis, therefore, reveals how local neural representation projects information into different subspaces that emphasize different distinctions among conditions. These methods provide a powerful tool for investigating how information is processed and re-represented in hierarchical and distributed neural systems.

THE ROLE OF OBJECT FEATURES, CATEGORIES, AND LEARNING FOR THE REPRESENTATION OF OBJECT SIMILARITY IN THE HUMAN BRAIN

Hans Op de Beeck, Laboratory of Experimental Psychology, University of Leuven – Multiple studies using functional magnetic resonance imaging (fMRI) have suggested the existence of category-selective regions in the human and monkey occipitotemporal cortex that represent between-category and within-category object similarity. We aim to understand where these category-based representations come from. First, they might reflect the existence of large-scale maps for object features that are correlated with category membership. Using multivariate fMRI analyses we have indeed shown that perceived shape is an organizational principle for object-selective regions in the human brain. These findings suggest that category selectivity might be decomposable into selectivity for simpler object features. Second, strong category selectivity might be induced by visual experience. We have found indeed that the neural representation of between- and within-category differences is altered by various forms of object learning. Thus, the strong category selectivity in the human brain might be related to a combined and dynamically updated coding of multiple object features.

THE EMERGENCE OF CATEGORICALITY ALONG HUMAN VENTRAL-STREAM STAGES OF VISUAL OBJECT PROCESSING

Nikolaus Kriegeskorte, Laboratory of Brain and Cognition, National Institute of Mental Health – The human ventral stream is known to host high-level representations of visual objects, from which category information can be read out with linear decoders. We have previously shown that single-object-image response patterns in human inferior temporal (hIT) cortex, when grouped by similarity, reflect conventional object categories and that the categorical structure as well as the within-category similarity structure matches between human and monkey IT. Here we start at early visual cortex and follow the ventral stream through key functional regions in order to understand how categoricity emerges across stages of processing. Early visual cortex exhibits a representational similarity reflecting visual shape (predicted, for example, by the dissimilarities of the silhouette images capturing the outer boundary of the objects); its response patterns did not allow readout of category information with a linear decoder. Categoricity (in the sense of categorical clustering of fMRI response patterns) appears to suddenly emerge at the level of the lateral occipital region (LO). The major categorical division is between animate and inanimate objects; the animate cluster is further subdivided into a face and a body cluster. We relate the representation at each stage to a range of computational models and to explicit object similarity judgments from human subjects. Within category clusters, hIT represents object exemplars in a continuous object space, which may reflect a form of visual similarity. However, the hIT representation is not well accounted for by a range of low- and intermediate-complexity computational models of visual features: these representations lack the strong categorical component found in hIT. This suggests the presence of visual features explicitly optimized for distinguishing natural categories as one possible explanation. The human similarity judgments better resemble the hIT representational similarities, but are even more strongly dominated by categoricity.

THE GEOMETRY OF NEURAL SIMILARITY SPACES *Geoffrey K. Aguirre, Hospital of the University of Pennsylvania* – What is the relationship between the perceptual similarity of sensory experiences and the similarity of the neural responses that encode them? In a series of experiments we have studied the neural representation of objects and shapes in human visual cortex using this question as a guiding principle. With continuous carry-over, functional MRI (Aguirre, Neuroimage, 2007), we can measure the similarity of evoked neural responses to objects on either a focal (within voxel adaptation) or distributed (across voxel pattern) spatial scale. For simple two-dimension shapes and for faces we have found that perceptual similarity predicts neural response similarity, but that the visual information represented at focal and distributed scales differ, both within and across visual areas. Specifically, the dorsolateral portion of the "object responsive" visual area LOC represents a subset of object features with a spatially coarse code, while ventral LOC contains focal populations of neurons that represent the entire object appearance. These studies show that neural population coding of object appearance within ventral LOC reflects perceptual similarity. The precise metric properties of perceptual similarity may further predict the stimulus axes along which these representations are organized. We hypothesize that integral perceptual axes (perceived as a composite with a Euclidean distance metric) are represented by populations of neurons that are conjointly tuned to the axes, while separable axes (defined by a rectilinear metric) are represented by independently tuned neural populations. Using fMRI we may measure the geometric properties of neural adaptation to distinguish between conjoint or independent tuning for a population of neurons. For both two-dimensional shapes and for faces we find that neural tuning within ventral visual areas reflects the metric properties of perception. For shapes, curvature and thickness are independently represented while two arbitrary dimensions of shape variation have conjoint representation. For faces, left ventral areas are tuned to represent face features, while right ventral cortex modulates tuning between face features and wholes depending upon stimulus context and reflecting behavioral measures.

Slide Sessions

Slide Session 1 Language

Saturday, March 21, 3:00 - 5:00 pm, Grand Ballroom A

Chair: **Tamara Swaab**

Speakers: **Mirjana Bozic, Keith J. Duncan, Corianne Rogalsky, Peter Gordon, Gerrit Hirschfeld (GSP Winner), Marina Bedny, Christopher Kurby, Danielle van den Brink**

A B S T R A C T S

NEURO-COGNITIVE COMPLEXITY OF DERIVATIONALLY COMPLEX WORDS *Mirjana Bozic¹, Lorraine K. Tyler², William D. Marslen-Wilson¹; ¹MRC Cognition and Brain Sciences Unit, Cambridge UK, ²Centre for Speech, Language and the Brain, University of Cambridge* – Lexical complexity plays a prominent role in modulating the activity of fronto-temporal language networks. Studies with regularly inflected words (jumped, smiled) show that the presence of morpho-phonological complexity (stem + inflectional affix) activates left-lateralised areas, while lexical-semantic complexity (presence of competing alternatives due to embedded stems, e.g., claim(clay), ramp(ram), etc) engages bilateral inferior frontal regions. The current efmRI experiment asked whether similar left-lateralised decomposition and bilateral competition processes hold for derivationally complex words (darkness, warmth), where the stem-affix relationship is strongly lexicalised and less semantically predictable. In a set of single spoken words we manipulated the presence of embedded stems and derivational suffixes with varying degrees of productivity, forming a gradient in the extent that the stimuli are predicted to trigger competition and decomposition processes. Words were contrasted with a complex auditory baseline that does not trigger a speech percept ('musical rain', Uppenkamp et al, 2006). We found that the presence of competing embedded stems engages bilateral fronto-temporal language regions, comparable to the results observed previously. In contrast, derivational affixes do not seem to selectively activate a left-lateralised subsystem. This is arguably because derivational affixes do not trigger decompositional processes in the same way as inflectional affixes. We suggest a neuro-cognitive account of the representation and processing of derivationally complex forms in English.

INVESTIGATING OCCIPITO-TEMPORAL CONTRIBUTIONS TO READING WITH TMS *Keith J. Duncan^{1,2}, Chotiga Pattamadilok^{1,3}, Joseph T. Devlin^{1,2}; ¹Cognitive, Perceptual and Brain Sciences, UCL, ²Institute of Cognitive Neuroscience, UCL, ³Fonds de la Recherche Scientifique-FNRS & Universite Libre de Bruxelles* – The debate regarding the role of ventral occipito-temporal cortex (vOTC) in visual word recognition arises in part from difficulty delineating the functional contributions of vOTC as separate from other areas of the reading network. Here we investigated the feasibility of using transcranial magnetic stimulation (TMS) to stimulate vOTC in order to specifically explore its contributions to visual word recognition. Three visual lexical decision experiments were conducted using neuro-navigated TMS. The first two used repetitive TMS to demonstrate and confirm that repetitive stimulation of vOTC slowed word, but not non-word, responses and that the effect was specific to vOTC. The third used paired-pulse TMS to investigate the time course of vOTC processing for words and revealed activation starting as early as 80-120msec post-stimulus onset – significantly earlier than that expected based on electrophysiological and magnetoencephalography studies. Taken together, these results clearly indicate that TMS can be successfully used to stimulate parts of vOTC previously believed to be inaccessible and provide a new tool for systematically investigating the information processing characteristics of vOTC. In addition, the findings provide strong evidence that lexical status and frequency significantly affect vOTC processing, findings incompatible with pre-lexical accounts of vOTC function.

CONTRIBUTIONS OF THE ANTERIOR TEMPORAL LOBE TO SENTENCE COMPREHENSION: A LESION STUDY *Corianne Rogalsky¹, David Driscoll², Jessica L. Wisnowski¹, Steven W. Anderson², Gregory Hickok³; ¹Brain and Creativity Institute & Dana and David Cognitive Neuroscience Imaging Center, University of Southern California, ²University of Iowa, Neurology, ³Center for Cognitive Neuroscience & Cognitive Sciences, University of California, Irvine* – Broca's area has long been implicated in syntactic processing, while lesion evidence has suggested that the anterior temporal lobe (ATL) is involved in lexical retrieval. Thus, one would hypothesize that damage to either region would result in sentence comprehension difficulties, but for different rea-

sons. However, a number of recent functional neuroimaging studies have found that portions of the ATL respond preferentially to structured sentence-level stimuli (in contrast to word-lists, for example), while Broca's area activity does not track with the presence of syntactic structure. If the ATL contains sub-regions that are involved in sentence-level structure processing (and not just lexical retrieval), the sentence comprehension abilities of subjects with ATL damage should decrease as a function of sentence complexity. The present study explored this possibility by measuring sentence comprehension abilities of subjects with left frontal-insular and/or ATL lesions. Subjects completed a psycholinguistic battery to assess their phonological, lexical, and sentence-level speech comprehension and production abilities. In support of the ATL contributing to sentence processing via lexical access, the sentence comprehension (as measured by a semantic plausibility task) was positively correlated with object naming performance for subjects with damage restricted to the ATL. However, their performance declined for the most complex sentences, object-relative clause sentences, compared to subject-relative clause sentences matched for semantic content and length. Conversely, the frontal-insular patients did not demonstrate this complexity effect, although naming and sentence comprehension performances were positively correlated. These preliminary results indicate that ATL sub-regions do contribute to sentence-level structure processing. Supported by NIH-DC03681.

NEURAL MECHANISMS OF COREFERENTIAL PROCESSING IN LANGUAGE COMPREHENSION *Peter*

Gordon¹, Natalie Kacirik², Tamara Swaab³; ¹University of North Carolina at Chapel Hill, ²Brooklyn College, CUNY, ³University of California, Davis – In previous work, we have shown that general memory mechanisms do not always guide language processing: The use of repeated names to establish relationships in discourse contexts induces processing difficulty when coreferentially repeated names are preceded by an antecedent name in discourse focus (e.g., John went to the store because John...). This repeated name penalty (RNP) manifests as an N400 effect in ERP research. A critical question is whether different classes of coreferential expressions (e.g., reflexives, pronouns, names) are allowable in terms of their syntactic relationship to their antecedents as formulated by linguistic theory. Alternatively, distinctions between types of coreference may depend on linguistic structure but not on the class of referring expression involved. To test this, we compared ERPs elicited by repeated names following prominent antecedent names that had been presented in the same clause or in a different clause with ERPs in control conditions with non-prominent antecedent names but matched syntactic structure (e.g., Suzy/Suzy's brother went to the pet store to buy/so that Suzy...). For names repeated within the same clause, significant P600s were observed, a pattern that matches those reported previously for ungrammatical reflexives. In contrast, for names repeated across different clauses, we replicated the N400 RNP effect. This shows that a single method of producing difficult-to-process coreference, repetition of a prominent name, elicits different ERP components depending on how the antecedent and repeated name are related grammatically, indicating distinct patterns of language processing in the brain that differ from those expected under standard linguistic theory.

MEG-EVIDENCE FOR MODAL AND AMODAL SEMANTIC REPRESENTATIONS IN LANGUAGE COMPREHENSION: TIME TELLS THE DIFFERENCE *Gerrit Hirschfeld^{1,3}, Christian Dobel^{2,3}, Pienie*

Zwitserlood^{1,3}; ¹University of Muenster, Psychology, ²Institute for Biomagnetism and Biosignalanalysis, University of Muenster, ³Otto Creutzfeld Center for Cognitive and Behavioral Neurosciences – Since its discovery, the N400 has shaped our thinking about semantics in profound ways. Its elicitation by multiple violations (at word, sentence, discourse, world-knowledge levels) in different modalities (visual or auditory words, pictures, sounds, videos) highlights the role of amodal representations in language comprehension. Recent theories suggest a perceptual basis of such representations (e.g. Barsalou, 1999), which we investigated with an MEG experiment with spoken sentences as contexts for picture processing. Participants listened to sentences and verified if the following picture depicted an object mentioned in the sentence or not. Targets were pictures of different objects, each photographed in two states, associated with different global object shapes (e.g. a flying duck vs. a sitting duck). Each target picture (e.g. the flying duck) appeared in three contexts: (1) a match sentence about a duck in the air, (2) a mismatch sentence about a swimming duck, and (3) an unrelated sentence without any ducks. Source localization (L2 minimum norm estimates) of the MEG data revealed a clear dissociation between late (300-450 ms) amodal effects in the left temporal lobe and early (120-145 ms) perceptual effects in the occipital cortex. The late N400 interval showed higher activity for the unrelated compared to the two related conditions, while the early interval showed enhanced activation for the match compared to the other two conditions. Our findings show specific and early top-down influences of language on perception and argue in favor of modal semantic representations preceding amodal ones.

EFFECTS OF VISUAL DEPRIVATION ON ACTION VERB REPRESENTATIONS IN THE LATERAL-TEMPORAL-CORTEX: EVIDENCE FROM CONGENITALLY BLIND ADULTS *Marina Bedny^{1,2}, Alfonso Caramazza³, Talia Konkle², Alvaro Pascual-Leone¹, Rebecca Saxe²; ¹Berenson-Allen Center for Noninvasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School, ²Massachusetts Institute of Technology, ³Harvard University* – How does our sensory experience shape conceptual representations during development? According to one hypothesis, the neuroanatomical organization of concepts is determined by the sensory modalities through which we learn them. For example, the meaning of the word “kick” is represented near visual motion regions activated during the visual observation of kicking. Previous research has found that conceptual and perceptual representations of actions in the lateral-temporal-cortex are distinct but occupy neighboring brain regions. In this project we investigated whether the proximity of verb regions to motion perception regions depends on having learned the meanings of our first verbs through sight. We addressed this issue by considering the neural organization of verbs in congenitally blind individuals. In Experiment 1, participants listened to auditory motion: receding or approaching tones and footsteps. In Experiment 2, participants made relatedness judgments on verb-and noun-pairs. We find that the visual motion perception system is functionally reorganized in congenitally blind adults: motion regions respond to sound in congenitally blind, but not sighted individuals. In contrast, regions that respond to verbs are unaffected by visual deprivation. We conclude that the neuroanatomical organization of event concepts is not determined by the sensory modality of learning. Instead, it is either innately specified or determined by non-sensory aspects of experience.

FMRI EVIDENCE FOR THE ACTIVATION OF MODALITY-SPECIFIC IMAGES DURING NARRATIVE COMPREHENSION *Christopher Kurby¹, Jeffrey Zacks¹; ¹Washington University* – Perceptual theories of language comprehension argue that readers generate perceptual simulations of the events described by text (Barsalou, 1999; Zwaan, 2004). This predicts that readers engage in imagery processes routinely during comprehension and that the images should reflect the perceptual modality implied by the text. As such, we used event-related functional MRI to ask whether modality-specific representations are activated during the silent reading of extended naturalistic narratives. Participants’ brain activity was recorded while reading narrative texts one word at a time. Based on separately collected imagery norms, we coded the high imagery clauses with respect to whether they elicited motor, auditory, or visual imagery. Clauses rated as producing high imagery in the motor modality selectively activated the left postcentral sulcus (somatosensory cortex). Clauses with auditory imagery selectively activated posterior regions including Wernicke’s area, and anterior regions including Broca’s area and adjacent regions of lateral frontal cortex, and dorso-medial prefrontal cortex. (This activation was bilateral, including the right-hemisphere homologs of Broca’s and Wernicke’s areas.) Clauses with high visual imagery activated left fusiform gyrus. These results support the hypothesis that modality-specific perceptual simulations are a concomitant of ongoing narrative comprehension.

SEX INFLUENCES SOCIAL LANGUAGE PROCESSING: A MATTER OF EMPATHY *Danielle van den Brink^{1,2}, Jos van Berkum^{1,3}, Marcel Bastiaansen^{1,3}, Jan Buitelaar², Peter Hagoort^{1,3}; ¹Donders Institute for Brain, Cognition and Behaviour, Nijmegen, The Netherlands, ²Radboud University Nijmegen Medical Centre, Psychiatry, The Netherlands, ³Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands* – When a 6-year-old girl claims that she cannot sleep without her teddy bear, hardly anybody will look surprised. However, when an adult male says the same thing, this is bound to raise some eyebrows. Language interpretation, thus, relies upon context-bound aspects of language, relevant for social discourse purposes. The present event-related brain potential (ERP) study investigated inter-individual differences in the cognitive processes that mediate the integration of social information in a linguistic context. Participants (n = 36; 18 female) heard Dutch utterances with a content that either did or did not fit probabilistic inferences about the speaker’s sex, age, and social-economic status, as could be inferred from the speaker’s voice. Whereas women showed brain reactivity when probabilistic inferences about a speaker conflicted with the content of the message, men did not. This sex-based difference in social information processing can be explained by a specific cognitive trait, one’s ability to empathize. Individuals who empathize to a greater degree revealed larger N400 effects, as well as a larger increase in gamma-band power (45-60 Hz) to socially relevant information, indicating they are more sensitive to social aspects of language.

Slide Session 2 Working memory and executive functions

Saturday, March 21, 3:00 - 5:00 pm, Grand Ballroom B

Chair: **Silvia Bunge**

Speakers: **Antonio Lara (GSP Winner), Simon van Gaal (GSP Winner), Yee Lee Shing, Mary Askren, Sari Karlsson, Sam Doesburg, Jacquelyn Gamino, Marieke van Vugt**

A B S T R A C T S

ENCODING OF GUSTATORY WORKING MEMORY IN ORBITOFRONTAL CORTEX Antonio Lara¹, Steven Kennerley¹, Jonathan Wallis^{1,2}; ¹Helen Wills Neuroscience Institute, University of California, Berkeley, ²University of California, Berkeley – There are two competing models regarding the organization of working memory (WM) in prefrontal cortex (PFC). The domain-specific model states that PFC areas that receive direct projections from a sensory modality maintain and manipulate that modality in WM. The operational model postulates that mid-dorsolateral (DLPFC) and ventrolateral (VLPFC) manipulate and maintain respectively all sensory information within WM. Previous studies focused on modalities that project directly to VLPFC making it difficult to distinguish the two models. Gustatory information enters PFC via orbitofrontal cortex (OFC). Thus, the domain-specific and the operational models predict that OFC or VLPFC respectively should maintain gustatory information in WM. Determining the locus of gustatory WM would help distinguish these two models. We recorded activity of PFC neurons from two animals while they performed a gustatory delayed match to sample task. Subjects had to maintain the identity of a juice in WM during a three second delay period. We delivered a water drop as a distractor halfway through the delay. During the pre-distractor delay, neurons in both VLPFC (11%) and OFC (21%) encoded the juice. After the distractor, however, more neurons in OFC (18%) continued to encode the juice compared to VLPFC (9%). Furthermore, the strength of selectivity was significantly greater in OFC relative to VLPFC. These results indicate that the OFC encodes gustatory information in WM more robustly than VLPFC in accord with the domain-specific model. The maintenance of reward in WM may be an important function of OFC and contribute to its role in decision-making.

UNCONSCIOUS ACTIVATION OF THE FRONTOPARIETAL NO-GO NETWORK Simon van Gaal^{1,2}, Steven Scholte¹, Richard Ridderinkhof², Johannes Fahrenfort^{1,2}, Victor Lamme^{1,3}; ¹Cognitive Neuroscience Group, Psychology, University of Amsterdam, Amsterdam, the Netherlands, ²Amsterdam Center for the Study of Adaptive Control in Brain and Behavior (Acacia), Psychology, University of Amsterdam, Amsterdam, the Netherlands, ³Netherlands Institute for Neuroscience, Amsterdam, the Netherlands – Inhibitory control, as measured with the Go/No-Go task, is consistently associated with the prefrontal cortex (PFC), particularly the right inferior frontal gyrus (IFG). Here, we investigated to what extent invisible No-Go stimuli are capable of reaching cortical areas involved in inhibitory control. To do this, we recorded fMRI signals while participants performed a Go/No-Go task that included visible (unmasked) No-Go trials, invisible (masked) No-Go trials as well as Go trials. Behaviorally, participants inhibited approximately 70% of their responses to visible No-Go trials. Invisible No-Go signals did not trigger full-blown inhibition, but instead caused a substantial slow-down of responses. Replicating typical neuroimaging findings, conscious response inhibition was associated with a right-lateralized frontoparietal “inhibition network”. Interestingly, invisible No-Go signals did not trigger the entire conscious inhibition network, but only a specific subset of nodes therein. This “unconscious inhibition network” included the right inferior, middle and superior frontal gyrus along with superior and inferior parietal cortices. Activity in the right IFG correlated strongly with individual variability in RT slowing to invisible No-Go trials, suggesting that this area plays a crucial role in unconscious inhibition. Though some suppose that the PFC is solely involved in conscious information processing, these results demonstrate that unconscious information is able to influence high-level control operations in the PFC. In addition, differences between conscious and unconscious control are revealed.

MODELING AGE AND INDIVIDUAL DIFFERENCES IN WORKING MEMORY WITH TIME-ACCURACY FUNCTIONS Yee Lee Shing^{1,2}, Florian Schmiedek^{1,2}, Martin Lövdén¹, Ulman Lindenberger¹; ¹Max Planck Institute for Human Development, Center for Lifespan Psychology, ²Humboldt University, Berlin – Working memory (WM), a system for the simultaneous storage and processing of information, declines with advancing adult age (Park et al., 2002). In this study, we use time-accuracy function (TAF) to characterize age-related declines in WM, and delineate potential mechanisms underlying this decline. By capturing individuals’ processing rates and performance asymptotes as distinct parameters, TAFs provide a joint description of speed and accuracy (Verhaeghen, 2000). Hundred-one younger adults (YA; 20-30 years) and 103 older adults (OA; 65-80 years) completed three WM tasks, i.e., spatial n-back, numerical memory-

updating, and verbal alpha-span. For each task, difficulty was manipulated by varying stimuli presentation times. Accuracy was modeled as a negatively accelerated function of presentation time using multi-level nonlinear modeling. In all three tasks, OA reached significantly lower asymptotes than YA. In memory updating, OA also showed significantly slower processing rates than YA. The task-general difference in asymptotes demonstrates that age-related deficits in WM cannot be remediated by longer presentation times. We conclude that core processes of WM, such as the coordination of binding and updating operations, are compromised in normal aging. In additional analyses, we find that the observed age-related decline in asymptotic WM performance is robust against large amounts of practice (100 sessions). Neuronally, age-related decline in WM asymptotes and plasticity may reflect deficient hippocampal binding (Mitchell et al., 2000) and striatal updating operations (Dahlin et al., 2008). We are currently testing this interpretation by relating the TAF parameters to available covariates and fMRI data from the same participants.

ACETYLCHOLINE AND COGNITIVE CONTROL: DONEPEZIL MODULATES PREFRONTAL AND DEFAULT-MODE REGIONS IN A TASK-SWITCHING PROCEDURE *Mary Askren¹, Elise Demeter¹, Stephan Taylor¹, Martin Sarter¹, Cindy Lustig¹; ¹University of Michigan* – Combining drug manipulations with functional magnetic resonance imaging (fMRI) can reveal how neurotransmitter systems drive task-related activations. The present experiment used a task-switching procedure to vary demands for cognitive control and donepezil hydrochloride (an acetylcholinesterase inhibitor) to vary extracellular acetylcholine levels. In the low control-demand conditions, participants performed the same task from trial to trial. In the high control-demand condition, the correct task rule switched unpredictably, so that participants had to adjust their responses accordingly. Young adults (age 18-30, n = 20 per group) performed the task-switching procedure at baseline and then were scanned 3 hours after receiving a placebo pill, 5 mg donepezil, or 10 mg donepezil. Drug administration did not influence behavioral performance: All groups showed equivalent demand-related slowing. Placebo participants showed task-related activations in prefrontal regions, particularly left inferior frontal gyrus, and task-related deactivations of default-mode regions including posterior cingulate and medial frontal cortex. Administration of 5 mg donepezil increased the demand-sensitivity of prefrontal activations, and reduction or even reversal of demand-related deactivations of the default-mode regions. The 10 mg group's activation patterns were intermediate between the placebo and 5 mg groups, suggesting a U-shaped dose-response curve. Mild enhancement of cholinergic function may potentiate attention to task-relevant information and the retrieval of task rules in the high-demand condition, whereas higher doses may disrupt these processes.

RELATIONSHIPS BETWEEN TRAIT- AND STATE-DEPENDENT DOPAMINE D1 BINDING AND FUNCTIONAL BRAIN ACTIVITY IN A SPATIAL WORKING MEMORY TASK *Sari Karlsson¹, Lars Nyberg², Håkan Fischer¹, Yvonne Brehmer¹, Anna Rieckmann¹, Petra Thülers¹, Per Karlsson³, Lars Farde³, Lars Bäckman¹; ¹Aging Research Center, Karolinska Institutet, Stockholm, Sweden, ²Umeå University, Integrative Medical Biology & Radiation Sciences, Sweden, ³Psychiatry Section, Karolinska Hospital, Clinical Neuroscience, Stockholm, Sweden* – Several lines of research (animal, molecular imaging, genetic, computational modelling) have demonstrated a link between dopamine (DA) functions and higher-order cognitive processing. In this study, we used multimodal brain imaging, molecular PET imaging and fMRI, in the same participants in order to directly demonstrate a link between DA D1 binding and functional brain activity during a spatial working memory (SWM) task. Relationships between striatal trait-dependent and state-dependent DA function and BOLD activation during a SWM task were investigated in 20 younger (20-30 years) participants. Participants underwent two [11C] SCH23390 PET measurements, one while resting and one while performing a cognitive task taxing inhibitory functioning, and they also underwent an fMRI scan while performing a SWM task. Trait-dependent DA was defined as D1 binding at resting state and is thought to reflect general level of receptor function. State-dependent DA was defined as the difference between D1 binding at resting state and D1 binding during the inhibition task and is thought to reflect DA release during cognitive activity. Trait-dependent striatal DA binding was positively related to prefrontal BOLD signal, whereas state-dependent striatal D1 binding was positively related to temporal lobe activity during SWM performance. This pattern of data suggests that both trait- and state-dependent DA activity are implicated in SWM performance, but may contribute in different ways.

MEG REVEALS GAMMA-BAND ACTIVATION IN PREFRONTAL AND VISUAL CORTEX DURING VISUAL SHORT-TERM MEMORY MAINTENANCE IN CHILDREN *Sam Doesburg^{1,2}, Urs Ribary^{2,3,4}, Anthony Herdman³, Teresa Cheung^{4,5}, Hal Weinberg³, Mario Liotti³, Ruth Grunau^{1,2}; ¹University of British Columbia, Pediatrics, ²Child and Family Research Institute, ³Simon Fraser University, Psychology, ⁴Down Syndrome Research Foundation, ⁵Simon Fraser University, Physics* – The retention and manipulation of visual information in short-term memory engages a network of brain regions including visual cortex and prefrontal cortex. In

adults, electroencephalography (EEG) has revealed increased gamma-band activation over frontal and posterior regions during the delay period of visual delayed-matching-to-sample task. This is consistent with the notion that gamma-band synchronization is relevant to active processing in task-relevant cortical areas, which in the context of short-term memory maintenance include prefrontal and visual cortex. Gamma-band synchronization is relevant to a variety of cognitive and perceptual processes, and the appearance of certain perceptual capacities during typical development coincides with the expression of gamma-band synchronization characteristic of those processes. It remains unclear, however, how gamma-band neural synchronization relevant to short-term memory processing is expressed during childhood. To investigate this, magnetoencephalographic (MEG) recordings were taken while children 6-10 years of age performed a visual short-term memory task. Preliminary beamformer source localization results indicate increased gamma-band activity within prefrontal and visual cortex during the retention of visual information. This confirms that gamma-band synchronization is relevant to maintenance of visual information in short-term memory and that these oscillations originate from a network of prefrontal and visual cortical areas. These preliminary results also expand our knowledge of the developmental continuity of oscillatory dynamics relevant to cognition and will provide a normative basis to characterize the neurocognitive development of special populations, which we will use in an ongoing study investigating visual short-term memory in children born very preterm.

NEW HOPE FOR EXECUTIVE FUNCTION AND REASONING REMEDIATION IN CHILDREN WITH ADHD: STRATEGIC MEMORY AND REASONING TRAINING (SMART) Jacquelyn Gamino¹, Sandra Chapman¹, John Hart¹, Sandra Vanegas¹, Elizabeth Hull¹, Lori Cook¹; ¹The University of Texas at Dallas, Center for BrainHealth –

In spite of the prevalence of poor academic performance in children with ADHD, interventions predominantly address medication effectiveness and behavioral issues, not learning. Thus, little is known regarding the remediation of learning impairment and, more specifically, the efficacy of metacognitive instruction in children with ADHD. Recently, we found many children with ADHD have impaired strategic learning. Strategic learning is the process of abstracting gist-based concepts from information and is related to Barkley's concept of reconstitution (2001). Evidence for robust memory for gist-based concepts suggests this ability facilitates learning. We developed the Strategic Memory and Reasoning Training (SMART) program to investigate potential remediation of these impairments. Fifty children with ADHD between the ages of 8 and 17 participated in this study. Twenty children were included in the SMART 12-week individual intervention and 30 children participated in an intensive 2-week SMART Camp. Over the course of the intervention, the children learned metacognitive strategies that included goal setting and planning. We found that strategic learning performance significantly improved in both cohorts of the SMART intervention. In addition, the 30 children who participated in the SMART Camp showed significant improvement in working memory, initiation, organization of materials, behavioral regulation, and metacognition as measured by the Behavioral Rating Inventory of Executive Function (BRIEF). This study provides the first known evidence that teaching children with ADHD specific metacognitive strategies has the potential to improve strategic learning and executive function. SMART participants will be followed for one year to determine the transferability of the intervention to academic performance.

THE INFLUENCE OF MINDFULNESS MEDITATION TRAINING ON VISUAL WORKING MEMORY Marieke van Vugt¹, Anastasia Kiyonaga², Ling Wong³, Amishi Jha²; ¹Princeton University, ²University of Pennsylvania, ³University of California, Davis –

Recent studies suggest that training in mindfulness meditation improves attention (e.g., Jha et al, 2007). Given the close relationship between attention and working memory (WM), we investigated how intensive meditation training (MT) may affect WM. Participants (N= 29) were tested on a delayed-recognition task before (T1) and after (T2) participation in an intensive one-month mindfulness meditation retreat. The primary mindfulness practice required attending to present moment experience using the breath as the anchor of attention. Their performance was compared to an age- and education-matched control group (N=29) who received no training. Overall accuracy and d' were greater and the variability in RT was reduced for the training vs. control group at T2. To determine how decision processes in WM might be affected by MT, we applied a drift-diffusion model (Wagenmakers et al, 2007) of decision making. This model parses behavioral results into 3 latent measures: amount of information required to make a decision (decision boundary), rate of information accumulation, and non-decision factors. The modeling results revealed that the rate of evidence accumulation increased and the decision boundary decreased in the MT but not control group over time. These modeling results, together with improvements in d' scores in the MT group at T2, suggest that information may be of higher quality after MT. Thus, intensive MT may improve WM via alterations in the mnemonic representations themselves, as opposed to alterations in decisional or non-specific factors.

Slide Session 3 Long-term memory

Sunday, March 22, 10:00 am - 12:00 pm, Grand Ballroom B

Chair: **Roberto Cabeza**

Speakers: **Stephen J. Gotts, Tyler Davis, Jennifer D. Ryan, Youssef Ezzyat, Andrew Butler (GSP Winner), Melanie Cohn, Erika Nyhus, Ken A. Paller**

ABSTRACTS

CONCEPTUAL BROADENING OF OBJECT REPRESENTATIONS REVEALED THROUGH FMRI-ADAPTATION *Stephen J. Gotts¹, Shawn C. Milleville¹, Alex Martin¹; ¹Laboratory of Brain and Cognition, NIMH/NIH, Bethesda, MD* – A fundamental question for cognitive neuroscience is how neural representations are altered by experience. In monkeys, extended experience with visual objects can lead single neurons to respond more selectively to particular objects, referred to as “sharpening” of neural representations (Grill-Spector, Henson, & Martin, 2006, TICS). However, this mechanism does not make a great deal of sense for conceptual representations: a sharpening mechanism makes representations more distinct by decreasing their neural overlap, and semantic memory requires “broad”, overlapping representations among associates. We have evaluated the extent to which experience with visual objects leads to sharpening versus “broadening” of neural representations by employing an fMRI-Adaptation paradigm with pictures of living things. Neural tuning was assessed along a conceptual dimension by rapidly adapting neural activity to one picture (e.g. cow) and measuring the recovered response to a different, “deviant” picture that shared a conceptual relationship to the adapted picture at one of 3 levels: exemplar (different cow), semantic associate (horse), and unrelated (lobster). The effect of experience on tuning was assessed by pre-exposing half of the adaptation stimuli in a picture-naming task prior to fMRI. Our results suggest that naming pictures leads to increased rather than decreased neural overlap among the representations of conceptual associates in left inferior frontal cortex and the fusiform gyrus, bilaterally. We suggest that this “conceptual broadening” phenomenon is consistent with an incremental learning mechanism that gradually creates and maintains overlapping neural conceptual representations in cortex, permitting similarity based recall of information and generalization to newly encountered objects.

THE NEURAL BASIS OF LEARNING EXCEPTIONS TO A CATEGORY RULE *Tyler Davis¹, Bradley C. Love¹, Alison R. Preston^{1,2}; ¹University of Texas at Austin, Psychology, ²University of Texas at Austin, Center for Learning and Memory* – A critical capacity of all organisms is the extraction, representation, and exploitation of regularities in the environment. However, it is also crucial to recognize occasions for which these regularities will not hold. Rule-plus-exception tasks have been used to study processes involved in learning items that deviate from learned regularities. In these tasks, participants learn to categorize items into categories based on the perceptual features of items while receiving feedback. The majority of items can be categorized according to a rule, however some items are exceptions to this rule and may thus be learned and represented separately. Behaviorally, such exception items are associated with enhanced recognition memory as well as elevated arousal. Recently, Love & Gureckis (2007) used model-based evidence to suggest that a network consisting of the hippocampus, surrounding medial temporal lobe (MTL) cortices, and prefrontal cortex (PFC) is engaged when learning items that are rule exceptions. Consistent with this model-based approach, the current fMRI study demonstrated greater activation in MTL and PFC when participants categorized items as exceptions than when items were categorized according to the rule. The results further revealed that correctly classifying exception items resulted in greater activation in areas of the ventral striatum that have been associated with feedback-based learning, suggesting that interactions between striatum, MTL and PFC regions may be essential to exception learning. Finally, analysis of the within-trial time series indicated that activation in these regions shifted dynamically during learning from feedback early in learning to stimulus onset late in learning.

THE BEHAVIORAL AND NEURAL SUBSTRATES UNDERLYING RELATIONAL AND TEMPORAL BINDING *Jennifer D. Ryan^{1,2}, Lily Riggs^{1,2}, Christina Villate¹, Esther Oziel¹, Steve Ly¹, Tim Bardouille^{1,2}, Anthony T. Herdman³; ¹Rotman Research Institute, ²University of Toronto, ³Simon Fraser University* – The construction of, and subsequent access to, representations regarding the relative spatial and temporal relations among sequentially presented objects was examined in separate studies using either eye movement monitoring or magnetoencephalography. 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. Eye movements revealed the binding of relations across study images; eye movements transitioned between the location of the presented object and the locations that were previously occupied by

objects. During test image viewing, eye movements distinguished intact displays from manipulated images through an increase in viewing to the now-empty, altered region, and through alterations in the temporal order by which objects were scanned. Significant neural responses related to the onset of the study images were found in the medial temporal lobe region, including the parahippocampus, as well as regions within the parietal and frontal cortices within 400 ms. Significant neural responses related to the onset of the test images were found in medial temporal, superior temporal, parietal and frontal cortices within 500 ms. The present findings suggest that memory representations of the visual world include information regarding the relative spatial and temporal relations among objects. Eye movements may be the conduit by which information is integrated into a lasting representation, and by which current information is compared to stored representations. Binding of, and subsequent access to, temporal and spatial relations is related to rapid engagement of the medial temporal, parietal and frontal cortices.

EVENT PERCEPTION INFLUENCES THE ORGANIZATION OF LONG-TERM MEMORY *Youssef Ezzyat¹, Lila Davachi^{1,2}*; ¹New York University, Psychology, ²New York University, Center for Neural Science – Cognitive psychological research has shown that people can easily and reliably segment continuous action into units called “events” (Newton 1976). Previous research has also shown that event segmentation influences the online processing of stimuli. Specifically, perception of event boundaries has been shown to render previously encoded information less accessible in working memory (Morrow 1989; Speer 2005; Zwaan 1998). However, it is unclear how this processing during encoding might affect long-term memory for the events. The purpose of the present study was to test the effects of event segmentation on long-term memory and to examine the neural processing that occurs at event boundaries. While scanned using fMRI, participants read narratives containing event boundaries and were later given a recall test for information in the narratives. At test, event boundaries served as better recall cues than control sentences; at encoding, event boundaries activated right dorsolateral and anterior prefrontal cortex, as well as the left hippocampus. These results show that event segmentation influences long-term memory and suggest that brain activity at event boundaries may serve to organize stimulus information for long-term memory encoding.

CUED RETRIEVAL OF NOVEL AUDITORY OR VISUAL STIMULI ACTIVATES MODALITY SPECIFIC CORTICES REGARDLESS OF CORRECT PERFORMANCE *Andrew Butler¹, Dylan Bargatz¹, Ryan Stevenson¹, Karin James¹*; ¹Indiana University – In this work, we investigated the effects of associating novel items that were presented in different modalities (visual and auditory) on brain activation patterns during both encoding and cued recall. Subjects were presented with cue-target associations comprised of pairs of nonsense objects, pairs of nonsense sounds, objects paired with sounds, and sounds paired with objects. Subsequently, they were required to recall the modality of the target given the cue. Because both stimuli were novel, we were assured that no known associations with a given modality would influence the results. We measured both accuracy and BOLD activation during encoding and retrieval sessions. Results replicate previous studies showing that successful retrieval of an auditory or visual target was associated with modality specific BOLD activation in the auditory (superior temporal gyrus) or visual (posterior occipital gyri) cortices, respectively. We extended these findings, however, and also showed that a) when a subject recalled the target modality incorrectly, they still had increased BOLD activation in the modality specific cortex associated with the falsely recalled target; and b) that retrieval of information from cross-modal associations activated the hippocampus, whereas within-modal associations did not. Together these findings suggest that retrieval of an auditory or visual target, regardless of whether it was correct or not, activates modality specific cortical regions. Additionally, cross-modal associations may require hippocampal involvement more than within-modal associations.

THE HIPPOCAMPUS SUPPORTS CONVERSION FROM FAMILIARITY TO RECOLLECTION *Melanie Cohn^{1,2}, Ayelet Lahat², MaryPat McAndrews^{1,2}, Morris Moscovitch^{2,3}*; ¹Krembil Neuroscience Centre, University Health Network, ²University of Toronto, Psychology, ³Baycrest Centre for Geriatric Care, Rotman Research Institute, Psychology – The role of the hippocampus in recognition memory is debated. One view proposes that the hippocampus is crucial to recollection (i.e., retrieval of contextual information), but not familiarity (i.e., decontextualized feeling of ‘oldness’). Another view proposes that hippocampal involvement is related to memory strength, irrespective of whether or not retrieval is accompanied by recollection of context. The current study aimed to test these proposals using event-related fMRI. We compared brain activation to items before provision of a context cue when they are judged familiar and after the cue was presented when some of the same items are judged as recollected. Participants studied pairs of words (A-B) and were scanned while performing a recognition task for the first member of the pairs (A). An uncued item, either a studied (A) or new word (C) was presented and participants indicated whether the item was new, familiar or recollected. A cued trial followed immediately, in which intact pairs (A-B) or new-old pairs (C-B) were presented; the recognition decision was again to be based only on the first item (A or C). Increased hippoc-

ampal activation (cued > uncued) was found only for items that became recollected, and not for items that remained familiar. As the only difference between those conditions was subjective experience, given that items and context cues were identical, our results are more consistent with the view that the hippocampus is selectively involved in supporting recollection per se rather than retrieval of strong memories.

RECOLLECTION REVEALED BY ITS ABSENCE: MIDAZOLAM-INDUCED AMNESIA REDUCES MEMORY FOR DETAILS AND THE ERP CORRELATE OF RECOLLECTION Erika Nyhus¹, Tim Curran¹; ¹University of Colorado at Boulder – Dual process models suggest that recognition memory is supported by familiarity and recollection processes. Previous research administering amnesic drugs and measuring event related potentials (ERPs) during recognition memory have provided evidence for separable neural correlates of familiarity and recollection. The benzodiazepine midazolam, which causes anterograde amnesia, has been shown to predominantly influence recollection, with limited effects on familiarity. In addition, it has been proposed that the FN400 component indexes familiarity, and the parietal old/new effect indexes recollection. The present study examined the effect of midazolam-induced amnesia on memory for details and the proposed ERP correlates of recognition. Midazolam or saline was administered while subjects studied oriented pictures of common objects. ERPs were recorded during a recognition test one day later. During the recognition test subjects were shown studied pictures in the original orientation, studied pictures in the opposite orientation, and new pictures; and judged whether each picture was “Old Same Orientation”, “Old Different Orientation”, or “New”. Subjects' discrimination of old and new pictures was worse when they were administered midazolam than saline; and discrimination of same orientation and different orientation old pictures was at chance when studied under midazolam, but above chance when studied under saline. Although the FN400 was similar under midazolam or saline, the parietal old/new effect was decreased with the administration of midazolam. These results provide converging pharmacological and electrophysiological evidence that recollection supports recognition for details and adds to previous research showing separable neural correlates of familiarity and recollection.

THE ELECTROPHYSIOLOGY OF REMEMBERING AND KNOWING WITH CONCEPTUALLY IMPOVERISHED KALEIDOSCOPE IMAGES Ken A. Paller¹, Joel L. Voss¹; ¹Northwestern University – Contemporary memory theories distinguish between contextual recollection and acontextual familiarity as two fundamentally different types of recognition memory. It is currently unclear whether recollection and familiarity are supported by two corresponding retrieval mechanisms, or whether the same type of retrieval processing supports both phenomena through varying contributions from retrieving item and context/source information. Electrophysiological findings in humans have widely been cited as support for the two-process position, in that late-onset parietal “LPC” potentials have been linked to recollection and early-onset frontal “FN400” potentials to familiarity. However, recognition memory is generally studied using conceptually rich stimuli such as words, which leaves open an alternative interpretation that one or both of these electrophysiological signals reflect implicit conceptual processing distinct from recollection and familiarity per se. We tested this hypothesis using conceptually impoverished kaleidoscope images, such that opportunities for conceptual processing were minimized. Recollection-based and familiarity-based recognition in a remember/know paradigm were both indexed by LPC potentials. Old/new amplitude differences were greater for recollection compared to familiarity. Despite ample familiarity-based recognition, FN400 old/new effects were not observed, consistent with the contention that these potentials index conceptual processing rather than familiarity. These results cast doubt on interpretations of prior electrophysiological evidence obtained using conceptually rich stimuli as dissociating neural mechanisms of recollection and familiarity. We also found that neural events during encoding differentially predicted later recollection versus later familiarity, which suggests that the engagement of distinct encoding processes can preferentially lead to recollection versus familiarity.

Slide Session 4 Emotion

Monday, March 23, 10:00 am - 12:00 pm, Grand Ballroom B

Chair: **Kevin Ochsner**

Speakers: **Joan Y. Chiao, Roma Vasa, Virginie Czernecki, Tor Wager, Kateri McRae, Katja Spreckelmeyer, Julie L. Hall (GSP Winner), Jamil Zaki**

A B S T R A C T S

CULTURAL VARIATION IN AMYGDALA RESPONSE TO EMOTIONAL SCENES *Joan Y. Chiao¹, Ahmad R. Hariri², Tokiko Harada¹, Hidetsugu Komeda³, Todd B. Parrish⁴, Norihiro Sadato³, Tetsuya Iidaka⁵; ¹Northwestern University, Psychology, ²University of Pittsburgh, Psychiatry, ³National Institute for Physiological Sciences, ⁴Northwestern University, Radiology, ⁵Nagoya University, Psychiatry* – Culture affects how people perceive and experience the emotional salience of events, such as threat in the environment. The human amygdala is critical to the evaluation of and response to threat-relevant signals. Although much is known about the role of the amygdala in emotional evaluation and response, very little is known about how culture affects amygdala response to threat-relevant signals in the environment. To examine the effect of culture on amygdala response to emotion, in Study 1 we used cross-cultural neuroimaging at 3T to measure neural response within the human amygdala and ventrolateral prefrontal cortex (VLPFC) during emotional evaluation and cognitive inhibition in Caucasian-Americans (CA) and native Japanese (JP). Results indicated greater bilateral amygdala response during evaluation of negative emotional scenes, but not cognitive inhibition, in JP relative to CA participants. There was no cultural variation in VLPFC during either emotional evaluation or cognitive inhibition. To determine whether the cultural variation observed in Study 1 was due to race rather than cultural environment per se, in Study 2, we measured neural response within the human amygdala and VLPFC during emotional evaluation and cognitive inhibition in Japanese-Americans (JA). Results showed no difference in bilateral amygdala or VLPFC response during emotional evaluation and cognitive inhibition between CA and JA participants. Critically, JP showed significantly greater response within bilateral amygdala during emotional evaluation, but not cognitive inhibition, compared to JA participants. Taken together, these findings provide convergent evidence of cultural variation in human amygdala response that is emotion-specific.

fMRI STUDY OF DEVELOPMENTAL DIFFERENCES IN NEURAL PROCESSING OF PICTORAL STIMULI *Roma Vasa¹, Daniel Pine², Tess Nelson¹, Eric Nelson², Christopher Monk³, Monique Ernst², Maggie Bruck⁴, Stewart Mostofsky¹; ¹Kennedy Krieger Institute, Johns Hopkins University School of Medicine, ²Mood and Anxiety Disorders Program, National Institutes of Mental Health, ³University of Michigan, Psychology, ⁴Johns Hopkins Hospital, Johns Hopkins University School of Medicine* – Adult neurobiological studies consistently implicate activity within the amygdala and prefrontal structures in response to emotional stimuli. Yet, data on involvement of these structures, particularly the amygdala, in pediatric emotional processing are inconsistent. Understanding age-related neural differences in emotion processing is crucial for developing hypotheses about risk factors and mechanisms for psychopathology across development. This study used event-related fMRI to compare the neural responses to positive and negative pictures in 18 adults and 12 adolescents. A surprise memory test was given thirty minutes postscan. The main contrasts compared brain activity associated with picture viewing versus control state as well as subsequently recalled versus not recalled pictures. During positive picture viewing, adolescents activated the right amygdala and orbitofrontal (OFC) whereas adults activated the left hippocampus and right OFC. When viewing negative pictures, adolescents activated bilateral amygdalae, the left hippocampus, right anterior cingulate and OFC. Adults similarly activated the left amygdala and bilateral hippocampi and OFC. No group contrasts were significant. The memory data revealed that adolescents, but not adults, exhibited greater activity in bilateral amygdalae and hippocampi, the right OFC and anterior cingulate when viewing subsequently recalled positive pictures compared with not recalled pictures; the groups displayed comparable memory performance. These data indicate that adolescents and adults both engage amygdala-OFC circuitry when responding to emotional pictures. Adolescents, however, exhibited greater limbic activity to positively recalled pictures; this finding may have implications for the increased reward and novelty seeking behavior observed during this developmental period.

INSULAR LOBE AND MULTIMODAL EMOTIONAL PROCESSING INTEGRATION: EVIDENCE FROM BRAIN-DAMAGED PATIENTS *Virginie Czernecki¹, Didier Grandjean³, Sylvain Delplanque³, Laurent Capelle², Carine Karachi², Bruno Dubois¹; ¹Inserm U610, IFR70, Neurology, Salpêtrière Hospital, Paris, France, ²Inserm U679,*

IFR70, Neurosurgery, Salpêtrière Hospital, Paris, France, ³Swiss Center for Affective Sciences, University of Geneva, Swiss – A growing body of evidence in social affective neuroscience highlights the involvement of the insular lobe in both experiencing and observing negative emotions. The contribution of the anterior territory of insula during the recognition of emotional facial expressions and observation of emotional scenes evocating disgust or fear has been well demonstrated. Moreover, functional brain imaging studies in healthy participants have shown insular activations during the inhalation of odorants producing a strong feeling of disgust. Here we used a multimodal emotional battery in a group of fifteen patients with glioma affecting the right or left anterior part of insula before and/or after a surgical resection. Positive and negative emotions were investigated in three different ways including olfactory stimuli, facial emotional expression stimuli and words (using an emotional stroop task). All patients showed altered pattern of emotional evaluation odours evocating a strong sensation of disgust in healthy participants regardless of the side of the insular lesion. The identification of facial expressions of disgust, fear and anger was also strongly disturbed. The implicit emotional reactivity to negative words is blunted whatever the laterality and the side of the lesion. These preliminary results provide evidence that the insular lobe is a crucial part of a distributed neuronal network involved in emotional processing independently of the visual or olfactory modality and probably related to visceral/autonomic perception. The integrity of the anterior insula seems necessary to experience unpleasant feelings, particularly disgust induced through olfactory modality, and to decode facial expressions and emotional semantic meaning of words.

ANTICIPATORY BRAIN ACTIVITY PREDICTS PLACEBO ANALGESIA AND IS MEDIATED BY LIMBIC RESPONSES DURING PAIN Tor Wager¹, Lauren Leotti¹, Lauren Atlas¹; ¹Columbia University, Psychology –

Placebo analgesia is a model paradigm for studying the effects of expectations on affective states. Previous studies have shown placebo-induced increases in fMRI activity in dorsolateral prefrontal (DLPFC) and orbitofrontal (OFC) cortices when anticipating pain, as well as opioid release in orbitofrontal and limbic cortices. In this study, we re-analyzed data from two fMRI studies of placebo analgesia (combined N = 45), focusing on how anticipatory fMRI activity relates to placebo effects in both brain responses to pain and reported analgesia. In the combined sample, we identified a number of brain regions in which anticipatory activity predicted placebo analgesia. Multivariate clustering analyses identified three independent networks among these regions that were each independently predictive of placebo analgesia. Together, these three networks explained 77% of the variance in placebo analgesia across individuals. In two networks—a fronto-parietal network including bilateral DLPFC and parietal cortices, and another network including dorsomedial PFC and frontal pole—anticipatory increases (Placebo - Control) were associated with more profound placebo analgesia in reported pain. The third network included bilateral SII, a well-known region implicated in pain processing; in this network, anticipatory decreases were associated with placebo analgesia. Anticipatory activity was mediated by changes during pain in ventral striatum, but not SII, insula, cingulate, and other "pain processing" regions. Overall, the results suggest that anticipatory brain processes play a central role in placebo analgesia, and that these effects are mediated by changes in pain processing in limbic brain systems rather than those traditionally associated with nociception.

BOTTOM-UP VERSUS TOP-DOWN EMOTION GENERATION: IMPLICATIONS FOR EMOTION REGULATION Kateri McRae¹, Supriya Misra¹, Aditya K. Prasad¹, Sean C. Pereira¹, Benjamin Edwards¹, James J. Gross¹; ¹Stanford University –

Current theories of emotion suggest that emotions may be generated in at least two different ways: bottom-up and top-down. Bottom-up emotion generation involves the perception of low-level features of the stimulus itself (e.g., properties of the eyes and mouth in an emotional face). Top-down emotion generation involves 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 great disappointment). The present study tested the hypothesis that top-down emotion regulation strategies are more effective when emotions are generated top-down than when emotions are generated bottom-up. In particular, we focused upon cognitive reappraisal, which has been shown to decrease self-reported negative affect and BOLD signal from the amygdala. 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. Measures of self-reported negative affect indicated that top-down emotions were more successfully regulated than bottom-up emotions. BOLD signal from the amygdala also showed this interaction, but paradoxically, amygdala activation was greater during regulation of bottom-up stimuli than during natural responding to bottom-up stimuli. In addition, medial prefrontal regions previously implicated in reappraisal 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. This implies that the type of emotion generation moderates the success of top-down emotion regulation strategies.

DISSOCIATION OF NEURAL NETWORKS FOR ANTICIPATION AND CONSUMPTION OF MONETARY AND SOCIAL REWARDS *Katja Spreckelmeyer¹, Lena Rademacher¹, Sören Krach^{1,2}, Gregor Kohls³, Arda Irmak¹, Tilo Kircher¹, Gerhard Gründer¹; ¹RWTH Aachen University, Germany, Psychiatry and Psychotherapy, ²Central Service Facility, ³RWTH Aachen University, Child and Adolescent Psychiatry, Child Neuropsychology Section, Germany* – Reward processing can be dissected into phases of reward anticipation and reward consumption. It is currently a matter of debate whether these processes are mediated by the same or different neural networks. Previous research has identified the ventral striatum as key structure in reward anticipation. However, its role in reward consumption is disputed. Here, we examined the neural basis of reward anticipation vs. consumption in an incentive delay task offering either money or social approval. In both conditions participants (N=28) were given a cue indicating potential reward. In order to receive reward, a target button had to be pushed within a certain time window (adapted for individual reaction time). Reward (pictures of coins or approvingly smiling faces) was presented for 1650 ms 300 ms after target time onset. Monetary or social conditions were alternated sessionwise. Imaging was performed on a 1,5 Tesla Siemens scanner in an event-related design. Anticipation of reward resulted in activation of mesolimbic brain structures, including the ventral striatum, independent of incentive type. In contrast, consumption of monetary or social reward resulted in individual activation patterns, neither of which included the striatum. Among other structures, monetary reward specifically activated the thalamus, while social reward specifically activated the amygdala. Our results corroborate the role of the ventral striatum as modality-independent mediator of reward anticipation but cast doubt on its importance for reward consumption. Moreover, the findings implicate that the neural mechanisms underlying reward consumption are more modality-specific than those for reward anticipation.

PUT YOUR MONEY WHERE YOUR HEART IS: AN FMRI INVESTIGATION OF AFFECTIVE INFLUENCES ON FINANCIAL INVESTMENT DECISIONS *Julie L. Hall¹, Richard Gonzalez¹, Oliver C. Schultheiss¹; ¹University of Michigan* – Traditional economic models assume that individuals are always rational when they make financial decisions. However, the current study suggests that emotions may play an important role in financial decisions. Our goal was to investigate whether affective primes could influence risk taking and anticipatory neural activation during financial decisions. Using fMRI, 24 participants viewed happy, angry, and neutral affective primes presented under subliminal and supraliminal conditions followed by an investment task where they had to decide between risky, high-payoff stocks and safe, low-payoff bonds. Our results indicate that both subliminal and supraliminal presentations of affective primes influence financial investment decisions and anticipatory neural activation in the NAcc and anterior insula. As predicted, participants showed greater NAcc activation and were more likely to make risky investment decisions after happy versus neutral face primes in both the subliminal and supraliminal presentation conditions. In addition, participants also showed greater anterior insula activation and made slightly less risky investment decisions after angry versus neutral face primes during supraliminal presentation conditions. In conclusion, our results demonstrate that facial expressions of emotion, even when they are not consciously perceived, can influence investment decisions and suggest that the inclusion of affect may lead to more accurate models of economic decision making, which better explain irrational financial behavior. They also suggest that affective states during pre-choice stages of the decision making process may alter the perception of benefits relative to costs, leading to changes in financial risk taking depending on whether the affective state is positive or negative.

THE NEURAL BASES OF EMPATHIC ACCURACY AND AFFECTIVE EXPRESSIVITY *Jamil Zaki¹, Jochen Weber¹, Niall Bolger¹, Kevin Ochsner¹; ¹Columbia University, Psychology* – How do people understand the thoughts and feelings of others, and effectively communicate their own internal states? While much research in cognitive neuroscience has addressed the mechanisms involved in sharing the sensory and emotional states of others, the mechanisms underlying accurate understanding those states have remained largely unexplored. We used a novel empathic accuracy (EA) paradigm to address this gap in extant knowledge. Brain activity was recorded from 16 perceivers using fMRI while they watched videos of social targets describing emotional autobiographical events, and continuously rated how positive or negative they believed targets felt. Correlations between these ratings and targets' own affect ratings served as measures of EA, and were used as predictors in subsequent fMRI analyses. This allowed us to explore brain activity tracking with perceivers' accuracy in understanding target affect. We found that periods of accurate – as opposed to inaccurate – inferences were supported by frontal and parietal activity associated with mental state attribution, and sensorimotor structures within the mirror neuron system. Furthermore, targets who scored high on a trait measure of emotional expressivity were more affectively “readable” – that is, they produced higher levels of EA across perceivers – and this was in part because target expressivity predicted the magnitude of perceivers' neural activity in several brain regions related to mental state attribution. Overall, these data demonstrate that multiple social cognitive processes are employed in concert to understand the emotions of others, and that the characteristics of social targets affect perceivers' neural and cognitive processes.

Slide Session 5 Attention

Monday, March 23, 3:00 - 5:00 pm, Grand Ballroom B

Chair: **B. J. Casey**

Speakers: **Nathan Parks, Jaap Munneke (GSP Winner), Mark Stokes, Jane Couperus, Aarlenne Khan, Søren K. Andersen, Kathy Niu, Richard Young**

ABSTRACTS

STEADY-STATE SIGNATURES OF PERCEPTUAL LOAD, NEURAL COMPETITION, AND MULTIMODAL DISTRACTOR FILTERING *Nathan Parks¹, Matthew Hilimire¹, Paul Corballis¹; ¹Georgia Institute of Technology* – The perceptual load theory of attention posits that the level of selection is dependent upon the perceptual demands (load) of the task, with early selection occurring under high load and late selection under low load. Using a steady-state evoked potential (SSEP) paradigm we investigated 1) the modality specificity of distractor filtering, 2) the effect of perceptual load on target-specific processing, and 3) neural-competitive interactions between target and distractor stimuli. Participants performed a central RSVP task that varied in perceptual load, requiring identification of a feature singleton under low load and a feature conjunction under high load. The RSVP task was performed in isolation and in the presence of irrelevant visual and auditory distractors. Task, visual distractor, and auditory distractor stimuli were modulated at unique frequencies (2.5 Hz, 8.5 Hz, and 40.0 Hz, respectively), allowing the cortical response of each to be tracked independently in the frequency-domain. Analysis of frequency-domain signal strength revealed: 1) High perceptual load decreased signal strength of within-modality visual distractors but had no effect on between-modality auditory distractors, suggesting perceptual-level distractor filtering is modality-specific; 2) High load increased task-specific parietal signal strength, consistent with top-down modulation of perceptual processing by a frontal-parietal network; 3) Within-modality visual distractors attenuated task-related signal strength, suggesting mutual suppression of target and distractor stimuli through neural competition. This competition further interacted with perceptual load such that signal suppression was present only under low load, a result suggesting that increased perceptual load biased competition in favor of task-relevant stimuli.

RETINOTOPIC ACTIVATION IN PRIMARY VISUAL CORTEX DURING SPATIAL WORKING MEMORY *Jaap Munneke¹, Dirk Heslenfeld¹, Jan Theeuwes¹; ¹VU University, Amsterdam* – Prior research indicated that spatial working memory and spatial selective attention share a distributed large-scale cortical network consisting of fronto-parietal regions. Similar patterns of neural activity have been observed in these regions during these tasks. We investigated whether the overlap in neural structures could be extended to the visual regions of the occipital cortex and in particular to primary visual cortex (V1). In the current study, participants conducted a spatial working memory task and a spatial attention task while the BOLD response was measured. While the instructions in both tasks differed, the trials were basically identical. Our results indicated that (1) the neural overlap between spatial working memory and spatial selective attention extends beyond the fronto-parietal network and can be observed in the visual cortex as well. (2) The primary visual cortex is involved in both tasks, indicating that V1 is more than a simple relay station passing on information coming from the retina and that top-down procedures can modulate the neural response in early visual cortex. The current results fit with a hypothesized model of working memory, claiming that shifts of spatial attention are required for maintenance during spatial working memory.

SELECTIVE ACTIVATION OF STIMULUS-SPECIFIC POPULATION CODES IN VISUAL CORTEX DURING TOP-DOWN ATTENTIONAL CONTROL *Mark Stokes^{1,2}, Russell Thompson², Anna Christina Nobre¹, John Duncan²; ¹Oxford University, Experimental Psychology, ²MRC Cognition and Brain Sciences Unit, Cambridge University* – Previously, we demonstrated that top-down control mechanisms can access stimulus-specific population codes in high-level visual cortex (Stokes et al., 2008). Using multivoxel pattern analysis (MVPA), we found that visual imagery activates content-specific perceptual representations stored in visual cortex, even in the complete absence of differential visual input. Here, we further examine top-down control over visual cortex for non-spatial selective attention. During fMRI, participants were cued via an auditory tone to attend to either the letter “X”, or the letter “O”, on a trial-by-trial basis. During a pattern localiser condition, participants were also scanned whilst viewing either the letter “X” or “O”, thereby enabling us to define the neural signature pattern for the visual codes corresponding to the contents of visual attention. Consistent with the well-established capacity of MVPA to resolve differential activation profiles that index distributed population coding, we could reliably differentiate between the patterns of visual activity associated with the two alternative perceptual states. Unique to the current study, however, we also found that pattern

analysis of the same areas in visual cortex that code for visual perception also differentiate between the corresponding attentional states: attending for either the letter "X" or the letter "O". We conclude that top-down mechanisms for selective attention can accurately modulate activity in visual cortex to bias functionally distinct, yet spatially overlapping, neural populations.

SEPARABLE MECHANISMS OF SIGNAL ENHANCEMENT AND SIGNAL SUPPRESSION DURING VISUAL-SPATIAL SELECTIVE ATTENTION Jane Couperus¹, George R. Mangun²; ¹Hampshire College, ²University of California Davis – Selective attention modulates activity at early levels of visual processing, as is reflected in changes in the P1 event-related potential (ERP) component. Although some have suggested that the process of selection involves primarily signal enhancement (e.g., Mangun et al., 1991), others have suggested that it involves both the enhancement of the signal of the attended stimulus as well as suppression of the unattended stimulus (e.g., Awh, Matsukura, and Serences 2003; Dell'Acqua et al., 2007). Using a spatial cuing paradigm, we examined target and distracter processing as a function of the expectancy of distracter presence versus absence. In Experiment 1, in different blocks of trials, distracters appeared frequently (70% of trials) or infrequently (30% of trials). Analysis of distracter-present displays (consisting of two stimuli, the attended target and unattended distracter in the opposite visual hemifield) showed that in addition to target enhancement of the occipital P1 ($F(1,18)=17.22$, $p=.001$) in the hemisphere contralateral to the target, processing of distracters was reduced in the frequent condition as compared to the infrequent condition ($F(1,18)=5.54$, $p=.03$) in the hemisphere contralateral to the distracter. Experiment 2 replicated these findings with the presence of the distracter cued from trial-to-trial rather than within a block design ($F(1,19)=13.58$, $p=.002$ and ($F(1,19)=5.71$, $p=.027$) respectively). These findings suggest that both active enhancement and active suppression are involved in visual-spatial selective attention. Moreover, the engagement of suppression mechanisms may be critically dependent on distracter presence, that when anticipated results in the use of suppression mechanisms.

SACCADE PLANNING IS DISSOCIATED FROM PRE-SACCADIC ATTENTIONAL FACILITATION AFTER DAMAGE TO THE POSTERIOR PARIETAL CORTEX Aarlenne Khan¹, Annabelle Blangero², Yves Rossetti², Romeo Salemme², J. Luaute^{2,3}, Heiner Deubel⁴, Werner Schneider⁴, N. Laverdure², Gilles Rode^{2,3}, Laure Pisella²; ¹Smith-Kettlewell Eye Research Institute, San Francisco, California, ²INSERM U864, Espace et Action, Bron, France; Université Claude Bernard, Lyon 1; Institut Fédératif des Neurosciences de Lyon (IFNL), Lyon, France, ³Hospices Civils de Lyon, Lyon, France, ⁴Ludwig-Maximilians-Universität, Munich, Psychology, Germany – Numerous studies have suggested that saccades to a location trigger an automatic attentional shift to the saccade goal, which enhances perceptual processing at that location. Here, we argue for a functional dissociation between pre-saccadic perceptual enhancement and saccade planning. A patient with a lesion in the right posterior parietal cortex participated in a dual saccade and letter discrimination task. The patient made saccades to the left or right visual field. During the saccade latency a letter was briefly presented at the saccade goal and the patient was asked to discriminate the letter after he completed the saccade. The patient was able to make the normal saccades to the left, impaired visual field that could not be distinguished from saccades to the right, healthy, visual field. However, he was unable to discriminate the letters presented at the saccade goal on his left visual field whereas his performance was excellent in his right visual field. By presenting letter changes at locations that were either closer to or further away from to the saccade goal location, we also tested whether this inability to discriminate a letter at the saccade goal in the impaired visual field was attributable to a distorted attentional shift. The patient performed at chance for all letters presented in the contralesional visual field. We conclude that the leftward saccades were made without an anticipating attentional shift, whereas the rightward saccades were accompanied by a normal attentional shift.

A SPLIT SPOTLIGHT OF FEATURE-SELECTIVE ATTENTION? Søren K. Andersen¹; ¹Institut für Psychologie I, Universität Leipzig, Leipzig, Germany – Previous studies have demonstrated that spatial attention can be 'split', i.e. divided between non-contiguous locations. Here we asked the question whether feature-selective attention can be split in an analogous way. Two completely overlapping random dot kinematograms (RDKs) of two different colors were presented on either side of a central fixation cross. Sustained attentional selection was measured by means of steady-state visual evoked potentials (SSVEPs) elicited by these frequency-tagged RDKs. Participants performed a divided attention task, in which they had to attend to two RDKs, one each side of fixation. We compared conditions in which both to-be-attended RDKs had the same color with conditions in which the colors of both RDKs were different. While the 'same' conditions were characterized by good behavioral performance and clear enhancement of SSVEP-amplitudes to attended stimuli, behavioral performance in the 'different' conditions was strongly reduced and there were no effects of attentional selection on SSVEP-amplitudes. This clearly shows that it is not possible to simultaneously direct attention to different features at different locations. This is in line with previous studies

that have reported a global effect of feature-selective attention, i.e. features are selected across the entire visual field. Our results provide evidence that global selection is not only the modus operandi of the visual system but that such selection can not be prevented even when it explicitly conflicts with task demands.

AUDIOSPATIAL ATTENTION EVOKES SIMILAR BRAIN ACTIVATION PATTERN TO VISUALSPATIAL ATTENTION *Kathy Niu¹, Ben Davis¹, Chris Rorden¹; ¹University of South Carolina, Columbia* – Neuroimaging studies suggest that a fronto-parietal network is activated when we expect visual information to appear at a specific spatial location. Here, we examine whether a similar network is involved for auditory. We used a block design, continuous functional magnetic resonance imaging (fMRI) experiment to infer brain activation while participants performed spatial and temporal order judgment (TOJ) tasks with auditory stimuli. Each trial presented two different sounds (a viola and a bassoon) that were separated perceptually in time and space. During the TOJ task, participants identified which of the two sounds came first. For the spatial task, half of the participants were instructed to select the sound that appeared further to the left in space, and half were instructed to select the one further to the right. Crucially, the same stimuli were presented for both tasks, and the same motoric mapping was used for responses (index finger for bassoon, middle finger for viola). Thus, the statistical contrasts of the spatial blocks with the TOJ blocks should give a pure measure of task-related differences, uncontaminated by differences in low-level perception or motoric response. Furthermore, task difficulty was controlled as measured by response time and accuracy. More activation was observed for the spatial task than the TOJ task in the bilateral temporal parietal junctions (TPJ), bilateral superior frontal regions near the frontal eye fields (FEFs), and bilateral intraparietal sulci (IPS), as well as bilateral occipital temporal junctions. These regions are similar to those reported for spatial attention for visual stimuli.

VALIDATION OF DRIVING STUDIES FROM THE LAB TO THE ROAD USING ERPS *Richard Young^{1,2}, Li Hsieh^{2,3}, Sean Seaman^{2,3,4}; ¹Wayne State University, School of Medicine, Psychiatry and Behavioral Neurosciences, ²Wayne State University, Institute of Cognitive and Applied Neuroscience, ³Wayne State University, Communication Sciences and Disorders, ⁴Wayne State University, Psychology* – Most investigations into driving performance involve the use of simulators, and this is especially true of neuroscience studies of driving performance (e.g., Hsieh et al., 2008; Bowyer et al., 2008). What is often lacking, especially in the neuroscience domain, is a validation of these simulators using neuroscience tools, which is especially important given 1. the cognitive complexity of a real-world driving task and 2. the policy implications of driving performance research. In this study, we used EEG and an array of behavioral measures to estimate the effects of a simulated cellular phone conversation on driving performance. EEG was measured in the vehicle using a laptop computer, a battery-powered 64-channel amplifier, and a shielded EEG cap. Participants drove on real roads in a test vehicle, and responded to simulated road events using light stimuli positioned around the driver's field of view in the vehicle. In the lab, this was simulated using a steering stimulator and light events presented on a computer. In both environments, participants' reaction times to visual events were assessed, and ERPs were recorded to the visual events. While driving, participants answered pre-recorded questions to simulate a cellular phone conversation. The goal of the study was to evaluate the reliability of both behavioral and EEG measures. Results show that behaviorally, the effects of conversation on the road and in the lab were consistent, showing a small increase in RTs and negligible patterns of inaccuracy in both environments. ERPs also show consistency across sites.

Slide Session 6 Perception

Tuesday, March 24, 10:00 am - 12:00 pm, Grand Ballroom B

Chair: **Reiko Graham**

Speakers: **Dominique Vuvan (GSP Winner), Bradford Mahon (GSP Winner), Emily S. Cross, Lawrence Ward, Jessica Wisnowski, Jessica Cantlon, Psyche Loui, V. S. Ramachandran**

A B S T R A C T S

THE COGNITIVE-PERCEPTUAL EFFECTS OF AUDIO GAME TRAINING *Dominique Vuvan¹, Claude Alain^{1,2}; ¹University of Toronto, Toronto, Canada, ²The Rotman Research Institute, Baycrest, Toronto, Canada* – The study reported here was designed to explore whether playing an audio game can yield improvements in auditory perception, attention, and memory. All participants underwent two laboratory assessments 14 days apart. These assessments included four tests of basic auditory function (pure tone thresholds, speech in noise, mistuned harmonic detection, and gap detection), and two cognitive-perceptual tasks (auditory

working memory and auditory attentional blink). Auditory event-related brain potentials were recorded during the cognitive-perceptual tasks. Half of the participants were asked to play Troopanium 2.0 (a complex audio game designed for the blind that is analogous to "Space Invaders") for 30 minutes per day over the 14 days between assessments. The other half served as a control group and did not undergo training. On the second test session, participants who played the audio game showed greater improvements in performance on both the working memory and attentional measures than those who did not play the game. These performance gains were mirrored by changes in sensory and cognitive ERPs. In addition, trained participants also exhibited a significant decrease in mistuned harmonic detection thresholds relative to controls. No corresponding improvements were seen for the three remaining basic psychophysical measures. The results from this study show that playing audio games may lead to enhanced auditory perceptual and cognitive skills, and parallel findings from research in the visual domain.

CATEGORY-SPECIFIC ORGANIZATION IN THE HUMAN BRAIN DOES NOT DEPEND ON VISUAL EXPERIENCE Bradford Mahon², Stefano Anzellotti², Jens Schwarzbach¹, Massimiliano Zampini¹, Alfonso Caramazza²; ¹Center for Mind/Brain Sciences (CIMeC), University of Trento, Italy, ²Harvard University, Psychology – Functional imaging studies of the normally developing human brain have shown that lateral regions of ventral occipital-temporal cortex show neural specificity for living things (faces, animals) while medial regions show neural specificity for nonliving things (tools, houses). The neural principles that give rise to this lateral-to-medial organization by semantic domain within ventral occipital-temporal cortex are actively debated. Here we show using fMRI that the same regions of occipital-temporal cortex that exhibit neural specificity for artifacts and animals in sighted adults exhibit neural specificity for the same categories in congenitally and late blind adults. Sighted and blind participants performed a size judgment task over animal and nonliving stimuli. Stimuli consisted of auditory words, and were blocked by semantic category (animal vs. nonliving) into twenty second blocks. Sighted participants also viewed pictures corresponding to the same animal and nonliving stimuli in a subsequent localizer scan. For the size judgment task over auditory stimuli, regions within the medial fusiform gyrus were more activated in all groups of participants (sighted, late and congenitally blind) for nonliving compared to living stimuli. In contrast, regions within lateral occipital-temporal cortex were more activated for all groups of participants for animal stimuli compared to nonliving stimuli. The same regions were identified based on the picture-viewing localizer for the sighted subjects. These findings demonstrate that category-specificity within the human visual system does not depend on visual experience, and suggest the operation of innately determined domain-specific constraints on the organization of object knowledge.

NEURAL REPRESENTATIONS OF STATIC PLAUSIBLE AND IMPLAUSIBLE BODY POSTURES Emily S. Cross^{1,2}, Emilie C. Mackie^{3,4}, George Wolford⁴, Antonia F. de C. Hamilton²; ¹Max Planck Institute for Human Cognitive & Brain Sciences, Leipzig, Germany, ²University of Nottingham School of Psychology, Nottingham, UK, ³University of British Columbia, Vancouver, BC, ⁴Center for Cognitive Neuroscience, Dartmouth College, Hanover, NH, USA – Understanding other's movements and interacting socially require a representation of other people's bodies. Research into the neural underpinnings of body representation implicates several regions in this kind of processing. One set of such regions, known as the mirror neuron system (MNS), comprises premotor and parietal cortices and responds to dynamic and familiar stimuli, especially moving bodies of other people. Another brain region, the extrastriate body area (EBA), is located within the lateral occipital cortex and is activated when viewing static body postures. It is less clear how these regions respond to unfamiliar contorted body postures. We examined which brain regions show viewpoint-independent responses to static images of plausible and implausible body postures, using a repetition suppression design in functional magnetic resonance imaging. Participants were scanned while observing static images of a contortionist in either plausible postures or in contorted, implausible postures. Greater activity emerged in bilateral EBA when participants viewed plausible compared to contorted postures. The inverse contrast revealed greater activity within the middle frontal gyrus. Repeated presentation of the same body posture lead to suppressed responses in inferior frontal gyrus and inferior parietal lobe, two regions classically associated with the MNS. These regions did not distinguish the plausibility of the posture. Overall, our data demonstrate that both the MNS and EBA are involved in static body posture coding. These results contrast with some previous studies of the neural representation of possible and impossible actions, and thus present new challenges for theories of body representation in the human brain.

RHYTHMS OF CONSCIOUSNESS: BINOCULAR RIVALRY REVEALS LARGE-SCALE OSCILLATORY NETWORK DYNAMICS MEDIATING VISUAL AWARENESS Lawrence Ward^{1,2}, Sam Doesburg³, Jessica Green⁴, John McDonald⁴; ¹University of British Columbia, Psychology, ²Brain Research Centre, University of British Columbia, ³University of British Columbia, Pediatrics, ⁴Simon Fraser University, Psychology – Consciousness has been proposed to emerge from functionally integrated large-scale ensembles of gamma-syn-

chronous (30-50 Hz) neural populations that form and dissolve at a theta band (4-7 Hz) frequency. We propose that discrete moments of perceptual experience are implemented by transient gamma-band synchronization of relevant cortical regions, and that disintegration and reintegration of these assemblies occurs according to an ongoing theta oscillation. In support of this hypothesis we provide evidence from 64-channel EEG data recorded from 14 subjects during binocular pattern rivalry. We measured phase-locking values, calculated from phases measured by the Hilbert transform-analytic signal method, between narrow-band signals from dipole sources seeded in brain regions located using BESA beamformer. We report that (1) rivalrous perceptual switching is time-locked to theta-modulated gamma-band synchronization, indicating that the onset of new conscious percepts coincides with the emergence of a new gamma-synchronous assembly that is locked to an ongoing theta rhythm; (2) the recurrent generators of these gamma rhythms are in prefrontal and parietal brain regions; (3) theta-modulated gamma-band phase synchronization is observed between these activated brain regions. These results suggest that ongoing theta modulated-gamma mechanisms periodically reintegrate a large-scale prefrontal-parietal network critical for perceptual experience. Moreover, activation and network inclusion of inferior temporal cortex and motor cortex uniquely occurs on the cycle immediately preceding responses signaling perceptual switching. This suggests that the essential prefrontal-parietal oscillatory network is expanded to include additional cortical regions relevant to tasks and perceptions furnishing consciousness at that moment, here image processing and response initiation.

IS DAMAGE TO THE FUSIFORM FACE AREA SPECIFICALLY RELATED TO FACE RECOGNITION IMPAIRMENTS? *Jessica Wisnowski¹, David Rudrauf², Sonya Mehta², Thomas Grabowski², Daniel Tranel², Steven Anderson², Hanna Damasio¹; ¹Brain and Creativity Institute and the Dana and David Dornsife Cognitive Neuroscience Imaging Center, University of Southern California, ²Division of Behavioral Neurology and Cognitive Neuroscience, Department of Neurology, University of Iowa* – An important and still unanswered question in cognitive neuroscience is whether the Fusiform Face Area (FFA), a small region in the right posterior temporal-occipital gyrus, has evolved to specifically process facial information or whether it is involved more generally in the visual recognition of concrete entities. We employed a novel approach to test the specificity of FFA by utilizing voxelwise logistic regression to analyze visual recognition data pertaining to the categories of famous faces, animals, fruits/vegetables and tools/utensils in 191 patients with focal brain lesions. This approach allowed us to identify regions where damage was significantly associated with impairments in the recognition of faces, after removing the variance that could be attributed to impairments in the other categories. The areas where damage was relatively specific for face recognition impairments were: the right lateral temporal-parietal-occipital junction, the right mesial temporal pole, and areas in the white matter underlying and interconnecting those areas. FFA was not included. We then examined a subgroup of 19 patients whose damage likely included FFA and found that they were impaired at recognizing animals (mean z-score = -4.5), fruits/vegetables (-5.0) and faces (-2.6), but not tools/utensils (-0.67). Finally, five patients with the largest lesions in FFA all performed poorly on the recognition of fruits/vegetables and animals; however, only 3 were impaired in the recognition of faces while 2 were entirely normal. We conclude that FFA is part of the system involved in visual recognition, but that it is not a neural substrate specifically subserving unique facial recognition.

CORTICAL ORGANIZATION OF VISUAL CATEGORIES IN EARLY CHILDHOOD *Jessica Cantlon^{1,2}, Kevin Pelphrey²; ¹Duke University Center for Cognitive Neuroscience, ²Yale University, Psychiatry* – Cortical regions along the inferior temporal and fusiform gyri exhibit greater responses to images of real objects compared with scrambled images and the like (e.g., Grill-Spector, Knouf, and Kanwisher, 2004). Within these cortical regions, certain object categories such as faces, houses, and symbolic strings evoke preferential responses in predictable subregions. How does this category-selective pattern of neural activity develop? We recorded brain activity (using fMRI) in four- to five-year-old children (N=14) and adults (N=14) as they passively viewed images from each of four categories (faces, numbers, letters, and shoes) in addition to their scrambled image counterparts. Four- to five-year-olds exhibited a similar degree of selectivity in the fusiform gyrus and occipito-temporal cortex to adults for faces and objects. Moreover, voxels that exhibited the strongest response to faces in children were within the typical adult fusiform face-selective region whereas voxels that responded more strongly to symbols (letters and numbers) were in the typical adult fusiform/inferior temporal word form area. Interestingly, the visual word form region that exhibited a response bias for both letters and numbers in children exhibited a bias only for letters in adults – perhaps because experience attunes this brain region to the specific symbolic elements relevant for reading words. These findings suggest that category-selectivity already may be developing by four years of age but it is not fully mature. The degree of category-selectivity in the ventral stream may be important for the development of adult-like visual recognition.

CORTICAL HYPERCONNECTIVITY IN ABSOLUTE PITCH MUSICIANS *Psyche Loui^{1,2}, Charles Li¹, Anja Hohmann¹, Gottfried Schlaug^{1,2}; ¹Beth Israel Deaconess Medical Center, ²Harvard Medical School* – The ability to categorize sound is crucial for language, music, and effective functioning in the environment. Sound categorization recruits temporal lobe structures and is extraordinarily accurate among possessors of Absolute Pitch (AP), who can name the appropriate pitch category of any given tone without a reference. While the incidence of AP is rare in the general population (< 1%), its prevalence depends inversely on age of exposure to pitch information (i.e. via musical training and/or tonal languages), suggesting that heightened pitch exposure may either trigger the development of neural circuitry essential for sound categorization, or may interfere with developmental pruning of naturally-present circuitry. Using Diffusion Tensor Imaging (DTI), we tested the hypothesis of heightened neural connectivity in superior temporal regions of AP possessors. Tractography was conducted using bilateral seed regions of interest in the superior temporal gyrus (STG) and middle temporal gyrus (MTG). AP possessors had significantly higher-than-control volume of white matter tracts connecting the left STG and MTG. Furthermore, the leftward asymmetry of white matter volume connecting perception and categorization areas (STG and MTG) was significantly correlated with the degree of AP possession (AP1 vs. AP2) as defined by behavioral performance on a pitch naming task. The present finding of hyperconnectivity within temporal regions of AP musicians extends previous research showing increased superior temporal lobe asymmetry in AP and provides a new model for studying the neuroplasticity and heightened local connectivity that have been proposed as possible biological bases of savant skills and cases of exceptional creativity.

TREATMENT OF INTENSE LEFT HEMI-FACIAL PAIN OF TRIGEMINAL NEURALGIA USING MIRROR VISUAL FEEDBACK *V. S. Ramachandran¹, Eric Altschuler^{1,2}; ¹UCSD, Center for Brain and Cognition, ²UMDNJ, PM&R* – A gentleman had been suffering from left hemi-facial pain (tic douloureux) for nearly 12 years and had gone through numerous conventional treatments which proved to be completely ineffective. Indeed, this pain is often considered intractable. Following a suggestion from one of us (VSR), the gentleman looked at his face in a double reflecting mirror. Unlike a normal mirror, a double-reflecting mirror (two mirrors taped at right angles) does NOT optically reverse your face. So, if you look in the mirror and someone touches the actual RIGHT side of your face it creates the illusion that the LEFT side of your face is being touched (because the normal “expected” reversal doesn’t occur). The patient made ingenious use of the technique: Obviously he couldn’t massage the left side of the face; the very attempt to get close to it or actually touching it lightly provoked excruciating pain. He looked in the mirror watched his wife’s hand massaging his right face so he SAW his left (painful) side being “massaged” without provoking pain; thereby progressively causing the “learned pain” to be unlearned. Astonishingly, the pain dropped from about 6 down to zero after 10 minutes and with repeated 10 minute treatments stayed at zero for months. Massage applied to the right face WITHOUT looking in a mirror was completely ineffective. The patient reports that the mirror procedure has changed his life. Controlled studies of mirror visual feedback for hemi-facial pain, and, if effective, the neurophysiologic correlates underlying the treatment, may be warranted.

Slide Session 7 Reasoning and decision making

Tuesday, March 24, 1:00 - 3:00 pm, Grand Ballroom B

Chair: **Chair: Kalina Christoff**

Speakers: **Roi Cohen Kadosh, Marinella Cappelletti, Oshin Vartanian, Adam Green, Elizabeth O’Hare, Amitai Shenhav (GSP Winner), Leonhard Schilbach, Penelope Lewis**

A B S T R A C T S

MODULATING NUMBER-SPECIFIC NEURONS IN THE HUMAN PARIETAL CORTEX *Roi Cohen Kadosh¹, Neil Muggleton¹, Juha Silvanto^{2,3}, Vincent Walsh¹; ¹Institute of Cognitive Neuroscience, University College London, London, UK, ²Beth Israel Deaconess Medical Center and Harvard Medical School, Laboratory of Noninvasive Brain Stimulation, Boston, USA, ³Psychology, University of Essex, Colchester, UK* – Numbers can come in many forms; we can represent the same quantity, as a verbal number "TWO", a digit (2), in Roman numerals (II), non-symbolically (??), in a temporal series, or with other verbal numbers (pair, duo, brace). The question of how we represent numbers and whether there is a unitary cognitive and neuronal basis for all forms of numerical representation (i.e., abstract representation) is therefore an important problem in numerical cognition, neuronal specialisation, education, and remediation from dyscalculia. To examine the commonly held view that numbers are represented in an abstract fashion in the intraparietal sulcus, a core area for

numerical representation we used a novel transcranial magnetic stimulation adaptation (TMSA) paradigm. TMSA provides superior functional resolution by allowing one to selectively stimulate even within overlapping populations of neurons. We show that the intraparietal sulcus, an area that is believed to hold an abstract numerical representation, is equipped with a specialized non-abstract representation. Moreover, we show here that, akin to similar results in single-cell neurophysiology in monkeys, TMSA modulated neurons with preference for the adapted digit, a symbolic, acculturated number, in the parietal lobes of numerate humans, and this TMS effect decreases as the numerical distance from this digit increases.

THE ROLE OF THE RIGHT AND LEFT PARIETAL LOBES IN THE CONCEPTUAL PROCESSING OF NUMBERS

Marinella Cappelletti¹, Hwee Ling Lee³, Elliot D. Freeman^{1,4}, Cathy J. Price²; ¹Institute of Cognitive Neuroscience, University College London, 17 Queen Square, London, UK, ²Wellcome Trust Centre for Neuro-imaging, Institute of Neurology, University College London, London, UK, ³MPI for Biological Cybernetics, Max Planck Institute for Biological Cybernetics, Tübingen, Germany, ⁴Brunel University, Psychology, School of Social Psychology, Uxbridge – Neuropsychological and functional imaging studies have associated the conceptual processing of numbers with bilateral parietal regions (including the intraparietal sulcus, IPS). However, the processes driving these effects remain unclear because both left and right posterior parietal regions are activated by many other conceptual, perceptual, attention and response-selection processes. To dissociate parietal activation that is number-selective from parietal activation related to other stimulus or response-selection processes, we used fMRI to compare numbers and object names during exactly the same conceptual and perceptual tasks while factoring out activations correlating with response times. We found that right parietal activation was higher for conceptual decisions on numbers relative to the same tasks on object names, even when response-time effects were fully factored out. In contrast, left parietal activation for numbers was equally involved in conceptual processing of object names. We suggest that left parietal activation for numbers reflects a range of processes, including the retrieval of learnt facts that are also involved in conceptual decisions on object names. In contrast, number-selectivity in the right parietal cortex reflects processes that are more involved in conceptual decisions on numbers than object names. Our results generate a new set of hypotheses that have implications for the design of future behavioural and functional imaging studies of patients.

THE ROLE OF RIGHT PREFRONTAL CORTEX IN REAL-WORLD PLANNING

Oshin Vartanian^{1,2}, Vinod Goel², Angela Bartolo³, Lila Hakim², Anna Maria Ferraro², Carla Budriesi⁴, Ildebrando Appollonio⁵, Valeria Isella⁵, Paolo Nichelli⁴; ¹DRDC Toronto, ²York University, ³Université Charles-de-Gaulle Lille III, ⁴University of Modena and Reggio Emilia, ⁵University of Milano - Bicocca – While much evidence has linked injury to the prefrontal cortex (PFC) to impairments in planning, much less is known about the underlying cognitive processes that are compromised as a consequence of PFC damage. In addition, the differential contributions of left and right PFC to planning remain controversial. To address these issues, we administered a real-world travel planning task to thirty participants comprised of six patients with focal frontal lesions to left PFC, six patients with focal frontal lesions to right PFC, six patients with posterior lesions, and twelve normal controls. Furthermore, we employed the methodology of verbal protocol analysis, enabling us to go beyond simple task performance and to analyze the underlying cognitive processes and strategies that underlie plan formulation. The results revealed that patients with right PFC lesions formulated significantly worse plans than patients with left PFC lesions and normal controls. No other comparison reached significance. To explore the underlying reasons for the planning impairment exhibited by right PFC patients, we computed the ratio of concrete to abstract problem-solving statements between the groups. The results demonstrated that right PFC patients had a significantly higher concrete-to-abstract ratio of problem-solving statements than left PFC patients and normal controls. No other comparison reached significance. We conclude that the role of right PFC in real-world planning involves the formulation and maintenance of abstract ideas as a function of task demands.

ANALOGICAL REASONING ABILITY MEDIATES THE RELATION BETWEEN INTELLIGENCE AND CREATIVITY

Adam Green¹, Joseph Kim¹, Michael Cohen¹, Colin DeYoung², Jeremy Gray¹; ¹Yale University, ²University of Minnesota – People who are intelligent are often creative as well. However the relationship between intelligence and creativity is not well understood. One likely mediator is Analogy. Analogy, a form of relational reasoning, is related to crystallized and especially to fluid intelligence. Analogy is also widely indicated to be an important cognitive mechanism for supporting creative insight and innovation. Work in our laboratory and elsewhere has reliably implicated frontopolar cortex in the neural implementation of analogy. Here, we tested whether a form of analogical reasoning that preferentially engages frontopolar cortex mediated the relation between intelligence and creativity in 160 participants. Analogical reasoning ability was measured by a task in which participants selected word-pairs to correctly complete four-word propositional analogies of the general form, 'A is to B as C is to D' (i.e., participants were pro-

vided with A:B and asked to select C:D from a list). Analogical reasoning ability significantly mediated the effect of intelligence (a latent variable comprising full-scale I.Q., and d-prime for verbal 3-Back performance) on creativity (a latent variable comprising the Creative Achievement Questionnaire, and creative verb generation). Notably, this mediation effect was driven by performance on cross-domain (semantically distant) analogies, a type of analogy for which frontopolar cortex shows preferential recruitment. These data provide new evidence that analogy is a key mechanism by which intelligence supports creativity, and indicate the intriguing hypothesis that frontopolar cortex mediates the link between intelligence and creativity.

MAPPING RELATIONSHIPS BETWEEN CORTICAL THICKNESS AND FLUID REASONING IN TYPICALLY DEVELOPING CHILDREN AND ADOLESCENTS Elizabeth O'Hare¹, Kirstie Whitaker¹, Zdena Op De Macks², Brian Johnson¹, Emilio Ferrer³, Silvia Bunge^{1,4}; ¹Helen Wills Neuroscience Institute, University of California, Berkeley, ²Leiden University, Developmental Psychology, The Netherlands, ³Dept. of Psychology, University of California, Davis, ⁴Dept. of Psychology, University of California, Berkeley – Fluid reasoning, or the ability to solve novel problems, is a core component of human cognition. Functional brain imaging studies in adults and children have implicated anterior prefrontal and inferior parietal regions in reasoning and relational integration. To date, however, no studies have examined potential brain structural correlates of fluid reasoning ability in a developmental population. We studied typically developing children and adolescents (ages 6-18) with high-resolution MRI at 3 Tesla (current N=18). All participants performed a series of fluid reasoning tasks. Semi-automated methods were used to match cortical geometry across subjects and to measure cortical thickness at every surface vertex. We then computed statistical maps of the correlation between thickness and cognitive performance at matched anatomical points. Statistical maps demonstrated that increased cortical thickness was significantly correlated with better performance on measures of fluid reasoning in left supramarginal gyrus (BA 40), independent of age (peak vertex, $r=0.70$, $p=0.001$). Additional correlations between cortical thickness and fluid reasoning ability were observed in left ventrolateral and left anterior prefrontal cortex (BA 10), where decreased thickness correlated with better reasoning performance (peak vertex $r=-0.61$, $p=0.006$). These results suggest that brain structure in prefrontal and inferior parietal regions correlates with fluid reasoning ability in children and adolescents. Furthermore, the observation of a significant relationship between fluid reasoning and cortical thickness in inferior parietal cortex that is independent of differences associated with age suggests that this region is a key source of individual differences in fluid reasoning ability during development.

UTILITARIAN CALCULATIONS, EMOTIONAL ASSESSMENTS, AND INTEGRATIVE MORAL JUDGMENTS: DIFFERENTIATING NEURAL SYSTEMS UNDERLYING MORAL DECISION-MAKING Amitai Shenhav¹, Joshua D. Greene¹; ¹Harvard University, Psychology – Recent research suggests that moral judgments are influenced by utilitarian reasoning (e.g. judging it acceptable to save five lives at the cost of one because of the net benefits) as well as automatic emotional responses that, in some cases, favor non-utilitarian judgments (e.g., judging it unacceptable to sacrifice one life to save five). When utilitarian reasoning conflicts with automatic emotional responses, a more integrative “all things considered” judgment may require the engagement of moral judgment processes that go beyond simple utilitarian calculations and automatic emotional responses. The present study aims to better isolate the neural bases of these distinct components of moral judgment using fMRI. In a within-subject design, participants undergoing fMRI were presented with moral dilemmas in which maximizing the number of lives saved requires harming one or more individuals. After reading each dilemma, subjects responded by indicating which of the two available options (a) will produce better overall results (utilitarian calculation), (b) evokes more negative feelings (emotional assessment), or (c) is more morally acceptable (integrative moral judgment). We found that fast emotional assessments recruited bilateral amygdala and hippocampus more strongly than fast integrative moral judgments, but that fast integrative moral judgments and utilitarian calculations more strongly recruited bilateral dorsolateral prefrontal cortex and anterior cingulate cortex.

MINDS MADE FOR SHARING: INITIATING JOINT ATTENTION RECRUITS REWARD-RELATED NEUROCIRCUITRY Leonhard Schilbach¹, Marcus Wilms², Simon Eickhoff², Sandro Romanzetti², Ralf Tepest¹, Gary Bente³, Nadim Shal², Gereon Fink^{2,4}, Kai Vogeley^{1,2}; ¹University of Cologne, Psychiatry, ²Institute of Medicine, Research Centre Juelich, ³University of Cologne, Social Psychology, ⁴University of Cologne, Neurology – The ability and motivation to share attention with someone is a unique aspect of human cognition. To investigate the neural correlates of joint attention we made use of a novel, interactive research paradigm in which participants' gaze behavior - as measured by an eyetracking device - was used in real time to control the gaze behavior of a computer-animated character. Convinced that the character on the stimulus screen was controlled by a real person outside the scanner, 21 participants interacted with the virtual other while undergoing functional magnetic resonance imaging (fMRI). Experimental variations

focused on leading vs. following the gaze of the character when fixating one of three objects also shown on the screen. Results demonstrate, firstly, that following someone else's gaze and engaging in joint attention recruits the ventral portion of medial prefrontal cortex (MPFC) known to be involved in the supramodal coordination of perceptual and cognitive processes. Secondly, directing someone else's gaze towards an object activated the ventral striatum which – in light of ratings obtained from participants – appears to underlie the hedonic aspects of sharing attention. The data supports the idea that other-initiated joint attention relies upon recruitment of MPFC previously related to the 'meeting of minds'. In contrast, self-initiated joint attention leads to a differential increase of neural activity in reward-related brain areas which might contribute to the uniquely human motivation to engage in the sharing of experiences.

NEUROANATOMICAL CORRELATES OF HIGH ORDER Penelope Lewis^{1,2}, Roozbeh Rezaie³, Rachel Browne⁴, Neil Roberts⁵, Robin Dunbar⁶; ¹School of Psychological Sciences, University of Manchester, ²Institute of Cognitive Neuroscience, University College London, ³Health Science Center at Houston, University of Texas, ⁴MARIARC, University of Liverpool, ⁵Division of Medical and Radiological Sciences, School of Clinical Sciences and Community Health, University of Edinburgh, ⁶Institute of Cognitive & Evolutionary Anthropology, University of Oxford –

The Social Brain Hypothesis proposes that mammalian brain size has evolved to support the demands of managing increasingly large numbers of complex social relationships in bonded groups. Underpinning this are 2 assumptions: that the number of social relationships is a function of neural processing power, and that evolutionary increases in prefrontal cortex volume have been driven, in part, by increased demand for this type of processing. This study tested the related prediction that people capable of a higher degree of intentionality processing have larger prefrontal grey matter volume (GMV). We used 5 stories followed by T/F questions to determine the intentionality and working memory ability level (failure point on a continuous scale of levels 2-6 intentionality/working memory) of 45 subjects. A separate questionnaire determined social group size. We obtained anatomical MRI scans for all subjects and used optimised voxel-based morphometry (VBM) to test for correlations between GMV and these measures. Behaviorally, we observed a positive correlation between intentionality ability and social network size ($p < 0.04$). Anatomically, we observed a correlation between GMV and intentionality but not working memory ability in dorsolateral prefrontal cortex (s.v.c. $p < 0.05$). Furthermore, GMV in right orbitofrontal and subgenual cingulate correlated with sympathy group size (s.v.c. $p < 0.05$). Finally, a conjunction analysis revealed that GMV in orbitofrontal cortex and right hemispheric temporo-parietal junction correlated both with intentionality score and sympathy group size ($p < 0.005$ uncorrected). These findings support a link between intentionality, social network size, and prefrontal cortex, and are in keeping with the Social Brain Hypothesis.

Poster Schedule

The presenting author must be present at least one full hour during the assigned session and the other authors should be present during the remaining time. You may post your materials on the board assigned to you at any time after the "Set-up Begins" time (listed above), but before the beginning of the assigned poster session. You must remove your poster promptly no later than the time listed above in "Take-down Complete." Any posters left up after the "Take-down Complete" time may be discarded. Do not leave personal items in the poster room.

On Saturday, the doors to the poster room close and lock at 8:00 pm. On Sunday-Monday the doors close and lock at 7:30 pm. On Tuesday, the doors close and lock at 5:15 pm. No attendee or exhibitor will be allowed to enter the exhibit hall once the doors are locked.

Poster Session	Date & Time	Set-up Begins	Session Begins	Session Ends	Take-down Complete
A	Saturday 3/21/09	5:00 pm	5:30 pm	7:30 pm	7:45 pm
B	Sunday 3/22/09	*7:30 am	8:00 am	10:00 am	11:30 am
C	Sunday 3/22/09	11:30 am	1:00 pm	3:00 pm	3:30 pm
D	Sunday 3/22/09	3:30 pm	5:00 pm	7:00 pm	7:30 pm
E	Monday 3/23/09	*7:30 am	8:00 am	10:00 am	11:30 am
F	Monday 3/23/09	11:30 am	1:00 pm	3:00 pm	3:30 pm
G	Monday 3/23/09	3:30 pm	5:00 pm	7:00 pm	7:30 pm
H	Tuesday 3/24/09	*7:30 am	8:00 am	10:00 am	12:30 pm
I	Tuesday 3/24/09	12:30 pm	3:00 pm	5:00 pm	5:15 pm

** Please note that only scheduled poster presenters may enter the exhibit hall during the early morning set-up time. All other attendees may only enter when the exhibit hall opens at 8:00 am.*

Poster Session A

Attentional processes: Auditory

A1

INDEPENDENT FACILITATION AND INHIBITION MECHANISMS IN AUDITORY SELECTIVE ATTENTION

Constanze Mikyska¹, Aurelie Bidet-Caulet¹, Robert T. Knight^{1,2}; ¹Helen Wills Neuroscience Institute, University of California, Berkeley, CA, ²University of California, Berkeley, CA – In a recent intracranial study, auditory selective attention has been shown to operate not only by enhancing the sensory responses to relevant sounds, but also by reducing these responses to irrelevant information in auditory cortices (Bidet-Caulet et al., 2007). Previous work in the visual modality indicates that cognitive load differentially affects facilitation vs inhibition. We employed a working memory load manipulation to assess whether facilitation and inhibition represent a unique gain control mechanism or two independent mechanisms in audition. We adapted the classic auditory selective attention paradigm employing a two selection task (Hansen & Hillyard, 1980) by adding a third condition (control condition) in which all sounds received the same amount of attention. Subjects had to detect deviants in the right or left ear or binaural targets (control condition) while they were keeping in memory a short auditory sequence to perform an easy or difficult acoustic comparison. We recorded EEG at 64 scalp electrodes in 16 subjects and compared event-related potentials (ERP) to the same sounds when they were attended, ignored or heard. We found differential effects of memory load on attention mechanisms. An early sensory ERP (P50) was inhibited only under memory load condition. A late negative frontal ERP (200-300 msec) showed less inhibition in the high memory load compared to the low memory load. The present results reveal evidence of independent excitatory and inhibitory mechanisms and support perceptual and cognitive load theories.

A2

SELECTIVE ATTENTION TO SPEECH IN MULTI-TALKER ENVIRONMENTS ACTS AS CONTINUOUS GAIN CONTROL

Jess R. Kerlin¹, Antoine J. Shahin¹, Lee M. Miller¹; ¹Center for Mind and Brain, UC Davis – Our ability to actively select a single talker in an environment with multiple competing speech sounds is a remarkable perceptual feat that serves a critical social function. Although many studies of auditory selective attention in the brain have been conducted for decades, there remains an ongoing debate about the neural mechanisms of sustained selective attention. One idea is that attention acts as a gain-control of bottom-up processing. Alternately, it may be a process without gain, but rather a redirecting of attention to stable bottom-up content. Furthermore, very few studies have addressed the unique nature of the selection of speech as a temporally extended and complex auditory object. We hypothesized that sustained selective attention to a particular speech stream in a multi-talker environment would act as a gain control mechanism on the early auditory cortical representations of speech. Using high-density electroencephalography and a template-matching method novel to the field, we discovered a signal of selective gain to the continuous speech content of the attended speaker, greatest at a frequency of ~2-6 Hz, in auditory cortex. This measure of attention, which appears to be related to the temporal speech envelope, may offer greater insight into the content-specific process of selective attention to speech.

A3

ANTICIPATION RELATED ALPHA DESYNCHRONISATION IN AUDITORY CORTEX FOLLOWING VISUAL CUES

Nadia Müller¹, Winfried Schlee¹, Thomas Hartmann¹, Isabel Lorenz¹, Nathan Weisz¹; ¹University of Konstanz – In most daily life situations we can anticipate external events and prepare our neuronal system for efficient processing. One way how the responsiveness of the brain is adjusted involves changes in oscillatory ongoing alpha activity: Alpha power decreases have been shown to be functionally related to an increased excitability of the accumbent brain area. However, these observations mainly stem from the visual and somatosensory/motor modality whereas the mechanisms in the auditory system are largely unknown. Recent results point to a role of alpha in auditory attention, but cannot disambiguate alpha to be exclusively top-down modulated, e.g. in absence of acoustic stimulation. By recording MEG we here investigated alpha power changes in the auditory cortex in response to visual cues. Thereby, we ruled out the possibility that bottom-up processing of the cue stimulus had an effect on the reported results. Time Frequency Analysis of the induced responses show prominent alpha power decreases peaking around 10Hz, in the second part of the cue-target period. These reductions in alpha power were then localized to auditory, left motor (emerging from subsequent right hand button press) and occipital cortex. Interestingly, following right cue presentation, alpha power was significantly reduced in both auditory cortices whereas after left cue presentation just a trend towards an alpha power reduction in the right auditory cortex was observed. To conclude, the responsiveness of the auditory cortex is indeed top-down modulated and shaped by the side of the cue. Finally, the functional relevance of occipital regions has to be further investigated.

A4

ERP COMPONENTS REFLECTING THE FOCUSING OF ATTENTION WITHIN AUDITORY SCENES

Marissa L. Gamble^{1,2}, Steven J. Luck^{1,2}; ¹University of California, Davis, ²Center for Mind and Brain – Humans must often focus attention onto a relevant sound source in the presence of simultaneous irrelevant sounds. In the visual domain, this has been extensively explored with the N2pc component, a negativity occurring approximately 200-300 ms over posterior scalp sites contralateral to a target within a bilateral stimulus array. In the present event-related potential studies, we searched for an analogous neurophysiological correlate of auditory attention. In experiment 1, two sounds were presented simultaneously for 750 ms, one from each of two laterally placed speakers. For each trial, participants indicated whether one of the two sounds was a pre-defined target. We found a negativity contralateral to the target at anterior and central sites. Further analyses indicated that this contralateral negativity was actually composed of two separate contralateral negativities. We observed a left anterior negativity for right-side targets starting approximately 100 ms poststimulus and a right antero-central negativity for left-side targets starting approximately 200 ms poststimulus. In addition, we observed a contralateral positivity over occipital cortex starting approximately 300 ms poststimulus, perhaps reflecting a link between visual and auditory orienting. In experiment 2, using a similar experimental design with different stimuli, we were able to replicate these effects. This set of contralateral-ipsilateral differences could be used to study selective attention within auditory scenes containing multiple simultaneous stimuli, just as the N2pc has been used to study the operation of attention within visual scenes.

A5

TIME-FREQUENCY ANALYSIS OF MEDITATION DURING AUDITORY ODDBALL PROCESSING: THETA, ALPHA, AND GAMMA FINDINGS

B. Rael Calm^{1,2,3}, Arnaud Delorme^{4,5}, Mark Geyer¹, Franz Vollenweider⁶, John Polich³; ¹UCSD, Psychiatry, ²UCSD Stein Institute for Research on Aging, ³The Scripps Research Institute, ⁴UCSD Institute for Neural Computation, ⁵UCSD Swartz Center for Computational Neuroscience, ⁶University of Zurich, Psychiatry – A three-stimulus auditory oddball series was presented to experienced Vipassana (mindfulness) meditators during meditation and a control thought period to elicit event-related brain potentials (ERPs) in the two different mental states. The stimuli consisted of a frequent standard, an infrequent oddball, and an infrequent distracter, with all stimuli passively presented. We have previously reported on the ERP findings wherein meditation compared to control state effects occurred most strongly for the distracter stimuli with frontal N1 amplitude, P2 amplitude, and P3a amplitude all decreased during meditation. We now report on the time frequency analysis of these data. We again found the greatest change in attention-related activity for the distracter stimuli with decreased stimulus-induced theta power induction. We also found a significant alpha desynchronization to the standard stimuli during the thought condition, but not the meditation condition, indicating less processing demands on the brain imposed to the frequent standards during meditation. We also found greater differential gamma activity in meditation compared to control period during the first 100 msec post-stimulus across stimuli, suggesting that the meditation state may involve greater sensitivity to the sensory surround at the early pre-attentive level of processing but decreased engagement of attentional circuits to such stimuli. Finally, meditation also increased broadband inter-trial coherence to the standards implying more stable entrainment of brain activity to the frequent standards. We discuss the relevance of such findings to the reported outcomes of meditation including enhanced self awareness and decreased distractibility and emotional reactivity.

A6

SYNCHRONOUS INTERACTIONS AND FUNCTIONAL ORGANIZATION OF AUDITORY CHANGE DETECTION

Shannon MacLean¹, Lawrence Ward¹; ¹University of British Columbia – The cortical dynamics underlying the process of auditory change detection are poorly understood. This high density electroencephalography (EEG) study comparing two auditory oddball tasks (passive listening/active identification) revealed the spatiotemporal interactions of active cortical sources through a modern approach of EEG analysis using independent component analysis. Our results establish active regions in the superior temporal gyrus (STG), inferior frontal gyrus (IFG), precentral gyrus (PCG) and cingulate cortex (CC) for both listening conditions. This demonstration of oscillatory dynamics between sources provides a measure of functional organization for change detection in the human auditory system. Synchronization in the beta-band between the CC and generators in the frontal and temporal regions was significantly enhanced for the identification task requiring attention compared to passive listening. Change detection processing appears to consist of initial detection in the primary auditory cortex, detailed analysis in the STG, and monitoring of task performance in the CC for the allocation of attentional resources in the IFG.

A7

OSCILLATORY BRAIN NETWORKS FOR THE ATTENTIONAL CONTROL OF COMPLEX AUDITORY PROCESSING MEASURED WITH MEG

Anthony Kavel^{1,2}, Corby Dale¹, Felix Darvas³, Tracy Luks¹, Darren Weber⁴, Robert Zatorre^{5,6}, Gregory Simpson¹; ¹University of California, San Francisco, ²University of California, Berkeley, ³University of Washington, ⁴Buck Institute, ⁵Montreal Neurological Institute, ⁶McGill University – Neural mechanisms of auditory attention hypothesize coordinated activity between frontal and parietal control regions and auditory sensory regions, orchestrated in a cortical network. We recorded whole-head magnetoencephalography (MEG) from 9 healthy volunteers while per-

forming a discrimination task that required processing linguistic information with simultaneous suppression of tonal pattern information, and vice versa. To examine oscillatory activity in control and sensory regions of interest, we utilized cortically-constrained minimum norm methods (Brainstorm) to reconstruct images of the neuronal currents specific to the anatomy of each subject (Freesurfer), applied wavelet transforms, and analyzed spectral data in six frequency bands. Synchronization of oscillatory activity within (spectral power) and between (phase locking) brain regions was calculated to determine involvement in auditory attention and selective processing of complex auditory stimuli. Results revealed statistically significant increases in local neural synchronization in frontal, parietal and sensory regions, showing dynamic asymmetries indicative of increased right hemisphere activity. Frequency-specific asymmetries in high alpha (12-14 Hz) and theta (3-7 Hz) bands also occurred in control and sensory regions. Increased communication between regions, measured by phase locking, was found both between frontal and parietal control regions and between control regions and auditory sensory cortex. Analysis of the relation between performance and synchronization between control and sensory regions revealed statistically significant correspondence between performance and phase locking values. The results support a critical role for oscillatory brain activity in auditory processing, and for functionally interconnected control and sensory regions that form networks to produce successful auditory attention.

Attentional processes: Other

A8

CROSS-MODAL CUEING OF ATTENTION ALTERS VISUAL APPEARANCE AND EARLY CORTICAL PROCESSING

Viola Störmer¹, John McDonald², Steven Hillyard³; ¹International Max Planck Research School "The Life Course: Evolutionary and Ontogenetic Dynamics" (LIFE) School MPI Berlin, ²Simon Fraser University, ³University of California San Diego – Recent psychophysical evidence suggests that visual cues can alter the appearance of subsequent visual objects (e.g. Carrasco, Ling, & Read, 2004). Here, we investigated whether cross-modal cueing can also alter the appearance of visual objects. We found that a reflexive shift of attention to a lateralized sound enhances the perceived contrast of a spatially co-incident visual object. Following the general design used by Carrasco et al., (2004), a bilateral pair of Gabor patches (8°x 8°1cpd) presented to the left and right of fixation was preceded by a spatially non-predictive sound on either the left or right side at one of the target locations. Target stimuli varied in relative contrast, orientation and phase and observers reported the orientation of the target that appeared to be higher in contrast. Target stimuli that were presented on the cued side appeared to be higher in contrast on the majority of the trials. To determine whether this apparent boost in perceived stimulus contrast was due to an effect of cross-modal cueing on early sensory processing, we recorded event-related potentials (ERPs) to equal-contrast targets (50% of trials). Cross-modal attention cueing led to enhancement of ERP activity over the occipital scalp beginning 90 ms after target onset, and the magnitude of this enhancement was predictive of the degree to which the cued-side target appeared higher in contrast. We conclude that the boost in perceived stimulus contrast by the cross-modal cueing of attention arises from increased signal strength in the early visual pathways.

A9

SPECIFIC ATTENTIONAL PROFILE IN PURE DEVELOPMENTAL DYSCALCULIA

Sarit Ashkenazi¹, Avishai Henik¹; ¹Ben Gurion University, Beer Sheva, Israel – Fourteen university students diagnosed as suffering from Developmental Dyscalculia (DD) [IQ and reading abilities in the normal range and no indication for ADHD (Attention-Deficit Hyperactivity Disorder)] [and 14 matched controls were examined with the ANT-I (Attentional Network Test - Interactions)]. This test was

designed to investigate three different attentional networks (executive, orienting, alerting) and the interactions between them. The results revealed deficits in those with DD in the alerting network (DD participants showed a larger alerting effect than controls) and the executive function network (DD participants showed a larger congruity effect). The interaction between these networks (alerting and executive function) was also modulated by group. These results imply specific attentional deficits in the executive function and alertness network in those with pure DD. This indicates that people having DD suffer from difficulties in recruiting attention, in addition to the deficits in numerical processing. Moreover, this suggests that DD is a non-unitary deficit.

A10

CROSS-MODAL AND ATTENTIONAL MODULATION EFFECTS IN THE THALAMUS AND EARLY SENSORY CORTICES

David Fegen^{1,2}, Taraz Lee^{1,3}, Jesse Rissman⁴, Bradley Buchsbaum^{1,3}, David Badre⁵, Mark D. Esposito^{1,2,3}, Henry H. Wheeler Jr. Brain Imaging Center, University of California, Berkeley, ²Helen Wills Neuroscience Institute, University of California, Berkeley, ³University of California, Berkeley, ⁴Stanford University, ⁵Brown University – Previous studies have found that attention can modulate activity in the lateral geniculate nucleus (LGN) of the thalamus. However, almost no studies have examined how different perceptual modalities interact in the thalamus as a function of one's attentional goals. We aimed to examine the effects of modality-specific attention and cross-modal conflict within the thalamus using high-resolution fMRI. Eighteen participants viewed a moving Gabor patch that was presented simultaneously with the sound of a musical instrument. In high-conflict blocks, participants were instructed to make either an auditory or visual speed judgment, which often were mapped to competing response alternatives. In low-conflict blocks, subjects had to make a visual width discrimination or an auditory instrument discrimination. In these blocks, the semantic decision space did not overlap between sensory channels. fMRI analyses revealed trend-level attentional modulation in LGN, as well as significant modulation of early visual areas, when visual stimuli were relevant targets versus irrelevant distractors. In contrast, a conflict-dependent suppression was only revealed in LGN and not other early visual areas. This suppression effect is difficult to explain through a simple attentional vigilance account, since LGN showed the lowest activity in the most difficult condition (as confirmed by behavior). This effect may be due to cross-modal interactions between thalamic nuclei, as predicted by single-unit studies. In conclusion, these findings confirm that modality-specific attentional modulation occurs at multiple levels of early sensory processing and further suggest that the thalamus may serve as a gatekeeper to help mitigate cross-modal conflict.

A11

NEUROFEEDBACK TRAINING ENHANCES THE EFFICIENCY OF CORTICAL PROCESSING IN NORMAL AGING

Elena K. Festa¹, William C. Heindel¹, Nina C. Connors¹, Lawrence Hirshberg¹, Brian R. Ott¹, ¹Brown University – The goal of the present study was to examine the efficacy of neurofeedback training (NFT) in improving selective neurocognitive measures of attention and sensory processing in normal aging. Healthy elderly subjects received either: a) real-time feedback linked to their individual brain activity (real-NFT group); or b) playback recordings of the actual feedback obtained from demographically-matched participants in the real-NFT group (mock-NFT group). Neurofeedback was based on a global z-score protocol in which participants trained to normalize quantitative brainwave parameters across four central posterior sites (C3, C4, P3, P4) that existed outside of a threshold as determined by a normative database. All participants were administered eight NFT sessions across four to six weeks, with mood and arousal measures and EEG recordings of resting brain activity obtained both immediately before and after each training session. To evaluate the effect of NFT on cognitive functioning, a battery of neuropsychological tests, neurocognitive tests of attention and sensory integration, and EEG recordings of resting brain activity were obtained both prior to and after the eight train-

ing sessions. For the real-NFT participants, neurofeedback produced a selective improvement in the efficiency of processing within the posterior sensory cortical network, but not in those selective attention and executive control processes associated with more anterior cortical networks. The mock-NFT participants showed either no change or a selective impairment on all outcome measures. Taken together, these results indicate that neurofeedback training can be effective in inducing changes in cortical processing associated with improvements in specific aspects of cognitive functioning.

A12

THE EFFECT OF AROUSAL ON HEMISPHERIC ATTENTION

Michael Minnema¹, Eran Zaidel¹, ¹University of California, Los Angeles –

INTRODUCTION: The two normal cerebral hemispheres constitute two independent cognitive systems, each orchestrated by its own attentional networks. We explored the effect of arousal on the attentional networks of the two hemispheres. We used a truncated, lateralized version of Posner's Attention Network Test. Our test measures three networks of attention in each hemisphere: (1) executive attention/Conflict Resolution, (2) spatial Orienting Cost and (3) spatial Orienting Benefit. METHOD: Forty-five undergraduates completed the task under conditions of high, mild, and no social arousal. Arrow targets pointing up or down were presented tachistoscopically up or down to only one hemisphere. Targets were flanked by congruent or incongruent arrows (Conflict) and preceded by valid, invalid, or central/neutral cues. The advantage of valid relative to neutral cues defines Orienting Benefit and the cost of invalid relative to neutral cues defines Orienting Cost. Subjects had to indicate unimanually the direction of the target arrow. RESULTS: There was a significant interaction of Arousal x Conflict, showing that Conflict decreased (improved) under mild arousal, but increased under high arousal. There was also a significant interaction of Arousal x target Visual Field (left, right) x spatial Orienting, showing a larger Orienting Benefit and a lower Orienting Cost in the right than the left hemisphere. CONCLUSION: Arousal followed the Yerkes-Dodson law for Conflict in both hemispheres. However, arousal affected selectively spatial Orienting in the right hemisphere. This conforms with the differential deficits in spatial attention observed in patients with left or right parietal lesions.

A13

VISUAL ATTENTION INTERACTS WITH CONGRUENCY OF LETTER/SOUND COMBINATIONS IN LATE AUDITORY ERPS

Ulrike Zimmer¹, Suksun Itthipanyanan¹, Marty Woldorff¹, ¹Center of

Cognitive Neuroscience, Duke University, Durham, NC – Reading of written letters can be slowed by incongruent, but speeded up by congruent, letter-sound combinations. Neuroimaging studies, using attended task-relevant stimuli, have revealed higher brain activity for incongruent than congruent stimulation in auditory cortex. In contrast, studies using passive (i.e., "unattended") stimulation have found the opposite pattern. However, these studies have all examined congruency effects for exclusively attended or unattended stimuli. Here, we specifically asked how selectively focused visual-spatial attention modulates ERP brain-activity patterns for congruent versus incongruent letter-sound pairs. Subjects attended to one of two concurrent streams of visual letters presented to the left and right fields. On some stimulus trials, a task-irrelevant letter sound was presented centrally, the responses to which were extracted by a series of subtractions for the different conditions. The modulation of the central-auditory letter-sound responses due to visual attention (i.e., being presented with an attended versus unattended lateral visual letter) differed as a function of congruency, but only at later latencies. First, at ~250-300ms, a frontal negativity was elicited only by incongruent auditory-letter sounds concurrent with attended visual-letter stimuli, consistent with an anterior-cingulate conflict response. Second, at ~500-550ms, another frontal negativity was observed revealing an attentional modulation interaction for incongruent versus congruent auditory ERPs. More specifically, the pattern suggests that if a visual letter is attended, a synchronous incongruent letter sound seems to act as a distracter that cap-

tures attention, evoking conflict detection in the ACC, followed by other cortical increases of activity that may reflect suppression of the distracting sound input.

A14

INHIBITION OF RETURN ACROSS MODALITIES: ELECTROPHYSIOLOGICAL EVIDENCE FOR CROSSMODAL BIASING OF ATTENTION

Jessica Green¹, John McDonald¹; ¹Simon Fraser University – Recent work in our lab has associated inhibition of return (IOR) - the slowing of responses to stimuli that appear at previously attended spatial locations - with a reduction of the N2pc component of the visual event-related potential (ERP). The N2pc, which reflects attentional processing of a visual stimulus, was reduced in amplitude when the target appeared at the same location across successive trials compared to when the target appeared at a new location. Here we adapted our paradigm to investigate audiovisual IOR. We used a target-target paradigm in which visual (V) and auditory (A) target trials were intermixed, resulting in consecutive targets in the same (VV and AA) or opposite (AV and VA) modality. Within each of these conditions the target could appear at the same or opposite location on successive trials. Both the N2pc to visual targets and a contralateral negativity to auditory targets were reduced for same location trials, regardless of the modality of the preceding target, highlighting the role of a location-based attentional bias in IOR. We then used distributed source modeling to estimate which brain areas were activated in each condition. We observed attention-related activities in regions of medial and lateral prefrontal cortex that were common to all conditions, suggesting the involvement of a supramodal attention system in producing IOR. In addition, in sensory-specific auditory and visual cortices we observed activities that reflected attentional processing of the current target as well as activities that reflected the suppression of the previous target location and modality.

A15

MIND WANDERING AND EARLY ATTENTIONAL SELECTION: ERP EVIDENCE FOR CROSS-MODAL EFFECTS

Julia W. Y. Kam¹, Todd C. Handy¹; ¹University of British Columbia – Mind wandering has been associated with reduced cognitive and sensory analysis of external visual events. However it is unclear whether the attenuation of sensory responses is restricted to the visual modality. This study examined whether mind wandering is associated with reduced early attentional sensory responses in both the visual and auditory modality. Participants performed a target detection task at fixation while event-related potentials (ERPs) were recorded. Interspersed with each target were a task-irrelevant probe in the visual periphery, and a task-irrelevant tone, presented in a randomized order. At the end of each trial block, participants self-reported on whether or not they had been mind wandering at the conclusion of the trial block. The ERPs to the visual and auditory probes were then examined as a function of whether or not they immediately preceded a report of mind wandering versus on task. Data analysis found that the visual sensory-evoked P1 and auditory sensory-evoked N1 ERP components both showed decreased amplitude during periods of mind wandering relative to being on-task. Our data thus suggests that the effect of mind wandering on early attentional selection is cross-modal in nature, equally affecting both visual and auditory inputs.

A16

THE IMPACT OF AGING ON SLIPS OF ACTION IN EVERYDAY LIFE

Amanda Clark¹, Eric Roy¹, Daniel Smilek¹, James Lyons²; ¹University of Waterloo, ²McMaster University – Many of our daily activities are successfully achieved through goal-oriented routines. This is an illustration of the adaptability and efficiency of information processing but nevertheless, slips of attention and action do occur. This study was designed to determine if slips of action can be induced in a well learned task and if so, how these slips are impacted by aging. We induced action errors in both younger and older adults by occasionally altering a routine action sequence and measured the frequency of errors in addition to reaction (RT) and movement times (MT). Participants also completed the Atten-

tion-Related Cognitive Errors Scale (ARCES), a measure of attention failures in daily life and the Sustained Attention to Response Task (SART). Numerous slips were committed by both participant groups but the older adults were surprising more accurate in the face of alterations to the routine. Also, while errors on the SART were highly predictive of slips, the ARCES only predicted errors on trials that did not require a change in the routine action sequence. By understanding the mechanisms through which slips are induced and how they relate to both errors in everyday life and aging, we hope to be able to use our slip induction task to identify individuals who are prone to attention failures and equip them with strategies to protect themselves in activities of daily living.

A17

THE DECOUPLED MIND: PHYSIOLOGICAL AROUSAL AND THE FOCUS OF ATTENTION DURING VIGILANCE

Jonathon Smallwood¹, Michael Franklin¹, Jonathan Schooler¹; ¹University of California, Santa Barbara – States of imaginative thought occupy a large proportion of our waking life and yet little is known about how different foci of attention are associated with physiological changes. This study employs novel statistical techniques to examine how different physiological measures (including skin conductance and heart rate) relate to the effectiveness of external attention. The results demonstrate how components of physiological arousal differentially relate to the focus of attention and suggests that physiological changes could be critical in understanding how internal and external focus of attention emerge.

Attentional processes: Visual

A18

SUPPORTING THE LINK BETWEEN THE LOCUS COERULEUS - NOREPINEPHRINE SYSTEM, THE P300, AND THE ATTENTIONAL BLINK

Christopher Warren¹; ¹University of Victoria – This poster presents evidence in support of the hypothesis that the locus coeruleus - norepinephrine (LC-NE) system is the neurophysiological basis of both the attentional blink (AB) and the event related potential (ERP) component known as the P300. The LC-NE system is thought to provide a brief burst of processing facilitation in response to motivationally salient events. The AB refers to decreased accuracy for reporting the second of two targets (T1 and T2) inserted into a rapid serial visual presentation (RSVP). The LC-NE account of the AB holds that the AB is the result of a refractory-like period in LC-NE activity. The LC-NE account of the P300 suggests the P300 is the electrophysiological manifestation of the activity of the LC-NE system. The proposed three-way link between these different aspects of brain activity is supported by work showing that subjects who show a larger amplitude P300 response to T1 (T1-P300) in the AB paradigm demonstrate a greater deficit for reporting T2 (Shapiro et al., 2006). Until the work reported here, this relationship has not been shown within subjects, across trials. I ran a typical AB experiment and used single trial analysis of the P300 in response to T1 (T1-P300) to categorize trials into low- and high-amplitude trials. The high-amplitude T1-P300 condition showed a greater T2 deficit. Consistent with the LC-NE theory of the AB, I conclude that T1-P300 amplitude indexes the investment of NE facilitated processing to T1, with resulting cost to T2.

A19

THE ROLE OF THE LEFT AND RIGHT FEF IN VOLUNTARY CONTROL OVER OCULOMOTOR REFLEXES; A TMS STUDY

Martijn G. van Koningsbruggen¹, Alex List¹, Robert D. Rafal¹; ¹School of Psychology, Bangor University – TMS was used to investigate the role of the left and right FEF in the voluntary control over oculomotor reflexes. TMS was used to investigate the role of the FEF in the cognitive control of oculomotor reflexes. The FOE, which is the difference in saccadic reaction time between overlap and offset trials, is a measure of the amount of influence an external fixation point has over oculomotor behaviour. For example, the FOE is larger when executing pro-saccades, than anti-sac-

causes. The reduced FOE during anti-saccades reflects an increase in voluntary control over the fixation reflex. It has been shown in monkeys that, in order to suppress reflexive saccades when anti-saccades are required, the preparatory set increases fixation related activity. Due to this increase in activity of fixation related process, the oculomotor system is less influenced by the presence or absence of an external fixation point, i.e. reducing the size of the FOE. Patients with unilateral lesions in the Frontal Eye Fields are impaired in controlling their oculomotor reflexes as measured by the FOE. In the present study, we investigated whether TMS over either the left or right FEF has the same effect in healthy controls. We measured the size of the Fixation Offset Effect (FOE) during both a block of Pro-saccades and Anti-saccades, while TMS was applied over either the left, or right FEF, or a sham control side. So far (N=4), results suggest that TMS over the FEF results in a loss of voluntary control over oculomotor reflexes.

A20

LINKING THE OCULAR MOTOR SYSTEM AND REFLEXIVE ALLOCATION OF ATTENTION: AN FMRI INVESTIGATION *Shai Gabay¹, Yoni Pertzov², Libe Gradstein³, Avishai Henik¹, Galia Avidan¹, ¹Zlotowski Center for Neuroscience, Ben-Gurion University of the Negev, Beer-Sheva, Israel, ²Interdisciplinary Center For Neural Computation, The Hebrew University, Jerusalem, Israel, ³Soroka Medical Center, Beer-Sheva, Israel* – It is generally accepted that eye movements and covert attention are closely related but the exact association between these two processes is still under debate. We addressed this issue by investigating a patient (GS) with Duane Retraction Syndrome—a congenital impairment in executing horizontal eye movements affecting only the left visual field in her left eye. GS and control participants performed Posner's exogenous cuing task during an fMRI scan. The experiment was repeated twice, each time with only one eye open. Behavioural results revealed an exogenous validity effect for controls in both eyes and both visual fields. Importantly however, a reversed pattern was found in GS's restricted visual field, even though no eye movements were required or preformed during the task. fMRI data revealed lower activation for GS in the left intraparietal sulcus (IPS), known to be involved in orienting of attention, when cues were presented in the restricted visual field. That is, GS presented intact behavioural performance and brain activation when viewing stimuli in the healthy visual field—evidence for normal development of attention. In spite of this, covert orienting depended on the ability to execute appropriate eye movements even when they were not explicitly required. This result provides evidence for a strong linkage between the reflexive orienting system and the ocular motor system.

A21

THE CAUSAL ROLE OF THE DORSOLATERAL FRONTAL CORTEX IN THE STROOP COLOR-NAMING TASK *Eishi Asano¹, Shin-ichiro Koga¹, Robert Rothermel¹, Csaba Juhász¹, Miho Fukuda¹, Masaaki Nishida¹, Sandeep Sood¹; ¹Children's Hospital of Michigan, Wayne State University* – Previous human studies using functional MRI demonstrated that a Stroop color-naming task induced greater cortical activation in the left dorsolateral-frontal region, compared to a word-reading task. In the present study, we evaluated event-related gamma-oscillations (80 - 100 Hz) during the Stroop color-naming and word-reading tasks in two epileptic patients who underwent intracranial electrocorticography. Using our in-vivo animation technique (Brown et al, NeuroImage 2008; Fukuda et al, Brain 2008), we delineated 'how' color-naming-specific gamma-augmentation involved the left dorsolateral-frontal region. Both Stroop color-naming and word-reading tasks commonly induced gamma-augmentation in the posterior-inferior temporal region immediately following presentation of colored-word stimuli. Both Stroop color-naming and word-reading tasks also commonly induced gamma-augmentation in the inferior Rolandic region immediately prior to and during overt responses. In addition, the Stroop color-naming task specifically induced gamma-augmentation in the left dorsolateral-frontal region approximately 500 - 300 msec prior to overt responses. Electrical stimula-

tion of the site showing color-naming-specific gamma-augmentation resulted in temporary naming impairment in both patients. The present study has provided further evidence that the left dorsolateral frontal region plays a causal role in the Stroop color-naming task.

A22

PRISM ADAPTATION REVERSES THE LOCAL PROCESSING BIAS IN PATIENTS WITH RIGHT TEMPORO-PARIETAL JUNCTION LESIONS *Janet Bultitude¹, Robert Rafal^{1,2}, Alexandra List¹; ¹School of Psychology, Bangor University, ²Wolfson Centre for Clinical and Cognitive Neuroscience* – Lesions to the right temporo-parietal cortex commonly result in hemispatial neglect. Lesions to the same area are also associated with hyperattention to local details of a scene and difficulty perceiving the global structure. This local processing bias is an important factor contributing to neglect and may contribute to the higher prevalence of the disorder following right compared to left hemisphere strokes. In recent years promising evidence has emerged for improvements in neglect symptoms following adaptation to rightward-shifting prisms. Explanations for these improvements have generally described a leftward realignment of attention, however the present investigation provides evidence that prism adaptation reduces the local processing bias. Five patients with right temporal-parietal junction lesions were asked to identify the global or local components of hierarchical figures before and after undergoing visuo-motor adaptation to rightward-shifting prisms. Prior to prism adaptation the patients had difficulties inhibiting the local elements when identifying the global component compared to ten age- and gender-matched controls. Following prism adaptation, however, this pattern was reversed, with greater global interference during local identification. The results suggest that prism adaptation may improve non-spatially lateralised deficits that contribute to the neglect syndrome.

A23

HOW DO WE LOOK AT FACES? *Aurelie Porcheron¹, Walter Jenner², Juergen Prippl², Maja Pivec², Michael Binder³, Erwin Tschachler^{1,3}, Frederique Morizot¹; ¹CE.R.I.E.S, Neuilly sur Seine, France, ²University of Applied Sciences FH JOANNEUM, Information Design, Graz, Austria, ³Medical University of Vienna, Dermatology, Vienna, Austria* – Facial appearance is an important source of social affective information. Face perception and visual attention play an important role in the judgement of social characteristics. The analysis of gaze behaviour provides information on how we are looking at faces. The objective of the present study was to determine the facial areas used for age estimation. The eye movements of women exposed to faces demonstrating different signs of aging was tracked. Twenty two women aged between 39 and 45 were exposed twice to 48 female facial pictures: a first time without any instruction, and a second time with the instruction to estimate the age of the faces shown. Images of the faces showing different signs of aging were from women of three age groups: young (30 to 39), middle (40 to 49) and old (50 to 59). We observed a common behaviour in the group of viewers exposed to female faces whatever the instructions. When subjects were instructed to rate the age of a face, their eyes remained fixated within an area which covers the eyes, the nose and the middle upper part of the mouth. More than 75,5% of all fixations fall within this area, whereas when subjects were instructed to just look at the faces, this area demanded only 64,7% of all fixations. Our results suggest that we mainly look at internal features when estimating the age of a face and we strongly focus on the eyes.

A24

PARIETAL CORTEX REPRESENTATION OF VISUAL PRIORITY: EVIDENCE FROM SPATIAL NEGLECT *Masud Husain^{1,2}, Victoria Singh-Curry^{1,2}, Jon Driver¹, Paul Bays^{1,2}; ¹Institute of Cognitive Neuroscience, University College London, UK, ²Institute of Neurology, University College London, UK* – Where we look is determined both by our current intentions and by the tendency of visually salient items to 'catch our eye'. This normal process of directing attention can be profoundly impaired by damage to parietal cortex, resulting in visual neglect of the contralesional hemispace. Here we use neglect patients' (n=5) eye movements in a

visual search task to separately evaluate impairments in goal-directed orienting to targets and in stimulus-driven orienting to salient distractors. These deficits are shown to be identical in both magnitude and spatial distribution. The findings appear consistent with damage to a single topographically-organized 'priority map' in posterior parietal cortex, representing both the goal-relevance and the visual salience of items in the visual scene. According to this hypothesis, left neglect occurs when right-hemisphere damage leaves left hemispace under-represented in the priority map, resulting in a pathological bias of attention towards ipsilesional space. However, because targets of attention are chosen by competition within the map, shifts of attention to left hemispace should still be possible if the leftward input is strong enough to overcome the over-representation of right space. We used an adaptive algorithm to systematically vary the distribution of distractor luminance in a search array, searching for a display that will normalize a patient's exploratory behaviour. Consistent with the priority-map hypothesis, we demonstrate that the rightward bias in neglect can indeed be eliminated and even reversed by biasing the distribution of visual salience towards the left.

A25

DISTRIBUTION OF GAZE AND ATTENTION DURING FACIAL IDENTITY AND EXPRESSION TASKS Susan M. Letourneau¹, Teresa V. Mitchell²; ¹Brandeis University, ²E.K. Shriver Center, University of Massachusetts Medical School – Two studies compared the distribution of gaze and attention during emotion and identity judgments. We hypothesized that the top and the bottom of the face would vary in salience depending on the type of judgment being made. Subjects learned names for a set of faces, and then were asked to make identity or emotion judgments of whole faces, isolated top halves, and isolated bottom halves of faces. Eye-tracking data was gathered and accuracy was measured. Subjects were more accurate in both tasks when whole faces, rather than isolated top or bottom halves, were presented. Emotion was recognized more accurately from the bottom of the face than the top, while the opposite was observed for identity judgments. Despite this difference, the top of the face immediately captured subjects' gaze in both tasks. Saccades were made to the bottom half of the face only during the emotion task, specifically from 500-1000ms after stimulus onset. In the second study, subjects were asked to identify the name or emotional expression in the top or bottom half of briefly presented composite faces (combining the top of one identity or emotion with the bottom of another). Subjects more accurate when judging emotion from the bottom halves of the stimuli, and when judging identity from the top halves. In sum, while early gaze fixations tend to fall on the top half of the face regardless of the task, later fixations and attention patterns are highly dependent upon the task and stimulus characteristics.

A26

DOES POWER SHIFT ATTENTION ON A VERTICAL DIMENSION? AN EVENT RELATED POTENTIAL STUDY Kiki Zanolie¹, Jasper Wijnen², Saskia van Dantzig^{1,3}, Inge Boot¹, Diane Pecher¹; ¹Erasmus University Rotterdam - Institute for Psychology, ²University of Amsterdam, ³Leiden University Institute for Psychological Research – People often use the spatial dimension up-down metaphorically when speaking and thinking of power. Studies show that thinking of power automatically activates the 'power is up' metaphor. This raises the question whether power stimuli can induce a shift of attention to the upper or lower visual field. To address this question, Event Related Potentials were recorded during a dual-task. Participants made power judgments to words denoting powerful or powerless people (e.g. 'king' or 'servant'), presented centrally. Following each judgment, a target letter was presented in the upper or lower visual field. Findings of 15 participants show an enhanced P1 and N1 amplitude when the spatial position of the target is congruent with the metaphorical direction of the preceding word (powerful-up, powerless-down). This result suggests that power stimuli induce a spatial shift of attention corresponding to their implied

direction, providing further evidence that metaphors play a role in grounding abstract concepts in sensorimotor processing.

A27

DIFFERENTIAL EFFECTS OF EXOGENOUS AND ENDOGENOUS ATTENTION ON PERCEPTUAL LEARNING Ikuko Mukai¹, Kandy Bahadur¹, Leslie Ungerleider¹; ¹Laboratory of Brain and Cognition, NIMH, NIH – Perceptual learning is a phenomenon in which one's visual perception improves after repeated exposure to a visual stimulus. However, large differences in the rate and extent of perceptual learning are often observed among subjects, for unknown reasons. Based on results from our previous study (Mukat et al., J. Neurosci 2007), we hypothesized that attention plays a key role in facilitating perceptual learning. To manipulate spatial attention at different locations during training, we used exogenous and endogenous attention cues. Training stimuli (tilted Gabor patches) were placed within four quadrants of the visual field. Subjects decided if the Gabor patch at a task location was tilted to the right or left from the vertical meridian. The contrasts of the stimuli were set at an accuracy level of 75% correct, based on threshold measurements conducted before training. When we manipulated attention by exogenous attention cues, we found a large improvement in accuracy and reaction times at the cued location but no significant improvement at the uncued location. On the other hand, when we manipulated attention by endogenous cues, improvements were observed at both cued and uncued locations, though accuracy was better and reaction times were shorter for the cued location. One possible explanation for these results is that exogenous, but not endogenous, attention facilitates perceptual learning. Another possibility is that our endogenous manipulation, specifically the number of valid task trials, did not sufficiently control subjects' attention during training. We will investigate this further by increasing this number and seeing its effect on learning.

A28

DISCRIMINATING DIFFERENT ATTENTION LEVELS BY THE ELECTROPHYSIOLOGICAL AND BEHAVIORAL MEASURES Yu-Chieh Chang¹, Shwu-Lih Huang^{1,2}, Ai-Ru Lee¹, Huan-Chun Sun¹; ¹National Chengchi University, ²Research Center for Mind, Brain & Learning, National Chengchi University – The purpose of present study is to find out indices which can discriminate different attention levels. Most of the previous studies could hardly control perceptual content well while manipulating attention levels. Thus the indices found may reflect a mixed effect from perceptual content and attention levels. Therefore, the task was revised in present study by equalizing perceptual content in different attention levels. A lot of measures such as electroencephalography (EEG), electrooculography (EOG), respiration and temperature were recorded simultaneously while doing the task. Four conditions were manipulated to induce different attention levels. In baseline condition, participants took a rest, opened their eyes and being motionless. In control condition, participants observed movie clips only. In low attention condition, participants observed the same clips and counted the easy target events defined by one feature dimension only. In high attention condition, participants counted the difficult target events defined by two feature dimensions conjointly. Based on the Feature Integration Theory, our high attention condition consumes more attention resources than the low attention condition. In order to equalize perceptual content in different attention levels, movie clips used in our conditions of control, low attention, and high attention were totally identical. A MANOVA analysis (N=24) of the data revealed that only power value of alpha band (8.2-12.9Hz) and delta band (1-2Hz) of EEG and blink duration may potentially discriminate different attention levels. The implications of present findings in psychophysiology and cognitive neuroscience could lead more explorative investigations in the future.

A29**PRISMS IMPROVE BOTH ACTION AND PERCEPTION IN AN ARTIST WITH NEGLECT**

James Danckert¹, Nadine Quehl¹, Colleen Merrifield¹; ¹University of Waterloo – We recently tested the hypothesis that prisms will influence dorsal but not ventral stream processing in patients with neglect using the line bisection and landmark tasks. In two patients with neglect we showed improvement in the line bisection task but no change in the landmark task, which represents a perceptual variant of line bisection. Here we tested a patient who had been a graphic artist prior to suffering a right fronto-parietal stroke leading to dense unilateral neglect. Prior to prisms he showed only a minor rightward bias on the line bisection task and a marked leftward bias on the landmark task (note: leftward biases on this task indicates that the patient perceives the left half of the line to be shorter than the right even when they are of equivalent lengths). After prisms the patient showed a significant leftward shift in line bisection mirroring the same effects observed in other neglect patients. In contrast to our previous work, this patient also showed a marked change in the landmark task such that he was no longer biased toward perceiving the left end of the line as shorter (his responses were more equally distributed towards left and right responses). It may be the case that accomplished artists have far stronger linkages between perception and action than do non-artists. Prisms may have restored such linkages for our patient leading to improved perception and action.

A30**HIGH-FIELD FMRI REVEALS CONTRALATERAL AND EGOCENTRIC-REFERENCE-FRAME PROPERTIES OF THE SUPERIOR COLLICULUS DURING SACCADE EXECUTION IN HUMANS**

Ruth Krebs^{1,3}, Marty Woldorff³, Claus Tempelmann¹, Nils Bodammer¹, Toemme Neosselt¹, Carsten Boehler^{2,3}, Jens-Max Hopf^{1,2}, Emrah Duzel¹, Hans-Jochen Heinze^{1,2}, Ariel Schoenfeld^{1,2}; ¹Clinic for Neurology, University of Magdeburg, Germany, ²Leibniz-Institute for Neurobiology Magdeburg, Germany, ³Center for Cognitive Neuroscience, Duke University, United States – Neural correlates of saccade execution in humans were mapped using 7T high-field fMRI. Subjects performed centrally cued saccades to a left or right lateral target square (centrifugal saccade) and maintained the new position until a second cue at that location indicated to return back to the center (centripetal saccade). Activity in the superior colliculus (SC) was significantly larger contralateral to the direction of the saccade, providing direct evidence for the contralateral functional anatomy of the SC in humans. Additionally, the SC exhibited higher activity for centrifugal compared to centripetal saccades, presumably reflecting higher processing demands. Correspondingly, centrifugal saccades were also associated with substantially greater deactivations in the default-mode network than were centripetal saccades, further supporting the notion that the return to the center of egocentric reference space is less effortful. These differential reference-frame effects may be due to reduced requirements for calculating the reference coordinates and thus for attentional allocation during saccades that return to the center of egocentric space. More generally, the present data support the view that the center of straight gaze, in which retinotopic and the egocentric frame are aligned, might represent the natural default baseline value for eye movements from which the visual world can be explored.

A31**NEURAL MODULATION OF RHYTHM INDUCED TEMPORAL EXPECTATIONS**

Gustavo Rohenkohl¹, Anna Dal Molin^{1,2}, Anna Christina Nobre¹; ¹University of Oxford, ²University of Verona – Time is an essential dimension of our experience, framing human behaviour at scales ranging from the millisecond organization of motor actions to circadian rhythms cycle, and beyond. Nevertheless, the mechanisms by which the brain keeps time and uses temporal information to organise behaviour remain unknown. Whereas the principles of the organisation of spatial cognition in the human brain are emerging, the same is not true for temporal cognition. The current study tested the influence of tempo-

ral expectations on attentional orienting to moving targets. In this task, a ball appeared at the left side of a screen and moved across the screen in steps following either a regular or irregular rhythm. After reaching an occluding band, the ball was temporarily occluded. When the ball reappeared, it contained either an upright (50%) or tilted (50%) cross. The task involved making a speeded perceptual discrimination about the target stimulus that reappears after the occlusion. The results indicated a strong behaviour benefit from temporal orienting. We recorded ERPs elicited by reappearance of the target stimulus, and investigated how temporal expectations influenced perceptual (e.g., visual P1 potential) and motor (lateralised readiness potential) stages of neural processing. The results showed that temporal expectations facilitated both early visual (P1) as well as motor (LRP) potentials. We are currently comparing induced frequency activity during the pre-occlusion and occlusion periods to look for modulation of rhythmic activity in lower frequency bands related to visual (alpha) and motor (mu) processing.

A32**DISTRACTIBILITY WITH ADVANCING AGE AND PARKINSON'S DISEASE: EVIDENCE OF DYSFUNCTIONAL REACTIVE INHIBITION**

Liana Machado¹, Amy Devine¹, Natalie Wyatt¹; ¹University of Otago – Focused attention can be compromised by the neurodegenerative processes associated with both healthy aging and Parkinson's disease (PD). Deficits in ignoring distractors with reflexive or overlearned response links have been attributed to impaired inhibition. The current research assessed whether similar deficits occur for distractors with recently learned arbitrary response associations, for which sensorimotor transformations are far less automatic and therefore considerably easier to resist. We used a selective attention task that evaluated distractibility and the use of distractor inhibition within the same context. The task involved stimuli that were arbitrarily assigned to responses based on a rule learned during the testing session. Performance showed that distraction increased with both healthy aging and PD. Moreover, these increases in distraction were accompanied by decreases in overt evidence of distractor inhibition, which appear to reflect at least in part a failure of reactive inhibition. Removing the distractor prior to the appearance of the target eliminated the age- and PD-specific increases in distractibility; however, inhibitory deficits remained evident. Comparison of the two groups indicates that the key differences reflect severity of symptoms, rather than distinct symptoms, suggesting that the deficits stem from neural changes associated with both advancing age and PD. These results demonstrate that age- and PD-related hyper-distractibility and impaired inhibition during focused attention affect stimuli without prepotent response links, suggesting a critical role for dopaminergic networks in the strategic control of arbitrary visuomotor transformations.

Emotion**A33****EMOTIONAL MEMORY CONSOLIDATION IN A CONDITIONAL DISCRIMINATION PARADIGM USING FMRI IN HUMANS**

Amal Achaibou^{1,2,3}, Irina Constantinescu^{1,2}, David Sander^{2,3,1}, Patrik Vuilleumier^{1,2,3}, Sophie Schwartz^{1,2,3}; ¹University of Geneva, ²Center for Neuroscience, University of Geneva, ³Swiss Center for Affective Sciences, University of Geneva – In classical aversive conditioning paradigms, a neutral stimulus (conditioned stimulus, CS) is paired with an aversive stimulus (unconditioned stimulus, US) and acquires an emotional valence. A conditioned response (CR) is then observable after presentation of the CS alone. Extinction of the CR occurs when the CS is presented alone for several trials, corresponding to a new safety-related memory rather than to the forgetting the conditioning phase. While this has been commonly used to assess fear inhibition, it remains difficult to disentangle between the "aversive" and "safety" signals associated with the CS. We used a conditional discrimination paradigm, in 21 participants while

they viewed pairs of faces during fMRI. One pair (AX, excitatory) was associated with an aversive noise (US) whereas another pair (BX, inhibitory) was never associated with the US. During a subsequent testing phase, subjects viewed the same pairs and 2 additional pairs to test the transfer of inhibition (AB) and of excitation (AC). Between sessions, participants took a 45-minute nap while their EEG was recorded, allowing us to assess any influence of sleep on emotional memory. Behaviorally, preliminary results show increased pupil responses to AX as compared to BX during testing, indicating efficient conditioning. In fMRI, we found increased activity in the Insula for AX as compared to BX and in prefrontal, hippocampal and retrosplenial regions for BX as compared to AX, suggesting a role of contextual memory systems for acquisition of safety signals. Further analysis will focus on sleep influence on emotional learning and associated brain activity.

A34**EEG MEASURES OF ADULT RESPONSE TO INFANT EMOTION**

Jeffrey K. Erbe¹, Nicole Landi^{1,2,3}, Julia R. Irwin², W. Einar Mencl², Jocelyn L. Topf⁴, Mark N. Potenza⁴, Linda C. Mayes¹; ¹Yale Child Study Center, New Haven, CT, ²Haskins Laboratories, New Haven, CT, ³University of Minnesota, ⁴Yale School of Medicine, New Haven, CT – At the earliest stages of infant development, the primary way in which infants communicate with caregivers is through facial expression and vocalizations such as cries. Thus, it is of great importance to understand how and when human caregivers process this information. Two experiments were conducted to examine EEG response to infant emotion in female adults. The first study compared processing of infant faces expressing happy, neutral or sad affect; the second study compared processing of low distress and high distress infant cries. We conducted temporal principle components analyses (PCA) for each of a set of a priori defined scalp regions for each experiment, followed by a series of repeated measures ANOVAs. In the face study we observed a large N170 effect in the right hemisphere occipital parietal scalp region that was modulated by valence such that both happy and sad faces produced more negative deflections than neutral faces, consistent with theories that postulate that the N170 and not just later components are sensitive to emotion (e.g., Blau et al, 2007). The cry analyses revealed more negative N1 responses to high distress cries relative to low distress cries. Critically, this EEG response demonstrates that the N1 is modulated by perceived distress level (previous research on cries has shown that the N1 is more negative for cries relative to a neutral sound, but has not examined distress level). Taken together these findings reveal that information about infant emotional valence is processed at very early stages of visual face and auditory cry perception.

A35**FUNCTIONAL CORTICAL ACTIVATION ASSOCIATED WITH PROCESSING OF INFANT EMOTIONAL STATES**

Nicole Landi^{1,2,3}, W. Einar Mencl², Jeff Erbe³, Mark Potenza⁴, Julia Irwin², Jocelyn Topf⁴, Linda Mayes³; ¹University of Minnesota, Minneapolis, MN, ²Haskins Laboratories, New Haven, CT, ³Yale Child Study Center, New Haven, CT, ⁴Yale School of Medicine, New Haven, CT – The nature of the bond between infant and caregiver has important effects on children's developmental trajectories. Because this bond is formed very early in development, during a time when the primary communication from the infant to the care-giver is expressed via facial expression and vocalizations such as coos and cries, it is of great interest to understand how care-givers process the emotional content of these basic visual and pre-verbal communications. We used event-related fMRI to examine the underlying neurocircuitry associated with this process. Twenty adult females viewed infant faces expressing happy, sad, or neutral emotion, and cries expressing high or low distress. The comparisons of infant face processing revealed modulation of the anterior cingulate (an area previously implicated in processing of infant facial affect), with greater activation for sad relative to neutral faces. We also observed differential processing for sad and happy faces in the globus pallidus, an area thought to be involved in integration of emotion and body location. These findings reveal a circuit for processing of infant

facial emotion involving both cortical and subcortical regions. For auditory cries, more distressed/sad cries again produced greater activation in the anterior cingulate, as well as the insula, another area implicated in infant facial emotion processing. Together these findings indicate that processing of infant facial emotion and cries reveals a partially overlapping network of regions that have been implicated previously in emotion processing.

A36**ACTIVE SUPPRESSION OF FACIAL MOVEMENT DIMINISHES BUT DOES NOT ABOLISH AUTOMATIC FACIAL MIMICRY**

Sebastian Korb^{1,2}, Didier Grandjean^{1,2}, Klaus Scherer¹; ¹Swiss Center for Affective Sciences, Geneva, Switzerland, ²University of Geneva, Switzerland – Automatic facial mimicry is a well described phenomenon involving people's reflexive tendency to display facial expressions they perceive in others. It has also been proposed to be the main process underlying emotion recognition, emotional contagion, and empathy. In order to address the question whether automatic facial mimicry persists despite voluntary, active inhibition of facial movements, we recorded facial electromyography (EMG) in healthy participants during an emotional Go/NoGo task. In a within-subjects design, participants were instructed to smile quickly to smiling faces and to keep a neutral expression to neutral faces (congruent condition), or the reverse (incongruent condition). Activity of the left corrugator and zygomaticus muscles was measured with EMG. Results showed significantly earlier activity of the zygomaticus for smiling in congruent compared to incongruent Go trials, and a higher false-alarm rate for incongruent compared to congruent NoGo trials. Moreover, activity of the zygomaticus was significantly higher during response-free incongruent than congruent NoGo trials. These results suggest that facial mimicry effects are present even at short intertrial intervals, and that they can survive participants' active suppression of facial movement.

A37**REWARDS EARNED FOR OTHERS - AN FMRI STUDY OF THE NEURAL CORRELATES OF ALTRUISM**

Jeff MacInnes^{1,2}, R. McKell Carter^{1,2}, R. Alison Adcock^{1,2,3}, Scott Huettel^{1,2,4}; ¹Center for Cognitive Neuroscience, Duke University, Durham NC, ²Brain Imaging and Analysis Center, Duke University, Durham NC, ³Duke University Medical Center, Durham NC, ⁴Duke University, Durham NC – The anticipation of reward has been reliably shown to elicit fMRI activations in the ventral tegmental area (VTA) and nucleus accumbens (NAcc). However, previous research has focused predominantly on rewards directly earned for oneself. Humans often exhibit altruistic behavior engaging in actions that lead to a reward for others, leaving an open question of whether these types of rewards are processed by mirroring self-directed rewards. We compared fMRI activations in 18 participants during a modified monetary incentive delay (MID) task in which participants played to earn money for a charity of their choosing. The experiment was divided into 2 block types, reward and punishment, where participants played to earn money or avoid losing money, respectively. Within each block participants were cued on a trial-by-trial basis whether they would be playing for themselves or for the charity. Trial outcomes were based on reaction times to targets presented following the cue. Participants received feedback on each trial. GLM analyses conducted in FSL examined fMRI activations during the anticipation period between cue and target across the different test conditions. We find strong striatal activations for both charity and self conditions. Consistent with past research examining the representation of self and other, an analysis comparing charity trial anticipation to self trial anticipation revealed significant activation in the posterior cingulate cortex (PCC) during both the reward and punishment blocks.

A38**REGULATING CRAVING FOR CIGARETTES AND FOOD: AN FMRI STUDY OF CIGARETTE SMOKERS**

Hedy Kober¹, Ethan Kross², Peter Mende-Siedlecki¹, Kevin Ochsner¹; ¹Columbia University, ²University of Michigan, Ann Arbor – A failure to regulate craving has been implicated in substance abuse disorders and in post-treatment relapse. This under-

scores the urgent need to understand the neural correlates of craving and its regulation in substance abusing populations. Therefore, this study used fMRI to examine the neural bases of craving for cigarettes and food, as well as the regulation of craving using cognitive strategies in a nicotine-dependent population. Twenty-one cigarette smokers viewed images of cigarettes and of delicious looking, unhealthy foods, and were instructed to think about either the (a) immediate sensory experience (e.g. increase craving), or (b) the long-term negative physical health implications associated with consuming each item (e.g. regulate craving). Subjective ratings indicated that participants experienced significantly less craving for both cigarettes and food when considering the long-term consequences associated with consumption, suggesting that cognitive strategies can be used to effectively regulate craving for both food and cigarettes (consistent with clinical data). On "increase craving" compared to "regulate craving" trials, we observed activation in "reward" regions including subgenual cingulate, ventral striatum, and ventral tegmental area. This pattern was stronger for cigarettes compared to food, consistent with participants' reports of greater craving for cigarettes compared to food. Conversely, on "regulate craving" trials we observed activity in "control" regions including the dorsomedial prefrontal cortex and inferior frontal gyrus. This pattern was stronger for food compared to cigarettes, suggesting a possible mechanism for the impaired regulation of cigarette craving (compared to food craving) exhibited by these cigarette smokers in everyday life.

A40

COULD THE CONTEXT BECOME A PREDICTOR OF AN AVERSIVE STIMULUS?

Marta Andreatta¹, Andreas Muelberger¹, Cornelius Gross², Peter Weyers¹, Paul Pauli¹; ¹University of Wuerzburg, ²European Molecular Biology Laboratory (EMBL) – After learning, a stimulus can signal that an expected aversive unconditioned stimulus (US) will not occur and it induces inhibition of defensive responses. Urcelay et al. (2006) in a study with rats found that context became a good predictor of US when it was presented for short periods of time in the absence of US. Thus, Pavlovian conditioned inhibition was disrupted because context competed with the stimulus predicting US (i.e. excitor) and it decreases inhibitory potential of the stimulus signaling the absence of US (i.e. inhibitor). Goal of the study is to investigate the conditions in which context becomes a predictor of US in humans. In a between-subject design, we compared Pavlovian inhibition with relatively spaced-trials (intertrial interval - ITI - 25 s) to Pavlovian inhibition with relatively massed-trials (ITI 7 s). A geometrical shape was associated with an aversive electrical shock (US) and functioned as excitor (A+), whereas a compound shape (AX-), which functioned as inhibitor, not. As index of inhibition startle reflex, skin conduction and subjective ratings were assessed during a summation test. According to animal data, we did not find conditioned inhibition modulation, when participants underwent massed-trials training. However, we would expect a conditioned inhibitory response to AX- compared to control compound shape (AY) when participants undergo a spaced-trials training. We conclude that context could work as predictor of US in rats as well as in humans. In fact, context seems to compete with the excitor and to down-modulate inhibitory effectiveness of AX-, when ITIs were short.

A41

EYE GAZE AND PUPIL RESPONSE AS INDICES OF EMOTIONAL RECOGNITION MEMORY

Daniel Younglove¹, Sara Bagley¹, Tony Buchanan¹; ¹Saint Louis University – Eye gaze and pupillometry have been used to index both emotion and memory. There is not, however, a reliable signature of gaze or pupil response patterns that predict recognition of emotional stimuli. Fifteen participants were shown 6 pleasant, 6 unpleasant, and 6 neutral pictures. Twenty-four hours later they saw each of these pictures again along with a new picture matched for content and valence in a two-alternative forced choice recognition memory task. Eye tracking methodology was implemented to examine the latency of the initial shift of gaze, duration of gaze on the initial fixation, and pupil

dilation. Participants were quicker to make their initial fixation to emotional compared to neutral picture pairs, with fixations to unpleasant pictures made the quickest, $F(2,13) = 4.98$, $p = 0.025$, $\eta^2 = 0.43$. There was no effect of prior viewing, as the latency of the first fixation did not differ between new and old pictures. Participants fixated longer on the 'old' neutral and pleasant pictures compared with the 'new' neutral and pleasant pictures, but were quicker to avert their gaze from the 'old' unpleasant pictures than from the 'new' ones, $F(2,13) = 9.1$, $p = 0.003$, $\eta^2 = 0.5$. A similar pattern was found with pupil diameter, such that 'new' unpleasant pictures elicited the greatest pupil dilation, $F(2,13) = 6.68$, $p = 0.01$, $\eta^2 = 0.51$. These results suggest that gaze pattern and pupil diameter may be useful implicit indicators of recognition memory for emotional stimuli.

A42

EMPATHIC NEURAL RESPONSE TO LIVING THINGS AS A FUNCTION OF AGENCY AND EXPERIENCE

Vani A. Mathur¹, Tokiko Harada¹, Bobby K. Cheon¹, Jason Scimeca¹, Joan Y. Chiao^{1,2}; ¹Northwestern University, ²Northwestern Interdepartmental Neuroscience Program – Living things in the natural world vary on their degree of agency (e.g., how much control they have over their world) and experience (e.g., their capacity to feel). Prior research has shown that these dimensions predict the extent to which humans infer that a living thing is capable of internal states, such as suffering. Though empathy may be defined as the human capacity to share and understand the internal states of other humans, people also display empathic feelings for other living things that vary in agency and experience such as animals and elements in the natural world. Additionally, people exhibit prosocial intentions and behaviors towards other biological entities, such as refusing to eat meat or recycling trash. Although it is well-established that neural regions within the pain matrix, such as anterior cingulate cortex (ACC) and bilateral anterior insula (AI) underlie empathy for other humans, here we examined the possibility that distinct or shared neural circuitry underlie empathic responses for biological entities in the world that vary on agency and experience. Using functional magnetic resonance imaging (fMRI), we measured neural activity while participants viewed images of humans, animals or nature in either egregiously negative (painful) or neutral situations. Results indicate that empathic neural response within the right AI varies as a function of agency and experience. Here we show for the first time that empathy for the suffering of humans, animals and nature relies on shared neural circuitry within the pain matrix.

A43

EMOTION-MODULATED VIEWING OF NEUTRAL FACES

Lily Riggs^{1,2}, Douglas A. McQuiggan^{1,2}, Jessica Chan², Ella Pan¹, Adam K. Anderson², Jennifer D. Ryan^{1,2}; ¹Rotman Research Institute, ²University of Toronto – We examined whether memory for faces, as indexed via changes in eye movement sampling behavior, could be modulated as a consequence of the type of emotional information that is associated with the face. During a study period, participants saw neutral faces presented alone, and then paired with either a negative or neutral sentence, followed by a repeated presentation of the face alone. This procedure was repeated across 5 study blocks. Viewing to particular face regions was modulated by whether the face had been associated with neutral vs. negative information. Participants spent more time viewing the eyes, and less time viewing the mouth, if the face had been associated with a negative sentence. During the test session, participants viewed displays of 3 faces presented simultaneously. The 3-face displays contained either 0, 1 or 2 faces previously paired with a negative sentence. Under free viewing conditions, memory for the emotional valence of associated information was assessed indirectly via eye movement monitoring. Sampling of the 3-face displays was related to the number of faces present within the display that had been previously associated with emotional information. For instance, the average fixation duration directed to the three faces increased with an increasing number of faces that had been previously paired with negative information; suggesting that associated emotional

information had been accessed during viewing of the faces. Altogether, these findings suggest that the retrieval of associated emotional information can alter the manner by which a perceptually neutral item is processed, even when presented in isolation.

A44**INCREASED AMYGDALA RESPONSE TO EMOTIONAL STIMULI DURING THE MID-LUTEAL PHASE OF THE MENSTRUAL CYCLE**

Joseph Andreano^{1,2}, Larry Cahill^{1,2}; ¹University of California, Irvine, ²Center for the Neurobiology of Learning and Memory – Previous studies of emotional encoding have indicated opposing effects of the ovarian hormones estrogen and progesterone on arousal-related activity in the amygdala, with emotional responses reduced during cycle phases when estrogen levels are high (Goldstein et al., 2005), but increased by progesterone treatments (Van Wingen et al., 2008). However, no study to date has assessed the effects of endogenous progesterone on amygdala activity in the context of a natural cycle, where progesterone release is coincident with the release of estrogen. To address this question, 17 naturally cycling women were scanned using fMRI during 2 hormonally distinct phases of their cycles: the early follicular phase, when both estrogen and progesterone are low, and the mid-luteal phase, when progesterone is at peak levels, and estrogen levels are also relatively increased. During both scans, participants viewed blocks of arousing negative images and blocks of low-arousal neutral images, drawn from the IAPS set. The results indicated significantly greater emotion-induced activity in the mid-luteal phase compared to early follicular phase in both the right amygdala and left hippocampus. These findings provide further support for the view that the activity of regions involved in emotional memory vary in women across the menstrual cycle due to modulatory influences of ovarian hormones.

A45**HEIGHTENED FUSIFORM GYRUS AND AMYGDALA FUNCTIONAL CONNECTIVITY DURING EMOTIONAL FACE PROCESSING IN WILLIAMS SYNDROME**

Brian W. Haas¹, Fumiko Hoeft¹, Ursula Bellugi², Allan L. Reiss¹; ¹Stanford University, Stanford, CA, ²Laboratory for Cognitive Neuroscience, Salk Institute for Biological Studies, San Diego CA – Williams syndrome (WS) is a genetic disorder caused by a hemizygous microdeletion on chromosome 7q11.23. WS is associated with a compelling symptom profile characterized by relative deficits in visuospatial function and relative strengths in face and language processing. Interestingly, WS is also characterized as being associated with a heightened drive towards social engagement. Recent brain imaging studies have demonstrated atypical fusiform gyrus and amygdala response to emotional stimuli in WS. However, emotional processing is extremely complex and involves a large neural network including the functional connections between the fusiform gyrus, amygdala and other brain structures. Based on the established social/emotional phenotype of WS, we predicted that the functional connectivity within this network would be aberrant in WS during emotional face processing. We used fMRI to study a sample of WS and typically developing (TD) participants who performed a gender discrimination task of emotional facial expressions (happy, fearful and neutral). The WS sample exhibited greater functional connectivity between the fusiform gyrus and medial prefrontal cortex compared to the TD sample during emotional face processing (both happy and fearful). The WS sample also exhibited greater functional connectivity between the amygdala and prefrontal cortex during happy face processing compared to the TD sample. These findings provide evidence that abnormal social/emotional processing in WS is in part due to atypical functional connectivity between a network of brain structures.

A46**CULTURAL VARIATION IN PERCEPTUAL STRATEGIES UNDERLYING EMOTION REGULATION**

Genna Bebkó^{1,2}, Steven Franconeri², Kevin Ochsner³, Joan Chiao^{1,2}; ¹Northwestern University

Interdepartmental Neuroscience Program, ²Northwestern University, ³Columbia University – Norms for the experience, expression, and regulation of emotion vary widely between individualistic and collectivistic cultures. Collectivistic cultures value conformity, social harmony, and social status hierarchies, so attention is directed to contextual emotion information and disruptive emotions may be suppressed. By contrast, individualistic cultures valuing autonomy and the pursuit of happiness are more likely to attend to central emotion information and to reappraise emotions to promote positive emotional experience. Here we examined how culture affects perceptual strategies employed during emotion regulation, particularly during cognitive reappraisal and emotional suppression. Eye movements were measured while healthy young adult participants viewed negative IAPS images and regulated emotions by using either reappraisal (19 Asian-American, 21 Caucasian-American) or suppression (21 Asian-American, 23 Caucasian-American). After image viewing, participants rated how negative they felt as a measure of subjective emotional experience. Consistent with prior studies, reappraisers made lower negative valence ratings after regulating emotions than suppressers across both Asian-American and Caucasian-American groups. Although no cultural variation was observed in subjective emotional experience during emotion regulation, we found evidence of cultural variation in perceptual strategies used during emotion regulation. During middle and late time periods, Asian suppressers made significantly fewer fixations to emotionally salient areas than Caucasian suppressers. These results indicate cultural variation in perceptual differences underlying emotional suppression, but not cognitive reappraisal.

A47**THE NEURAL CORRELATES OF GUILT AND SHAME - AN FMRI STUDY**

Ullrich Wagner^{1,2,3}, Karim N'Diaye^{1,2,3}, Thomas Ethofer¹, Patrik Vuilleumier^{1,2,3}; ¹University Medical School, University of Geneva, Switzerland, ²Center for Neuroscience, University of Geneva, Switzerland, ³Swiss Center for Affective Sciences, University of Geneva, Switzerland – Within the relatively new research field of "affective neuroscience" much progress has been achieved in understanding the neural bases of fundamental emotions like fear and disgust, but little research has been devoted so far to the more complex "self-conscious" emotions like guilt, shame, and pride. These emotions typically occur in interpersonal contexts and can constitute important psychological factors guiding social behavior. Here, we use an autobiographical memory paradigm to investigate the specific neural networks associated with the negative self-conscious emotions guilt and shame by functional magnetic resonance imaging (fMRI). In a pre-scanning questionnaire, subjects defined situations from their personal life that were associated with strong personal feelings of guilt or shame, as well as situations of sadness (negative basic control emotion) and neutral situations. For each situation, subjects provided general context information (place, time, other persons present) and four specific keywords. These were later used as reminder cues in the scanner, where subjects were asked to relive the personal situations and the associated feelings in their mind as vividly as possible (block design: 4 blocks of 20s mental imagery for each emotion condition). This is the first study that directly compares the neural correlates of the closely related self-conscious emotions guilt and shame. Results point to distinct patterns of brain activation associated with these emotions mostly in prefrontal and temporal areas. In particular, guilt more strongly than shame activated medial prefrontal brain areas related to self-referential processing, suggesting higher self-relevance for guilt than shame.

A48**EMPATHIC NEURAL RESPONSES TO OTHERS' PAIN ARE MODULATED BY EMOTIONAL CONTEXTS**

Shihui Han¹; ¹Peking University, China – Recent brain imaging studies indicate that empathy for pain relies upon both the affective and/or the sensorimotor nodes of the pain matrix. In addition, empathic neural responses are modulated by stimulus reality [Gu and Han, 2007; Fan and Han, 2008], personal experience [Cheng et al., 2007], and perceived fairness of others [Singer et al.,

2006]. The current work investigated whether and how empathic neural responses are modulated by social emotional contexts. Using functional magnetic resonance imaging (fMRI), we first showed that perceiving a painful stimulation (needle penetration) applied to a face with neutral expression induced activation in the anterior cingulate cortex (ACC) relative to non-painful stimulation. However, when observing the painful stimulus delivered to a neutral face was intermixed with observation of painful or happy faces, the ACC activity decreased whereas the activity in the face area of the secondary somatosensory cortex increased to the painful stimulation. Moreover, the secondary somatosensory activity associated with the painful stimulation was decreased when the painful stimulation was applied to faces with happy and painful expressions. The findings suggest that observing painful stimuli in an emotional context weakened affective responses but increased sensory responses to perceived pain and imply possible interactions between the affective and sensory components of the pain matrix during empathy for pain.

A49

BRAIN REGIONS INVOLVED IN RESISTING EMOTIONAL DISTRACTION Alan Anticevic¹, Grega Repovš¹, Jennifer Staplins¹, Tara Benesch¹, Todd Braver¹, Deanna Barch¹; ¹Washington University in St. Louis – Emotional stimuli that communicate survival relevance often demand immediate attention re-allocation. However, there are times when emotional distractions need to be suppressed in the service of ongoing goals. Human have the unique ability to resist distraction and orient attention in a goal directed fashion. This ability involves a dorsal frontal-parietal network that is engaged in a wide range of cognitive operations. One such process is maintenance and manipulation of information in working memory (WM). In the context of WM function, previous work has shown that emotional distracters have a different effect on dorsal and ventral prefrontal regions. However, one question not fully explored is the relationship between signals in these cortical regions during emotional interference and behavioral performance. Here we examine these relationships using slow event-related fMRI at 3T allowing us to discern signals at different phases of a WM task. First, we show that frontal, but not parietal nodes of the dorsal network show a within subject, trial-by-trial relationship with performance during emotional distraction. Specifically, less deactivation was associated with better performance. Conversely, in ventral frontal regions more activation was associated with better performance. Also, we demonstrate that, across-subjects, less amygdala signal correlates with better performance during emotional distraction. Lastly, using trial-based functional connectivity, we show that amygdala signal is negatively correlated with frontal, but not parietal nodes of the dorsal network during emotional distraction. Together, these findings suggest that the source of emotional regulation may originate from dorsal and ventral frontal, but not parietal cortical regions.

A50

REPETITION EFFECTS OF AFFECTIVE VISUAL STIMULI (IAPS) ON ERPS Ryan Yee¹, Bella Rozenkrants², John Polich¹; ¹The Scripps Research Institute, ²University of Southern California – Visual stimuli from the International Affective Pictures System (IAPS) were presented as target stimuli in an oddball discrimination task, with a geometric figure as the standard stimulus (n=16). Three repetitions of each picture occurred sequentially, with varying numbers of standards between these target stimuli. Stimulus pictures were chosen purposefully to reflect extreme arousal (low, high) and valence (negative, positive). Participants were instructed to press a button when a target occurred and to ignore standards. ERP waveforms were assessed systematically from early (N1, P2, N2) and later (P3, SW1, SW2) components. Component amplitudes increased across repetitions from P2 to SW1; amplitudes were larger for high compared to low arousal stimuli for N2 through SW1; amplitudes were larger for positive compared to negative valence stimuli only for SW1, although arousal and valence demonstrated reliable statistical interactions for N2, P3, and SW2. These effects were generally consistent across stimulus repetitions. Taken together, the visual affective stimuli

used in a simple discrimination task in which target stimuli are repeated produce ERPs in which (1) stimulus repetition changes component magnitude, (2) arousal and valence characteristics differentially modulate specific component amplitudes, and (3) stimulus repetition affects ERP component amplitudes generally independent of affective condition.

A51

WHERE YOU LOOK AFFECTS VISUALLY-SPECIFIC MEMORY Michael P. Blank¹, Richard E. Biga¹, Chad J. Marsolek; ¹University of Minnesota – Visual attention is more restricted when viewing emotional scenes than when viewing non-emotional scenes (the "weapon focus" effect; Loftus, 1979). Recently, we showed that this difference in attentional allocation during encoding affects visually-specific memory (VSM) for both high-arousal, emotional scenes and low-arousal, less emotional scenes (Blank & Marsolek, 2006). Specifically, when participants rated the emotionality of scenes during encoding, broadening of attention (more fixations of shorter duration) predicted subsequent VSM for low-arousal scenes, whereas restriction of attention to emotionally salient parts predicted subsequent VSM for high-arousal scenes. In this study, we examined whether those results would be observed when participants freely view the scenes during encoding rather than rate their emotionality. We recorded eye movements while participants freely viewed high-arousal and low-arousal scenes for two seconds each. Then, we measured VSM in a recognition test by asking participants to decide whether briefly presented scenes were in the same orientation or mirror-reversed compared with encoding. In contrast with the results from the previous study, a relative broadening of attention during encoding - more fixations of shorter duration - predicted subsequent VSM for both low- and high-arousal scenes (this pattern was previously observed only for low-arousal scenes). Thus, an interesting difference in subsequent memory for low- and high-arousal scenes, previously observed when participants explicitly rated the emotionality of scenes during encoding, is not found under more typical, everyday free-viewing conditions. If so, particular viewing conditions and goals during encoding may alter the information stored in memory representations of low- and high-arousal scenes.

A52

NEURAL CORRELATES OF EMOTIONAL INFLUENCES ON ATTENTION Jamil Bhanji¹, Jennifer Beer¹; ¹University of Texas at Austin – Emotion may influence judgments by directing attention to information that is the same valence as the emotional state experienced by an individual. The current study examines neural activity associated with the mood-congruent influence of emotion on attention. Participants made judgments of ambiguously valenced pictorial compositions of facial expressions after viewing negative or neutral word primes. Each ambiguously valenced composition contained both a 'happy' and an 'angry' facial emotion expression overlaid on top of each other. These stimuli were presented rapidly so that participants only had time to see one of the facial expressions clearly. The participants indicated which emotion they saw in the picture, thus revealing which emotion they preferentially attended to while viewing the picture. Behavioral data showed that participants attended to 'angry' expressions more frequently when the pictures were preceded by negative word primes compared to neutral word primes. Functional Magnetic Resonance Imaging data revealed regional neural activity that was associated with this mood congruent influence of the negative primes on the ambiguous judgments. Activity in ventromedial prefrontal cortex and insular cortex was associated with mood-congruent attention to the ambiguously valenced composition. Discussion focuses on how regional neural activity associated with the word primes may modulate neural activity associated with the subsequent viewing of the ambiguously valenced composition.

A53

SEROTONIN TRANSPORTER GENE VARIATION MODERATES ACTIVITY IN REGIONS INVOLVED IN THE COGNITIVE CONTROL OF EMOTION Peter C. Clasen¹, Christopher G. Beevers¹, Cristina Benavides¹, John E. McGeary^{3,4}, David M. Schnyer^{1,2}; ¹The University

of Texas at Austin, ²Imaging Research Center, The University of Texas at Austin, ³Research Service, Providence VA Medical Center, ⁴Center for Alcohol and Addiction Studies, Brown University – Evidence suggests that genetic variation in the serotonin transporter-linked polymorphic region (5-HTTLPR) is associated with individual differences in the activity of brain regions underlying emotional regulation (Hariri & Holmes, 2006). A common polymorphism of this gene results in long or short alleles and it has been shown that short allele carriers demonstrate hyper-reactive amygdala response to negative faces (e.g. Hariri et al., 2005). However, this evidence relies on tasks that elicit emotional reactivity incidentally. Therefore, it is unclear whether genetic status also moderates activity in regions associated with the conscious regulation of emotion. Using a task where participants actively regulate emotional appraisal (Ochsner et al., 2002), we tested whether 5-HTTLPR variation moderates functional patterns of activation in brain regions previously associated with the cognitive control of emotion. Participants genotyped for the 5-HTTLPR polymorphism (N = 12) were asked to either "decrease" their emotional response to a series of negative pictures or simply "look" at the pictures while undergoing fMRI scanning. Examining activity in lateral prefrontal cortex regions associated with the cognitive control of emotion indicated the expected finding of greater activity when participants were asked to "decrease" their emotional response. Short allele carriers (N = 6) demonstrated higher levels of activity in these regions compared to long allele homozygotes (N = 6). These preliminary findings indicate that genetic variability associated with the serotonin transporter gene alters activity in brain regions associated with the cognitive control of emotion.

A54

EFFECTS OF REGULATION ON POSITIVE AND NEGATIVE EMOTIONS: A STUDY OF ELECTROPHYSIOLOGICAL RESPONSES Chun-Yu Chen¹, Nai-Shing Yen^{1,2}, Hsuan-Yu Lin¹; ¹National Chengchi University, Taipei, Taiwan, ²Research Center for Mind, Brain, and Learning, National Chengchi University, Taipei, Taiwan – The aim of the current study is to investigate the effects of emotion regulation on the electrophysiological responses. In the present study, subjects' emotion was elicited by presenting affective pictures (positive, negative, and neutral), and emotion regulation was manipulated by providing instructions (attend, enhance, and reappraisal). In both "enhance" and "reappraisal" conditions, subjects were instructed to imagine the events or images which related to the presenting pictures. In the behavioral results, the subjective valence rating changed differently according to the instructions which delivered to subjects. The facial electromyogram (EMG) showed that the activity of corrugator, which correlates negatively with the valence of the subjects' emotional response, reduced when subjects were instructed to reappraise the emotion after the presenting of negative pictures. For the heart rate data, the heart rate change reduced during 3.5 to 4 second after presenting the instruction under the reappraisal conditions. For skin conductance response (SCR), the differences of SCRs before and after the presenting of the emotion regulation instruction were larger under the reappraisal conditions. Event-related potential (ERP) showed that, at site Pz, the amplitude at 400ms after the instruction was more positive going under the "enhance" condition than under the "attend" condition. In summary, behavioral and electrophysiological data showed different effects of emotion regulation, and the subjective valence rating went with the electrophysiological responses consistently.

A55

WHAT'S LOVE GOT TO DO WITH IT? NEURAL CORRELATES OF LONG-TERM PAIR-BONDING IN HUMANS Bianca Acevedo^{1,3}, Arthur Aron¹, Helen Fisher², Lucy Brown³; ¹State University of New York at Stony Brook, ²Rutgers University, ³Albert Einstein College of Medicine – This study investigated the neural correlates of romantic love among individuals in long-term marriages (> 10 years) using functional magnetic resonance imaging (fMRI; BOLD response). Ten females and seven males (mean ages: 51 and 55 years, respectively) who reported being intensely in love with a long-term spouse (married mean of 21.4 years) underwent

fMRI scanning while they viewed headshots of their partner and a highly-familiar neutral person (HFN), interspersed with a distraction-attention task. Group activation specific to the long-term partner compared to the HFN occurred in dopamine-rich mesolimbic areas involved in early-stage romantic love (1-17 mos.; Aron et al., 2005; Bartels & Zeki, 2000) in humans. In addition, consistent with research on monogamous pair-bonding in voles and primates, responses to the long-term partner were displayed in oxytocin and vasopressin-rich regions. Correlations of brain activity with self-report measures of romantic love and passionate love showed significant neural activity in the caudate body and left angular gyrus, replicating findings from previous studies of early-stage romantic love (Aron et al., 2005; Ortigue et al., 2007). Correlating neural activity and marital satisfaction scores displayed significant activations in areas involved in reward processing and decision making; empathy; and social cooperation. We discuss implications of these results and conclude that regions of the mesolimbic reward system—rich in dopamine, oxytocin, and vasopressin—are part of a network that influence the establishment, conservation, and enhancement of pair-bonds in humans.

A56

IS SELF-FACE RECOGNITION SPECIAL? EVIDENCE FROM THE RECOGNITION OF FACIAL EMOTIONS Yuan Hang Li¹, Shu-wen Wang¹, Eran Zaidel^{1,2}; ¹UCLA, Los Angeles, CA, ²Brain Research Institute, UCLA, Los Angeles, CA – INTRODUCTION: Is Self-face recognition different from face recognition in general? The majority of faces we see convey emotion, and the neural mechanisms for processing emotions and faces may partly interact. Consequently, we used emotional face stimuli in a face or emotion identification task in normal participants. METHODS: Forty five undergraduates from the University of California at Los Angeles (UCLA) completed two tasks. The tasks were either to judge the identity of the face or the emotion of the face. Stimuli were presented tachistoscopically to the left or right visual hemifield. RESULTS: An Analysis of Variance (ANOVA) of Task (Face, Emotion) x Face Type (Self, Familiar) x Emotion (Happy, Sad) x Visual Field (VF) (Left, Right) showed significant interactions between Face Type and Emotion in accuracy and latency. Participants were significantly faster and more accurate at identifying their friend's sad face compared to their friend's happy face. At the same time, participants were significantly faster at identifying their own happy face compared to their own sad face. This pattern held true for both tasks and VFs. DISCUSSION: This evidence suggests that Self-face recognition differs from general face recognition in the effect of emotional valence on face processing. Furthermore, the recognition of Self-Happy and Familiar-Sad faces in the left VF correlated most strongly with the Sad General Situations subscale of the Social Anxiety Scale for Adolescents (SASA). This suggests one way in which elevated levels of social anxiety influences processing of emotional faces, both self and familiar other, in normal individuals.

A57

ACTIVITY IN MEDIAL PREFRONTAL AND POSTEROMEDIAL CORTICES CORRELATE WITH PSYCHOPATHIC TRAITS: IMPLICATIONS FOR THE RESTING STATE NETWORK Tong Sheng^{1,2}, Anahita Gheyntanchi⁴, Lisa Aziz-Zadeh^{2,3}; ¹Neuroscience Graduate Program, University of Southern California, ²Brain and Creativity Institute, University of Southern California, ³Division of Occupational Science and Occupational Therapy, University of Southern California, ⁴Pacific Graduate School of Psychology – The medial prefrontal (mPFC) and posteromedial (PMC) cortices have been implicated in a number of studies investigating executive and emotional functions in both healthy and clinical populations. The mPFC is generally considered to be involved in response control while the PMC is commonly associated with self-referential processes. In the current fMRI study, we investigated whether activity in these regions is functionally distinguishable by correlating them with different interpersonal and behavioral factors of psychopathy. Subjects were instructed to either produce or not produce speech depending on a visual cue. During rest conditions as compared to task conditions, activity was

observed in the mPFC and the PMC, in accordance with previous research on the resting state network. We tested the hypothesis that the mPFC and PMC are functionally dissociable by correlating their hemodynamic responses during rest conditions with different scales of the Psychopathic Personality Inventory-Revised. As predicted, we found that activity in the PMC positively correlates with a scale relating to narcissism and social dominance (Machiavellian Egocentricity; ME). Furthermore, mPFC activity correlated positively with a scale relating to spontaneity (Carefree Non-planfulness, CN). These results offer preliminary support for the idea that different components within the resting state network can be functionally dissociated.

A58

IMPAIRED AVERSIVE LEARNING IN NARCOLEPSY WITH CATAPLEXY PATIENTS - A FMRI STUDY Aurelie Ponz¹, Ramin Khatami², Rositsa Poryazova², Esther Werth², Peter Boesiger³, Claudio Bassetti², Sophie Schwartz¹; ¹Neurosciences, Center for Neuroscience, University of Geneva, ²Neurology, University Hospital Zurich, ³Biomedical Engineering, University of Zurich & Swiss Federal Institute of Technology – Narcolepsy with cataplexy (NC) is characterized by excessive daytime sleepiness, cataplexy episodes, caused by a deficiency in hypocretin/orexin (HCRT). Recent animal studies suggest that this hypothalamic neuropeptide may also be involved in incentive motivation. Our previous functional MRI findings (fMRI) demonstrated that NC-patients present an abnormal emotional response to positive stimuli within limbic and reward brain circuits. In the present fMRI study, we tested whether the HCRT system plays a general role in regulating emotional learning. We scanned nine unmedicated NC-patients and nine matched controls while they performed a fear conditioning paradigm. Participants saw visual shapes in two different possible colors: one color (CS+) signaled a possible upcoming aversive unconditioned stimulus (US; painful electrical stimulation); another color was never associated with any emotional stimulation (CS-). Our results reveal that both NC-patients and control activated the pain matrix during the presentation of the CS+/US (anterior cingulate, insula, somatosensory cortex, amygdala). However, while controls showed increased activation in the amygdala for the CS+ alone, as expected in this aversive conditioning paradigm, NC-patients did not show any conditioned response in the amygdala. Our new fMRI results thus provide evidence that the HCRT system can affect amygdala activity related to aversive emotional learning. These findings confirm that the Hcrt system is not only involved in sleep-wake regulation, but also in emotion regulation, thus establishing a close connection between both systems.

A59

COORDINATION OF BRAIN ACTIVITY ACROSS MULTIPLE TIMESCALES BY EXCERPTS OF POPULAR MUSIC Petr Janata¹; ¹UC Davis, Center for Mind and Brain – Tonal structure in music unfolds on multiple timescales. Our perception of it is influenced by local contexts generated by transitions from one chord/harmony to the next as well as more global contexts that provide a sense of key. In this study I examined tonality-tracking responses in the whole-brain BOLD data of 13 subjects, each of whom listened to thirty 30 s excerpts of popular music that was largely familiar and/or autobiographically salient to them. The dynamics of the tonal structure were modeled on three timescales that ranged from the moment-to-moment chord changes to the more stable sense of tonal center that might be used for determining whether a piece is in a major or minor key. A region of the dorsal medial prefrontal cortex (MPFC) that was modulated by the overall degree of autobiographical salience of an excerpt exhibited tonality tracking at every timescale. Other brain areas exhibited preferential sensitivity to different timescales in the tonal structure. Posterior temporal and occipital areas exhibited tonality tracking on the fastest time scale, whereas left VLPFC, DLPFC, and ventral MPFC responded preferentially to the slower timescales, with the most ventral excursion of activity in MPFC on the slowest timescale. Given the role of ventral MPFC in emotional regulation, these results are consistent with the idea that the gross tonal char-

acteristics, e.g. the major or minor quality of a piece, shape mood states across tens of seconds. Multiple timescales in music may serve to bind memories, mental images, and emotion into a cohesive experience.

A60

INDEPENDENT INFLUENCES OF PERCEPTUAL LOAD AND EMOTIONAL STIMULI ON THE AMYGDALA AND MOTION AREA V5/MT+ Catherine Hindi Attar^{1,2}, Matthias M. Müller¹, Christian Büchel², Michael Rose²; ¹Institute of Psychology I, University of Leipzig, Leipzig, Germany, ²University Medical Center Hamburg-Eppendorf, Hamburg, Germany – There is an ongoing debate over the extent to which selective attention can impede the processing of task-irrelevant emotional stimuli. In this fMRI study subjects had to attend to a display of moving random dots which were superimposed upon happy, fearful or neutral faces. The attentional task required subjects to detect short intervals of coherent motion under two levels of perceptual load. Faces in the background were always task-irrelevant and were not to be attended. For emotional compared to neutral faces we observed a stronger decrease in activation within motion-sensitive area V5/MT+. Likewise, the amygdala showed significantly stronger responses to fearful relative to neutral faces. Most importantly, these emotion effects were independent of the amount of perceptual load associated with the attentional foreground task. A notable finding was that an effect of load was also observed in the amygdalo-hippocampal region which yielded stronger responses to low relative to high load conditions. Since low load conditions were perceptually more salient than high load conditions this might implicate a broader role of the amygdala as salience detector and challenges the widely held view of its fear specificity. To date, these findings demonstrate for the first time that task-irrelevant emotional stimuli receive prioritized processing independently of varying perceptual load demands of the attentional task at hand. This strongly implies that attentional and emotional modulations originate from distinct neural sources and act in parallel upon specific visual processing areas.

A61

EMOTION IMPROVES AND IMPAIRS EARLY VISION Bruno R. Boccanegra¹, René Zeelenberg¹; ¹Erasmus University, Rotterdam – Recent studies indicate that emotion enhances early vision, but the generality of this finding remains unknown. Do the benefits of emotion extend to all basic aspects of vision or are they limited in scope? Our results show that the brief presentation of a fearful face, compared to a neutral face, enhances sensitivity for the orientation of subsequently presented low-spatial-frequency (LSF) stimuli, but diminishes orientation sensitivity for high-spatial-frequency (HSF) stimuli. This is the first demonstration that emotion not only improves but also impairs low-level vision. The selective LSF benefits are consistent with the idea that emotion enhances magnocellular processing. Additionally, we suggest that the HSF deficits are due to inhibitory interactions between magnocellular and parvocellular pathways. Although not predicted by previous data and models, the observed pattern of benefits and deficits shows that the neural mechanisms underlying emotional vision sacrifice the detection of fine visual details for the processing of coarse information. Our results suggest an emotion-induced trade-off in visual processing rather than a general improvement. The magnocellular pathway plays an important role in the perception of motion, depth, direction, global configuration and allows for faster processing than the parvocellular pathway, all of which are potentially important for the detection of threat in the environment. Thus, this trade-off may benefit perceptual dimensions that are relevant for survival at the expense of those that are less relevant.

A62

SELECTIVE ATTENTION MODULATES THE EMOTIONAL EVALUATION OF FACES Sonia Doallo¹, Jane E. Raymond², Monika Kiss³, Kimron L. Shapiro², Martin Eimer³, John G. Taylor⁴, Anna C. Nobre¹; ¹University of Oxford, ²University of Wales, Bangor, ³Birkbeck College, University of London, ⁴King's College London – Recent evidence indicates that attentional selection of stimuli affects their subsequent emotional

evaluation, such that previously unattended stimuli are valued more negatively than previously attended stimuli ("Distractor Devaluation Effect"). In this study, we used event-related functional magnetic resonance (fMRI) to examine the brain activity associated with this emotional devaluation effect. Participants were asked first to perform a Go/No-Go task involving Asian and Caucasian faces, making a motor response to faces of one race (Go), and refraining from responding to faces of the other race (No-Go). In a subsequent evaluation task, a trustworthiness rating for each face was required. A region-of-interest (ROI) approach was used to measure neural activity during the evaluation task in areas involved in the emotional and perceptual processing of faces (i.e. amygdala and fusiform gyrus). Behavioral data showed that previous No-Go faces were rated as less trustworthy than previous Go faces. Functional imaging data revealed increased activity in the right amygdala along with the left fusiform gyrus for low-rated faces relative to high-rated faces. Furthermore, this emotional response in the amygdala was significantly modulated by attention and race, with greater activity to low-rated (versus high-rated) Asian faces when they were previously presented as No-Go stimuli. These findings indicate that attentional selection has consequences for the social-emotional evaluation of faces, in part by modulating the activity in emotion-related areas, and provide additional evidence that other relevant social signals in faces, such as the race, may play an important role in mediating these effects.

A63**ANTICIPATION OF MONETARY AND SOCIAL REWARD DIFFERENTLY ACTIVATES MESOLIMBIC BRAIN STRUCTURES IN MEN AND WOMEN**

Lena Rademacher¹, Sören Krach^{1,2}, Gregor Kohls³, Arda Irmak¹, Tilo Kircher¹, Kerstin Konrad³, Gerhard Gründer¹, Katja Spreckelmeyer¹; ¹RWTH Aachen University, Germany, ²Central Service Facility, RWTH Aachen University, Germany, ³Child Neuropsychology Section, RWTH Aachen University, Germany – Social reward has been identified as a strong incentive for goal-directed behavior. The aim of the present study was to examine if the neural mechanisms underlying the anticipation of monetary rewards would also apply to the anticipation of social feedback in the form of friendly faces. Based on previous findings indicating a linear relation between reward value and striatal activation for monetary rewards, we expected to find a similar relationship for social incentives. Furthermore, gender was introduced as an additional factor, postulating greater sensitivity to social stimuli in women than men. Sixteen male and 16 female participants performed two tasks on a 1.5 Tesla scanner: the "monetary incentive delay" paradigm (Knutson et al., 2000) and an adaptation of the former, termed "social incentive delay" task, replacing monetary by social rewards (smiling faces). In both conditions a cue indicated potential reward. In order to receive reward a target button had to be pushed within a certain time window. fMRI recording during the anticipation phase revealed proportional activation of neural structures constituting the human reward system for increasing levels of reward, independent of incentive type. However, turning our attention to gender effects showed differences in brain activation between male and female participants: in men activation was strong in the prospect of monetary rewards but weak for social rewards, while in women activation level was intermediate, but equally strong for both incentive types. The results suggest a common neural basis but gender-specific activation intensities for the anticipation of monetary and social rewards.

A64**FACIAL EMOTION RECOGNITION DEFICITS IN PARKINSON'S DISEASE ARE NOT MODULATED BY DOPAMINE REPLACEMENT THERAPY**

Alison Simioni¹, Lesley Fellous¹; ¹McGill University, Montreal, Quebec, Canada – Although the basal ganglia are thought to play a critical role in the ability to recognize emotions from facial expressions, there is little consensus regarding the contribution of dopamine to this ability. There are conflicting data on the effects of Parkinson's disease (PD) on facial emotion recognition, with some studies suggesting deficits in specific emotions, and others reporting intact per-

formance. Differences in disease severity, and medication status, as well as in the sensitivity of the tasks used across studies, may explain this lack of consensus. Here we examined both the effects of PD, and of dopamine replacement therapy, on facial emotion recognition, using a sensitive and well-validated task. Twenty-one non-demented patients with mild-moderate Parkinson's disease were tested twice, once while taking their usual dopamine replacement therapy, and once after an overnight medication washout, and compared to 18 demographically-matched healthy control participants. The task featured morphs between an emotionally neutral face and an emotional expression posed by the same individual and asked participants to rate each face on the degree of all 6 cardinal emotions, one at a time. Patients with PD showed selective impairments in the ability to recognize sadness and anger in these subtle morphs. However, dopamine replacement therapy did not modulate the ability to detect any of the emotions studied. These findings support an effect of PD on emotion recognition from faces, at least for certain emotions. However, the lack of effect of the medication manipulation argues that dopamine depletion is not the basis for this deficit.

A65**TRAIT ANXIETY PREDICTS PULVINAR AND AMYGDALA REACTIVITY TO BACKWARD MASKED FEARFUL FACES**

Joshua Carlson¹, Tsafir Greenberg¹, Lilianne Muijica-Parodi¹; ¹State University of New York at Stony Brook – Previous research suggests that backward masked fearful faces are processed through a subcortical fear network consisting of the thalamic pulvinar and amygdala. Additionally, there is evidence that anxiety is associated with heightened amygdala reactivity to masked, but not unmasked, fear stimuli in both clinical and nonclinical populations. However, while amygdala reactivity to masked fear appears to be correlated with anxiety, the relationship between anxiety and pulvinar reactivity to masked threat is unknown. Therefore, the aim of the current study was to examine the extent to which trait anxiety predicts pulvinar and amygdala responses to masked and unmasked fearful faces. Participants completed the Trait Anxiety Inventory and an event-related fMRI passive viewing backward masking task. Each trial began with a fixation cue (1000ms) that was immediately followed by an initial face (33ms)-mask face (167ms) pairing. Trial types included fearful-neutral (masked fear), neutral-fearful (unmasked fear), and neutral-neutral. Amygdala and Pulvinar ROIs were created using MARINA. Results revealed that higher levels of trait anxiety coincided with greater subcortical activity in the pulvinar and amygdala during masked, but not unmasked, fearful face processing. Additionally, masked and unmasked fearful faces appear to differentially influence functional connectivity within a broader neural network. The results are consistent with an amygdala-pulvinar network involved in the processing of crude representations of fearful faces and activity in this network is associated with an individual's level of trait anxiety.

A66**THAT'S ONE ANGRY EYEBROW: SEMANTIC PROCESSING OF EMOTIONAL FACIAL EXPRESSIONS IN EMPATHY**

Alicia Hofelich¹, Stephanie Preston¹; ¹The University of Michigan – Humans are highly attuned to facial emotions, likely because they provide important information about another's internal state. Prior research has shown that people mimic others' facial emotions, even when subliminally presented (Dimberg et al., 2000). This effect is higher for those with high trait empathy (Sonnby-Borgstrom, 2002). People also spontaneously access semantic emotion categories when viewing facial emotions, even when the face is irrelevant to the task (the Emostroop Effect; Preston & Stansfield, 2008). However, it is unknown whether subliminal face perception also activates semantic knowledge, and if the extent of semantic activation is related to trait empathy. To test this, participants who are high versus low on trait empathy were compared on three different emotional Stroop tasks: 1) A supraliminal Emostroop task where congruent and incongruent emotion adjectives were overlaid on facial expressions (replicating the 2008 study), 2) A subliminal Emostroop where emotional faces were

presented for 13ms, then masked by an emotion adjective overlaid on a neutral face, and 3) An intrusive cognitions task (McKenna & Sharma, 1995). Participants were instructed to categorize the emotion adjective into the corresponding basic emotion. The supraliminal task replicated the Emostroop Effect with slowed responses on incongruent trials. Results in all three emotional Stroop tasks suggest that highly empathic participants process emotional adjectives faster than low empathy participants, and may be more affected by subliminal perception of emotional faces. These findings suggest that individual differences in empathy may emanate from differences in the tendency to access semantic information when perceiving other's states.

A67**WHAT? AND HOW GOOD?: DISTINCT NEURAL MECHANISMS ENCODE REWARD AND IDENTITY PREDICTION** *Cendri*

Hutcherson¹, Antonio Rangel¹; ¹California Institute of Technology – In order to adaptively respond to its environment, an organism needs to learn which cues are associated with the most reward. A considerable amount of evidence has shown that such learning can be accomplished through the computation of reward prediction errors, which respond to the unexpected delivery or omission of reward, and that BOLD response in the ventral striatum is correlated with this type of signal. However, because the value of a particular outcome can vary with context, organisms need to learn not only stimulus-reward associations (how good?), but also stimulus-outcome associations, in which the organism learns to predict reward indirectly by first representing the identity of an outcome (what?). In most previous learning studies, prediction errors of reward and identity are perfectly correlated, making it impossible to identify their unique or overlapping neural basis. We present the results of a novel experimental setting designed to dissociate the neural representation of these two types of signals using human functional magnetic resonance imaging. Our results suggest that the two learning signals have common and dissociable components in regions of the ventral striatum and orbitofrontal cortex.

Memory: Memory systems**A68****PARIETAL LOBE MEMORY RETRIEVAL MECHANISM: IS THE EPISODIC BUFFER HYPOTHESIS A FEASIBLE ACCOUNT?**

Marian E. Berryhill^{1,2}, Ingrid R. Olson^{1,2}; ¹Temple University, ²University of Pennsylvania – A current question of interest in the memory field is the role of posterior parietal cortex (PPC) in memory. PPC damage does not cause severe memory deficits, yet PPC activations are consistently observed in neuroimaging studies of episodic retrieval. The 'episodic buffer' hypothesis proposes that something analogous to the episodic buffer, whose function is to temporarily maintain and/or manipulate retrieved multisensory, multidimensional information, resides in the inferior parietal lobe (Vilberg & Rugg, 2008). Several of our prior findings can be interpreted as supporting this hypothesis: PPC damage can cause impaired autobiographical free recall (Berryhill et al., 2007) and diminished visual short-term memory (Berryhill et al., 2008). Here, we directly test one prediction of the episodic buffer hypothesis, that PPC damage will impair memory for narratives when tested immediately or after a delay. Two patients with bilateral PPC damage were tested in immediate- and delayed- recall of short narratives. Findings provide partial support for the episodic buffer hypothesis, indicating that this hypothesis has merits but will require modifications to fully account for emerging findings.

A69**IMPROVING THE PERFORMANCE OF PARKINSON'S DISEASE PATIENTS ON A SELECTIVE-ATTENTION-DEMANDING, CATEGORY-LEARNING TASK** *Shawn Ell¹, Lacey Favreau²; ¹University of Maine, ²FHC, Inc.*

– Numerous studies have demonstrated a category-learning impairment in Parkinson's disease (PD) patients. The most consistent findings have been on selective-attention-demanding, category-learning tasks where patients attempt to learn to categorize based upon a subset of the possible stimulus information. The goal of the present study was to investigate the efficacy of training PD patients on a category learning task with low selective-attention demands on the subsequent performance of a category learning task with high-selective attention demands. Participants were assigned to one of two training conditions that varied in selective-attention demand. In the low selective-attention (LSA) condition, the stimuli varied only along the relevant dimension. In the high selective-attention (HSA) condition, the stimuli also varied along an irrelevant dimension. Following training, all participants completed a categorization test phase using the HSA condition categories. Preliminary data was collected from PD patients in the LSA and HSA conditions, as well as age- and education-matched, healthy control participants in the HSA condition. Consistent with previous work, patients in the HSA condition were impaired relative to controls. The accuracy of PD patients in the LSA condition, but not the HSA condition, was indistinguishable from controls by the end of the test phase. These results suggest that categorization training with low selective-attention demand improves the subsequent performance of PD patients on a categorization task with high selective-attention-demand. Basic research studies such as these are a necessary step in the development of successful interventions that will improve cognitive functioning in PD patients.

A70**AN FMRI EXAMINATION OF THE EFFECTS OF AGING ON MEMORY MONITORING FOR SOURCE AND ITEM RECOGNITION** *Jennifer Pacheco¹, Natalie Dailey¹, Maria Olivares¹, Caitlin Tenison¹, David M. Schnyer¹; ¹The University of Texas at Austin*

– Evidence has shown that memory monitoring in older adults is impaired in a domain-specific manner. The neural activity associated with memory monitoring ability was assessed in a group of older adults (61-74 years old) and younger adults (20-30 years old) using retrieval confidence ratings in an item and source recognition memory fMRI paradigm. Participants were shown a series of sentences read aloud by a male or female speaker and their memory for both the sentence and speaker was tested; participants also reported ratings of 'certain' or 'probable'. Both young and older adults showed highly accurate item recognition performance as well as accurately calibrated monitoring assessments - higher accuracy rates for those items rated 'certain' versus 'probable'. Performance for source memory was lower than item memory for both groups, significantly worse for older adults compared to younger adults. Younger adults maintained calibrated source monitoring ratings but elderly subjects demonstrated significantly less accurate source memory monitoring. Functional MRI images collected during the test phase of the experiment were analyzed using standard methods in FSL. Bilateral medial temporal lobe, right frontal, and left parietal activation is seen in the younger adults for accurate 'certain' responses when compared to inaccurate 'certain' responses; dissociable frontal activation is seen for accurate versus inaccurate 'probable' responses, with less significant MTL activation. These results suggests a network of frontal and MTL regions that contribute to the accuracy of source memory monitoring in young adults, we expect to be able to uncover differences in this network for older adults.

A71**THE DEVELOPMENT OF BRAIN SYSTEMS FOR EPISODIC MEMORY RETRIEVAL** *Noa Ofen¹, Xiaoqian J. Chai¹, John D.E. Gabrieli¹;*

¹Brain and Cognitive Sciences, MIT, Cambridge, MA – Multiple brain regions are involved in episodic memory retrieval in adults, but the brain regions that support episodic memory retrieval in children have not been

identified. This study investigated the development of brain regions involved in episodic memory retrieval. Participants (age range 8-24, $n = 73$) studied 140 pictures of indoor and outdoor scenes and then were given a recognition test while being scanned with 3T MRI scanner. Participants made old/new decisions for the previously studied pictures and 140 new pictures. Participants correctly recognized 0.52 ± 0.14 of the studied pictures (Hit rate, mean \pm SD) and correctly gave a 'new' response to 0.75 ± 0.12 of the new pictures (CR rate). Recognition accuracy (Hit + CR) increased with age ($r = 0.50$, $p < 0.001$). Frontal, parietal and temporal cortical regions and medial temporal lobe (MTL) and basal ganglia regions were active for successful retrieval (Hits > CR). Within these regions activations associated with successful retrieval increased with age in left lateral parietal cortex (BA 7/40), left dorsolateral prefrontal cortex (PFC) (BA 8/9), left ventrolateral PFC (BA 46), bilateral inferior frontal gyri (BA 47) and basal ganglia. Activation for both Hits and CR decreased with age in regions of the MTL, but, these age dependent reductions in activation were not selective to successful memory retrieval. These results suggest that with age, frontal, parietal and basal ganglia regions are progressively recruited to reach adult-like pattern of brain activation during episodic memory retrieval. Age-related changes in MTL activation during episodic memory retrieval may however, be independent of successful memory retrieval.

A72

NEURAL CORRELATES OF EMOTIONAL AROUSAL AND SEMANTIC PROCESSING DURING MEMORY FORMATION: A LEVELS-OF-PROCESSING APPROACH Maureen Ritchey^{1,2}, Sheldon Rudisill¹, Kevin S. LaBar^{1,2}, Roberto Cabeza^{1,2}; ¹Center for Cognitive Neuroscience, Duke University, ²Duke University – Results from the animal and human literatures have highlighted the amygdala and its interaction with the MTL memory system as supporting improved consolidation for emotional memories. However, behavioral and neuroimaging results in humans have also implicated emotion-driven enhancements during encoding as predicting improvements in subsequent memory. In particular, it has been proposed that emotional stimuli are subject to deeper semantic processing during encoding, evidenced by the presence of greater memory-related activity in the left inferior prefrontal cortex (LIPC), a region frequently associated with semantic processing, during emotional relative to neutral memory encoding. This hypothesis, however, has not yet been explicitly tested. In the present study, participants were scanned using fMRI while encoding emotional and neutral images. Half were encoded with a semantic description task and half with a non-semantic perceptual feature task. Behavioral results indicate an interaction between emotion and task: the enhancement of emotional over neutral memory was strongest for items encoded in the non-semantic task. Neuroimaging results likewise suggest that the amygdala best distinguishes between remembered and forgotten emotional items in the non-semantic condition. Although the LIPC is overall more activated during semantic encoding, it similarly distinguishes memory best in the non-semantic condition. These results support the hypotheses that amygdala engagement benefits emotional memory most when encoding resources are diminished, and that under these circumstances, emotional items may also benefit from incidental semantic encoding. These mechanisms thereby serve to protect emotionally arousing items from the mnemonic consequences of shallow encoding.

A73

REWARD MODULATION OF MEDIAL TEMPORAL LOBE SUBREGIONS DURING ASSOCIATIVE ENCODING AND CUED RECALL Sasha M. Wolosin^{1,2}, Dagnar Zeithamova^{1,2}, Nicolaus T. Schmandt^{1,2}, Alison R. Preston^{1,2}; ¹The University of Texas at Austin, TX, ²Center for Learning and Memory, The University of Texas at Austin, Austin, TX – The medial temporal lobe (MTL) is critical for episodic memory for individual events. Emerging data suggest that MTL processing is modulated by midbrain regions under conditions of reward resulting in enhanced episodic encoding. Current theories further sug-

gest that MTL subregional function may be differentially influenced by midbrain inputs that signal reward. Using high-resolution fMRI, the present study characterized MTL subregion function during associative encoding under reward as well as reward-related effects on later cued recall performance. During associative encoding, high- and low-value monetary cues preceded paired associates indicating potential reward for successful retrieval. At test, participants performed cued recall followed by match (correct association) or mismatch (incorrect association) probe decisions and received feedback on their performance. Behaviorally, cued recall performance was superior for pairs preceded by high reward cues at encoding relative to pairs preceded by low reward cues. Initial analyses revealed successful memory formation associated with activation in hippocampus, perirhinal cortex, and midbrain regions that was modulated by reward with greater subsequent memory effects observed for high relative to low reward pairs. Successful memory retrieval during cued recall was further modulated by reward status where correct relative to incorrect retrieval was greater for high relative to low reward pairs in hippocampal and perirhinal regions. Moreover, hippocampal and midbrain activation differentiating associative novelty at probe (mismatch vs. match) was greater for high relative to low reward pairs. These findings suggest that motivation during learning affects MTL-based memory formation as well as later retrieval processes through interactions with midbrain regions.

A74

SYSTEMS CONSOLIDATION OF LONG-TERM REAL-LIFE-LIKE MEMORY: A FUNCTIONAL NEUROIMAGING STUDY Orit Furman¹, Yadin Dudai¹; ¹Weizmann Institute of Science, Rehovot, Israel – Systems consolidation is a hypothetical slow process of reorganization whereby memory storage and retrieval come to rely on different brain systems with the passage of time. Of particular relevance is the relationship between declarative memory retrieval and the involvement of medial temporal lobe (MTL) over time. The present study aims to characterize systems consolidation of declarative memory, using a novel movie-memory paradigm we recently devised for the study of long-term and remote memory under real-life-like conditions (Furman et al., *Learning & Memory* 14, 457, 2007; Hasson et al., *Neuron*, 57, 452, 2008). A 27-min documentary movie (created in-house specifically for memory research) was the memoranda, and a computerized questionnaire was used to assess recall and recognition of events sampled every ~20 sec of the movie. Metamemory was also assessed. Three groups of subjects were scanned in a 3T MRI scanner during both movie viewing and memory testing, allowing comparison of neural activity during retrieval at three different study-test intervals: 3 hours ($N=13$), 3 weeks ($N=15$) and 3 months ($N=14$). Participants in a control group ($N=13$) completed the questionnaire without viewing the movie. While involvement of a distributed neural network remained similar over time, MTL activation during recognition was significant only when memory was recent (3 hours, 3 weeks) but not remote (3 months). During recall tasks, which involved instructions to imagine movie episodes, MTL activation was significant in all groups, including control, suggesting this area's time-independent involvement in re-experiencing or mental imagery of complex events.

A75

UTILIZATION OF CONTEXTUALLY GENERATED EXPECTATIONS Elissa Aminoff¹, Michael Miller¹; ¹University of California Santa Barbara – Repeated exposure to typical environments (e.g., restaurant) allows one to generate expectations about objects likely to be encountered in that context (e.g., a menu). This can be advantageous to subsequent cognition, e.g., faster at recognizing related objects (Biederman et al., 1982); but can also lead to subsequent cognitive errors, e.g., false recognition of related objects (Aminoff et al., in press). Is it possible to control the use of contextually generated expectations? The current experiment tests this by having participants name two sequentially presented objects. The objects were either contextually related (e.g., cow and tractor), or contextually unrelated (e.g., bed and acorn). On each trial,

a cue indicated how likely the second object was related to the first: highly likely (70%), or unlikely (30%). Using the cue, we expected participants to modulate how much they utilized contextually relevant expectations. Behavioral results indicate that when objects were contextually related, participants were significantly faster at naming the second object if it was cued to be highly likely related to the first object compared to when the second object was most likely unrelated to the first object. Furthermore, in the unlikely cued condition, participants were significantly slower at naming a related object compared to naming an unrelated object. Although this trend was significant in the group, variability revealed individual differences in the control and use of contextual expectations. What these results reveal about the mechanism underlying contextual processing, and how neural activity sensitive to contextual associations can predict these results, will be discussed.

A76

SYMPATHETIC AND PARASYMPATHETIC EFFECTS ON COGNITIVE PERFORMANCE Shannon McCoy¹, Brandon Cosley¹, Shawn Ell¹; ¹University of Maine – Recent research in cognitive neuroscience has shown that social pressure may enhance performance on certain cognitive tasks (Markman et al., 2006). One reason social pressure may lead to differences in cognitive performance may be linked to its effects on physiological arousal or stress. When the body responds to psychosocial stressors the primary system that leads to increases in arousal is the sympathetic nervous system. Conversely, the parasympathetic nervous system acts to attenuate the arousing effects of the sympathetic system helping the body return to homeostasis. Drawing on this research, we hypothesized that when the sympathetic nervous system is aroused explicit reasoning processes are impaired. In contrast, the inhibitory effects of increases in parasympathetic activation are predicted to help restore explicit reasoning. In order to assess these differential effects of the two branches of the autonomic system on cognitive performance, participants performed an information-integration category learning task and a uni-dimensional task following a 20 minute social stressor (i.e. TSST; Krishbaum et al., 1993). In information-integration tasks, optimal performance requires the integration of information from two or more stimulus dimensions, and is not highly dependent upon explicit reasoning. In uni-dimensional tasks, optimal performance requires hypothesis testing strategies to determine the dimension of categorization. As predicted, the more participants experienced sympathetic arousal the better their performance on the information integration task. Conversely, greater influence of the parasympathetic system was found to be positively related performance on the uni-dimensional task.

A77

LEARNING MORE, KNOWING LESS: REPETITION MODULATES MEDIAL TEMPORAL LOBE AND BASAL GANGLIA CONTRIBUTIONS TO LEARNING AND GENERALIZATION Nathaniel Clement¹, Karin Foerde¹, Daphna Shohamy¹; ¹Columbia University – Studies of the neural bases of learning and memory suggest that the medial temporal lobe (MTL) and basal ganglia support distinct memory systems. The MTL supports rapid learning and creates flexible memories that can be easily generalized, while the basal ganglia support gradual learning of inflexible stimulus-response associations that do not generalize. This predicts that extended learning experience may lead to knowledge that is less generalizable. The goal of this study was to test this prediction by examining how experience during learning impacts generalization. We used functional imaging (fMRI) to examine MTL and basal ganglia activity while subjects engaged in a two-phase learning and transfer task. Subjects engaged in feedback-based learning of associations that repeated either many times (high-repetition condition) or few times (low-repetition condition). Next, subjects were asked to generalize their learned knowledge to novel stimulus combinations. We predicted that fewer repetitions would permit greater generalization. Results indicated that learning of trained associations was similar for both conditions, but generalization was greater for the low-repetition condition. fMRI data

revealed that MTL regions showed greater activation to low-repetition stimuli during learning than to the high-repetition stimuli; furthermore, the magnitude of that difference was related to better generalization for the low-repetition condition. The basal ganglia showed decreased activation over learning, across both conditions. These findings are consistent with the idea that the basal ganglia support iterative learning while the MTL supports the generalization of learned associations, and suggest that interactions between these systems over learning have implications for subsequent representations.

A78

NEUROPHYSIOLOGICAL EVIDENCE THAT EXEMPLAR-SPECIFIC REPRESENTATIONS SUPPORT VISUAL OBJECT CATEGORIZATION AND IMPLICIT MEMORY AFTER 200 MS

Stephen Maher¹, Haline Schendan¹; ¹Tufts University – The timing and format of visual knowledge representations supporting object categorization are largely unknown. Previous event-related potential (ERP) research indicates that visual object representations that are view- but not contour-specific are activated between 200 and 400 ms, indexed by a frontopolar N350, and support object model selection from a perceptual representation system in occipitotemporal cortex to enable a category decision. This experiment investigated whether these and later representations are specific to the particular exemplar of a basic level category experienced and vary with exemplar typicality (e.g., cell vs. rotary phone). People categorized objects during an indirect memory test in a 3 study (same or different exemplars of repeated categories, new category) x 2 typicality (high, low) design. Repetition effects showed that, regardless of typicality, knowledge underlying the N350, as well as a later parietal P600 implicated in post-model selection processes, was specific for the same exemplar. A centrofrontal FN400, implicated in conceptual implicit memory with some perceptual information, demonstrated perceptual specificity but also generalization to different exemplars. These findings support and extend a two-state interactive account of visual object knowledge and multiple memory systems theories. After 200 ms, a perceptual representation system for model selection during the N350 also stores perceptual implicit memory, coding each view of a category exemplar. Afterwards, conceptual knowledge representations shared by multiple exemplars and implicated in conceptual implicit memory are activated during the FN400. Finally, memory during the P600 is highly specific for the local contours in a specific view of a category exemplar.

A79

FUNCTIONAL CONNECTIVITY OF IMPLICIT PROBABILISTIC SEQUENCE LEARNING IN AGING Jessica R. Simon¹, Eric R.

Murphy¹, Chandan J. Vaidya^{1,2}, James H. Howard Jr.^{1,3}, Darlene V. Howard¹; ¹Georgetown University, ²Children's Research Institute, Children's National Medical Center, ³Catholic University of America – Implicit sequence learning, an acquired sensitivity to regularities without explicit awareness, requires a high level of functional integration among underlying neural networks. We used functional Magnetic Resonance Imaging (fMRI) to identify age differences in functional connectivity, i.e. temporal correlation between distinct brain regions, during an implicit probabilistic sequencing task. fMRI is increasingly being used to study functional connectivity, but this analysis has rarely been applied to study aging. Over 3 fMRI runs, 11 young and 12 healthy old adults viewed a series of three sequential stimuli: 2 cues and 1 target. Participants responded to only the target stimulus using a corresponding button. Unbeknownst to them, the first cue's location predicted one target location for most trials (High Probability) and another location for the rest (Low Probability). Both age groups demonstrated learning (e.g. faster responses to High vs. Low Probability trials). To investigate age differences in functional connectivity as modulated by cognitive events, we conducted a voxel-based correlation analysis. Given the striatum's importance in processing sequential and probabilistic information, we used the peak caudate voxel in each subject as a seed for psychophysiological interaction analysis and performed a brain-wide search for voxels where BOLD covaried signifi-

cantly with this interaction term. Learning was supported by different patterns of functional integration in young and old adults; for example, in Run 3, caudate connectivity was greater with the putamen and cerebellum for the young but the hippocampus in the old. These findings may reflect age-related compensation and/or changes in white-matter integrity.

A80

AN fMRI STUDY OF ITEM, ASSOCIATIVE, AND INTEGRATIVE EPISODIC MEMORY PROCESSING Scott M. Hayes^{1,2}, James Kragel^{1,2}, Roberto Cabeza^{1,2}; ¹Center for Cognitive Neuroscience, Duke University, Durham, NC, ²Duke University, Durham, NC – Regions within both prefrontal cortex (PFC) and the medial temporal lobes (MTL) are thought make distinct contributions to item and associative memory. According to some dual-process models of memory, forming associations between distinct items relies on the hippocampus, whereas item memory is thought to be mediated by rhinal cortex. More recently, it has been suggested that perirhinal cortex processes item details and that it may play a critical role in processing integrated or unitized stimuli. To examine this issue, we collected whole-brain fMRI data during encoding and retrieval of abstract figures. Participants studied monochromatic abstract figures (Item condition), multi-chromatic abstract figures (Integrative condition), or pairs of monochromatic abstract figures (Associative condition). At test, participants made old/new recognition judgments using a four-point confidence scale (definitely old, probably old, probably new, definitely new). Results of fMRI analyses revealed bilateral prefrontal cortex activation during both Associative and Integrative retrieval relative to the Item recognition. Within the medial temporal lobes, preferential activation was observed in the hippocampus during Associative retrieval relative to the Integrative and Item conditions. Overall, these data are consistent with the idea that different PFC and MTL regions contribute to item and associative memory.

A81

TOP-DOWN MODULATION OF MEDIAL TEMPORAL ACTIVITY DURING EPISODIC RETRIEVAL Norbou Buchler¹, Ian Dobbins², Roberto Cabeza¹; ¹Center for Cognitive Neuroscience, Duke University, ²Washington University in St. Louis – It is generally assumed that medial temporal lobe (MTL) activity during episodic retrieval reflects the recovery of memory traces, and hence, it is mainly driven bottom-up by the recovered memories. However, MTL activity could also reflect the intention to remember, and be partly driven top-down by memory control processes mediated by the prefrontal cortex (PFC). To investigate these issues we conducted an fMRI study in which we manipulated top-down processes by varying intention to remember, and bottom-up processes, by varying stimulus oldness. While in the scanner, previously studied words and new words were presented in an incidental non-memory or an intentional memory task. Our design first examined the patterns of MTL and PFC activity that are elicited automatically in a non-memory lexical decision task, and then examined the patterns of activity associated with intentional uses of memory, such as recognizing old and new words, and also the retrieval of more specific source information. Our data demonstrated bottom-up influences in the non-memory task, that MTL activity can be elicited automatically, independently of whether there is intention-to-retrieve. Top-down influences were observed across types-of-tasks for intentional remembering and were associated with greater PFC and MTL activity. Pure top-down influences were observed by varying instructional emphasis on recognizing new or recognizing old words, resulting in greater PFC and MTL activity to new or old stimuli, respectively. The finding that MTL activity can be modulated top-down by retrieval intentions indicates that MTL activations cannot be simply attributed to memory recovery.

A82

VALUE GENERALIZATION IN CONDITIONING: BRAIN MECHANISMS SUPPORTING HUMAN SENSORY PRE-CONDITIONING WITH MONETARY REINFORCEMENT G. Elliott Wimmer¹, Michael Szeto¹, Daphna Shohamy¹; ¹Columbia University – When pairs of stimuli are related through coinciding experiences - say, a new couple that one has become acquainted with - how does learning new value information about one pair member impact the value of the other? This value generalization effect, referred to as sensory preconditioning, 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 sensory preconditioning 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 generalization of value. To test this hypothesis, we used fMRI and a newly developed monetary reinforcement sensory preconditioning paradigm. In the task, stimuli are first incidentally paired (with no reinforcement). Then, one stimulus from each pair is used as a predictor of monetary reinforcement (gain, loss, or null outcome). Behavioral results show that the primary conditioning procedure was effective, as evidenced by significant changes in stimulus liking ratings and strong post-conditioning forced-choice preference for the reward-predicting stimulus over the punishment-predicting stimulus. Importantly, this acquired value also transferred to the paired stimuli that were never conditioned, and thus had no reward history of their own. Functional magnetic resonance imaging analyses provide insight into the neural substrates underlying successful value generalization in sensory preconditioning, with particularly important roles for the basal ganglia in value prediction and for the medial temporal lobe in generalization.

A83

PARIETAL CORTEX TRACKS THE AMOUNT OF INFORMATION RETRIEVED FROM MEMORY EVEN WHEN IT IS NOT THE BASIS OF A MEMORY DECISION Scott Guerin¹, Amy Frithsen¹, Michael Miller¹; ¹University of California, Santa Barbara – A growing number of fMRI studies are raising the prospect that the parietal cortex may play a role in memory. In recognition memory studies, regions of the parietal cortex appear to track the amount of information retrieved from memory and the participant's subjective impression that an item is old. Since parietal cortex tracks the subjective impression that an item is old, it may be encoding the decision variable that determines the outcome of the decision process: if activity in this region exceeds a certain threshold, the participant responds "old"; otherwise, the participant responds "new". We used a frequency discrimination paradigm to dissociate the amount of information retrieved from memory and the decision variable. In this task, the participant studies a series of stimuli that repeat a variable number of times. Then, in the memory test, the participant is presented with two items, one of which was presented more frequently than the other during the study session. The participant's task is to choose the stimulus that was presented more frequently. In yes/no recognition, the decision is based on the absolute amount of information retrieved. In frequency discrimination, the decision is based on the relative amount of information retrieved. Nonetheless, we observed that activation in the angular gyrus and precuneus tracked the absolute amount of information retrieved, even when it was not the basis of the participant's decision. This suggests that parietal cortex does not encode the decision variable that underlies recognition decisions.

A84

EPISODIC MEMORY FOR FEEDBACK EVENTS DURING PROBABILISTIC LEARNING Karin Foerde¹, Nathan Clement¹, Daphna Shohamy¹; ¹Columbia University – Multiple systems in the brain support learning and memory. Feedback-based, incremental learning of stimulus-response associations is supported by the basal ganglia. A distinct mem-

ory system supports rapidly formed memories of single-trial episodes and depends on the medial temporal lobes. The present study tested the hypothesis that a critical factor driving learning to depend on one system or the other is the timing of response-contingent feedback. To test this prediction, participants underwent functional imaging (fMRI) while engaged in a feedback-based probabilistic learning task that included a trial-by-trial measure of episodic memory. Participants learned to associate abstract symbols with a category outcome, using trial-by-error feedback that was delivered either immediately, or after a 3 or 6 second delay. The feedback was provided in the form of trial-unique scene photographs. Outside the scanner participants were given a surprise memory test: they classified all the encountered feedback images and an equal number of novel images according to whether they had seen them during scanning or not, and additionally indicated their confidence in the decision. Subjects performed the learning task equally well after learning with varying feedback delays. However, subsequent memory performance was impacted by the timing of the feedback: longer delays during learning resulted in enhanced subsequent memory of the feedback events, in particular for negative feedback. During learning, greater activity was seen in the parahippocampal gyrus for negative compared to positive feedback events. These results suggest that the timing of response-contingent feedback during learning affects the systems that support learning and memory.

A85

DIFFERENCES IN BRAIN ACTIVITY DURING ENCODING AND RETRIEVAL OF WORDS AS A FUNCTION OF STRATEGY, COGNITIVE STYLE, AND STRUCTURAL CONNECTIVITY

Danielle R. King¹, Christa-Lynn Donovan¹, Michael B. Miller¹; ¹University of California, Santa Barbara – Episodic memory is by nature an unconstrained and strategic task. There has been little investigation of how mnemonic strategies used spontaneously by learners relate to brain activity patterns in episodic memory tasks. To test whether different strategies engage different networks, 20 subjects were scanned during intentional encoding and retrieval of highly imageable words. Subjects completed a visualizer/verbalizer test battery, from which visual and verbal factor scores were computed to reflect the subject's tendency to process information visually/verbally. Subjects also reported their encoding strategy, which was subsequently classified as "visual" or "verbal." Subjects were then subdivided into groups based on their reported strategy. A two-sample t-test was conducted to identify regions differentially active between groups. This identified several right-lateralized regions in the prefrontal and temporal cortices, and a left-lateralized region in the precuneus. Regions of interest (ROIs) were then defined functionally using clusters identified in the 2-sample t-tests. To test whether the laterality of these activations was associated with differences in connectivity across the corpus callosum (CC), mean fractional anisotropy (FA) values were computed in each subject for the anterior CC, which connects the prefrontal regions, and the posterior CC, which connects temporal/parietal areas. A correlation analysis assessed the relationships between mean FAs, activity in the ROIs, reported strategy and visual and verbal factor scores. Results show that differences in strategy and cognitive style are associated with different functional activity during encoding and retrieval and that these differences may be related to the structural connectivity of the individuals' brain.

A86

INDIVIDUAL VARIABILITY IN BRAIN ACTIVITY DURING EPISODIC ENCODING AND RETRIEVAL: WITHIN- AND BETWEEN-SUBJECTS VARIABILITY OVER THE COURSE OF ONE YEAR

Christa-Lynn Donovan¹, Meghan Roarty¹, Michael B. Miller¹; ¹University of California, Santa Barbara – We have previously shown extensive individual variability in brain activity during episodic retrieval. The purpose of this study was to compare sources of within- and between-subject variability during encoding and retrieval. Of particular interest was to what degree variability in brain activity was related to dif-

ferences in mnemonic strategy and further, how does this compare to variability related to differences in anatomy, physiology and other sources of individual differences? Twelve participants were scanned with functional MRI while they intentionally encoded lists of highly and lowly imageable words and completed subsequent recognition memory tests. After scanning, subjects were asked to report their strategy, and to complete a Visualizer-Verbalizer test battery and personality questionnaire. Subjects returned 4 more times within one year. Each time, they performed the same tasks (with new stimuli). Our results show how between-subjects variability relates to differences in brain anatomy, connectivity, coherence of the default network at rest, reported mnemonic strategy, memory performance, visualizing/verbalizing trait and personality. Further, it's shown that within-subjects variability is predicted by changes in mnemonic strategy over time. Our results demonstrate that individuals can recruit widely dispersed brain regions during an episodic memory task, that individuals patterns of activity are relatively stable over time and that interindividual differences in activity patterns are related to a number of factors including anatomical features of the individual's brain, the individual's unique mnemonic strategy as well as trait factors such as visualizing/verbalizing ability and personality.

A87

THE HUMAN HIPPOCAMPUS AND RECOGNITION MEMORY: EVIDENCE FROM YES/NO TESTS AND FORCED-CHOICE TESTS WITH EITHER CORRESPONDING OR NON-CORRESPONDING LURES

Annette Jeneson¹, C. Brock Kirwan¹, John T. Wixted¹, Larry R. Squire^{1,2}; ¹University of California, San Diego, La Jolla, ²VA Healthcare System, San Diego – The hippocampus has been proposed to support both recollection and familiarity. Alternatively, it has been suggested that the hippocampus selectively supports recollection and that adjacent cortex can support familiarity. The latter view has led to two suggestions: (a) both recollection and familiarity are involved in yes/no recognition but familiarity can support forced-choice recognition, at least when the targets and lures are quite similar; and (b) familiarity is better able to support good recognition performance when targets are presented with highly similar lures (termed corresponding lures) than when targets are presented together with lures that are similar to other targets (termed non-corresponding lures). By this view, patients with hippocampal lesions should exhibit a greater impairment in yes/no recognition than in forced-choice recognition tests that use corresponding lures. Second, patients with hippocampal lesions should benefit more from a forced-choice test that uses corresponding lures than from a forced-choice test that uses non-corresponding lures. We administered yes/no, forced-choice corresponding, and forced-choice non-corresponding tests to five memory-impaired patients with circumscribed hippocampal lesions and 14 controls. In recognition tests of photographs of objects as well as in recognition tests of silhouette images, hippocampal lesions impaired performance on all three tests (yes/no, forced-choice corresponding, and forced-choice non-corresponding). For silhouettes, the pattern of performance across the three tests was similar in patients and controls. For objects, patients tended to perform better on the forced-choice corresponding test than on the other tests, though this effect depended largely on the performance of a single patient.

A88

OSCILLATORY CORRELATES OF EPISODIC RETRIEVAL DURING ITEM AND SOURCE MEMORY CONFIDENCE JUDGMENTS

Andrew J Watrous¹, Richard J Addante¹, Andrew P Yonelinas^{1,2}, Charan Ranganath^{1,2}; ¹Neuroscience Graduate Group, University of California-Davis, ²University of California-Davis – A significant question regarding episodic memory is whether recollection and familiarity are unique, qualitatively distinct processes, or if they reflect a single process along a graded strength continuum. In accord with the dual process account, some findings from event-related potential studies indicate that recollection and familiarity may have dissociable neural correlates. However, much less is known about the oscillatory correlates of episodic memory. For example,

in both animals and humans, theta oscillations arising from the hippocampus have been implicated in memory processes, but the exact role of theta oscillations in episodic memory processing remains controversial. We sought to further characterize this relationship by recording scalp electroencephalography (EEG) data during encoding and retrieval of verbal material. During encoding, participants made animacy or pleasantness judgments. During each retrieval test, studied and unstudied words were presented and participants made confidence judgments as to whether the item was previously studied and as to which task was performed with each item. We have employed time-frequency analysis techniques to elucidate which frequency bands are associated with episodic memory processes. Initial analyses of data during the retrieval phase show that power in the theta band was modulated by successful recognition of studied items. Further analyses will characterize and compare oscillatory correlates of recollection and familiarity during retrieval.

A89

ERP CORRELATES OF RECOLLECTION AND FAMILIARITY: ITEM AND SOURCE MEMORY CONFIDENCE Richard James Addante^{1,2}, Andrew P. Yonelinas^{1,2,3}, Charan Ranganath^{1,2,3}; ¹University of California - Davis, ²Center for Neuroscience, ³Center for Mind and Brain – Memory

judgments can be based either on recollection of qualitative information about a previous event or on rapid assessments of stimulus familiarity. Evidence for this 'dual process' view is quite extensive, but a major competing 'single process' account is that recollection simply reflects stronger memory traces than familiarity. We used a novel item and source recognition confidence method to provide behavioral measures of recollection and familiarity that overcomes several limitations associated with prior procedures, and recorded Event-related potentials (ERPs) during retrieval. Subjects studied words under conditions of pleasantness or animacy judgments, then made item recognition and source recognition confidence judgments at test. Event-related potentials (ERPs) during retrieval revealed two different effects that differentiated between old and new items: an early mid-frontal negativity, and a later onset, parietally-distributed effect. Examination of the data as functions of both item and source memory judgments indicated that the mid-frontal effect was correlated with familiarity, whereas the parietal effect was correlated with recollection. Moreover, the results from the item confidence analysis and the source contrasts provided convergent results. The parametric confidence approach used reveals a number of further findings that would not have been apparent using standard methods for both item recognition and source monitoring. The results support dual process models of recognition memory and additionally show the utility of acquiring continuous measures of memory confidence in neuromonitoring studies.

A90

NEURAL CHANGES DURING THE DEVELOPMENT OF AUTOMATICITY IN PERCEPTUAL CATEGORIZATION Jennifer

G. Waldschmidt¹, Jessica Roeder¹, Maria Schellenberger¹, F. Gregory Ashby¹; ¹University of California, Santa Barbara – This study used fMRI to examine changes in neural activation that accompanied the development of automaticity in a difficult perceptual categorization task. Each participant completed 20 sessions of training in an information-integration categorization task (approximately 12,000 trials). Sessions 2, 4, 10, and 20 were completed inside the scanner. Stimuli were circular sine-wave gratings, each category had hundreds of exemplars, and category membership was determined by a rule that required integrating perceptual information about bar width and bar orientation in a way that could not be described verbally. At the behavioral level, accuracy gradually increased to near perfect levels and response times decreased to a low nearly constant value. Both results are classic markers of automaticity. The fMRI data generally supported a recent computational model called SPEED (Subcortical Pathways Enable Expertise Development; Ashby, Ennis, & Spiering, 2007, Psychological Review), which assumes that the development of automaticity is mediated by a transfer of control from a subcortical pathway through the basal ganglia to a faster purely cortical pathway from sensory association cortex to the relevant areas of premotor and motor cortex.

A91

UNIQUE NEURAL CORRELATES OF AUTOBIOGRAPHICAL MEMORY AND THEORY OF MIND Jennifer S. Rabin¹, Donald T.

Stuss^{2,3}, Asaf Gilboa⁴, Raymond A. Mar¹, R. Shayna Rosenbaum^{1,2}; ¹York University, Toronto, Canada, ²Rotman Research Institute, Baycrest, Toronto, Canada, ³University of Toronto, Neurology, Rehabilitation Sciences, Canada, ⁴University of Haifa, Mount Carmel, Israel – Neuroimaging studies report a common network of brain regions involved in thinking about one's own past experiences during autobiographical memory (AM) and other people's current experiences during theory of mind (ToM). However, lesion data show that amnesics have intact ToM, suggesting that distinct neural mechanisms support the two abilities. This study examined the brain regions and processes involved in imagining one's own and other people's experiences using a real-world 'family photos' test. Participants were scanned with fMRI as they recollected past events in response to personal photos ('AM' condition) and generated possible events in response to strangers' photos ('ToM' condition). Content and vividness were matched across the AM and ToM photos. Analyses revealed a common network of brain regions, including bilateral medial prefrontal cortex (mPFC), inferior frontal gyrus, medial temporal lobes (hippocampus, parahippocampus), posterior cingulate/retrosplenial cortex, temporal poles, and middle temporal gyrus. However, activity within the entire network was greater during AM except for left inferior frontal gyrus, which was greater during ToM. More specific analyses of event construction and elaboration revealed greater mPFC and hippocampal activation during elaboration for both conditions, although the precise location of activity within these regions differed across conditions. Moreover, right temporal-parietal junction (rTPJ) activation was unique to ToM during event elaboration. These data suggest that differences in AM and ToM emerge when vividness is taken into account, particularly during event elaboration. Furthermore, mPFC and rTPJ, but not the hippocampus, may be needed for ToM, given that this ability is intact in amnesics.

A92

PREFRONTAL ACTIVATION DURING SUCCESSFUL ENCODING OF TASK-RELEVANT AND IRRELEVANT INFORMATION

Andrew Heusser¹, Francis Richter¹, Ian Ramsay², Dan Ragland^{1,2}, Cameron Carter^{1,2}, Charan Ranganath^{1,2}; ¹Center for Neuroscience, University of California - Davis, ²Imaging Research Center, University of California - Davis – Regions in the lateral prefrontal cortex are critical for working memory control processes that support selection of goal-relevant information. Activity in the ventrolateral prefrontal cortex (VLPFC) has been reliably linked with successful long-term memory encoding, but the role of the dorsolateral prefrontal cortex (DLPFC) in encoding is unclear. Some research suggests that DLPFC may represent abstract rules that determine what information is task-relevant, whereas the VLPFC may more specifically support the selection of relevant stimulus or response information. Building on this idea, we conducted an event-related fMRI study to test whether these regions differentially support long-term memory formation. Subjects were scanned while performing a context-dependent encoding paradigm with two different conditions. On blocks of 'no rule' trials, participants were told to make animacy judgments on a series of words. On 'target/nontarget' blocks, participants were first shown a target color (orange or green) and instructed to make animacy judgments for words shown in the target color or to make a non-target response for words in the other color. Following scanning, participants were given a recognition test consisting of all words, along with unstudied foil items. Behavioral data demonstrated that recognition memory was better for words from no-rule blocks than for words from target/nontarget blocks, and that recognition was superior for target words than for non-target words. Preliminary fMRI analyses revealed that prefrontal activation was modulated by task condition and successful encoding. Further analyses will assess interactions between task and subsequent memory status and activity in DLPFC and VLPFC.

A93

PERSPECTIVE DIFFERENTIALLY MODULATES NEURAL ACTIVATION DURING REMEMBERING AND IMAGINING AUTOBIOGRAPHICAL EVENTS

Christine L. Cox¹, Lynn Nadel¹, Lee Ryan¹; ¹Cognition and Neuroimaging Laboratories, University of Arizona – The perspective from which autobiographical memories (AM) are retrieved can influence their subjective experience. Participants report reduced detail, emotionality, and sense of reliving for AMs recalled from third-person "observer" perspective (3pp) compared to those recalled from first-person "field" perspective (1pp; Berntsen & Rubin, 2006; McIsaac & Eich, 2002). Recent studies indicate that recalling AMs and imagining fictitious autobiographical events (FAE) recruit largely overlapping neural networks (Addis et al., 2007; Hassabis et al., 2007). Despite evidence that perspective is important in AM retrieval, and that recalling AMs and imagining FAEs engage similar processes, the effects of perspective on the neural correlates of these tasks are currently unknown. Participants in the present study underwent fMRI scanning while retrieving AMs and imagining FAEs, subsequently indicating from which perspective (1st/3rd) they saw themselves in each event. Parametric modulation analyses were performed, determining brain regions whose activation was modulated by differences in perspective. Results indicated that while 1pp modulated activity in medial prefrontal cortex during AM retrieval, activity in lateral parietal cortex and the cerebellum was modulated during FAE imagination. And while 3pp modulated activity in dorsolateral prefrontal cortex and the precuneus during AM retrieval, activity in anterior prefrontal cortex, premotor cortex, basal ganglia, and lateral parietal cortex was modulated during FAE imagination. These findings suggest that recalling and imagining oneself from the first and third person differentially engage brain regions implicated in self and other processing, motor planning, and spatial cognition, demonstrating the important role played by perspective in the (re-)construction of autobiographical events.

A94

THE RELATIONSHIP BETWEEN PERCEPTUAL/CONCEPTUAL PRIMING EFFECTS AND REPETITION SUPPRESSION IN POSTERIOR/FRONTAL CORTICAL REGIONS

Chun-Yu Lin¹, Lee Ryan¹; ¹University of Arizona, Tucson, AZ – Priming refers to the change in speed, accuracy or bias in processing a stimulus following prior exposure to the same stimulus. Neuroimaging studies have revealed that behavioral priming is typically accompanied by reduced activity (i.e. repetition suppression, or RS) in several cortical regions. When a perceptual priming task is used, RS is usually found in posterior cortical regions, and when a conceptual priming task is used, RS is normally found in frontal regions. It is hypothesized that RS may be the neural basis for behavioral priming. If this is the case, the magnitude of behavioral priming (i.e. the amount of facilitation in reaction time) should correlate with the magnitude of RS. However, reviews showed that so far several studies have reported frontal RS correlated with behavioral conceptual priming effects, but no strong evidence has been published yet supporting the correlation between posterior RS and perceptual priming effects. Therefore, the main goal of the present functional magnetic resonance imaging (fMRI) study was to examine the relationship between posterior/ frontal RS and perceptual/conceptual priming. Each participant performed three perceptual priming tasks (symmetry judgment on novel shapes or known objects, and picture naming on known objects) and one conceptual priming task (natural or man-made judgment on known objects). Results showed that more posterior than frontal RS effects were found in perceptual priming tasks, and the magnitude of behavioral perceptual priming also correlates with the extent of posterior RS, supporting the view that posterior regions are important for perceptual priming.

A95

DISTINCT PATTERNS OF FUNCTIONAL CONNECTIVITY BETWEEN PERIRHINAL CORTEX AND OTHER CORTICAL REGIONS IN RECOGNITION MEMORY AND PERCEPTUAL DISCRIMINATION

Edward O'Neil¹, Anthony Cate², Jordan Poppenk^{3,4}, Stefan Köhler¹; ¹The University of Western Ontario, ²VA Research Service, Martinez, CA, ³University of Toronto, ⁴Rotman Research Institute – The prevailing view of the medial temporal lobe (MTL) holds that its structures are dedicated to declarative memory. Recent evidence challenges this position, suggesting that perirhinal cortex (PRc) in the MTL may also play a role in online processing of objects when perceptual discriminations of stimuli with highly overlapping visual features are required. Here, we conducted an fMRI experiment to compare functional interactions of PRc with other cortical regions in recognition memory and in perceptual discrimination. The perceptual task required an 'oddball' judgment on sets of morphed faces. The memory task involved forced-choice recognition of a studied face among similar morphed lures. In previously reported analyses, we identified a right PRc region whose activity was related to accuracy in both tasks. In our new analyses, we aimed to determine whether these accuracy effects involved distinct interactions between PRc and other cortical regions. Specifically, we tested whether these patterns included (i) correlations between PRc and prefrontal regions previously implicated in retrieval monitoring that were specific to recognition memory, and (ii) correlations between PRc and ventral visual-pathway regions previously implicated in face perception that were specific to perceptual discrimination. A multivariate partial least-squares (PLS) analysis with a seed in the critical PRc region uncovered distinct patterns of functional connectivity that confirmed our hypotheses. Together these findings suggest that it is not engagement of PRc as such, but its pattern of interactions with other cortical regions that is uniquely associated with successful performance in recognition memory as compared to online processing of objects.

A96

LONG-TERM REPRESENTATIONS OF FAMILIAR LANDMARKS AND SCENES AS REVEALED BEHAVIOURALLY AND WITH EYE MOVEMENTS

Sabrina Agnihotri^{1,2,3}, Jennifer D. Ryan^{2,3}, Morris Moscovitch^{2,3}, Gordon Winocur^{2,3}, Marie-Eve Couture², R. Shayna Rosenbaum^{1,2}; ¹York University, ²Rotman Research Institute: Baycrest Hospital, ³University of Toronto – Research suggests that spatial memory representations of familiar environments are organized as schematic cognitive maps that preserve the gist of the environment without rich contextual details that may be necessary for re-experiencing it. In this sense, remote spatial memories can be considered similar to remote semantic or context-free memories, which can be retrieved independently of the hippocampus. It has also been suggested that, under certain conditions, eye movements are sensitive markers of hippocampal activity. To better understand long-term spatial memory representations and retrieval, the current study examined the ability to detect modifications to well-known landmarks located in downtown Toronto in a group of healthy young adults with extensive experience navigating in that environment. In general, participants demonstrated great difficulty identifying scenes containing altered landmarks, even if the modification was to the relative size of landmarks, to their internal features, or to the surrounding context. Their performance was best when a landmark was transposed to a different location. This pattern was reflected in the eye movement data, suggesting that there was a change in viewing time only in response to the few modifications for which participants were aware. These results support the contention that very familiar landmarks are strongly integrated within the spatial context in which they were first experienced, and that as long as the overall spatial configuration of landmarks remain intact, changes to fine or incidental details can go unnoticed.

A97

EXPLORING THE CONTRIBUTIONS OF CORTICOSTRIATAL LOOPS TO CATEGORIZATION LEARNING USING TEMPORAL DIFFERENCE MODELING AND GRANGER CAUSALITY MODELING Carol Seger¹, Erik Peterson¹, Dan Lopez-Paniagua¹, Corinna Cincotta¹; ¹Colorado State University – We used multiple fMRI analysis methodologies to identify the roles of three corticostriatal loops in categorization: the motor loop connecting putamen with motor cortex, the visual loop connecting caudate with visual cortex, and the motivational loop connecting ventral striatum with ventromedial frontal cortex. Subjects viewed a face or house, responded whether it belonged to category A or category B, and received feedback. Stimuli were arbitrarily assigned to categories and category assignment could not be learned via a rule or pattern. We performed three analyses: (1) General linear model (GLM) contrasts identifying activity specific to correctly categorized trials (2) Regression analysis using temporal different model predictors of the error function (identifying regions sensitive to feedback processing and expectancy) and the value function (identifying regions coding correct category response) (3) Granger causality modeling (GCM) to identify directed influences between regions. GLM analyses found that striatal regions in both the motor loop (putamen) and visual loop (caudate) were associated with categorization learning. However, the putamen was sensitive to the value function and exerted directed influence on motor cortex, whereas the caudate received directed influence from visual cortex regions. These results indicate that the motor loop is involved in motor responding and the visual loop is involved in visual analysis during categorization. Activity in the ventral striatum was predicted by the error function, which is consistent with this region playing a role in reward and feedback processing within the motivational corticostriatal loop.

A98

SOURCE MEMORY AND FUNCTIONAL CONNECTIVITY Paul Metzack^{1,2}, Elton Ngan¹, Liang Wang^{1,2}, Jen Whitman^{1,2}, Todd Woodward^{1,2}; ¹University of British Columbia, ²Provincial Health Services Authority, BC Mental Health and Addictions Research Institute – Previous fMRI research on source memory suggests that this process is associated with dorsolateral prefrontal cortex activity. In the current study, we sought to investigate the functionally connected neural networks underlying source memory task performance, and their temporal progression throughout a trial. Twenty-four healthy participants were scanned while presented with words they had seen during training. Specifically, they were asked to recall whether, for a given word, they had (1) quietly read it, (2) provided an associated word, (3) said it themselves as the solution to a word puzzle, or (4) heard it as a digitized sound file solution to a word puzzle. Using a Finite Impulse Response (FIR) basis set modelling the peristimulus time points in conjunction with constrained principal component analysis (cPCA) for fMRI data, we extracted 3 functionally interacting but separate components. In the first component, the highest loadings were found bilaterally in the hippocampus and in the cerebellum. In the second component, the highest loadings were found in the visual cortex. In the third component, the highest loadings were found bilaterally in the dorsolateral prefrontal cortex, and in the dorsal anterior cingulate. The importance of each component over peristimulus time was computed and subjected to a test of statistical significance. The interaction between memory performance (miss/recall) and time point was found to be significant for all three components, indicating that all three neural networks are associated with successful source memory performance.

A99

ELECTROPHYSIOLOGICAL AND BEHAVIORAL MEASURES OF SWITCHING BETWEEN MEMORY TASKS Kristine A Wilckens¹, Eric D Signoff¹, Ashley J Abraham¹, David A Wolk², Mark E Wheeler¹; ¹University of Pittsburgh, ²University of Pennsylvania – Cognitive set, or retrieval orientation, can influence the effectiveness and accuracy of memory retrieval. To test the extent to which behavioral and electrophysiological measures of retrieval performance are influenced by orientation,

we used a task-switching paradigm in which subjects were cued on every trial to perform either a semantic (living or nonliving) or an episodic (old or new) memory task. Here we report preliminary data (n = 5) from a study that will ultimately compare older and younger adults on behavioral and neural measures of retrieval orientation. Stimuli consisted of common visual objects, and studied (old) and non-studied (new) items were intermixed randomly at test. We were interested in the degree to which event related potential (ERP) old/new effects were modulated by the need to either switch from one task to another (switch) or to continue performing the same task on the previous one (stay) and two (stay+1) trials. We also tested for retrieval orientation effects by comparing ERPs of new items following either semantic or episodic cues. Behaviorally, subjects were slowest on switch trials and fastest on stay+1 trials. ERP data showed an old/new effect in left posterior superior (LPS) sites. Further, there appeared to be a step-wise increase in the old/new effect across switch, stay, and stay+1 conditions which corresponded with the behavioral data. Moreover, we found differences between processing of new stimuli following episodic vs. semantic task cues, which may reflect retrieval orientation. These data suggest that processing of a stimulus differs when switching between memory tasks.

A100

INTERACTIVE CORTICAL AND SUBCORTICAL STRUCTURES SUPPORT DIFFERENT TIME SCALES IN MOTOR SEQUENCE LEARNING Nicholas F. Wymbs¹, Scott T. Grafton¹; ¹University of California, Santa Barbara – Nonlinear performance changes during sequence learning suggest that motor skills may be acquired on multiple time scales. We hypothesized that the underlying neural substrates supporting learning reflect these multiple time scales. It was predicted that prefrontal and rostral premotor areas and their basal ganglia (BG) projections support initial improvement, whereas caudal premotor and motor cortex and their BG connections support slow improvement. We used a cued sequence production task and functional magnetic resonance imaging. Participants translated a visually instructed explicit 12-element sequence into responses by the four fingers of the left hand. The entire sequence was presented at once, which served as the imperative to respond. Participants practiced three sequences frequently (189 trials/sequence), three occasionally (27 trials/sequence), and nine additional sequences rarely (8 trials/sequence) over the course of three sessions completed within five days, allowing us to use frequency of exposure to identify brain areas that are sensitive to the amount of training. Analyses of BOLD activity identified transient activity in prefrontal cortex and rostral basal ganglia for rare sequences, consistent with a novelty effect. Sequences that were practiced occasionally recruited pre-SMA, rostral PMd and associated BG that diminished with frequent practice. In parallel, there was a progressive increase of activity in caudal PMd, SMA, motor cortex and sensorimotor BG with frequent practice. Different brain regions are more prominent at particular times during motor learning, with a shift of recruitment from rostral to caudal premotor and associated subcortical areas.

A101

EEG CORRELATES OF PROCESSING THREATENING VISUAL STIMULI Clifford Calley¹, Matthew Brier¹, Thomas Ferree², Rajen Patel¹, Yana Gelman¹, Gail Tillman¹, Michael Kraut³, John Hart¹; ¹Center for BrainHealth: University of Texas at Dallas, ²University of Texas Southwestern Medical Center, ³Johns Hopkins University School of Medicine – An organism's ability to rapidly detect threatening stimuli is crucial to its survival. Previous fMRI studies of pictures of threatening and nonthreatening stimuli across a variety of categories demonstrated differential signal change of BA 18 and 19 for threatening compared to non-threatening stimuli. The fMRI data, however, were uninformative as to the timing of whether the para-striate visual regions was being activated directly from feed-forward connections of striate cortex or late through feedback from more rostral cortical regions. To address this issue, we recorded surface EEG as subjects performed the same task used for the fMRI experiment

noted above. Subjects were shown threatening and non-threatening images, as well as their phase-scrambled equivalents. Time-frequency analysis was performed using 0.25-sec moving windows. For threatening versus non-threatening stimuli, there were differences in the theta band EEG power in the left occipital-temporal region at about 1 sec and in the fronto-central region at about 1.3 sec. The findings support the contention that the previously observed BA 18 and 19 fMRI signal changes reflect feedback activation as opposed to direct feedforward information flow, which is consistent with axonal connections from the amygdala to visual regions which have been shown to influence processing in visual cortices. The finding of theta-band activity involved in threat detection in humans is consistent with previous findings in animals for threat recognition in the amygdalo-hippocampal circuit.

A102

PROCESSING OF SOUNDS DURING SLOW WAVE SLEEP IN HUMANS: AN EEG/fMRI STUDY OF AUDITORY STIMULATION IN NON-REM SLEEP Manuel Schabus^{1,2}, Thanh Dang-Vu², Melanie Boly², Anabelle Darsaud², Genevieve Albouy², Virginie Sterpenich², Christophe Phillips², Pierre Maquet²; ¹University of Salzburg, Austria, Division Physiological Psychology, ²University of Liege, Belgium, Cyclotron Research Centre – The present study aimed at identifying the neurophysiological responses associated with auditory stimulation during deep non-rapid eye movement (NREM) sleep using simultaneous EEG/fMRI recordings. It was reported earlier that auditory stimuli produce bilateral activation in auditory cortex, thalamus, and caudate during both wakefulness and NREM-sleep (Portas et al., 2000). However, due to the spontaneous membrane potential fluctuations cortical responses may be highly variable during NREM. Here we now examine the modulation of cerebral responses to tones depending on the phase of the slow oscillation. Up to now 7 healthy young subjects were scanned successfully during slow wave sleep in the first half of the night in a Siemens-Allegra-3T scanner (EPI sequence: 32 slices, TR: 2460ms). Subjects were not sleep-deprived and sounds which were occurring around the peak negativity of NREM slow-waves were identified. These detected sounds were then entered as regressors of interest in fMRI analyses. Results are consistent with the hypothesis that brain responses during deep NREM-sleep vary as a function of the fluctuating state of thalamo-cortical circuits. In accordance with Massimini and colleagues (2003) larger evoked responses are observed at the negative slope of the slow oscillation. The presence of short temporal windows during which the brain is open to external stimuli is consistent with the fact that even during deep sleep meaningful events can be detected. Altogether, brain responses during NREM sleep appear to be non-stationary and highly dependent upon the phase of the slow oscillation which may also determine the faith of incoming stimuli while asleep.

A103

NEURAL MECHANISMS OF THE DISTRIBUTED PRACTICE EFFECT Michael Mozer¹, Harold Pashler²; ¹University of Colorado, ²University of California, San Diego – When individuals learn facts (e.g., foreign language vocabulary) over multiple study sessions, the temporal spacing of study has a significant impact on memory retention. Behavioral experiments have shown a nonmonotonic relationship between interstudy interval (ISI) and retention, with intermediate ISIs yielding better performance than short or long ISIs, and the optimal ISI strongly depending on the retention interval. Many theories have been proposed to explain these effects, but none captures the wealth of data. We propose a hybrid theory that combines features of three existing models: Anderson and Milson (1989), Raaijmakers (2003), and Staddon, Chelaru, and Higa (2002). Our theory is cast as a neural network, and is based on the notion that items are encoded with a time-varying contextual representation, of the sort that has been proposed to reside in the dentate gyrus of the hippocampus (Aimone, Wiles, & Gage, 2006). The similarity of the contexts at study and test determines the probability of retrieval success. Extending previous models, our theory posits a context that wanders on multiple time scales. The model can fit data over a range of interstudy intervals from minutes to months. Moreover, the model has strong pre-

dictive power: Given the forgetting function for a set of items studied once, the model successfully determines the spacing of study sessions that yields optimal retention.

A104

THE EFFECT OF SLEEP ON TEMPORAL ORDER IN EPISODIC MEMORIES Andrea Hoffmann¹, Kerstin Hoedlmoser¹, Hermann Griessenberger¹, Wolfgang Klimesch¹, Manuel Schabus¹; ¹University of Salzburg, Division Physiological Psychology – Meanwhile there is plenty of evidence indicating that sleep has a beneficial effect on declarative and procedural memory consolidation. Here we study the influence of sleep versus sleep deprivation on temporal order in episodic memories. 34 young participants either slept or had to stay awake during the whole night after learning various stories. Each story consisted of 12 pictures (6 faces and 6 objects) presented in sequence and participants had to invent a story with themselves being a part of it. In addition to a previous screening/adaptation night the "sleep group" slept in the sleep laboratory after learning with full polysomnography attached. Retest was done the next morning, as well as after 2 recovery nights in order to circumvent fatigue effects of the sleep-deprived group. Results revealed that performance in temporal order memory was only deteriorated in the post-training sleep deprived group. Furthermore, we report a positive relationship of rapid eye-movement (REM) sleep after learning and performance in temporal order recall. Last but not least we could confirm earlier findings reporting positive association of (fast) non-REM sleep spindles and cognitive abilities (as revealed by the Wechsler Memory Scale- revised and Raven's Advanced Progressive Matrices). This repeatedly found general association might indicate that sleep spindles are a good indicator for cognitive capability because they allow a rough estimation about the degree of thalamocortical connectivity.

Memory: Other

A105

RECOLLECTION BENEFITS AND THE REACTIVATION OF SENSORY-SPECIFIC BRAIN REGIONS DURING THE RETRIEVAL OF CONTEXT INFORMATION Erin Skinner¹, Myra Fernandes¹, Cheryl Grady^{2,3}; ¹University of Waterloo, Ontario, ²Rotman Research Institute, Baycrest Center for Geriatric Care, Toronto, Ontario, ³University of Toronto, Ontario – The neural correlates underlying the retrieval of contextual details during recollection were investigated using event-related fMRI. Previous work suggests that participants can use contextual detail provided at study to benefit later memory performance (Skinner & Fernandes, in press). We examined whether such a benefit is associated with the reactivation of sensory-specific brain regions. The fusiform face area was localized in fourteen younger adult participants, who subsequently performed three study-test sessions. During study, participants viewed words presented with pictures of faces, or scrambled faces, and in a subsequent scanned recognition test made remember, know, or new judgments to the words presented alone. Overall, behavioural results showed no difference in recognition performance for words studied with faces or scrambled faces. Neuroimaging data, however, showed higher fusiform activation during remember responses to words studied with faces as compared to words studied with scrambled faces. In a further analysis, we divided the participants based on behavioural performance: 8 participants who gave more remember responses to words studied with faces than scrambled faces (Context-benefit group) and 6 participants who did not show this pattern (Context-neutral group). Whereas the Context-benefit group showed higher fusiform activation during remember responses to words studied with faces as compared to scrambled faces, the Context-neutral group did not. The results suggest that the retrieval of contextual detail during recollection is associated with the reactivation of sensory-specific brain regions, and that this is supported by processes that bind item and context information at study, improving subsequent recollection.

Poster Session B

Cognitive and brain development

B1

NEURAL CORRELATES OF AUDITORY PHONOLOGICAL PROCESSING IN TYPICAL READING DEVELOPMENT AND DYSLEXIA

Elizabeth S. Norton^{1,2}, Ioulia Kovelman¹, Nadine Gaab^{3,4}, Joanna A. Christodoulou^{4,1}, Dan A. Lieberman^{5,1}, John Lymberis¹, Susan Whitfield-Gabrieli¹, Maryanne Wolf², John D.E. Gabrieli¹; ¹Massachusetts Institute of Technology, ²Tufts University, ³Children's Hospital Boston/Harvard Medical School, ⁴Harvard University Graduate School of Education, ⁵Harvard Medical School – Phonological awareness (PA), our ability to manipulate the phonemic units of language, is predictive of successful reading acquisition. Children with dyslexia are often impaired on PA tasks. Neuroimaging studies find differences in brain function between typical and dyslexic readers using visual (written text) PA tasks. Although deficits in visual PA tasks are thought to originate from diminished auditory language PA, little is known about auditory PA brain differences between typical and dyslexic children. We compared neural correlates of auditory PA in typically-developing and dyslexic children. METHOD: Dyslexic readers (n=13, ages 7-12), age-matched typical readers (n=13), and kindergarteners, PA ability-matched to dyslexics (n=10, ages 5-6), completed word-rhyming PA and word-matching control tasks during fMRI. RESULT: Age-matched typical readers exhibited left dorsolateral prefrontal cortex (DLPFC) activation for word-rhyming relative to word-matching. Activation was significantly greater than in dyslexics, who did not exhibit DLPFC activation. Kindergarteners exhibited left DLPFC activation similar in magnitude to the typical readers. CONCLUSIONS: Left DLPFC appears to support PA for auditory language in typically developing children before (kindergartners) and during (age-matched readers) reading instruction. Dyslexic readers do not appear to engage DLPFC for PA. These findings suggest that auditory PA is important for successful reading acquisition, that left DLPFC plays a role in auditory language PA, and that dyslexics have differences in DLPFC function that cannot be accounted for by reading or PA proficiency. Rather, these differences in the left DLPFC region supporting auditory PA may play a critical role in the etiology of dyslexia in many children.

B2

THE ROLE OF INDIVIDUATION VERSUS CATEGORIZATION IN THE DEVELOPMENT OF PERCEPTUAL EXPERTISE

Lisa Scott¹; ¹University of Massachusetts Amherst – Prior research investigating the acquisition of perceptual expertise in adults suggests that increased expertise is exhibited in those who are trained to discriminate at more specific levels. It is possible that the manner in which perceptual expertise is acquired in adults is similar to the manner in which face expertise is acquired through experience during development. Here it was predicted that experience discriminating novel types of faces and objects at the individual level, but not the category level, during the first year of life, will lead to specialized processing for those trained stimuli. Four groups of infants completed pre-training (6 months) and post-training (9 months) behavioral (Visual-Paired Comparison) and electrophysiological (Event-Related Potentials) assessments, which indexed face and object discrimination. Following the pre-training assessment, two groups of infants were sent home with training books of monkey faces or of strollers, which were labeled at the individual level (i.e. all faces and strollers had individual names). Two more groups of infants were sent home with books of monkey faces or strollers labeled at the category level (i.e. all faces were named 'monkey' or 'stroller'). Infants returned at 9-months and results revealed

both behavioral and electrophysiological (N290; P400) differences from 6 to 9 months, and between training conditions such that infants trained at the individual level exhibited a differential pattern of neural activity relative to those trained at the category level. These results are discussed in relation to visual perceptual narrowing and the development of face processing.

B3

DO INFANTS SHOW THE COMPATIBILITY EFFECT? AN EVENT-RELATED POTENTIAL STUDY OF GAZE-EMOTION INTERACTION

Silvia Rigato¹, Teresa Farroni^{1,2}, Mark H. Johnson¹; ¹Centre for Brain and Cognitive Development, School of Psychology, Birkbeck College, London, UK, ²Dipartimento di Psicologia dello Sviluppo e della Socializzazione, Università di Padova, Italy – Event related potentials were recorded from four-month-old infants while they viewed pictures of faces with direct or averted gaze displaying happy, fearful, and angry expression. We predicted differential emotional expression processing, at least between certain facial expressions, at the infant face sensitive ERP components (N290, P400) and at the negative component (Nc). Further, we expected to observe modulation by gaze direction for happy and angry expressions. Electrophysiological activity was recorded by using 128 channels Hydrocel Geodesic Sensor Net, while infants were seated on their mum's lap in front of a 40X29 cm monitor. Their attention was drawn to the middle of the screen by a colour cartoon, which lasted between 1400-1800 ms, and then a face replaced it for 1000 ms. Face stimuli were counterbalanced, presented in random order and with equal probability for as long as the babies were willing to look at them. 42 babies participated in the study. Analysis showed that the Nc is affected by emotional expression, with larger amplitudes for happy and angry than fearful face stimuli. Significant gaze effects were found at the Nc in response to angry expressions, and at the frontal sites for happy faces only. Our results suggest that infants' brain responses differ between emotional expressions, showing larger activation to happy and angry expressions, possibly reflecting a greater allocation of attention. Infants discriminate gaze direction in these emotions revealing an interaction between emotion and gaze direction in approach-oriented emotions.

B4

FACE-SPECIALIZED CORTICAL AREAS EMERGE SLOWLY: A DEVELOPMENTAL FMRI STUDY

Kathrin Cohen Kadosh¹, Frederic Dick^{1,2}, Roi Cohen Kadosh³, Richard N. A. Henson⁴, Mark H. Johnson¹; ¹Centre for Brain and Cognitive Development, School of Psychology, Birkbeck College, University of London, UK, ²Center for Research in Language, University of California, San Diego, CA, ³Institute of Cognitive Neuroscience, University College London, London, UK, ⁴MRC Cognition & Brain Sciences Unit, Cambridge University, Cambridge, UK – Faces are complex social stimuli that convey much information, such as for example the identity, or the emotional state of a person. Several studies have shown that children's abilities to process different facial features are delayed in comparison to other objects categories (Carey & Diamond, 1977; Mondloch et al., 2003). Recent fMRI evidence suggested that immature behavioural abilities might be related to the slow emergence of face-sensitive cortical areas (Scherf et al., 2007). In the current study we evaluated the neuro-cognitive mechanisms of different facial features as a function of development. Forty participants (14 adults, 12 children (7-8 years), 14 children (10-11 years)) had to detect a specific identity, emotional expression, or direction of eye gaze in a stream of consecutively presented faces. The adult participants showed comparable performance for all tasks, while the neural processing of the different facial features varied as a function of task and facial fea-

ture, in particular in the fusiform gyrus, the inferior occipital gyrus and the superior temporal sulcus. The children's performance varied significantly depending on the specific facial feature and age, and neural activation showed reduced functional integration between the facial features, as both children groups relied on additional frontal and parietal brain areas. Thus, our findings suggest that previous reports on improvements in behavioural abilities for face processing observed between 7-11 years of age, are mirrored by slowly changing neuronal activation patterns that depend on task requirements and the specific facial feature investigated.

B5

NEUROBIOLOGY OF SEX DIFFERENCES IN PARIETAL LOBE DEVELOPMENT

Joel Salinas^{1,2}, Peg Nopoulos²; ¹Doris Duke Clinical Research Fellowship Program, University of Iowa, ²University of Iowa – Structural MRI studies continue to provide evidence for sexual dimorphism in the human brain, especially overall cerebral volume. Previously, our lab found adult males to have parietal lobe surface area proportionately greater than females; however, females had a greater ratio of parietal lobe cortex to parietal lobe white matter. To our knowledge there are no studies examining this sexual dimorphism of parietal lobe structure in younger populations or in the context of development and aging. This study evaluates structural differences of the parietal lobe in younger males and females (ages 7-18). Also, by adding the cohort of previously studied adults (ages 18-50), sexual dimorphism of parietal lobe morphology was examined across ages 7-50. In the youth sample, we found that the ratio of parietal cortex to parietal white matter was greater in girls compared to boys. Unlike the adult sample, however, there was no sexual dimorphism in the parietal surface area. When examining the youth and adult samples together, though, parietal surface area was found to have a significant sex by age interaction. Both sexes had linear decreases in parietal surface area over time, but the slope was significantly steeper for females compared to males. Therefore, in youth, parietal surface area is not significantly different between the sexes, but, in adults, males end up with larger parietal surface area. These findings support the notion of clear structural sexual dimorphism in the parietal lobe, not only in the context of cross sectional assessment, but also in terms developmental trajectories.

B6

THE ONTOGENY OF HANDEDNESS: EVIDENCE FROM THE KISS SYNDROME

Sebastian Ocklenburg¹, Corinna Buerger¹, Christine Westermann¹, Daniel Schneider¹, Heiner Biedermann², Onur Guentuerkuen¹; ¹Institute of Cognitive Neuroscience, Ruhr-University Bochum, Germany, ²Private Practice, Cologne, Germany – The ontogeny of functional lateralisation and especially of handedness has often been explained with genetic models. In birds, however, it has been shown that epigenetic factors also play a critical role in the development of lateralisation. In pigeons and chicks a skewed visual input during development has been found to modulate morphological and functional asymmetries. To test the hypothesis that epigenetic factors, especially visual experience, may also modulate human functional lateralisation, children with the KISS (Kinematic imbalances due to suboccipital strain) syndrome were tested. These children have a permanently fixed asymmetric posture of the head due to a functional disorder of the occipito-cervical region. This head tilt can be to the left or to the right side, leading to opposing asymmetries in visual experiences of the two hands. We compared functional asymmetries in children with a left- or right-sided KISS syndrome with those in healthy controls. Children's individual handedness, footedness and eye-preference were assessed using behavioural tasks. Right-handedness was more frequent in children with a head tilt to the left than in control children. Children with a head tilt to the right, in turn, had a lower frequency of right-handedness than controls. For footedness and eye-preference no differences between the three groups were observed. These findings show a clear influence of an epigenetic factor on handedness and therefore strongly suggest a combined genetic-epigenetic model for its development.

B7

DEFAULT NETWORK FUNCTIONAL CONNECTIVITY DEPENDS ON WHITE MATTER MATURATION

Evan Gordon¹, Philip Lee², Jose Maisog², Jennifer Foss-Feig², Michael Billington², John VanMeter², Chandan Vaidya^{2,5}; ¹Interdisciplinary Program in Neuroscience, Georgetown University Medical Center, ²Georgetown University, ³Children's Research Institute, Children's National Medical Center – Functional connectivity measured between the medial prefrontal cortex (mPFC) and the posterior cingulate cortex (PCC), known collectively as the 'default network', is correlated in adults with the structural integrity of the cingulum white matter bundle which runs between these two regions. While previous work in children has demonstrated that functional connectivity within the default network increases with age, it is not known whether this developmental increase correlates with an increase in white matter integrity; nor are the behavioral correlates of these connectivity increases well characterized. We examined the relationship between default network functional and anatomic connectivity in fourteen boys age 9 to 12 years who had been assessed with a neuropsychological battery. We measured both functional connectivity between the network components (as indexed by the coherence of the fMRI signal during rest) and the structural integrity of the cingulum bundle (as measured by the mean Fractional Anisotropy within the cingulum, obtained via Diffusion Tensor Imaging). We found a significant positive relationship between the integrity of the white matter in the cingulum bundle and the functional connectivity between the mPFC and the PCC ($r(12)=.55$, $p=.05$). Behaviorally, functional connectivity in this network correlated positively with cognitive processing speed ($r(12)=.62$, $p<.05$), but not with motor processing speed ($p=.28$) or with executive function ($p=.31$). Thus, the functional integrity of the midline default network relies upon maturation of the underlying white matter and influences efficiency of information processing. Funded by MH65395.

B8

HEMISPHERIC LATERALIZATION OF VERBAL AND SPATIAL WORKING MEMORY EXISTS IN DEVELOPING YOUTH

Megan M. Herting¹, Damien Fair¹, Richard Bruno¹, Bonnie J. Nagel¹; ¹Oregon Health and Science University – Adult functional magnetic resonance imaging (fMRI) literature suggests that a left-right hemispheric dissociation may exist between verbal and spatial working memory (WM), respectively. However, investigation of this type has been obscured by incomparable verbal and spatial working memory tasks and/or visual inspection at arbitrary thresholds as means to assess lateralization. Furthermore, it is unclear if hemispheric lateralization exists in youth, or when during development this pattern emerges. This study, therefore, used comparable verbal and spatial WM n-back tasks during fMRI and a bootstrap analysis approach to calculate lateralization indices (LI) across several thresholds to examine the potential of a left-right WM hemispheric dissociation in youth ages 10 to 15 (verbal WM: $n=38$; $M=13.04$, $SD=1.63$; spatial WM: $n=31$, $M=13.31$, $SD=1.58$). By applying a bootstrap algorithm to our group statistical maps, we were able to generate mean LIs and mean weighted LIs (LIW) for each task that do not rely on qualitative visual inspection or arbitrary thresholds (Wilke & Schmithorst, 2006). We found a significant hemispheric lateralization ($p=.003$) for both verbal (left, $LI=.16$, $p<.05$; $LIW=.27$) and spatial WM (right, $LI=-.11$, $p<.001$; $LIW=-.18$). Although no relationship was observed between LI and age, significant age-related activations were seen within regions of lateralized WM activity. Our findings highlight the importance of utilizing non-biased statistical methods and comparable tasks for determining patterns of functional lateralization. Our findings also suggest that, while a left-right hemispheric dissociation of verbal and spatial WM is present by early adolescence, age-related functional activations during WM are present.

B9**DEVELOPMENTAL TRAJECTORIES OF MAGNITUDE PROCESSING AND INTERFERENCE CONTROL: AN fMRI STUDY**

Guilherme Wood¹, Anja Ischebeck², Florian Koppelstaetter², Thaddaeus Gotwald², Liane Kaufmann²; ¹University of Salzburg, Austria, ²Innsbruck Medical University, Austria – Neurodevelopmental changes regarding interference and magnitude processing were assessed in three age groups (children n=10, young adults n=11, elderly n=9) by using an fMRI version of the numerical Stroop task. Behaviorally, comparable distance and size congruity effects were found in all three age groups. Distance effects were most pronounced in the more difficult numerical task, while size congruity effects were comparable across tasks. Imaging results disclosed an almost age-linear trend in the pattern of activation observed in left and right prefrontal and inferior temporal regions of the brain. This implicates that with increasing age interference control requires increasing effort (possible explanations for children's relatively lower interference effects are provided). In contrast, the distance effect produced a negative linear trend in right prefrontal, SMA and intraparietal cortex. This suggests that relative to old adults, children and young adults had to recruit a larger network upon processing magnitude. The latter findings are even more remarkable considering that the behavioral effects were similar across groups.

B11**ELECTROPHYSIOLOGICAL CORRELATES OF INFANT MEMORY: NOVELTY, FAMILIARITY, OR RECENCY?**

Kelly Snyder¹, John Garza¹, Liza Zolot¹, Anna Kresse¹; ¹University of Denver – Event-related potential (ERP) studies of memory in young infants have shown that prior experience with a visual stimulus modulates the amplitude of a late slow wave (LSW) component. In a previously unrelated line of research, intra-cellular recordings in non-human primates have demonstrated that different populations of neurons in the temporal lobe encode information regarding stimulus novelty, familiarity, and recency of occurrence (Xiang & Brown, 1998). We used high-density electroencephalography to investigate the functional significance of the LSW in 6-month-olds by examining effects of repetition of highly familiar and novel stimuli on the amplitude of the LSW. Twenty-four familiar pictures (pictures of items from the infant's home such as people, pets, and toys) and twenty-four novel pictures (pictures of similar items from another infant's home) were each repeated exactly once while ERPs were recorded. We found that (a) immediate repetition caused equivalent suppression of LSW amplitude for familiar and novel stimuli [Repetition x Lead interaction at central leads, $F(2,44) = 3.79, p = .03$; LSW amplitude was smaller in response to repeated stimuli at right-central leads, paired-t (22) = 2.50, $p = .02$], and (b) there were no effects of repetition on the LSW when there was a single intervening item between the first and second presentations of a stimulus. These effects are most consistent with the response properties of recency neurons in inferior-temporal cortex, suggesting that the LSW may reflect neural activity associated with the incidental encoding (or updating) of the immediate visual environment into a short-term perceptual store.

B12**CROSSMODAL SYNCHRONY AND ASYNCHRONY PERCEPTION IN 6-MONTH-OLD INFANTS**

Franziska Kopp¹, Claudia Dietrich¹, Ulman Lindenberger¹; ¹Max Planck Institute for Human Development, Berlin – Close temporal proximity of sensory modalities is an important prerequisite for intersensory integration to form a coherent percept. In contrast to adults, the temporal threshold to detect intersensory asynchrony is higher in infants. The aim of the present study was to investigate brain dynamics related to perception of audio-visual synchrony and asynchrony in 6-month-old infants using event-related potentials (ERP). In a behavioral experiment, infants were habituated to a synchronous social stimulus. Once infants met the habituation criterion, an asynchronous test trial of the same stimulus was presented in which the visual stream was delayed to the auditory stream by 400 ms. Only infants who

discriminated this change in temporal alignment on behavioral level were included in further EEG assessment. The EEG experiment varied between two conditions: In the synchronous condition the visual and auditory stream were in synchrony, whereas in the asynchronous condition the visual stream was delayed to the auditory stream by 400 ms. ERP data showed longer latencies of the Nc component in the asynchronous condition. An additional negative component peaking between 300 and 400 ms after stimulus onset was identified only in asynchronous stimuli. Furthermore, the auditory P2 component showed significantly longer latencies in asynchronous as compared to synchronous trials. Because auditory stimulation occurred at the same point in time in both conditions, this result indicates that a temporal delay of activity might be an adequate mechanism of the infant brain to integrate both modalities.

B13**INFANTS' EYE MOVEMENTS DURING FAMILIARIZATION WITH AN OBJECT CATEGORY: A TRANSITION FROM SALIENCY-DRIVEN TO OBJECT-BASED LOOKING PATTERNS**

Nadja Althaus¹, Denis Mareschal¹; ¹Centre for Brain and Cognitive Development, School of Psychology, Birkbeck, University of London – Past research has shown that infants' perceptual category formation in familiarization paradigms depends on the feature distributions present in the familiarization set (Mareschal, French, & Quinn, 2000). However, infants' processing of the stimuli during familiarization has rarely been studied directly and therefore there is no account of the learning process as such: evidence for perceptual learning would involve a change in infants' looking patterns across familiarization. The current study therefore uses eye tracking to investigate the impact of bottom-up saliency, as measured by saliency maps based on neural processing principles, on infants' fixation targets over the course of familiarization with a category (color images of deer). Twenty-five 12-month-olds and 34 4-month-olds were presented with a sequence of eight images of deer, followed by a test trial consisting of a novel deer paired with a horse. Category learning was successful in both age groups, as indicated by infants' preferential looking at the horse. In order to investigate to which degree infants' eye movements were driven by bottom-up saliency, i.e. initiated by early visual brain areas, we compared recorded fixation locations to a saliency map of the corresponding stimulus image (Itti & Koch, 2001; Kienzle, Wichmann, Schoelkopf, & Franz, 2007). Results show that for both age groups the impact of bottom-up saliency on infants' fixation targets is large prior to learning, but much lower after familiarization. This indicates that infants' looking is initially driven by bottom-up saliency, but increasingly influenced by categorization-based higher-level visual processing as learning progresses.

B14**THE RIGHT INFERIOR OCCIPITOTEMPORAL CORTEX: A CONVERGENCE ZONE FOR READING-RELATED COGNITIVE ABILITIES**

Stefan Heim^{1,2,3}, Marion Grande², Elisabeth Bay^{1,2}, Helen Schreiber^{1,2}, Simon B. Eickhoff^{1,2,3}, Juraj Kukulja⁴, Nadim J. Shah¹, Katrin Amunts^{1,2,3}; ¹INB3-Medicine, Research Centre Jülich, ²Medical Faculty, RWTH Aachen University, ³Medical Faculty, JARA, RWTH Aachen University, ⁴University Hospital Bonn – Successful reading depends on a number of cognitive functions, including phonological awareness and visual attention. In this fMRI study, we demonstrate that the neural basis underlying the influence of these cognitive variables on reading is located in the right inferior occipitotemporal cortex (IOTC). 38 children (mean age: 9 years; 19 dyslexics, 19 controls) read aloud German words. Reading-related brain activation in the right IOTC, overlapping with cytoarchitectonic area hOC4v, was modulated by scores for phonological awareness and visual attention. This modulation was stronger for controls than for dyslexic readers. In two additional fMRI studies we further demonstrated that in right IOTC, reading ability modulates the activation during phonological decisions and visual attention. Together, these findings indicate that different cognitive influences on reading converge in the right IOTC, contralateral to the visual word form area, and thus con-

tribute to understanding the neurocognitive basis of reading and dyslexia.

B15**MAPPING DA-RELATED GENETIC VARIATION INTO ATTENTION-RELATED BRAIN ACTIVATION IN 5 YEAR-OLD CHILDREN**

M. Rosario Rueda¹, Purificacion Checa¹, Pascale Voelker²; ¹Universidad de Granada, Spain, ²University of Oregon – The sequencing of the human genome has allowed examination of the genetic basis of cognitive functions in the past several years. Recent studies have shown that the executive control of cognition and action is among the highest heritable psychological functions (Friedman et al., 2008 JEP:G). Performance of conflict tasks such as Stroop and flanker has been related to activation of the executive attention network which involves the anterior cingulate cortex (ACC) and lateral prefrontal areas and appears to be modulated by dopamine (Posner, Rueda & Kanske, 2007 Handbook Psychophy). Variations in particular genes affect dopaminergic pathways in the brain through different molecular mechanisms (Diamond, 2007 CeCortex). We have looked at polymorphisms in several genes thought to influence dopaminergic pathways (DAT1, COMT and DRD4) in a group (n=37) of children. Then, we examined EEG activation during performance of a flanker task in relation to genotype. Children having the 9-repeat polymorphism in the DAT1 gene showed smaller flanker interference than children homozygous for the 10-repeat polymorphism. Smaller flanker effects (although not statistically significant) were also observed for children with the 7-repeat in the DRD4 gene, as well as those with at least one Val allele of the COMT gene. Better performers also showed larger negative amplitudes for the incongruent trials at the frontal midline leads. Further analysis of brain activation using source-localization models suggest that the pattern of activation shown by good performers is due to greater differentiation of activation in the medial frontal gyrus for incongruent compared to congruent trials.

B16**DOES REASONING ABILITY IN CHILDREN IMPROVE WITH TRAINING?**

Allyson Mackey¹, Susanna Hill¹, Natalie DeShetler¹, Carter Wendelken¹, Silvia Bunge¹; ¹University of California, Berkeley – We present encouraging preliminary data suggesting that fluid reasoning, an ability critical for academic achievement, can be trained in children. In a pilot study, children ages 5 to 10 (n=6) played a variety of store-bought computerized games and board games for one hour a day, for 16 to 24 days, over the course of 6 weeks. Children who played the game with the strongest problem solving demands (n=3) exhibited a mean increase of 7 points in performance IQ as measured by the Wechsler Abbreviated Scale of Intelligence. This change seemed to be driven by improvements in the Block Design component of the scale, which improved an average of 4.25 points, while scores on Matrix Reasoning remained steady. In addition to these standardized measures, children also performed a relational integration task modified from Smith et al., 2007 pre- and post-training. Interestingly, accuracy on one-relational items did not improve with training, but accuracy on two-relational problems improved on average 23%. These children participated in the same number of training sessions on average (22) so outcome differences were not due to training duration. Differences are also not explained by improvements in visual processing, because performance on the Rapid Visual Information Processing task from the CANTAB did not improve. In summary, children who played a complex problem solving game improved in measures of visual spatial reasoning and relational integration. A larger study is currently underway to compare gains in reasoning ability from reasoning training (n=15) with speed of processing training, an active control (n=15).

B17**EFFECT OF DOPAMINE TRANSPORTER GENOTYPE ON CAUDATE VOLUME IN CHILDHOOD ADHD AND CONTROLS**

Devon Shook¹, Colin Brady¹, Philip Lee¹, John VanMeter³, Edwin Cook⁴, Mark Stein⁴, Laura Kenealy², Chandan Vaidya^{1,2}; ¹Georgetown University,

Washington DC, ²Childrens National Medical Center, Washington, DC, ³Center for Functional and Molecular Imaging, Georgetown University Medical Center, Washington, DC, ⁴University of Illinois, Chicago, IL – Structural neuroimaging studies of Attention Deficit Hyperactivity Disorder (ADHD) have identified grey matter volumetric reductions in prefrontal striatal regions. While multiple neurotransmitter systems influence prefrontal function, striatal regions such as the caudate are primarily dopaminergic. Striatal dopamine levels are regulated by the dopamine transporter. The present study examined differences between alleles of the dopamine transporter genotype (DAT1) on caudate volume, a nucleus shown to differ functionally between ADHD and control children. We hypothesized that caudate volume would differ by DAT1 functional polymorphism and diagnosis. We performed structural magnetic resonance imaging (MPRAGE) in 7-13 year old children with either two copies (10/10) or 1 copy (9/10) of the 10 repeat allele of DAT1. Using a region of interest (ROI) approach, we compared caudate volumes in a DAT1 (10/10, 9/10) X Diagnosis (ADHD, Controls) X Hemisphere (Left, Right) ANOVA. Results showed main effects of diagnosis indicating smaller caudate volumes in ADHD compared to controls, and DAT1 indicating smaller caudate volumes in 10/10 compared to 9/10 children. Further, a DAT1 X Hemisphere interaction indicated that caudate differences by DAT1 were driven by differences in the left rather than right hemisphere. Genotypic differences did not vary by diagnosis. Thus, structural striatal maturation is influenced by genetic differences in dopamine transporter function. Funded by NIMH MH065395

B18**ASSOCIATIONS AMONG MORPHOMETRIC MEASURES, ELECTROPHYSIOLOGICAL CORTICAL RESPONSES AND LANGUAGE ABILITIES IN CHILDREN: PREDICTING FROM 6 MONTHS TO 24 MONTHS OF AGE**

Silvia Ortiz-Mantilla¹, Judy Flax¹, Cecylia K. Chojnowska¹, Myong-sun Choe², P. Ellen Grant², April A. Benasich¹; ¹Center for Molecular & Behavioral Neuroscience, Rutgers University, Newark, NJ, ²Center for Morphometric Analysis, Neuroscience Center, Massachusetts General Hospital at Harvard Medical School – Recently, there has been much interest in identifying relations among morphometric indices (e.g. brain volumes), electrophysiological responses (EEG/ERPs) and measures of language and cognition across early development. In this study, structural MRIs and high-density EEG/ERPs to complex tone-pairs were collected in normally developing children at 6 months of age. Standardized language and cognitive assessments were administered at 24 months. We found that children with larger right amygdala (RA) volume at 6 months had lower expressive (r = -.55, p = .015) and receptive (r = -.51, p = .027) language scores at 24 months. Children that at 6 months had larger N2 amplitude at left frontal channels scored higher on expressive (r = -.74, p = .001) and receptive (r = -.54, p = .025) language. Infant RA size and N2 amplitude together predicted performance at 24 months on both expressive (F = 6.47, p = .010) and receptive (F = 15.6, p = < .001) language. At 24 months, 41% of variance in expressive language was accounted for by RA size (24%) and amplitude of N2 (17%). Similarly, for receptive language, 65% of variance was explained by RA size (23%) and N2 amplitude (42%) at 6 months. These results suggest that the amygdala plays a significant role during early language acquisition, although the mechanisms involved are as yet unclear. Further, links among amygdala volume, auditory cortical responses in infancy and later language abilities are identified, emphasizing the importance of using converging methodologies to elucidate the course of infant development.

B19**DEVELOPMENTAL CHANGES IN BRAIN MECHANISMS UNDERLYING RECIPROCITY**

Wouter van den Bos^{1,2}, Michiel Westenberg^{1,2}, Eric van Dijk¹, Serge A. R. B. Rombouts^{1,2,3}, Eeeline A. Crone^{1,2}; ¹Leiden University, Institute for Psychological Research, Leiden, the

Netherlands,²Leiden Institute for Brain and Cognition, Leiden, the Netherlands, ³Leiden University Medical Center, Leiden, the Netherlands – Reciprocity, or repayment of what others have provided us, is an important aspect of social exchange and undergoes changes until late adolescence. Prior studies have demonstrated a network of brain regions important for social exchange and reciprocity, including the anterior medial prefrontal cortex (amPFC) and the dorsolateral prefrontal cortex (DLPFC), but the developmental trajectories of these regions are currently unknown. In this event-related functional MRI study we examined behavioral choices and neural responses in a variant of the Trust Game (Berg et al., 1995), in 54 participants between ages 12-22 (12-14-years, n=21, 15-17-years, n=15, 18-22-years, n=18). Participants were playing numerous one-shot games with unknown age-matched peers and were trusted money on a proportion of trials. We examined whether on those trials, participants reciprocated trust by sharing a large proportion of the money with the trustor, or defected by sharing a small proportion of the money but maximizing their own gains. fMRI data were analyzed for reciprocal and defective choices and resulted in two main findings. First, bilateral anterior insula and anterior cingulate cortex were positively correlated with reciprocity behavior, and this pattern was similar for all age groups. Second, our analysis revealed an age-related decrease in the amPFC for reciprocate choices and an age-related increase in DLPFC for reciprocate and defect choices. These results were interpreted to suggest increased selectivity for self referential thought across adolescent development (Amodio & Frith, 2006). The current findings will be discussed vis-à-vis current theories of social cognitive brain development and psychopathology.

B20**HOW NATURE SHAPES NURTURE: A COMPUTATIONAL ACCOUNT OF GENETIC INFLUENCES ON THE NEURAL SUBSTRATES OF FACE PROCESSING** Lee Newman¹, Thad Polk¹;

¹University of Michigan – A number of findings suggest that genetics play a more important role in shaping the processing of faces compared with other visual stimuli. For example, brain damage immediately after birth can produce lasting, selective deficits in face recognition (Farah et al., *Cogn Neurosci*, 17:117, 2000), but there are no similar reports of early brain damage producing selective deficits in the recognition of other categories like cars or birds. Patterns of cortical activation evoked by face processing are also more similar in monozygotic twins than in dizygotic twins, but that is not true for patterns evoked by other visual stimuli such as words and chairs (Polk et al., *Jnl Neurosci*, 27:13921, 2007). By what mechanism could genetics influence the cortical processing of faces more than the processing of other visual stimuli? We hypothesize that an innate subcortically-driven preference to look at faces in early development (Johnson, *Nature Rev Neurosci*, 6:766, 2005) interacts with established principles of cortical self-organization to lead to the observed effects. We present a neural network model that makes explicit how this hypothesis could work. In particular, we demonstrate that manipulating the similarity of initial connectivity patterns in different models (to simulate the effect of zygosity) has a much bigger effect on the similarity of activity patterns evoked by faces than by other visual stimuli. The model therefore provides a computationally explicit account of the observed effects of zygosity on neural activation patterns in human twins and, more generally, explains how genetics could influence face processing preferentially.

B21**AN ODDBALL INVESTIGATION OF MONOLINGUAL AND BILINGUAL INFANTS' PHONETIC DISCRIMINATION USING FUNCTIONAL NEAR-INFRARED SPECTROSCOPY (FNIRS)**

Matthew Dubins¹, Melody S. Berens¹, Ioulia Kovelman², Mark Shalinsky¹, Laura-Ann Petitto¹; ¹University of Toronto, ²Massachusetts Institute of Technology – For decades, behavioral data have not adjudicated the question of whether infants use general-auditory or language-specific mechanisms to learn the set of phonetic units that comprise their native language. Here we ask this question by using functional Near-Infrared

Spectroscopy (fNIRS, Hitachi ETG-4000) to investigate the neural correlates of language processing in monolingual and bilingual infants. Using an Oddball/Event paradigm, monolingual and bilingual Young infants (age 2-6 months, n = 19), Older infants (age 10-14 months, n=14), and Adults (n=38) were presented with nonlinguistic Tones, and linguistic syllables that differed by one phonetic feature in English, and in Hindi, while undergoing fNIRS. fNIRS measures hemodynamic change (deoxygenated, oxygenated, total hemoglobin), is child-friendly, quiet, portable, and tolerates movement. Its temporal resolution (10-Hz) and spatial resolution (~3-4 cm depth) are excellent for cortical studies of language. Results: Specific neural tissue classically associated with language processing was recruited differently across ages, reflecting maturational changes corresponding to universal linguistic timing milestones. Young monolingual and bilingual infants recruited Left Broca, and bilateral STG, while listening to native and non-native contrasts. Remarkably, all Older infants showed decreased neural recruitment of Left Broca for native English relative to non-native Hindi contrasts. Conclusions: The findings provide first-time imaging evidence that infants use language-specific tissue when learning the set of phonetic units in their native language. Significance: fNIRS allowed examination of the neural underpinnings of phonetic learning in infants, providing important information about the interplay between biology and experience in the developing brain. Funding-Petitto (P.I.): NIHR21HD0505802. NIHR01HD04582203.

B22**WHITE MATTER DIFFERENCES IN FRONTAL REGIONS PREDICTS COGNITIVE VULNERABILITY TO SLEEP DEPRIVATION**

Matthew Rocklage¹, Victoria Williams¹, Jennifer Pacheco¹, David Schnyer¹; ¹University of Texas at Austin – The corpus callosum (CC) has been implicated in a number of important aspects of interhemispheric processes. Indeed, research has indicated that the CC in general and the genu in particular is important for tasks utilizing the prefrontal cortex (PFC) (Narberhaus et al., 2007). Using diffusion tensor imaging (DTI), we examined whether there were microstructural differences in the CC that predicted a person's vulnerability to the effects of sleep deprivation (SD). To this end, participants were asked to complete a simple visual-motor control task both before and after a span of 36 hr without sleep. A median split analysis was conducted using the percent change in accuracy from pre-SD to post-SD on this visual-motor control task to separate participants into susceptibility groups. A 25 direction DTI scan was acquired from each participant and fractional anisotropy (FA) was calculated and examined across 3 regions of the CC. The results revealed a relationship between a participant's susceptibility to SD and FA values in the genu of the CC, where vulnerable had significantly lower FA values relative to non-vulnerable. There were no differences in either the body or splenium of the CC between the two groups, thus demonstrating the specificity of the anterior CC. These results indicate that differences in the development of cross cortical communication pathways contribute to a person's ability to function effectively when sleep deprived.

B23**EVIDENCE FOR A LARGE IMPROVEMENT IN INTERFERENCE CONTROL OVER MIDDLE CHILDHOOD**

Pedro M. Paz-Alonso^{1,3}, Jon Lovas², Chris Blais¹, Silvia A. Bunge^{1,2}; ¹Helen Wills Neuroscience Institute, University of California, Berkeley, ²University of California, Berkeley, ³University of Granada, Spain – We sometimes experience difficulty distinguishing memories pertaining to the present from memories pertaining to the past, such as where we parked the car today. The ability to overcome interference from previously encountered information is a key component of executive functioning. Age-related increases in the ability to limit interference in working memory have been documented across childhood and adolescence. Here, we tested children aged 7-12 and young adults on a continuous recognition paradigm that places heavy demands on interference control (current N = 20). This task was originally developed by Schnider et al. (1996) to characterize monitoring deficits in confabulating patients. Participants must indicate whenever an

image is repeated within a run, which becomes more difficult as familiarity with the images increases from run to run. In the present study, four runs containing the same set of 110 pictures were presented. Preliminary results shown that increases in memory false alarms (FA) from run to run varied with age. 7-8-year-olds exhibited strong initial FA increases from Run1 (M = 6.20%) to Run2 (M = 30.33%), which diminished slightly in Runs 3-4 (M = 27.15%). 10-12-year-olds and adults both showed a gradual increase of FA from Run1 (M = 5.71%) to Run4 (M = 20.02%). These findings suggest that a large improvement in interference control occurs during middle childhood. For children but not adults, FA rate on the recognition task was positively correlated with response inhibition errors on a Go/No-Go task, suggesting that impulsive responding may influence memory monitoring failures observed during childhood.

B24

NEURAL CORRELATES OF FAIRNESS IN SOCIAL DECISION-MAKING ACROSS ADOLESCENCE AND ADULTHOOD Berna Guroglu^{1,2,3}, Wouter van den Bos^{1,2,3}, Serge Rombouts^{1,2,3}, Eveline Crone^{1,2,3}, ¹Leiden University, Institute for Psychological Research, ²Leiden Institute for Brain and Cognition, ³Leiden University Medical Center – Displays of fair behavior play a crucial role in collaboration and reciprocal exchange in social interactions. The concerns for self versus other change across adolescence but the neural mechanisms that contribute to these developmental changes are currently unknown. The Ultimatum Game (UG), in which a responder can accept or reject an offer made by a proposer, is a well-established tool to study fairness concerns. In this study we have used an adapted version of the UG, the mini-UG, which is better suited for examining fairness and intentionality considerations in social exchanges (Falk, Fair, & Fischbacher, 2003). Prior neuroimaging studies based on the UG in adults have demonstrated that the insula is activated when unfair offers are rejected, whereas the lateral prefrontal cortex (lat-PFC) is activated when unfair offers are accepted and the tendency to reject unfair offers is overridden (Sanfey et al., 2003). We tested whether these brain areas are sensitive to low offers per se, suggesting self-oriented concerns, or to unfairness, suggesting self-other concerns, and the developmental time courses of these brain areas in participants between ages 12 and 25 (current n = 40). Preliminary results show that insula and lat-PFC activity associated with rejection of unfair offers is intention-dependent. Rejection of unfair offers when the proposer did not have a better (fairer) alternative was specifically associated with insula activity. Findings on age differences will be discussed based on the development of perspective-taking across adolescence.

B25

THE SHARED GENETIC UNDERPINNINGS OF IQ AND BRAIN STRUCTURE DECREASE WITH AGE DURING CHILDHOOD AND ADOLESCENCE Greg Wallace¹, Eric Schmitt², Rhoshel Lenroot¹, Philip Shaw¹, Kenneth Kendler², Michael Neale², Jay Giedd¹; ¹Child Psychiatry Branch, National Institute of Mental Health, ²Virginia Institute for Psychiatric and Behavioral Genetics, Virginia Commonwealth University – Our understanding of the relationship(s) between genes/environment, brain, and behavior remains relatively limited, particularly within the context of child and adolescent development. Given that both intelligence and brain structure are highly heritable, determining whether intelligence and neuroanatomic endophenotypes have shared genetic underpinnings has been a central question to cognitive neuroscience. However, most studies have indicated that the phenotypic correlations between intelligence and brain endophenotypes are surprisingly small. Using data from pediatric twins, siblings, and singletons (n=600) in an extended twin design, we evaluated the shared genetic and environmental correlations between brain structure (i.e., cortical thickness from MRI) and intelligence (measured by age-appropriate Wechsler Intelligence Scales) and how these relationships changed during the child and adolescent years. Within targeted brain areas (predominantly frontal regions) in which intelligence was related to cortical thickness in an age-dependent fashion (Shaw et al., 2006), we predicted and found higher shared genetic mediation of cortical

thickness and intelligence than found in the remaining cortical regions. Moreover, despite small phenotypic and genetic correlations between intelligence and cortical thickness, we observed strong and statistically significant genetically mediated relationships when age was incorporated into the analysis. Children with high intelligence appear to have substantially higher genetic variance in cortical thickness, but only during the first decade of life. Our findings indicate that like many aspects of neurodevelopment, the associations between genes/environment, brain structure, and intelligence must be considered dynamic processes in order to fully understand their relationships in children and adolescents.

B26

DEVELOPMENTAL EFFECTS OF NEURAL ACTIVITY ON LANGUAGE PROCESSING: EVIDENCE FROM FMRI Owens Elizabeth¹, Aznar-Besé Noemi¹, Meschyan Gayane¹, Hernandez Arturo¹; ¹University of Houston – The purpose of the present study was to compare neural mechanisms in bilingual children and adults, and to examine the effects of language proficiency level on neural activity during a single word, reading task. All participants were early Spanish-English bilinguals, having learned English by age 7, and having learned Spanish prior to learning English. During the functional magnetic resonance imaging (fMRI) experiment, a list of 60 very simple words, 30 English and 30 Spanish, were presented on a screen one at a time. Participants were instructed to read the words silently and to press a hand-held button when they had finished reading each word. Significant differences in neural activity were found between children and adults. Adults showed increased activity in precentral and middle-frontal gyri compared to children when reading in English. In addition, children showed greater activity in the amygdala, precentral, and postcentral gyri than adults when reading in Spanish. Furthermore, hemispheric differences emerged with activity being more left-lateralized in adults and right-lateralized in children. Taken together these results suggest that word reading progresses from a basic, emotional process to a more integrated, cognitive process as language proficiency changes across development.

B27

REACHING EXPERIENCE AND PERSONALITY INFLUENCE FACE-PREFERENCE - AN EYE-TRACKING STUDY OF INFANTS AND ADULTS Klaus Libertus¹, Amy Needham¹; ¹Duke University – New-born infants show preferential tracking of moving face-like stimuli (Johnson, Dziurawiec, Ellis, & Morton, 1991). This preference disappears over the course of the first month. Using static images, young infants show a preference for patterns and only around 4-5 months start to prefer faces (Keller & Boigs, 1991). What factors influence this face-preference and how does this behavior relate to infants' own abilities? Here we present two eye-tracking experiments that 1) replicate previous findings on young infants' face preference and also test older infants and adults using the same paradigm, 2) show how a simple motor manipulation - simulated reaching experience - is able to influence this preference, and 3) show correlations between face-preference and infant and adult personality scores. Without motor training, pre-reaching 3-month-old infants show no preference for images of faces over images of toys across two experiments (both p>0.5). However, age-matched infants who received two weeks of object-directed reaching training behave differently and do show a preference for faces (p=0.028), similarly to older infants between 4-14 months. Further, face-preference and parent-reported activity level (e.g. unfocused activity like kicking and squirming) show a negative correlation in infancy (p<0.02) while adults show a positive correlation between face-preference and the self-consciousness score on the IPIP personality inventory (p<0.03). Our findings suggest a relation between focused motor abilities and attention towards social stimuli in early infancy. Infants who experience being able to independently act on objects may - similar to adults - look towards faces for signs of social encouragement.

B28

GENETIC POLYMORPHISMS AFFECTING DOPAMINERGIC ACTIVITY PREDICT SPONTANEOUS BLINK RATE IN YOUNG CHILDREN David Lindenbach¹, Courtney Stevens¹, Jeff Currin², Ted Bell², Helen Neville²; ¹Willamette University, ²Brain Development Lab, University of Oregon – Eye blink rate (EBR) has been shown in a variety of experiments to be a marker of central dopamine activity, with higher blink rate associated with higher levels of dopamine (e.g., Deuschl & Goddemeier, 1998; Jutkiewicz & Bergman, 2004). Related research suggests that EBR is associated with performance on some cognitive tasks, including executive functioning in adults (Muller et al, 2007; Dreisbach et al., 2005) and theory of mind in children (Lackner et al., 2008). The present study investigated the relationship between EBR, performance on cognitive tasks, and genetic polymorphisms in young children aged 3-5 years. Eighty children completed an ERP and behavioral battery as part of a larger study. EBR was measured from a 5-minute segment of the EOG/EEG data collected while children passively viewed a short cartoon. The behavioral battery included measures of executive function, theory of mind, and nonverbal intelligence. In addition, children were genotyped for a small set of genes affecting dopaminergic activity, including DAT1, DRD2, and DRD4. Results indicated that children's EBR was associated with their genotype and performance on some cognitive tasks. The largest association was between children's EBR and polymorphisms of the DRD4 gene, with presence of the 7 repeat associated with higher EBR. These findings suggest that EBR is related to both genetic variation and performance on cognitive tasks in young children.

B29

DIFFERENT AGES, DIFFERENT STAGES: A NEURODEVELOPMENTAL AGE-BASED DATABASE OF NORMAL BRAIN DEVELOPMENT FOR MAGNETIC RESONANCE IMAGING Carmen Sanchez¹, Alexandra Basilakos¹, John Richards¹; ¹University of South Carolina – The NIH Magnetic Resonance Imaging (MRI) study of normal brain development recently documented normal brain maturation in children ages 4 years, 6 months to 18 years (Evans, 2006). Using MRIs obtained from the Brain Development Cooperative Group's MRI database, this investigation explored the utility of developing brain templates based on age increments of 6 months. The main goal of the work was to create a database of age-normed MRI volumes and stereotaxic atlases for use with MRI and other forms of neuroimaging. Participants included 860 children and adolescents ranging from 4.5 years to 19.0 years and were divided into age groups by 6 month increments (i.e., children 4.5 to 5.0 years combined as one group). FSL was used to analyze all MRI Volumes. A 'pipeline' was created that produced T1-weighted, T2-weighted, brain and material-segmented (gray matter, white matter, CSF) files for each participant. Following the methods set forth by Evans, et al. (1993), each MRI volume was standardized to the appropriate age norm, and the individual MRIs were registered ('warped') to the age norm average, and then a final average was made. This average was used to develop average T1-Weighted, T2-Weighted, normed MRI volumes in six-month increments from 4.5 to 19 yrs. This database is available for use by qualified laboratories doing this kind of work and can be useful in identifying differences in normed data and in typical MRI work. Several aspects of the database were also examined with respect to known characteristics of brain development.

B30

IS FRAGILE X SYNDROME AN APPROPRIATE NEUROANATOMICAL MODEL FOR AUTISM? Elizabeth Walter¹, Fumiko Hoeft¹, Joseph Piven², Allan Reiss¹; ¹Stanford University, Center for Interdisciplinary Brain Sciences Research (CIBSR), ²University of North Carolina, Chapel Hill, Neurodevelopmental Disorders Research Center – Fragile X syndrome (FXS) is the most common known genetic cause of autism. However not all individuals with FXS are diagnosed with autism (AUT) and it is not presently clear whether FXS provides a helpful neuroanatomical model for AUT. If FXS is a good model for AUT, then both disor-

ders should show similar anatomical differences from the brains of control participants, even from an early age. In order to explore this possibility, we performed voxel-based morphometry to compare the neuroanatomy of boys between the ages of 1.5 and 4 years old who were diagnosed with FXS or AUT (with no diagnosis of FXS), with a control sample comprised of typically developing (TD) and developmentally delayed (DD) boys (FXS: n=52; AUT: n=63; TD: n=31; DD: n=19). We found that FXS and control participants were maximally different in a region comprising bilateral basal ganglia, cingulate cortex and insula. In contrast, differences between AUT and controls were seen primarily in the cerebellum and ventral temporal lobe as well as bilateral inferior frontal gyrus. In addition, support-vector machine (SVM) analyses designed to maximally differentiate groups were best able to discriminate FXS brains from AUT, and FXS from control participants. The SVM was not very accurate at discriminating AUT from controls. This analysis provides further evidence that neuroanatomical development in FXS follows a trajectory that differs from boys with autism, as well as from control participants. In short, FXS may not provide a helpful anatomical model of autism, at least at this young age.

B31

REWARD SENSITIVITY AND RISK TAKING IN ADOLESCENT DEVELOPMENT Linda Van Leijenhorst^{1,2,3}, Bregtje Gunther Moor^{1,2,3}, Michiel Westenberg¹, Serge Rombouts^{1,2,3}, Eveline Crone^{1,2,3}; ¹Leiden University, Institute for Psychological Research, ²Leiden Institute for Brain and Cognition, ³Leiden University Medical Center – Previous studies on adolescent decision-making have suggested that the protracted development of prefrontal relative to limbic brain regions could bias adolescents to focus on potential rewards and engage in risky behavior. This hypothesis is based on imaging studies using simple reward paradigms. How these regions contribute to decision-making on a trial-to-trial basis has not yet been tested in this age group. We collected event-related fMRI data in 46 participants aged 8 to 25 using a task in which participants repeatedly chose between safe gambles, associated with a 67% chance of winning 1 Euro, and risky gambles, associated with a 33% chance of winning 2, 4, 6 or 8 Euros. This design enabled us to examine brain regions sensitive to reward magnitude and their contribution to risk taking throughout adolescence. Behavioral data show that all participants chose more risky gambles as rewards were higher. Participants were increasingly risk averse, and differentiated more between reward amounts with age, which indicates strategy differences. Analysis of brain activation preceding choices revealed that in adults risky gambles were associated with decreased lateral prefrontal activation, whereas in adolescents risky gambles were accompanied by increased activation in the ventral striatum. We suggest that children and adolescents adopt an explorative strategy in contrast to an exploitative strategy used by adults because of immature contribution of prefrontal cortex regions. We are currently testing whether neural activation predicts risk taking in different age groups, and can increase our understanding of the role of reward sensitivity in adolescent decision-making under risk.

B32

WHITE MATTER MATURATION SUPPORTING THE DEVELOPMENT OF FLUID REASONING Kirstie Whitaker¹, Elizabeth O'Hare¹, Zdena Op de Macks², Brian Johnson¹, Emilio Ferrer³, Silvia Bunge^{1,3}; ¹Helen Wills Neuroscience Institute, University of California, Berkeley, ²Leiden University, The Netherlands, ³University of California, Davis – Little is known about the changes in connections between brain regions that underlie cognitive development. The goal of this study (current N=24) is to investigate the structural integrity of white matter tracts using diffusion tensor imaging. We hypothesize that strengthened connections between frontal and parietal cortices are critical for the development of higher cognition. Here we present cross-sectional data from a longitudinal study examining how white matter development contributes to fluid reasoning ability, a key construct in human intelligence. Participants aged 6 to 19 years were scanned at 3T with a 64-direction diffusion-

weighted acquisition. These subjects also completed performance IQ (block design, matrix reasoning) subtests of WASI and the verbal IQ (vocabulary) subtest. Whole-brain correlations show strong age-related increases in FA throughout the brain. Functionally-derived regions of interest (ROI) in rostralateral prefrontal cortex from our prior fMRI research on reasoning development (Wright et al., 2008) revealed a strong positive correlation between FA and age, but not with age-corrected IQ measures. We also created an ROI in left inferior parietal cortex based on our recent finding of an age-independent positive relationship between cortical thickness and fluid reasoning ability in left inferior parietal cortex (O'Hare, CNS abstract submission, 2009). In the white matter regions surrounding these coordinates, we saw a significant correlation between mean FA and age-corrected scores on block design ($r = 0.411$, $p = 0.023$). In this limited sample, structural changes in parietal cortex are most predictive of individual differences in fluid reasoning from age 6 to 19.

B33**DOPAMINERGIC MODULATION OF SPATIAL WORKING MEMORY PERFORMANCE IN ADOLESCENCE: A MOLECULAR GENETIC APPROACH**

Monica Luciana^{1,2}, Dustin Wahlstrom^{1,2}, Tonya White^{1,2}; ¹University of Minnesota, ²University of Minnesota, Center for Neurobehavioral Development – Dopamine modulates cognitive processes that are prefrontally and striatally-mediated, including spatial working memory. This modulatory role has been studied in animals using lesion and pharmacological approaches and confirmed in adult humans using pharmacological probes. It is unknown whether dopamine modulates behaviors prior to adulthood in a manner that is similar to its role in adult behavior. We have assessed dopamine's modulation of spatial working memory in human adolescence (broadly defined) using a molecular genetic approach focusing on single nucleotide polymorphisms that regulate various aspects of dopamine activity: catabolism (COMT Val/Met 158/108), postsynaptic receptor activity (DRD2 Taq1A allele), and presynaptic regulation/transporter mechanisms (DAT). Participants, ($n=182$, ages 9 to 23), provided a DNA sample and completed neurocognitive tasks, including a visuomotor spatial delayed response task requiring participants to recall spatial locations after delays of 0, .5 and 8 seconds. Task performance improves until age 13 and stabilizes thereafter. Performance is modulated by the COMT and DRD2 genotypes, which interact with age to influence performance. Individuals who are Val-Val homozygotes for COMT and possess the low receptor activity DRD2 allele perform worst when working memory demand is high. The influence of COMT on working memory likely occurs through prefrontal mechanisms; the D2 receptor system's influence on spatial working memory more strongly involves striatal versus frontal regions. Thus, dopamine activity in both regions contributes to spatial working memory performance as adult levels of performance are being attained. Findings will be discussed in relation to mechanisms that underlie adolescents' vulnerabilities to impairments in executive function.

B34**THE EFFECT OF SYNTACTIC COMPLEXITY AND SENTENCE LENGTH ON ORAL LANGUAGE PROCESSING IN CHILDREN: A FUNCTIONAL NEUROIMAGING STUDY**

Jason Yeatman¹, Michal Ben-Shachar^{2,3}, Gary Glover¹, Heidi Feldman¹; ¹Stanford University, School of Medicine, ²Stanford University, ³Gonda Brain Research Center, Bar Ilan University – Though language is conceptualized as a left lateralized brain function, adult neuroimaging studies document bilateral activation for sentence comprehension when task demands are high. We sought to describe changes in neural networks of children comprehending sentences of varying length and syntactic complexity. Participants were 11 through 14 year olds ($n=8$) with normal language abilities. Functional magnetic resonance imaging data were collected on a 3T scanner using a spiral in/out sequence. Each subject completed four runs of an event-related, sentence verification task with 24 different sentences presented in random order. A general linear model was estimated for each subject; contrasts were generated for syntactically hard > easy and long > short

sentences. These contrasts were used in a random effects analysis to generate group maps. The hard > easy contrast showed significant peaks ($p < 0.001$) in the right insula and right occipital lobe (lingual gyrus) for the group. The long > short contrast showed significant peaks in the left and right superior and middle temporal gyri, with more significant voxels on the right side for the group. 2 out of 8 subjects showed significant peaks ($p < 0.01$) in the inferior frontal gyrus on hard > easy and 3 out of 8 on the long > short contrast. Right hemisphere regions appear to play a greater role in understanding spoken language for children, as syntactic complexity and sentence length increase. Future studies will determine if children's language abilities are related to individual differences in active brain regions.

B35**PARENT TRAINING INTERVENTIONS ENHANCE SELECTIVE AUDITORY ATTENTION IN 3- TO 5- YEAR OLD CHILDREN**

Jeff Currin¹, Jessica L. Fanning¹, Scott R. Klein¹, Helen J. Neville¹; ¹University of Oregon, Institute of Neuroscience – The development of selective attention skills begins at an early age and continues through early adulthood. Evidence suggests that proper development of selective attention skills is crucial for self-regulation abilities and academic achievement. Research has shown event related brain potentials (ERPs) can be used to index mechanisms of selective attention in 3- to 5- year old children (Sanders et al 2005). Additionally, Stevens et al. (in press) reveals that children from low socio-economic status (SES) backgrounds have reduced amplitude selective attention effects compared to higher SES children. This study investigates the effectiveness of an attention-training program designed for typically developing, economically disadvantaged children and families to improve cognitive performance and attention. Prior to the seven-week training period, parents were randomly assigned to a control group or to receive training. Training consisted of eighteen hours over seven weeks of discussion on parenting methods and strategies. The training also included seven hours of attention building activities for children. Children were tested before and after the training period on an array of behavioral assessments and ERP paradigms. Specifically, children participated in a Hillyard type auditory selective attention task while ERPs were recorded to attended and unattended stimuli. Children in the training group revealed significant increases in ERP amplitudes as well as a more global distribution of the attention effect when compared to controls. Gains in a variety of behavioral tests were also observed. This evidence suggests that modifications in parenting behavior and child attention training lead to marked enhancements in children's cognitive function.

B36**MEG MEASURES OF NEURAL SYNCHRONY AND PERCEPTUAL REPRESENTATION IN AUDITORY LANGUAGE CORTEX IN CHILDREN WITH AUTISM AND TYPICALLY DEVELOPING CHILDREN**

Nicole Gage¹, A. Lisette Isenberg¹, Paul Fillmore¹, Kathryn Osann¹, M. Anne Spence¹; ¹University of California, Irvine – We used Magnetoencephalography (MEG) to assess neural synchrony and activation levels in auditory language cortex in children with autistic disorder (AD) and typically developing (TD) controls. Previously, we reported reduced hemispheric synchrony in left and right M100 peaks in children with AD vs. controls. Here we recorded M100 latency and amplitude in response to speech (consonant-vowel syllables) to assess hemispheric synchrony and neural activation levels over time during brief (4m) scans. Our sample included 10 boys (5 AD, 8-12 years). For each child, the recorded scan was divided into 4 equal blocks representing the first, second, third, and final 100 epochs. We assessed the time course of neural processing by measuring M100 latency and amplitude for each block. Hemispheric symmetry: TD - M100 LH-RH latencies were tightly coupled in time and decreased from the 1st (19.5ms) to final block (12.5ms). AD - M100 latencies were more offset and this increased from the 1st (26 ms) to the final (35.8) block. Neural activation: TD - M100 amplitude increased 20% from initial to final block. AD - M100 amplitude decreased -0.04% from first to

final block. Results provide evidence that TD children have LH and RH responses that are initially tightly coupled in time and become more synchronized, with increased neural activation levels, over time. In sharp contrast, children with AD have LH and RH responses that are initially offset in time and become more dyssynchronous, with decreased activation levels, over time.

B37

ADOLESCENT DEVELOPMENT AND PRISONER'S DILEMMA TASK STRATEGIES: COGNITIVE, PERSONALITY, AND PSYCHOPHYSIOLOGICAL CORRELATES Elizabeth Olson¹, Paul Collins¹, Monica Luciana¹; ¹University of Minnesota – The Prisoner's Dilemma is a task that reflects decision-making in social circumstances in which choice behavior affects not only oneself but also a partner. We have previously reported findings regarding cognitive, personality, and psychophysiological correlates of Prisoner's Dilemma task behavior in college-aged students (Olson et al., CNS poster, 2006). The present analysis will expand upon this work by presenting developmental changes in younger adolescents' strategic approaches to the Prisoner's Dilemma task as compared to college students. Both overall cooperation rates and trial-by-trial responses to ongoing interactions are examined. Relationships between Prisoner's Dilemma behavior and impulsive decision-making on a delay discounting task are reported. Task performance is evaluated with respect to performance on measures of intelligence, executive functioning (Iowa Gambling Task, Go-NoGo task), and personality factors on the Multidimensional Personality Questionnaire (MPQ). Skin conductance and heart rate data are examined for physiological correlates of task performance. Individual differences in skin conductance responses to feedback predict task strategies. Results are discussed in terms of the relative rates of maturation during adolescence of ventral versus dorsal prefrontal cortices, regions that support social decision-making processes.

B38

CONNECTING THE DOTS: HOW LOCAL STRUCTURE AFFECTS GLOBAL INTEGRATION IN INFANTS Melanie Palomares¹, Mark Pettet¹, Vladimir Vildavski¹, Chuan Hou¹, Anthony Norcia¹; ¹The Smith-Kettlewell Institute – Glass patterns are moirés created from a sparse random dot field paired with its rotated, expanded or translated copy. Because discrimination of these patterns is not based on local features, they have been used extensively to study global integration processes. Here, we investigated whether 4-5.5 month old infants are sensitive to the global structure of Glass patterns by measuring Visual Evoked Potentials (VEPs). Although we found strong responses to the appearance of the constituent dots, we found sensitivity to the global structure of the Glass patterns in the infants only over a very limited range of spatial separation. In contradistinction, we observed robust responses in the infants when we connected the dot pairs of the Glass pattern with lines. Moreover, both infants and adults showed differential responses to exchanges of between line patterns portraying different global structures. A control study varying luminance contrast in adults suggests that infant sensitivity to global structure is not primarily limited by reduced element visibility. Together our results suggest that the insensitivity to structure in conventional Glass patterns is due to inefficiencies in extracting the local orientation cues generated by the dot pairs. Once the local orientations are made unambiguous or when the interpolation span is small, infants can integrate these signals over the image.

B39

CORTICAL SOURCES OF INFANT VISUAL PREFERENCES Greg Reynolds¹, John Richards², Mary Courage³; ¹University of Tennessee, ²University of South Carolina, ³Memorial University – The major goal of this study was to identify the cortical sources of infant visual preferences. Paired-comparison trials were embedded within the modified-oddball ERP procedure in order to assess the distribution of infant visual preferences throughout ERP testing. The cortical sources of ERP components associated with visual preferences were localized with equivalent current dipole (ECD) analysis. Forty-seven infants were tested at 4.5, 6, or 7.5

months of age. Infants were videotaped during testing and high-density EEG was recorded. Paired-comparison trials were embedded within the modified-oddball ERP procedure. This involved blocks of brief stimulus ERP presentations of frequent familiar, infrequent familiar, and infrequent novel stimuli, alternated with a single paired-comparison between stimulus types. Looks were coded to determine visual preferences. A spatial Independent Component Analysis (ICA) was run on the EEG data. The location of cortical sources from the ICA weights was estimated with ECD analysis. The cortical source models for the ECD analysis used 'finite-element model' (FEM) mapping to map the source locations onto anatomical MRIs obtained from infant participants. The cortical sources for the 4.5-month-olds were scattered across the medial-lateral aspects of the basal prefrontal cortex. There was an increasing trend with increased age for infants to show a larger proportion of active midline areas. The best fitting areas in common between the brief stimulus and paired-comparison procedures were in the inferior prefrontal regions. This common activation indicates that these areas of the brain are involved in infant visual preferences and the allocation of attention toward a given stimulus.

B40

ASSOCIATIONS OF EVENT-RELATED POTENTIAL MEASURES OF COGNITIVE CONTROL WITH NEUROIMAGING-DERIVED INDICES OF STRUCTURAL BRAIN DEVELOPMENT IN ADOLESCENCE Paul Collins¹, Kristin Sullwold¹, Ryan Muetzel¹, Kelvin Lim¹, Monica Luciana¹; ¹University of Minnesota – Studies of adolescent brain development have documented age-related changes in event-related potentials (ERPs) associated with response monitoring and cognitive control, such as the stimulus-locked N2 and the response-locked error-related negativity (ERN). Neuroimaging research has demonstrated that maturational changes in cortical structure continue throughout adolescent development, including age-related decreases in gray matter and increases in white matter. This study used ERP time and frequency analyses to investigate response monitoring and inhibitory control during a go no-go task performed by adolescents and young adults (n=50; age range 11-25 years, median age 17 years). Participants also completed a structural MRI protocol, including a T1 scan that was processed to derive cortical thickness measures for a broad set of parcellated anatomical regions. As expected, ERN amplitude was greater in older participants while N2 amplitude was greater for younger participants, effects that were particularly pronounced in theta-band frequencies. Additionally, ERN and N2 amplitudes in both the time and theta-band frequency domains were associated with cortical thickness in the middle cingulate cortex, as well as in immediately adjacent cortical regions (e.g., postcentral gyrus). The results will be interpreted in relation to interactions involving structural and neurophysiological brain development during adolescence within regions that modulate cognitive control.

B41

THE DEVELOPMENT OF COGNITIVE CONTROL IN CHILDREN AND ADOLESCENTS WITH AUTISM SPECTRUM DISORDERS Marjorie Solomon^{1,2,3}, Stanford Ly¹, Cameron Carter^{1,3}; ¹University of California, Davis, ²MIND Institute, ³Imaging Research Center – Individuals with autism spectrum disorders (ASDs) exhibit impairments in cognitive control. As yet, there has been little study of the developmental trajectory of the neural correlates of cognitive control in these individuals. Participants included 4 groups of 15 individuals with ASDs and typical development (TYP), divided into younger (12-15) and older (16-18) ages. Slow event-related fMRI was used to examine differences in performance between the groups in the Preparing to Overcome Prepotency task, a stimulus response incompatibility paradigm. Beta series correlations were used to investigate developmental changes in functional connectivity during the task in frontal regions including anterior PFC (aPFC) and DLPFC using a method adapted from Dosenbach et al., (2008). Younger individuals exhibited higher levels of brain activation in frontal and parietal brain regions than older ones. The TYP group exhibited increases in

functional connectivity with increased cognitive control demands over time for regions of the aPFC and the DLPFC. In TYPs, aPFC connections were limited in younger children, however integration with occipital cortex became evident for older ones. For the DLPFC, younger TYPs exhibited connectivity with aPFC, thalamus and temporal parietal junction. Older TYPs did not exhibit DLPFC connectivity. For the young ASD group, connectivity with aPFC and DLPFC was limited, however, by the older age period, the ASD group demonstrated patterns of regional connectivity comparable to younger TYPs. In ASDs, connectivity patterns show a delayed developmental trajectory compared to TYPs. Further studies are needed to determine whether functional brain integration may catch up in ASD's.

Higher level cognition: Other

B43

ESCAPING THE PRISONERS DILEMA: AN FMRI STUDY OF SOCIAL COOPERATION IN A COORDINATION GAME Timothy Hodgson¹, Francesco Guala², Tim Miller³, Hannah Enke¹, Ian Summers⁴, ¹Exeter Centre for Cognitive Neuroscience, School of Psychology, University of Exeter, UK, ²School of Humanities & Social Sciences, University of Exeter, UK, ³School of Business & Economics, University of Exeter, UK, ⁴Peninsula MR Research Centre, School of Physics, University of Exeter, UK – Previous studies have used the prisoners dilemma task to study brain mechanisms involved in social cooperation. But is life really a prisoners dilemma? We suggest that strong mutual incentives usually exist which bias behaviour towards social cooperation. Opportunities to break cooperative conventions only occur infrequently in the real world. We report the results of an fMRI study of a 'coordination game' in which pairs of participants make a choice to press one of two response buttons. On most rounds participants receive monetary reward only when they choose the same response key. These coordinating or 'normal' rounds are interspersed with 'special' rounds on which the participant in the scanner is given an incentive to defect (analogous to breaking a social convention). Compared to normal rounds the decision period on special rounds was associated with increased activity in widespread areas of the prefrontal cerebral cortex. Regions which showed greater activity for defect compared to cooperate decisions included the caudate nucleus and the orbitofrontal cortex. On rounds for which participants opted to continue cooperation, activity was observed in inferior (BA47) and rostral medial (BA10) prefrontal cortex along with more ventral areas of the striatum. The number of rounds of successful coordination prior to the first special round was a significant predictor of anterior cingulate activity during decision periods. We conclude that periods of successful cooperation modify the degree of decision conflict when defection opportunities arise. Participants who sustain cooperation engage mentalising processes which bias decision making against responses based on proximal rewards.

B44

NEURAL SYSTEMS CODING WHO IS THE ACTOR IN GOAL-DIRECTED ACTION Richard Ramsey¹, Antonia Hamilton¹; ¹School of Psychology, University of Nottingham, University Park, Nottingham, UK – The identity of other people is critical for the meaning of social interactions. For example, handing #10 to a shop-keeper or to a man with a knife are two very different things. That is, the meaning of a simple, goal-directed action can vary depending on the identity of the actors involved. Research examining action understanding has identified a mirror neuron system (MNS) in the inferior frontal gyrus (IFG) and inferior parietal lobe (IPL) which encodes action features such as goals and kinematics. However, it is not yet known how the brain represents actor identity within the context of goal-directed action. In the present paper, we used a repetition suppression (RS) paradigm during functional magnetic resonance imaging (fMRI) to examine the neural representation of actor identity within the context of goal-directed actions. Participants watched video

clips of two different actors with two different goals. Repeated presentation of the same actor suppressed the blood oxygen level-dependent (BOLD) response in right middle frontal gyrus (MFG), a region superior to the classic MNS region of IFG. This data suggests that right MFG contains a population of neurons that encodes the agent of action - that is; they encode who is performing goal-directed action. Our data support the hypothesis that the MNS is agnostic with respect to who is performing the action, and other brain regions are needed to make complete sense of social situations. These results advance our understanding of the neural basis of social cognition.

B45

TUNING IN: PREFERRED MUSICAL RHYTHMS BOOST PREMOTOR ACTIVITY Katja Kornysheva¹, D. Yves von Cramon^{1,2}, Thomas Jacobsen³, Ricarda I. Schubotz^{1,2}, ¹Max Planck Institute for Neurological Research, Cologne, Germany, ²Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, ³BioCog-Cognitive and Biological Psychology, Institute of Psychology I, University Leipzig, Germany – Recent studies showed that motor-related areas become involved both during rhythm tasks and preference-related responses to music. Does attention to preferred rhythms increase activity in the motor system? Our goal was to determine whether the BOLD-response in the motor system is enhanced by preferred compared to not preferred rhythmic musical rhythms and whether this activity can be traced back to the most important timing-related preference, namely tempo (i.e., beat frequency). Based on the subjects' aesthetic judgments, individual preferences were determined for the different constituents of the systematically controlled musical rhythms. Results demonstrate activity in several motor-related areas to be elevated by preferred musical rhythms and reveal a central role of the ventral premotor cortex (PMv) in timing-related preference, specifically during attention to preferred tempo.

B46

PRESTIMULUS EEG FRONTAL THETA AND OCCIPITAL ALPHA ACTIVITIES REFLECT PRESTIMULUS TOP-DOWN PROCESSING Byoung-Kyong Min^{1,2}, Jae-Jin Kim^{1,2,3}, Hae-Jeong Park^{1,2,3}, ¹Brain Korea 21 Project for Medical Science, Yonsei University College of Medicine, Seoul, Korea, ²Nuclear Medicine and Research Institute of Radiological Science, Yonsei University College of Medicine, Seoul, Korea, ³Yonsei University College of Medicine, Seoul, Korea – The prestimulus reflection of poststimulus events was recently reported in human EEG alpha activity. Nevertheless, it still remains unclear whether other oscillatory activity can reflect top-down processing, even before stimulation. Since theta activity has been implicated in working memory processing, we investigated whether EEG theta activity reflects top-down inhibitory control in advance of stimulus onset. EEG was recorded from 15 healthy controls performing a color and a shape discrimination task. Both tasks required inhibition of the task-irrelevant feature. To investigate the time course and power of oscillatory activity, EEG signals were convolved with Morlet wavelets. We observed that the amount of both frontal theta and occipital alpha power in the prestimulus period was modulated by subsequent task relevance. Taken together with behavioral results, the difficult task (shape task) was preceded by significantly higher occipital alpha and frontal theta power compared to the easy task (color task). Since such task-differences were already reflected in prestimulus alpha and theta power, not only prestimulus alpha but also prestimulus theta activity may convey a top-down preparation of the subsequent task performance.

B47

SOCIAL AND SEMANTIC PROCESSING IN THE ANTERIOR TEMPORAL LOBES: EVIDENCE FROM AN FMRI CONJUNCTION TASK Lars A. Ross^{1,2}, Marian Berryhill^{1,2}, David Drowos^{1,2}, Ingrid Olson^{1,2}, ¹Temple University, Philadelphia, PA, ²University of Pennsylvania, Philadelphia, PA – The anterior temporal lobes (ATL) have been hypothesized to have semantic memory functions and social-emotional functions, such as theory of mind (ToM). Insufficient discourse between different

divisions of the literature has motivated recent attempts to reconcile these distinct functions. In the fMRI experiment reported here we contrasted conditions that have been found to stimulate ATL activity in past experiments in order to investigate overlap between activations evoked by stimuli of vastly different nature. Since functional imaging of the ATL's often suffers from signal dropout due to their proximity to the nasal sinuses, we used an optimized pulse sequence and small voxel size. Our findings are discussed in reference to recent evidence of the involvement of the ATL's in social semantic processing and neuropsychological data from patients with frontotemporal dementia.

B48

RHYTHM EVOKES ACTION: PROCESSING OF METRIC DEVIANCES IN EXPRESSIVE MUSIC BY EXPERTS AND LAYMEN REVEALED BY ELECTRICAL NEUROIMAGING Clara E. James^{1,2}, Christoph M. Michel^{1,3}, Juliane Britz^{1,3}, Patrik Vuilleumier^{1,3}, Claude-Alain Hauert^{1,2}; ¹Geneva Neuroscience Center, Switzerland, ²Faculty of Psychology and Educational Sciences, University of Geneva, Switzerland, ³Fundamental and Clinical Neurosciences, University of Geneva, Switzerland – Within expressive classical piano compositions, temporal expectancies were manipulated by alternating conventional masculine cadences at metrically strong positions with less common feminine or metrically unaccented cadences. Interspersed pieces terminating on conventional and deviant cadences were presented to 13 expert pianists and 13 musical laymen while high density EEG was recorded. D-prime scores revealed that experts detected deviant cadences better than laymen. An early positive frontal ERP component was elicited by both conventional and deviant closure (~ 150-300 ms) in both groups; analyses on a large array of ERP difference waves (deviant minus conventional) showed stronger amplitudes at frontal and parietal electrodes in experts. An ANOVA on Global Field Power (GFP) for this time window exhibited a Group X Condition interaction; contrasts confirmed stronger GFP in experts for metric deviance. Using an ERP source imaging approach, we localized putative contributive sources for this component by means of statistical parametric mapping. In a subset of 50 regions of interest, activated by both groups, including bilateral supplementary motor areas, posterior cingulate cortex, right (pre)cuneus and right medial temporal areas, experts manifested overall stronger activation. Later on (470-600 ms), posterior cingulate cortex was exclusively activated in experts. Like in a previous study, using harmonically incongruent cadences with the same participants and compositions, stronger right medial temporal activations occurred early in time in experts. However, differences were overall much larger for harmonic than for metric deviances. In conclusion the broadly distributed concurrent motor activations in response to metric deviances suggest that rhythm particularly evokes action.

B49

ARE YOU LEFT BRAINED OR RIGHT BRAINED? DIFFERENCES BETWEEN DEMOCRATS AND REPUBLICANS ON A POLITICAL FLANKER Scott McLean¹, Sandra Wiebe¹, Michael Dodd¹, John Hibbinig¹, Kevin Smith¹, Kimberly Espy¹; ¹University of Nebraska-Lincoln – Recent findings suggest a role for genetic factors in political attitudes (Alford et al., 2005). Differences in political attitudes are also tied to neural and behavioral performance in a go/no-go task tapping sensitivity to cues altering a habitual response (Amodio et al., 2007). We used the Eriksen flanker paradigm to measure interference control in another way, using political stimuli (faces of current political figures) and non-political stimuli (happy and angry faces). Participants were 63 undergraduates at a Midwestern university. In a pretest, participants reported their own political affiliation and rated a battery of potential task stimuli in terms of likability; the two highest-rated happy and own-party faces and the lowest-rated angry and other-party faces were used. In the flanker task, participants pressed one of two buttons indicating like/dislike of the center target picture, flanked by either congruent or incongruent stimuli. Reaction time (RT) was averaged by target and flanker. For Democrats, a significant flanker congruency effect for RT occurred only for angry targets

with angry flankers (relative to angry flanked by happy; $p=.03$), whereas for Republicans significant effects were found for Republican/Republican vs. Republican/Democrat ($p=.002$), happy/Republican vs. happy/Democrat ($p=.05$), and happy/happy vs. happy/angry faces ($p=.04$). This is consistent with previous findings suggesting politically conservative individuals' performance is more susceptible to interference from conflicting information. These results will be discussed in relation to neural regions involved in the processing of conflict information.

B50

EVENT-RELATED POTENTIALS OF SUBJECTS WHO FEEL STUDIED LARGELY DIFFER FROM THOSE OF SUBJECTS WHO DO NOT HAVE THIS FEELING Marie Prévost^{2,3}, J. Bruno Debruille^{1,2,3}; ¹McGill University, ²McGill University, Neurology and Neurosurgery, ³Douglas Mental Health University Institute – The feelings of being studied and submitted to magnetic or electrical fields could have an impact on the way subjects process stimuli during fMRI or TMS experiments. The present study is a first attempt at exploring this impact. Subjects were placed behind a one way mirror and were told that electrical fields could be emitted to temporarily change the way their brain functions. A short scale was created with three items to assess feelings of being studied and two items to assess whether the subjects felt that their functioning was changed. The event-related potentials (ERPs) of 38 subjects were recorded during a semantic categorization task. In the N400 time window, ERPs were more positive over left frontal electrodes in subjects who felt studied than in subjects who did not feel studied. These feelings did not impact the N400 amplitude over centro-parietal electrodes, where it is classically maximal. Interestingly, subjects who felt studied had greater late positivities than those who did not and this large difference was widespread over the scalp. The late positivity has been proposed to reflect processing about the self and others. It is thus possible that subjects who felt studied were more focused on the experimenters and on themselves, as they were aware of the attention devoted to them. In contrast, the feelings of having one's functioning changed had no impact on the ERPs. These results are of major importance for neuropsychological studies, as it is often assumed that all subjects react similarly to the laboratory environment.

B51

MODULATIONS OF NEURAL RESPONSES TO FACIAL ATTRACTIVENESS BY PERSON-KNOWLEDGE Jasmin Cloutier¹, William Kelley², Todd Heatherton²; ¹MIT, ²Dartmouth College – This study examined how person-knowledge modulates the neural substrates underlying the perception of facial attractiveness. Using fMRI, female subjects were imaged while viewing faces varying on physical attractiveness. Prior to seeing the faces, participants were sometimes presented with descriptive information (i.e., person-knowledge). Subjects were instructed that, when available, they should use the person-knowledge to form impressions of the subsequently presented faces. Importantly, this information depicted the person in either a positive, neutral, or negative light. Of interest was the neural activity to faces varying on attractiveness as a function of the type of person-knowledge presented. Analyses focused on brain areas previously shown to be sensitive to the reward value of facial attractiveness (Cloutier, Heatherton, Whalen, & Kelley, 2008). Results revealed that the ventral striatum was only preferentially responsive to attractive faces when no person-knowledge or when neutral person-knowledge preceded the faces. In contrast, ventral medial prefrontal brain regions were preferentially recruited when viewing faces preceded by positive information, irrespective of facial attractiveness.

B52

DEFAULT NETWORK FUNCTIONAL CONNECTIVITY IS MODULATED BY SMOKING Brett Froeliger¹, Rachel Kozink¹, Avery Lutz¹, Jed Rose¹, F. Joseph McClernon¹; ¹Duke University Medical Center – Smoking abstinence has been shown to result in persistent changes in spontaneous brain activity using electroencephalographic measures (Gilbert et al., 1999, 2004). Recently, fMRI and PET methods have elucidated correlated

spontaneous brain activity in the absence of task demands in a network of midline structures including the precuneus, medial prefrontal cortex and anterior cingulate cortex. Functional connectivity (fc) of the 'default network' likely reflects non-goal directed, introspectively oriented cognition. The current study sought to evaluate the effects of smoking abstinence on the spatial distribution of this network. BOLD-fMRI images were collected in smokers (n = 15) during a 5-minute eyes-closed resting period during two sessions: once following 24 hr abstinence, and once following smoking as usual. In each session, fc was observed between brain regions previously identified as comprising the default network. Session differences revealed increased default network fc during satiety relative to abstinence in left caudate, while greater default network fc during abstinence relative to satiety was observed in right superior temporal gyrus, left superior parietal and paracentral lobules. The caudate is known to be highly innervated by dopaminergic neurons, and smoking has been shown to increase dopamine release in the caudate. The present findings suggest the caudate to be more functionally connected to the default network during satiety than during abstinence. This shift to increased caudate-default network connectivity during satiety may reflect the reinforcing aspects of smoking addiction. Implications for understanding the relationship between caudate and default mode within the framework of smoking addiction will be discussed. Research funded by a grant from the National Institute on Drug Abuse (K23DA017261; FJM). CORRESPONDING AUTHOR: F. Joseph McCleron, Ph.D., Tobacco Research Laboratory, Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Box 2701, Durham, NC 27708.

B53**GONADAL STEROID HORMONES MODULATE SUBGENUAL ACTIVITY IN WOMEN DURING REST**

Shau-Ming Wei¹, Erica B. Baller¹, Daniella Furman², Philip D. Kohn¹, Peter J. Schmidt¹, Karen F. Berman¹; ¹National Institute of Mental Health, National Institute of Health, ²Stanford University – There is considerable evidence that gonadal steroids modulate neural circuits underlying cognitive and affective behaviors in humans. To further investigate the effects of gonadal steroids on neural function, we used PET to assess resting regional cerebral blood flow (rCBF) as a function of hormone condition. Twenty-five healthy, regularly-menstruating women underwent two eyes-open resting PET scans (10 mCi H2150 IV per scan) during each of three different hormone conditions: ovarian suppression (i.e. hypogonadism) induced by the gonadotropin-releasing hormone agonist leuprolide acetate (Lupron); Lupron plus estradiol replacement; and Lupron plus progesterone replacement. The two scans per hormone condition were averaged and entered into a second-level random effects analysis (SPM5) to compare across hormone conditions. Additionally, rCBF values extracted from a sphere centered on the between-hormone-condition difference in subgenual cortex (BA25) were entered into a whole-brain cross-correlation analysis to assess BA25 connectivity. In the presence of estradiol and progesterone, there was significantly increased ($p < 0.002$, uncorrected) activity in BA25 compared to Lupron treatment alone (i.e. in the absence of ovarian hormones). With estradiol replacement, connectivity analysis revealed positive functional interactions ($p < 0.002$, uncorrected) between BA25 and several regions highly associated with affective processing, including anterior cingulate, left amygdala, hippocampus, and putamen. Our data demonstrate that the hormonal milieu is important for regulating circuit-level activity including BA25. Since BA25 is known to be important for pathophysiology and treatment of depression, our findings provide a framework for understanding affect control in general, and, more specifically, hormonally-dependent conditions, such as perimenopausal, post-menopausal and menstrual-cycle-dependent mood disorder.

B54**THE EFFECTS OF STIMULUS SALIENCE, ATTENTION-SWITCHING, AND WORKING MEMORY LOAD ON P3 AMPLITUDE IN A DECEPTION TASK: AN ERP STUDY**

Laura Bradshaw-Baucom¹, Scott Meek¹, Michelle Phillips¹, Jennifer Vendemia¹; ¹University of South Carolina – Stimulus salience, attention-switching, and working memory load mediate event-related potentials (ERPs) associated with deception. College-aged students (N=45) performed one of three variations of a two-stimulus directed-lie task while ERPs were assessed with a 128-channel sensor net. Two ERPs were examined, a waveform related to workload and attention (P3b) and a waveform associated with attention-switching (P3a). Participants were assigned to respond deceptively to 20%, 50%, or 80% of trials. Previous ERP research suggests that P3b waveform amplitude decreases with increased working memory load while it increases in response to highly salient stimuli (Kok, 2001). Switching from a difficult response to an easier response produces an increase in amplitude of the P3a waveform (Comerchero & Polich, 1999). We expected to see a maximum decrease in P3b waveform amplitude when participants responded deceptively to 80% of trials due to increased working memory load. P3b amplitude was expected to be greatest when participants responded deceptively to 20% of trials due to increased salience of the stimuli pertaining to deception. We expected to see a maximum increase in P3a waveform when switching from making a more difficult deceptive response to making an easier truthful response when responding deceptively to 50% of trials. The findings are discussed as they relate to the theoretical link between stimulus salience, attention-switching, and working memory load in the formulation of deceptive responses.

B55**NEURAL MECHANISMS OF REWARD PROCESSING IN NICOTINE ADDICTION AND OBESITY**

Laura Martin¹, Rebecca Chambers¹, Lisa Cox¹, Joseph Donnelly², Cary Savage¹; ¹University of Kansas Medical Center, ²University of Kansas – Everyday individuals make decisions impacting health in which they weigh the benefits of short- versus long-term rewards. The purpose of the current study was to examine the similarities and differences between neural mechanisms of reward associated in nicotine addiction and obesity. The current study used fMRI to examine brain responses during prediction, anticipation, and delivery of monetary rewards and punishments in healthy weight (HW) non-smokers, HW smokers, and obese non-smokers. The task consisted of the presentation of cues predicting the delivery of a reward or punishment with 75% probability, followed by feedback for the current trial. To date, we have collected data in 7 HW non-smokers, 6 HW smokers, and 7 obese non-smokers. Preliminary results in smokers and obese participants show increased activation to rewards compared to punishments in the anterior cingulate cortex (ACC), a region associated with reward processing and impulse control. Smokers showed greater activation to rewards than punishments during prediction and anticipation and obese participants showed greater activation during delivery. By comparison, HW non-smokers showed greater activation to the anticipation of punishments than rewards in areas of prefrontal cortex and medial orbitofrontal cortex (OFC). These results demonstrate that smoking and obesity are associated with increased brain activation during reward processing; however, this difference is seen during anticipation for smokers and during delivery for obese individuals. HW non-smokers appear to be more sensitive to signals of punishment. These results are consistent with behavioral studies showing increased sensitivity to reward and decreased sensitivity to punishment in impulsive individuals.

B56**THE NEURAL SUBSTRATES OF IMPLICIT AND EXPLICIT MENTALIZING ARE DIFFERENTIALLY MODULATED BY GROUP MEMBERSHIP**

Dylan D. Wagner¹, William M. Kelley¹, Todd F. Heatherton¹; ¹Dartmouth College – Previous psychological research has demonstrated an ingroup bias and outgroup deficit in the attribution of

complex emotions and mental states. Convergent evidence from brain imaging has found either reduced or differential recruitment of regions involved in mentalizing when making judgments about outgroup members. Based on previous work demonstrating spontaneous recruitment of mentalizing areas when viewing rich social material, we reasoned that recruitment of mentalizing regions when processing in- and outgroup members would differ according to level of processing (implicit vs. explicit). In the present study 14 participants made personality attributions or rated the degree to which a face was gender typical when the target was a racial ingroup or outgroup member. A subset of brain regions associated with mentalizing demonstrated an interaction between group status and level of processing. Dorsal medial prefrontal cortex (dMPFC), left temporo-parietal-junction (TPJ), left fusiform and right temporal pole did not distinguish between in- and outgroup targets during the explicit mentalizing condition but demonstrated increased activity to ingroup targets during the implicit condition. Additionally, the left temporal pole showed greater activity for outgroup members during the explicit condition, but also favored ingroup members during the implicit condition. These findings indicate that under explicit task demands participants are equally as likely to recruit mentalizing regions for in- or outgroup targets and may in fact show a bias in favor of outgroup members. However, during implicit processing of targets, mentalizing regions favor ingroup members.

B57**VENTROMEDIAL PREFRONTAL DAMAGE INCREASES UTILITARIAN MORAL JUDGMENTS FOR IMPERSONAL AND PERSONAL MORAL DILEMMAS**

Bradley Thomas¹, Katie Croft¹, Daniel Tranel; ¹*Division of Cognitive Neuroscience, University of Iowa* – Previous research has suggested that the ventromedial prefrontal cortex (VMPC) is involved in rejecting utilitarian moral judgments (or making non-utilitarian, deontological judgments) about personal, but not impersonal utilitarian moral dilemmas. Subsequent research examining patients with VMPC damage confirmed the previous findings, but also indicated that the VMPC is involved in high-conflict but not low-conflict personal moral dilemmas. In a high-conflict dilemma, the relative value of the consequences of the two horns of the dilemma (e.g., letting 5 strangers die versus killing your daughter) is difficult to compute in order to determine which horn is right. In this sense, the vast majority of impersonal dilemmas so far examined in moral cognition research have been low-conflict. Thus, we sought to explore high-conflict impersonal dilemmas to determine if the VMPC is crucially involved in making non-utilitarian moral judgments of only high-conflict personal dilemmas, or of high-conflict dilemmas in general. We presented 8 high-conflict impersonal dilemmas to patients with circumscribed bilateral, adult onset VMPC lesions (VMPC group; n=10), and demographically matched normal (NC group; n=20) and brain damaged comparison participants (BDC group; n=5). As predicted, the VMPC group was more likely than NC and BDC groups to make utilitarian moral judgments of high-conflict impersonal dilemmas. These findings suggest that the VMPC is crucially involved in rejecting utilitarian judgments and making deontological judgments of high-conflict dilemmas in general.

B58**MOOD MODULATION OF INFERENCE PRIMING DURING STORY COMPREHENSION**

Heather Mirous¹, Mark Jung-Beeman¹; ¹*Northwestern University* – When people comprehending stories hear a premise state (John was wearing jeans) and later a changed state (John is wearing a tuxedo), they bridge this gap by inferring a causal connection (John changed). Drawing such causal inferences is often necessary to maintain coherence during language comprehension. Mood, whether assessed or induced, affects performance in a variety of cognitive tasks that likely share some component cognitive processes with drawing inferences. In the current study, before participants listened to stories, we induced mood via film clips to examine the influence of positive affect and anxiety on drawing causal inferences. We contrasted priming of

inference-related target words presented at an early time point (when the inference is predictive and optional) and a late time point (when a bridging inference is necessary to maintain story coherence) after each mood induction. Participants showed greater inference priming after positive mood induction than anxious mood induction, especially at the later time point. These results provide evidence that mood modulates inference processing during natural story comprehension. It is not yet clear whether mood is directly influencing the process of drawing inferences, or if the influence of mood is mediated through another cognitive mechanism, such as attention or working memory, which is under investigation. Though preliminary, these results could have implications for student learning.

B59**INVESTIGATING CONCEPTUAL PROCESSING WITH PICTURE-TO-PICTURE REPETITION PRIMING**

Eric S. Clapham¹, Aaron T. Karst¹, C. Mark Wessinger^{1,2,3}; ¹*University of Nevada, Reno,* ²*Charter Oak State College,* ³*Northcentral University* – The current study uses a repetition priming paradigm to investigate the extraction and encoding of conceptual information. The basic experimental trial began by exposing participants to briefly presented primes, followed by a target stimulus that remains visible until the participant makes a decision. Prime and target stimuli were drawn from a standardized pool of real world pictures. On each trial the number of primes preceding the decision task varied from 1 - 4. Primes were presented with forward and backward masks in order to limit processing to the specified exposure interval. Furthermore, the presentation time of each prime varied between 25 and 100 ms. Twenty-five ms was shown to be below visual awareness in a separate picture identification task. To assess conceptual processing, the priming task required participants to categorize target stimuli as natural or manufactured. In general, the congruent conditions resulted in a facilitation of performance in the form of reaction time gains. However, the gains tended to increase when the prime interval was larger.

B60**SEX DIFFERENCES IN STRESS EFFECTS ON BRAIN ACTIVATION AND BEHAVIOR DURING RISK TAKING**

Nichole Lighthall¹, Michiko Sakaki¹, Sarinnapha Vasunilashorn¹, Sangeetha Somayajula¹, Eric Chen¹, Mara Mather¹; ¹*University of Southern California* – Sex differences in financial risk taking are frequently observed (e.g., Jianakoplos & Bernasek, 1998) and experimental research indicates that stress may enhance these sex differences (Mather et al., in press; Preston et al., 2007). Stress appears to activate prefrontal structures more in men and limbic structures more in women (Wang et al., 2007). Thus, stress-induced sex differences in risky behavior may stem from sex differences in how stress affects analytical versus emotional processing. To test this, we investigated the neural mechanisms of stress-sex interactions in financial risk taking by comparing stress effects on behavior and brain activation in 48 men and women during a computerized risk task. Prior to the risk taking game, half of the participants were exposed to cold stress and the other half completed a control condition. Functional imaging data was collected throughout the risk taking task; during the anticipated cortisol peak. Men and women had similar behavior and activated similar brain regions during the task under control conditions. However, stressed males earned more money during the risk task and increased activation in regions related to cognitive analysis such as the anterior cingulate, dorsolateral PFC, insula and medial PFC compared to control males, whereas stressed women earned less money and showed less activity in all of these regions but more activity in the amygdala and ventromedial PFC than control females. These findings suggest that stress will enhance decision making effectiveness in women when decisions benefit from emotional processing and in men when decisions benefit from cognitive analysis.

B61**DEFAULT NETWORK RELATIONSHIPS TO INTELLIGENCE AND CREATIVITY IN NORMAL SUBJECTS**

Leonard Leyba¹, Andrew Mayer^{1,4}, Alexandre Franco¹, Robert Chavez¹, Shirley Smith^{1,3}, Alison Marshall¹, Rane Flores¹, Rex Jung^{1,2,3,4}; ¹Mind Research Network, University of New Mexico, ²University of New Mexico, Neurosurgery, ³University of New Mexico, Psychology, ⁴University of New Mexico, Neurology – Spontaneous brain activity in the absence of a cognitive task may be related to intelligence (Song et al., 2008). Low frequency oscillations (0.01-0.1 Hz) of this spontaneous activity have been found to be consistent across subjects (Damoiseaux et al., 2006) and may be important in cognitive processing (e.g. Greicius et al., 2008). The present study examines whether the power of spontaneous fluctuations in the DMN at rest is correlated with intelligence or creativity. Full Scale Intelligence Quotient (FSIQ) was assessed with the Wechsler Adult Intelligence Scale; creativity was assessed with measures of divergent thinking described previously (Miller & Tal, 2007), from which a creative intelligence quotient (CIQ) was derived. Subjects underwent a 5-minute resting fMRI scan. Data was motion corrected, placed in MNI stereotaxic space, and group ICA (GIFT matlab toolbox; Calhoun et al., 2004) was used to identify 33 spatially independent components. Four components were selected having high spatial correlation with anterior inferior, anterior superior, posterior inferior, and posterior superior regions of the DMN network (Correa et al., 2006). The power spectra of individual subject timecourses corresponding to these 4 spatial components was used to calculate the proportion of total power in the 0.01-0.1 Hz range. This power was regressed against FSIQ and CIQ scores. FSIQ had a correlation approaching significance ($r=0.30$, $p=0.055$) with the power (0.01-0.1 Hz) of the spatial component representing the posterior superior aspect of the DMN. The power spectra of no other components were related to FSIQ or CIQ scores.

B62**EFFECT OF PHYSICAL WARMTH ON ECONOMIC DECISION-MAKING PROCESS**

Yoona Kang¹, John Bargh¹, Jeremy Gray¹, Lawrence Williams²; ¹Yale University, ²Colorado University – Recent lines of evidence suggest a link between physical and emotional perceptions. People rated others to have a warmer (colder) personality after incidentally touching a warm (cold) coffee cup (Williams & Bargh 2008, Science), suggesting a relation between physical temperature and interpersonal warmth (trust). Various studies indicate a possibility of a shared underlying mechanism for physical and interpersonal warmth. The insula, in particular, is shown to activate in response to physical warmth as well as perceived interpersonal trust. Using this paradigm, we tested whether physical warmth will increase interpersonal warmth, which may influence one's economic decision-making process. Study 1 was a behavioral study designed to be compatible with the constraints of MR imaging. We examined the effect of physical warmth (coldness) on participants' economic decision in an investment game. Participants conducted an ostensive product evaluation, which involved touching either a warm or cold therapeutic pack. In 29 individuals, those who touched a warm therapeutic pack entrusted significantly higher amount of money to their investment game partners than those who touched a cold pack. In addition, we tested two participants using fMRI. In both subjects, experimentally manipulated warmth led to greater activation in the anterior insula, consistent with prior work. Thus, we have found that perceptions of physical temperature influenced one's interpersonal economic decision making, potentially through the involvement of a common underlying neural mechanism.

B63**AGE DIFFERENCE IN THE MEDIATION OF COGNITIVE PROCESSING SPEED BY PREFRONTAL CORTEX**

Michael Motes^{1,2}, Bharat Biswal³, Bart Rypma^{1,2}; ¹Center for BrainHealth, School of Behavioral Sciences, University of Texas at Dallas, ²University of Texas

Southwestern Medical Center, Psychiatry, ³University of Medicine and Dentistry of New Jersey, Radiology – Research has revealed age-related slowing on measures of cognitive processing speed and that processing speed declines account for age-related variability on a variety of more complex cognitive tasks. These findings have led to hypotheses that the efficient use of limited sets of cognitive operations governs a variety of age-related cognitive declines. fMRI was used in the present study to examine the neural basis for age-related differences in processing speed, particularly targeting prefrontal cortex (PFC). During scanning, groups of older and younger participants completed an fMRI-adapted version of a cognitive processing speed task. On each trial, participants determined whether a symbol-number pair also appeared in a simultaneously presented array of nine symbol-number pairs. Estimates of task-related BOLD signal-change were obtained for each participant. These estimates were then correlated with the participants' performance on the task. For younger participants, BOLD signal-change within PFC decreased with better performance, but for older participants, BOLD signal-change within PFC increased with better performance. The results suggest that differential efficiency in the use of PFC neural resources mediates age-related changes in processing speed, in particular, and cognitive performance, more generally.

B64**FUNCTIONAL DYNAMICS OF ANTERIOR INTRAPARIETAL SULCUS WITHIN THE ACTION OBSERVATION NETWORK DURING UNDERSTANDING OTHER PEOPLE'S INTENTIONS: EVIDENCE FROM COMBINED FMRI AND EEG REPETITION SUPPRESSION**

Stephanie Ortigue¹, James Thompson², Raja Parasuraman², Scott Grafton¹; ¹4D Brain Electrodynamics Lab, UCSB Brain Imaging Center, Institute for Collaborative Biotechnologies, ²George Mason University – Inferring intentions of other people based on the observation of their behavior recruits brain regions within the inferior frontoparietal network (including the mirror neuron system) extending to the superior temporal sulcus (STS). However, the functional dynamics between these brain areas remains unclear. To assess this question, we tested repetition suppression (RS) effects in 24 healthy men who performed an intention inference task while their brain activity was recorded with high-spatial fMRI and high-temporal EEG recordings. During this task, participants were instructed to attend to video-clips displaying hand-on-object actions, and to try to decode 'why' actions were being performed (e.g., to use a gun or to transport it). Functional MRI results confirmed the specific role of the inferior frontal lobe, anterior intraparietal sulcus (aIPS) and STS in intention understanding. High-density EEG neuroimaging combining brain microstate analysis with LAURA distributed linear source estimations expanded these results by revealing the temporal dynamics within this brain network. Suppressed responses for intention decoding were observed in STS in the early stage of processing (~100ms after hand-on-object interaction). Then, a specific recruitment of aIPS was observed around 200ms. Finally, a combined STS and aIPS recruitment was observed around 330ms. Within this cascade of events, the recruitment of aIPS was more specifically observed for action goals than objects per se. Together, these results show the temporal dynamics of intention understanding within the human action observation network that are different than those used to decode lower level visual features related to the object per se.

B65**AGING EFFECTS ON RULE-BASED AND INFORMATION-INTEGRATION CATEGORY LEARNING**

Bo Zhu¹, Jennifer Pacheco¹, Maia Langford¹, David M. Schmyer¹, W. Todd Maddox¹; ¹University of Texas at Austin – Rule-based (RB) and information-integration (II) category learning was investigated in healthy older participant (60 - 81 years old). Participants were asked to categorize single line stimuli that varied in length and orientation into one of four categories. In the RB condition, correct classification required that each line be classified as short or long and steep or shallow, and these decisions integrated using a conjunctive

rule. In the II condition, the optimal strategy had no verbal analog, but instead involved a pre-decisional integration of length and orientation. The RB and II categories were structurally equivalent in the sense that within- and between-category variance was constant. All other procedures were fixed across conditions (e.g., optimal accuracy, nature of the feedback, response requirements, etc). Each subject completed 6-100 trial blocks in each condition. Accuracy- and model-based analyses were performed. The results suggested that (a) elderly participants were less accurate than controls in the RB condition, (b) elderly participants were less accurate than controls in the II condition early in learning, but showed no II performance impairment during the last half of the session, and (c) the locus of the accuracy deficits (when they emerged) were due to a deficit in categorization rule learning, and not to increased variability in the application of the rule. These results replicate previous studies that show RB deficits in normal aging and extend them to conjunctive rule learning. The early learning II deficit converges with previous results, but the lack of impairment late does not.

B66

A NON-PHARMACOLOGICAL ALTERNATIVE FOR THE TREATMENT OF INSOMNIA - INSTRUMENTAL CONDITIONING OF BRAIN OSCILLATIONS Kerstin Hoedlmoser¹, Thanh Dang-Vu², Martin Desseilles², Pierre Maquet², Manuel Schabus^{1,2}; ¹University of Salzburg, Austria, Division Physiological Psychology, ²University of Liege, Belgium, Cyclotron Research Centre – Electroencephalographic recordings over the sensorimotor cortex show a very distinctive oscillatory pattern in a frequency range between 12-15Hz termed sensorimotor rhythm (SMR). SMR appears to be dominant during quiet but alert wakefulness, and synchronizes by the inhibition of motor behaviour. This frequency range is also known to be abundant during light non-rapid eye movement sleep, and is overlapping with the sleep spindle band. Given earlier findings we aimed at changing sleep quality and cognitive performance in humans by using instrumental conditioning (IC) of that SMR frequency band. Twenty-seven subjects were randomly assigned to either a SMR-conditioning protocol or to a randomized-frequency-conditioning protocol. Whereas the experimental group was trained to enhance the amplitude of their SMR-frequency range during 10 IC sessions over the course of 2 weeks, the control group participated in a placebo conditioning protocol. Before and after these IC blocks subjects had to attend the sleep laboratory to take a 90min nap and additionally had to perform a declarative memory task. Results confirmed the increase of 12-15Hz activity over the course of the ten training sessions in the experimental group. Interestingly, the increased SMR activity (i) was also expressed during subsequent sleep by eliciting positive changes in various sleep parameters like sleep spindle number or sleep onset latency and (ii) was associated with the enhancement of declarative memory performance. In addition, preliminary data from our own laboratory indicate that people suffering from insomnia could also benefit from SMR-conditioning as indicated by improved measures of subjective and objective sleep quality.

Linguistic processes: Semantics

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NEURAL PROCESSING OF ICONIC AND METAPHORIC CO-VERBAL GESTURES: WHAT MEMORY TELLS US ABOUT UNDERLYING PROCESSES Benjamin Straube^{1,2}, Antonia Green¹, Anjan Chatterjee², Tilo Kircher¹; ¹RWTH Aachen University, Aachen, Germany, ²Center for Cognitive Neuroscience, The University of Pennsylvania, Philadelphia, PA – Iconic and metaphoric gestures illustrate verbal utterances with shape, space or action information. However, these gesture types differ in reference to the abstractness of the sentence content. The question arises how the different information of speech and gesture is processed and stored on the neural level. This study tested the hypothesis

that iconic and metaphoric gestures contribute to memory for spoken sentences and that they have different neural instantiations. During fMRI-data acquisition participants were presented with videos showing an actor performing iconic (IG), metaphoric (MG) or no gestures (NG) to corresponding concrete or abstract sentences, respectively. After scanning, participants performed a recognition task for videos of the spoken sentences without gestures of each condition. Behavioral results indicate that co-verbal gestures lead to better memory performances for spoken sentences than when the sentences were spoken without gestures. We found for the IG condition, bilateral temporo-occipital and parietal activation accompanied by predominantly right lateral hippocampal activation was associated with better subsequent discrimination. By contrast, for the MG condition fronto-temporal and predominantly left lateral hippocampal activation was related to better recognition. These results suggest differences in encoding processes for both gesture types. The right hippocampus is probably more involved in concrete visuo-spatial integration processes of speech and gesture. By contrast, the left hippocampus and a fronto-temporal network are more involved in semantic integration of abstract information of speech and metaphoric gestures.

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NEURAL SUBSTRATE FOR INTEGRATING SEMANTIC AND PHONOLOGICAL PROCESSING IN CHINESE CHILDREN Shu-Hui Lee¹, Tai-Li Chou¹, Li-Ying Fan¹, Mei-En Hsieh¹; ¹National Taiwan University – Functional magnetic resonance imaging (fMRI) was used to examine the neural correlates of auditory semantic judgments to Chinese characters in a group of 10-15 year old Chinese children. The participants had to judge if two Chinese characters were related in meaning. The first character was visually presented and the second character was auditorily presented. Different from English, Chinese has plenty of homophones in which each pronunciation corresponds to many characters. This task required the participants to select a semantically appropriate answer among homophones, given that the first and the second characters were related in meaning. The participants showed activation in left middle temporal gyrus (BA 21, 22) and left inferior frontal gyrus (IFG, BA 45, 47) for semantic processing. Consistent with previous visual semantic findings, characters with stronger semantic association elicited greater activation in left inferior parietal lobule (BA 40). Different from previous visual semantic findings, characters with weaker semantic association elicited activation in left IFG (BA 45), suggesting greater engagement of selection among homophones for Chinese characters. We also examined whether age explained variance in the patterns of activation. Increasing age was correlated with greater activation in IFG (BA 45) for related pairs and in IFG (BA47) for unrelated pairs. The developmental results indicate greater integration of semantic and phonological processes to select the correct answer among homophones for related pairs, and demanding retrieval processes to judge unrelated pairs for older children. Our findings imply different roles for subparts of IFG, BA 45 and BA 47 during semantic judgments.

B69

MOOD AFFECTS SEMANTIC PROCESSING: EVIDENCE FROM N400 Dorothee J. Chwilla¹, Constance, Th. W. M. Vissers², Daniele Virgillito³, Dan Fitzgerald⁴, Anne, E. M. Speckens², Indira Tendolkar²; ¹Donders Institute for Brain, Cognition and Behaviour, ²Donders Institute for Brain, Cognition and Behaviour, Psychiatry, ³Scuola Superiore di Catania, Catania, Italy, ⁴Behavioral Science Institute – N400 amplitude systematically varies with the degree at which a word is expected based on context. This N400 effect of cloze probability with larger amplitudes for less expected words is taken to reflect the ease with which a word is integrated into context. In this study we explored the interaction of language, in particular of semantics, with emotion. This was accomplished by investigating the effects of emotional state on N400. EEG was recorded while female participants (N=31) read high-cloze sentences ('In that library the pupils borrow books...') and low-cloze sentences ('The pillows are stuffed with books...'). Mood was manipulated between participants

by presenting short film clips that displayed fragments from a happy movie or a sad movie. These film clips have been shown to effectively induce the intended mood. The main results were as follows: Participants scored significantly higher on a 9 point-mood scale after watching the happy film clips than after the sad film clips ($p < .01$). For N400 (300 to 500 ms epoch), an interaction of cloze probability and mood was found for the midline and the lateral sites ($ps < .05$). For the midline sites an N400 effect was present in the happy mood but absent in the sad mood condition. For the lateral sites the interaction indicated that the N400 effect in the happy mood condition was more broadly distributed across the scalp than in the sad mood condition. The N400 data show that mood in healthy subjects affects semantic processing, in particular meaning integration.

B70

COMPREHENSION OF ACTION AND NON-ACTION VERBS IS PRESERVED IN PARKINSON'S DISEASE David Kemmerer^{1,2,3}, Luke Miller², Megan MacPherson¹, Jessica Huber¹; ¹Purdue University, Speech, Language, and Hearing Sciences, ²Purdue University, Psychological Sciences, ³University of Iowa, Neurology – The Embodied Cognition Framework (ECF) maintains that action concepts depend in part on the primary motor and/or premotor cortices. This predicts that disturbances to those regions should impair comprehension of action verbs (e.g., throw) but not non-action verbs (e.g., think). A recent study reported reduced repetition priming for verbs but not nouns in non-demented patients with Parkinson's disease (PD), a movement disorder that indirectly affects the motor cortices due to abnormal input from the basal ganglia and the mesocortical dopaminergic pathway (Boulenger et al., 2008). However, in that study all the verbs encoded actions and all the nouns encoded objects, leading to a conflation of grammatical and semantic categories. In the current study we compared the performance of 10 non-demented PD patients with 10 healthy control subjects on a task assessing comprehension of action and non-action verbs. All participants received the Semantic Similarity Judgment Task, which requires determining which of two verbs is more similar to a third (Kemmerer et al., 2008). There were 144 items₂₄ for each of 6 classes of verbs, 4 classes involving actions (running, speaking, hitting, and cutting) and 2 classes not involving actions (changes of state, and psychological processes). The PD patients were tested both 'on' and 'off' their anti-parkinsonian medication. Relative to healthy controls, PD patients did not have significantly lower accuracies for any of the verb classes, regardless of medication status. Thus, PD patients appear to have intact comprehension of action and non-action verbs, raising important questions about the scope of the ECF.

B71

REVEALING THE ROLE OF THE ATL IN SEMANTIC COGNITION: EVIDENCE FROM DISTORTION-CORRECTED FUNCTIONAL MAGNETIC RESONANCE IMAGING Richard Binney¹, Elizabeth Jefferies², Matthew A. Lambon Ralph¹; ¹Neuroscience and Aphasia Research Unit, University of Manchester, UK, ²University of York, UK – The association between bilateral anterior temporal lobe (ATL) atrophy and a generalised semantic impairment in semantic dementia (SD) has led to the supposition that this region could be a core component of the cortical semantic network. However, despite the remarkable consistency of this association in SD, this hypothesis is still controversial. One reason for this is that fMRI studies of healthy individuals have thus far failed to provide consistent evidence for the involvement of the ATL in semantic tasks. This is at least partially explained by the fact that conventional gradient-echo echo-planar fMRI is vulnerable to geometric distortions and signal dropout in areas that are near to bone or air-filled cavities. One of the most severely affected areas is the ATL. However, it has recently been shown that it is possible to correct these distortions by using a combination of spin-echo echo planar imaging and a novel correction algorithm. We report the analysis of corrected images that revealed significantly greater ATL activation when healthy participants performed a semantic judgement task as contrasted with an equally-demanding control task.

This is consistent with previous studies that used this same task and demonstrated that SD patients perform significantly more poorly than a healthy control group, and that semantic decision times of healthy participants are significantly slowed by inducing a 'virtual lesion' in the left or right temporal pole using low-frequency repetitive TMS. These findings add substantial weight to a growing body of evidence for the role of the ATL in semantic representation.

B72

ELUCIDATING THE NATURE OF DEREGULATED SEMANTIC COGNITION IN SEMANTIC APHASIA: EVIDENCE FOR THE ROLES OF PREFRONTAL AND TEMPOROPARIETAL CORTICES Krist A. Noonan¹, Elizabeth Jefferies², Matthew A. Lambon Ralph¹; ¹Neuroscience and Aphasia Research Unit (NARU), University of Manchester, UK, ²University of York, Psychology, UK – Semantic cognition - semantically-driven verbal and nonverbal behaviour - is composed of at least two interactive principal components: conceptual representations and executive control processes that regulate and shape activation within the semantic system. Previous studies indicate that semantic dementia follows from a progressive yet specific degradation of conceptual knowledge. In contrast, multimodal semantic impairment in aphasic patients (semantic aphasia) reflects damage to the control component of semantic cognition (Jefferies & Lambon Ralph, 2006). The purpose of the present study was to examine the nature of the semantic control deficits in semantic aphasia (SA) in detail for the first time. Seven patients with SA were tested on four comprehension and naming tasks which directly manipulated the requirement for executive control in different ways. In line with many theories of cognitive control, the SA patients demonstrated three core features of impaired control: they exhibited (i) poor online manipulation and exploration of semantic knowledge; (ii) poor inhibition of strongly associated distractors; and (iii) reduced ability to focus upon or augment less dominant aspects of semantic information, even though the knowledge itself remained and could be successfully cued by external constraints provided by the examiner. Our findings are consistent with the notion that the anterior temporal lobes are crucial for conceptual knowledge whilst the left prefrontal and temporoparietal cortices, damaged in patients with SA, play a critical role in regulating semantic activation in a task-appropriate fashion.

B73

THE DYNAMICS OF SENSE-MAKING: ERP EVIDENCE OF WORDS WITHIN WORDS Petra van Alphen¹, Jos van Berkum^{1,2}; ¹Max Planck Institute for Psycholinguistics, ²Donders Institute, Centre for Cognitive Neuroimaging – In two ERP experiments, we examined whether listeners, when making sense of spoken language, take into account the meaning of spurious words that are embedded in longer words, either at their onsets (e.g., pie in pirate) or at their offsets (e.g., pain in champagne). Listeners heard sentences in which the critical multisyllabic words contained either an initial or final embedding. The semantic fit of the carrier words and embedded words in the context was manipulated in such a way that semantic involvement of the embedded words should result in a modulation of the N400 components. The results of the first experiment showed that when the context supports the meaning of the embedding but not that of the carrier word, listeners briefly relate the meaning of both initial and final embeddings to the context. Crucially, the second experiment showed that when the carrier word but not the embedded word is supported by the context, final (but not initial) embeddings are still taken into account. This indicates that even when the comprehension system is already pursuing a sensible interpretation, it can still start a second sense-making stream for the following (stressed) syllable of the word, in parallel to the first one. The absence of an effect for the initial embeddings, however, could be taken to suggest that the system is not able to start two such processes at exactly the same time. These results give us new insights into the dynamics of the sense-making process and its link to lexical activation.

B74

CONFLICTS BETWEEN SYNTAX AND SEMANTICS: AN ERP-STUDY Miriam Kos¹, Theo Vosse^{1,2}, Peter Hagoort^{1,3}; ¹Radboud University Nijmegen, Donders Institute for Brain, Cognition and Behaviour, Centre for Cognitive Neuroimaging, ²University of Leiden, ³Max Planck Institute for Psycholinguistics, Nijmegen – Research has shown that conflicts between constraints for grammatical role assignment and thematic role biases elicit P600 effects (Kuperberg, 2007). This P600 has no apparent syntax-specific characteristic, and thus seems to be at variance with the dominant view that P600 effects are modulated by syntactic violations, ambiguities or complexities. To explain these findings it has been postulated that conflicts between syntax and semantics trigger a prolonged combinatorial or a monitoring process. We, however, favor a different interpretation: due to the strong semantic bias, the conflict between syntax and semantics was 'perceived' at the syntactic level. There can only be one winner and, in the ERP effect, 'the loser takes it all'. We investigated the nature of these conflicts further in a Dutch ERP study. First, participants read relative clause sentences, structurally ambiguous in Dutch, with strong semantic constraints (the dentist who(m) the client treats, the client who(m) the dentist treats). The conflict between syntax and semantics elicited an N400 effect. This is possibly due to subject-first strategies overriding the semantic-thematic bias. Second, we presented sentences containing a conflict between syntax and semantics at a point in the sentence at which the syntactic constraints were very strong (baseline condition: Father eats a sandwich / Father eats in a restaurant; thematic role violations: Father eats in a sandwich / Father eats a restaurant). The combinatorial and monitoring explanations predict a P600. However, in this case an N400 effect was observed, supporting our 'loser takes it all' account.

B75

ANAPHORIC REFERENCE TO QUANTIFIED STATEMENTS: AN EVENT-RELATED POTENTIAL STUDY Ruth Filik¹, Linda Moxey¹, Anthony Sanford¹, Hartmut Leuthold¹; ¹Centre for Cognitive Neuroimaging, University of Glasgow, UK – We report two event-related potential (ERP) experiments examining how readers process sentences containing anaphoric reference to quantified statements. Previous studies (Moxey & Sanford, 1987; Paterson, Sanford, Moxey, & Dawydiak, 1998; Sanford, Moxey, & Paterson, 1996) have shown that positive (e.g. 'many') and negative (e.g. 'not many') quantifiers cause readers to focus on different sets of discourse entities. For example in 'Many of the fans attended the game', focus is on the fans who attended (the reference set), and subsequent pronominal reference to this set, as in, 'They cheered very loudly', is facilitated. In contrast, if 'many' is replaced by 'not many', focus shifts to the fans who did not attend (the complement set), and pronominal reference to this set, as in 'They stayed home instead', is preferred. In the current studies, the electroencephalogram (EEG) was recorded while participants read positive or negative quantified statements followed by anaphoric reference to the reference set or complement set. Results suggest that positive quantifiers make the reference set available on encountering the quantified statement, with reference to the complement set being perceived as anomalous. Specifically, following a positive quantifier, there was an N400 effect for complement set reference relative to reference set reference (Experiment 1). In contrast, for negative quantifiers, anaphoric reference to the reference set did not produce an N400 effect. Results instead suggest that the complement set is added to the discourse model on reading the anaphoric sentence (Experiment 2). Findings are discussed in relation to theoretical accounts of reference resolution.

B76

AGING MODULATES TOP-DOWN BUT NOT AUTOMATIC PROCESSES DURING LEXICAL AMBIGUITY RESOLUTION: AN ERP STUDY Chia-lin Lee¹, Kara D. Federmeier¹; ¹The Beckman Institute for Advanced Science and Technology, University of Illinois – The current experiment investigated how older adults process noun/verb (NV) homographs (e.g., park) given prior syntactic and semantic contextual information. We compared ERP responses to NV-homographs and

matched unambiguous words that completed sentences with either both semantic and syntactic contextual information (congruent sentences) or syntactic information only (syntactic prose sentences). Our earlier work with young adults demonstrated that, relative to unambiguous words, NV-homographs elicit (1) larger N400 responses in congruent sentences, suggesting a semantic mismatch between the context and the automatic activation of the contextually-inappropriate sense, and (2) a sustained frontal negativity in syntactic prose, suggesting the recruitment of top-down mechanisms mediated by frontal brain areas to aid semantic selection when semantic constraints are less available. In older adults as a group, there were similar (although smaller) N400 effects for congruent sentences, whereas the frontal negativity previously observed in the syntactic prose condition in the young was absent. Analyses of individual differences revealed a positive correlation between the size of the frontal negativity effect and verbal fluency scores, showing that more fluent older adults maintained a young-like effect pattern. These findings support the hypothesis that lexical ambiguity resolution engages multiple neural mechanisms. With age, more automatic semantic processing mechanisms seem to be relatively well-maintained, whereas top-down executive mechanisms may be less available or efficient.

B78

SYNTACTIC POSITION OUTRANKS SYNTACTIC FUNCTION: REFERENTIAL PROMINENCE REVISITED Petra Schumacher¹, Dietmar Roehm^{2,3}; ¹Johannes Gutenberg University Mainz, Germany, ²University of Salzburg, Austria, ³Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany – Accessing an antecedent expression during referential processing is guided by a variety of 'prominence features', such as discourse prominence (e.g. topic, non-topic), syntactic prominence (e.g. subject, object), form features (e.g. definite, indefinite, pronominal),... ERP research has reported enhanced N400-effects as indication of referential processing cost, e.g. when definite noun-phrases (contra pronouns) refer to highly prominent antecedents. Previously, we showed that a definite noun-phrase prefers i) an indefinite antecedent over a definite antecedent and ii) an object antecedent over a subject antecedent (evidenced by an enhanced N400 for the dispreferred entities). These findings indicate that a definite noun-phrase ideally refers to a less prominent entity in discourse. In the present investigation, we wanted to find out whether the latter prominence effect was driven by syntactic function alone (subject vs. object) or by the syntactic position (because we had only used subject-before-object order). Since German has a flexible word order, we were able to tease apart these two prominence features. We examined referential processing in a two-sentence reading study, where the first sentence manipulated the antecedent's syntactic function (subject, object) and its position (subject-before-object, object-before-subject), while the second sentence contained the referring noun-phrase. ERPs measured to the onset of the referring noun-phrase replicated our previous results (more pronounced N400 for subject over object antecedents in subject-before-object order) and also revealed an enhanced N400 for object over subject antecedents in object-before-subject order. This indicates that syntactic position - which encodes prominence features - is a stronger predictor for prominence than syntactic function is.

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BRAIN POTENTIALS AND THE PROCESSING OF (IN)DEFINITENESS IN LATE LEARNERS OF ENGLISH John E. Drury^{1,4}, Erin J. White^{2,4}, Lydia White^{3,4}, Karsten Steinhauer^{1,4}; ¹McGill University, School of Communication Sciences and Disorders, ²McGill University, Psychology, ³McGill University, Linguistics, ⁴McGill University, Centre for Research on Language, Mind, and Brain – Much research has examined the extent to which late second language (L2-)learners may attain native-like proficiency, including a recent surge of studies using

event related brain potentials (ERPs). However, ERP research in this domain has so far ignored L2-acquisition/processing of semantic/pragmatic distinctions such as (in)definiteness. The present ERP study tested adult native English speakers alongside two groups of late-learners of English (native French/Chinese speakers) in a sentence reading/judgment study examining two different types of violation paradigms: (i) syntactic category violations [e.g., The man hoped to *meal the enjoy with friends vs. The man hoped to enjoy the meal with friends], and (ii) violations of the definiteness restriction [DR-violations] in existential constructions [e.g., There was *the/a man in the room; note * marks deviance/unacceptability]. DR-violations have been shown elsewhere to yield late P600-type effects and concurrent late left anterior negativities [L-LANs] in English natives. We have previously shown that syntactic/type-(i) violations elicit LAN/P600 responses in English native-speakers and in (both French/Chinese) high-proficiency late-L2 learners, whereas corresponding low-proficiency (French/Chinese) L2-learners do not elicit a LAN. Here, in the same group of subjects, we demonstrate a complete absence of any ERP effects for DR-violations in both French and Chinese low-proficiency groups. In contrast, high-proficiency French/Chinese groups appear to approximate native-like ERP-patterns [both show late P600-like effects], but the two groups differed from each other both behaviourally and in the timing of ERP-effects. The full array of findings suggest that L1-background may differentially effect distinct linguistic sub-domains in late second language learning.

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SEMANTIC PROCESSING IN WERNICKE'S APHASIA AND SEMANTIC DEMENTIA Juliana Baldo¹, Jennifer Ogar^{1,4}, Nina Dronkers^{1,2,3}, Maria Luisa Gorno Tempini⁴, ¹VA Northern California Health Care System, ²University of California, Davis, ³University of California, San Diego, ⁴University of California, San Francisco – Anterior temporal cortex has been associated with semantic processing, as evidenced by both lesion and imaging studies. More posterior portions of temporal cortex, especially in the left hemisphere, have been implicated in lexico-semantic processing aspects of language. In the current study, we examined the role of these areas by comparing behavioral and anatomical changes in patients with semantic dementia (SD) and Wernicke's aphasia (WA). Ten patients with WA and ten SD patients were tested on measures of speech, language, and semantic association abilities. Performance of SD patients was evaluated at two different intervals: initial testing and 1-2 year follow-up. Both SD and WA patients exhibited significant language deficits that declined further over time in SD. Despite significant anomia in both groups, SD patients tended to have richer, more intelligible speech, relative to Wernicke's patients, but both groups exhibited significant lexico-semantic impairments in comprehension. One striking area of contrast was the impaired semantic processing evidenced by SD patients on a triadic comparison task, which was relatively intact in WA. Voxel-based morphometry in the SD patients revealed left anterior temporal atrophy, with some gray matter loss extending to medial portions of the left temporal lobe. In contrast, the WA patients had temporal lesions that overlapped to the greatest extent in the left posterior middle temporal gyrus. The differences between WA and SD in behavioral performance as well as anatomical involvement further support the critical role of left anterior temporal cortex in semantics and more posterior left temporal regions in core language processes.

B81

COVARIANCE STRUCTURES IN NARRATIVES STUDIED WITH FMRI - PROOF OF CONCEPT Mikkel Wallentin^{1,2}, Peter Vuusti^{1,3}, Kim Mouridsen¹, Andreas Roepstorff^{1,4}, Torben Ellegaard Lund¹; ¹Center of Functionally Integrative Neuroscience, Aarhus University Hospital, ²Center for

Semiotics, University of Aarhus, ³The Royal Academy of Music, Aarhus, ⁴University of Aarhus, Social Anthropology – Narratives are difficult to study scientifically. Changes in use of frequent words, however, must be followed by changes in meaning and thus be salient for a cognitive system involved in comprehension, e.g. if a story that has previously used only third person ('she') starts using first person ('I') then this signals a change in meaning (e.g. a shift to dialogue). Such changes can be observed as covariance between the most frequent words. This study investigated hemodynamic changes in language regions evoked by these changes. Covariance components were made by taking onsets for the 10 most frequent verbs, 9 pronouns and 10 prepositions from a recording of 'The Ugly Duckling' by Hans Christian Andersen. Onsets for each word was convolved with the HRF in SPM and these 29 regressors were then analysed with principal component analysis (PCA). To test the effects of these components with minimal variance we scanned the same subject 8 times while he listened to the recording. Scannings: on a 3T system (580 volumes/session, 34 slices, 3x3x3 mm, TR: 2200 ms). Data were analysed in SPM. 1st level: 10 primary covariance components were used as regressors in one GLM/session. 2nd level: The first six components entered into a factorial model treating sessions as random effects. Main result (P<0.05, FWE-corrected): A striking left lateralized pattern with two foci: Inferior frontal and posterior temporal cortex. This serves as proof of concept that monitoring linguistic covariance is an important part of language and that this may be studied using fMRI.

B82

HOW FAST CAN WE TELL DUCK FROM MUD: AN ERP INVESTIGATION OF CATEGORY DECISION Xin Zheng¹, Sidney Segalowitz¹; ¹Brock University – In a previous ERP study (Segalowitz & Zheng, 2008), we found evidence in the N1 component suggesting early lexical access at 160 ms, P1 enhancement in semantic priming, and that individual differences in task performance correlated with the P1 sensitivity to semantic task manipulation. In the current study using a different paradigm, these effects were further tested. Participants (n=12) performed a living/nonliving category decision, in which words were visually presented, and participants pressed corresponding buttons. Half of the stimuli in both categories were 'new', as they were not previously seen in the study. In contrast, the other half of the stimuli were 'old' and had been used earlier in another task (a semantic priming task with words presented in pairs). Furthermore, these repeated stimuli could have been previously used either as a 'prime' or as a 'target'. Between 400 - 550 ms, there was a main effect for category in the N400: words of non-living categories (e.g., mud) had a larger N400 than words of living categories (e.g., duck). The N400 was also affected by 'repetition'. It was smaller for words used as 'targets' than for words that were either 'new' or used as 'primes', while the N400 between the latter two were not different. In addition, the earliest category differentiation appeared as early as 160 ms in N1 component (trend, p = .08): nonliving items had larger N1 than living items. For P1, no main effects or interaction were found.

B83

ERP EVIDENCE FOR MODAL SUBORDINATION IN SPOKEN SENTENCES Veena D. Dwivedi¹, Natalie A. Phillips², Shari Baum³, John E. Drury³, Karsten Steinhauer³; ¹Brock University, ²Concordia University, ³McGill University – We used event-related brain potentials (ERPs) in an auditory study to examine the nature of anaphoric resolution in 2-sentence discourses. The first Context sentence was either Hypothetical (S1) or Factual (Control condition S1'). The subsequent continuation sentence either included (S2a) or excluded (S2b) a modal auxiliary (e.g., must, should) and contained a pronoun. Thus, either it was a Modal or a Non-modal sentence. S1: John is considering writing a novel. S1': John is reading a novel. S2a: It might end quite abruptly. S2b: It ends quite abruptly. The Modal sentence (S2a) is a natural continuation of the Hypothetical context (S1), but is also compatible with Control context S1'. In contrast, the Non-modal sentence (S2b) does not follow naturally from S1, since a novel does not exist yet, rendering the discourse anomalous.

No such anomaly results when combining the factual context S1' with the non-modal continuation sentence S2b. In terms of ERP patterns, we predicted that there would be no empirical difference between Modal continuation sentences that followed Hypothetical vs. Control contexts. In contrast, continuation sentences that were Non-modal should differ, depending on the previous context, where the Control context is felicitous but the Hypothetical context results in anomaly. Results showed that waveforms for Non-modal sentences in anomalous Hypothetical contexts elicited a positive-going deflection that reliably differed from Control contexts, whereas no such context-dependent difference emerged for Modal sentences. The P600-like effect replicated and extended our previous findings from a reading study -- lending ecological validity to our previous claims.

B84

HOW INPUT MODALITY AND ACTION PROPERTIES AFFECT SEMANTIC PROCESSING: EVIDENCE FOR GRADED SEMANTIC AND SOMATOTOPIC REPRESENTATIONS *Carrie Esopenko¹, Cummine Jacqueline¹, Sarty Gord¹, Borowsky Ron¹; ¹University of Saskatchewan* – We examined the semantic processing of objects presented in picture and word format, in order to evaluate three models of semantic representation: an amodal semantic system (Caramazza et al., 1990), multiple semantic systems (Shallice, 1988), and a hybrid graded semantics model (Plaut, 2002). Previous neuroimaging research has supported the notion of a hybrid graded semantics model by showing both unique and shared regions of activation during the semantic processing of picture and word stimuli (Borowsky et al., 2005; Vandenberghe, Price, Wise, Josephs, & Frackowiak, 1996). Other neuroimaging research has shown a somatotopic-semantic organization in the premotor cortex during the processing of action-related language (Esopenko, et al., 2008; Hauk, et al., 2004; Tettamanti et al., 2005). We used an event-related fMRI paradigm to examine both the effect of input modality and action-properties within-participants using both a naming task and a semantic categorization task (SCT; i.e., is the object used by arm or leg?). Both tasks showed shared and unique areas of activation as a function of input modality and action-properties. Moreover, the premotor cortex was found to be organized somatotopically independent of input modality. This all-within participant's experiment further supports the graded semantics model and the somatotopic-semantic organization of the premotor cortex.

B85

REDUNDANCY EVALUATION VS. SEMANTIC COMPETITION: AN ERP INVESTIGATION OF PRONOUN-DROP IN TURKISH *Sukru B. Demiral¹, Matthias Schlesewsky², Ina Bornkessel-Schlesewsky¹; ¹Independent Junior Research Group Neurotypology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, ²English and Linguistics, Johannes Gutenberg University, Mainz, Germany* – Many languages allow for sentence participants to be omitted from an utterance. In Turkish, for example, subjects are omitted in approximately 70% of transitive sentences. Subject-drop is particularly pervasive with 1st- and 2nd-person-subjects, since these are also marked on the verb. How does the human language comprehension system deal with this 'covert' information? Is the avoidance of redundancy most important, hence favoring pronoun-drop? Alternatively, does the overt realization of subject pronouns reduce processing complexity as induced by the construction of the null-subject? These hypotheses were contrasted in an ERP study, which compared 1st-person-Pronoun-Object-Verb (POV) to Object-Verb (OV) sentences in Turkish. Objects were marked with accusative case and were either animate or inanimate. Animacy was manipulated in order to examine the semantic competition for subjecthood; animate arguments are highly prominent and may compete for the subject position, especially when the subject is constructed on the verb. This may induce semantic processing cost reflecting as N400. ERP measures at the verb revealed an N400 for all conditions in comparison to the inanimate OV condition. Furthermore, the inanimate POV condition engendered a P600

in comparison to all other conditions. These findings suggest that the N400 effect appears to reflect both competition and the existence of the redundant pronoun. By contrast, the evaluation of the redundancy of the pronoun depended on the degree of competition: A P600 effect was engendered only when semantic competition was low. Redundancy evaluation was blocked when the overt-pronoun served to prevent competition, leading to an attenuated P600.

B86

NEURAL REPRESENTATION OF CONCRETE AND ABSTRACT CONCEPTS *Jing Wang¹, Julie A. Conder¹, Svetlana V. Shinkareva¹; ¹University of South Carolina* – Many studies have attempted to identify the brain regions that can be associated with representation of abstract concepts. However, diversity among brain regions previously identified as involved in this process has resulted in controversy. This is perhaps due in part to the wide variety of tasks used to assess abstract concept representation. In the current study, we used event-related functional magnetic resonance imaging (fMRI) and a similarity judgment task to identify brain regions associated with representation of abstract and concrete concepts. While being scanned, participants were required to view word triplets consisting of three highly-related concepts. Stimulus words were selected from abstract and concrete categories. The abstract condition included words related to emotion or cognition, whereas the words in the concrete condition were related to tools or dwellings. In the similarity judgment task, participants were required to decide which word of two was most similar to a third word, thus eliciting semantic meaning for the concept represented by the word triplet. Results indicated that representation of abstract concepts is associated with increased activation in several right hemisphere regions including superior frontal gyrus, middle temporal gyrus, and cerebellum. These results do not support recent findings suggesting that left frontal and temporal regions play a larger role in abstract concept representation.

B87

CROSS-LANGUAGE PRIMING EFFECTS: EVIDENCE FROM RTS AND ERPS *Sofie Schoonbaert¹, Phillip J. Holcomb², Robert J. Hartsuiker¹; ¹Ghent University, Belgium, ²Tufts University, MA* – Our main goal was to further explore lexico-semantic organisation in a second language, using a translation priming paradigm. In the present study English-French bilinguals performed a lexical decision task while reaction times (RTs) and event related potentials (ERPs) were measured to L2 targets, preceded by non-cognate L1 translation primes versus L1 unrelated primes (Experiment 1a), and vice versa (Experiment 1b). Significant masked translation priming was observed, indicated by faster RTs and a decreased N400 for translation pairs as opposed to unrelated pairs, both from L1 to L2 (1a) and from L2 to L1 (1b), the latter effect being weaker (RTs) and less longer lasting (RTs, ERPs). The obtained N400-priming effects are taken as an indication of semantic involvement during priming in both directions, and therefore suggest strong lexico-semantic connections for L2 (as well as for L1). This can be interpreted as evidence against the Revised Hierarchical model (Kroll & Stewart, 1994), assuming only weak links from L2 to concepts. We provided evidence for the temporal delay assumption of the BIA+ model (Dijkstra & Van Heuven, 2002) by showing that effects to L2-targets occurred later compared to L1-target effects. --- References: Kroll, J. F., & Stewart, E. (1994). *Journal of Memory and Language*, 33, 149-174. Dijkstra, T., & Van Heuven, W. (2002). *Bilingualism: Language and Cognition*, 5, 175-197.

B88

N400-LIKE EFFECTS EVOKED BY SINGLE PAIRS OF WORDS *Louis Renoult^{1,3}, J. Bruno Debruille^{1,2}; ¹Douglas Mental Health University Institute, Montréal, Québec, Canada, ²McGill University, Montréal, Psychiatry, Québec, Canada, ³McGill University, Montréal, Neurology and Neurosurgery, Québec, Canada* – The N400 event-related potential (ERP) is an electrophysiological index of semantic processing. A number of studies have shown that N400 effects could be markedly reduced or suppressed by the inclusion of one or several stimulus repetitions. Neverthe-

less, we have recently shown that significant N400-like effects of semantic matching and category could be obtained with massively repeated target words in a prime-target semantic categorization task (Debrulle & Renault, in press). The present study aimed at extending these findings to the study of single pairs of words. A similar primed semantic categorization task was used. The prime could be one of two category words and the target one of two exemplar words. To control for physical matching, letter case was manipulated so that both the meaning (semantic matching) and case (physical matching) of target words could be compared to that of prime words. The effect of task instruction was also evaluated by contrasting a bloc of trials where subjects had to focus on meaning (semantic instruction) and one where they had to focus on case (physical instruction). Results showed that the N400-like ERP was modulated by semantic matching and semantic category, but not by physical matching. The effect of semantic matching was observed only with the semantic instruction, while the effect of category was not modulated by task instruction. These results show that massive repetition could allow, at least in explicit semantic tasks, a drastic simplification of N400 protocols and permit the study of specific categories or individual differences

B89

INFLUENCE OF ANIMACY AND THEMATIC ROLE TYPE ON INTERPRETATION OF DIRECT OBJECT ARGUMENTS IN ACTIVE ENGLISH SENTENCES Martin Paczynski¹, Gina Kuperberg^{1,2}, Ewan Ruppell¹; ¹Tufts University, ²Massachusetts General Hospital – In

two experiments we explored the neural processing associated with the processing of Direct Objects, using Event Related Potentials (ERPs). In experiment one we compared Direct Object noun phrases (NPs) that were strongly prototypical Patients (inanimate) with weakly prototypical Patients (animate). The NPs were presented within a sentence context following verbs selecting for animate (e.g. frisk) or inanimate (e.g. reopen) Direct Object. In normal sentences, a small, transient N400 effect was found for weakly prototypical animate NPs relative to inanimates. In sentences with animacy violations (e.g. frisked the *gate/reopened the *passenger), anomalous NPs evoked a biphasic N400-P600 effect relative to their normal counterparts, that was larger for anomalous inanimate NPs at frontal sites. In experiment two, animacy selecting Agent-Patient verbs (e.g. frisk) were compared with Causer-Experiencer (e.g. please) verbs, thus contrasting a prototypical Direct Object role (Patient) with an atypical role (Experiencer). In normal sentences, Experiencer NPs evoked a large, early, frontal N400 effect compared to Patient NPs, indicating that atypical roles rapidly incur greater integration processing costs. Animacy violations (e.g. frisked the *gate/pleased the *gate) evoked a biphasic N400-P600 which was not modulated by Thematic Role type. Taken together, the two experiments suggest that how prototypical an NP is relative to its Thematic Role has modest influence on semantic integration costs, while the level of prototypicality of a Thematic Role markedly impacts early semantic processing. Additionally, these experiments show that the semantic P600 is not modulated by animacy per se nor Thematic Role type.

B90

THE TIES THAT BIND THE LEXICON: LEXICAL ASSOCIATIVE PROCESSES IN THE CEREBRAL HEMISPHERES Padmapriya

Kandhadai¹, Kara Federmeier^{1,2}; ¹University of Illinois, ²Beckman Institute for Advanced Science and Technology – This study investigated lexical associative processes in the cerebral hemispheres using the visual half-field technique in conjunction with event-related potentials (ERPs). Participants read pairs of words for comprehension and were told to try to remember the pairs for a later cued recall task. Word pairs were asymmetrically associated (e.g., butcher-meat), allowing a manipulation of associative strength while keeping semantic content relatively constant. In the forward direction (forward pairs), there was a strong association from prime to target and the target was the primary associate of the prime. However, when these pairs were presented in the backward direction (backward pairs), there was a weak association from prime to target.

For both hemispheres, ERPs to lateralized targets revealed that N400 amplitudes were graded, smallest to forward pairs and largest to unrelated pairs. This suggests that both hemispheres are sensitive to lexical associative strength. However, there was a P2 enhancement for forward pairs limited to the left hemisphere (LH), indicating that only the LH uses context information to predict upcoming words when there is a strong association from prime to target. Further, enhancement of the late positive complex to the backward targets in the LH suggests that the LH additionally employed controlled processes to reshape and amplify the weak association from prime to target. These results suggest that even though both hemispheres are sensitive to lexical association, they engage in complementary processes to appreciate such associative relationships.

B91

NOMINAL AND PREDICATE METAPHOR PROCESSING IN PARTICIPANTS WITH LEFT AND RIGHT HEMISPHERE LESIONS Gwen L. Schmidt¹, Eileen Cardillo¹, Alexander Kranjec¹, Anjan

Chatterjee¹; ¹University of Pennsylvania – The traditional view that people with right hemisphere (RH) lesions have difficulty understanding figurative language such as metaphors is currently under fire. Recent imaging work has provided conflicting results which may be due to various factors including poor stimulus control. Furthermore, metaphor theory and research typically only consider nominal metaphors ('My job is a jail'). However, verbs are frequently used metaphorically in predicate metaphors ('He swept the woman off her feet'). To address these potentially critical factors, we developed a closely-matched set of nominal metaphors, predicate metaphors, and literal sentences with accompanying comprehension questions for testing with participants with strokes (n=32). While participants with LH lesions showed similar performance across conditions, participants with RH lesions were less accurate on metaphors than literal sentences, an effect driven by performance in the predicate metaphors. The residuals from a regression of predicate metaphors on matched literal sentences did not differ between the two groups, while the residuals from a regression of literal sentences on predicate metaphors were significantly different between the groups. Thus it was the differences in literal sentence processing between the groups that drove the effect, and participants with LH lesions had higher scores for metaphors than literal sentences. One possible explanation is that they derive a benefit from an intact right hemisphere which facilitates their processing of metaphors more than literal sentences.

B92

BRAIN MECHANISM OF CHINESE IDIOM COMPREHENSION: EVIDENCE FROM A FUNCTIONAL MAGNETIC RESONANCE IMAGING STUDY Jie Yang¹, Hua Shu¹; ¹State Key Laboratory of

Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China – Idiom processing has evoked interesting empirical researches and led to theoretical debates regarding the role of the left versus the right hemisphere in the processing of idioms. The current study investigated the brain mechanism of Chinese idiom to identify the neural substrates of idiom processing. During the experiment, participants judged whether there was an italic character in each opaque idiom, transparent idiom, or regular phrase. Group analysis and conjunction analysis showed idioms activated bilateral brain regions, while phrases only activated left regions. ROI analysis showed in the left inferior frontal gyrus the sum signal intensity of opaque idioms was significantly greater than that of transparent idioms and regular phrases, but there was no significant difference between the later two conditions. In the right inferior frontal gyrus, there was clearly a graded effect of the sum signal intensity across opaque idioms, transparent idioms, and phrases, suggesting that this region may be particularly involved in idiom processing. Besides, in left middle temporal gyrus phrases showed significant greater signal intensity than idioms. In sum, the results showed bilateral neural substrates are involved in idiom processing. The left regions might be responsible for general lexical retrieval and semantic integration, while the right regions may play the more important role. This role might be

due to the involvement of the right inferior frontal gyrus in the retrieval of long-term, episodic memory, given that the Chinese opaque idioms require special efforts in organizing and completing a knowledge-based story comprehension.

B93

SEMANTIC INTERFERENCE IN THE POSTCUE NAMING PARADIGM IS A POSTLEXICAL EFFECT: EVIDENCE FROM FMRI Julia Hocking¹, Katie McMahon¹, Greig de Zubicaray¹; ¹fMRI Lab, Centre for Magnetic Resonance, University of Queensland – In the postcue naming paradigm, participants are shown pictures of two objects and are cued to name one (the target) following their presentation. When the two objects are categorically related, naming latencies are slower compared to unrelated objects. Three different mechanisms have been proposed to account for this effect occurring at pre-lexical, lexical and post-lexical levels of processing. We tested these accounts using event-related functional magnetic resonance imaging with a sparse design at 4 Tesla. Over 50 trials, participants were required to view two superimposed line drawings of real objects (one red, one green). A subsequently presented selection cue - the postcue (a red or green dot) - then indicated which item was to be named. Half the superimposed pairs were categorically related. Following standardized data preprocessing stages in SPM5, we computed the effect of naming in related compared to unrelated trials. At the second, random effects level, naming in the context of related compared to unrelated distractors increased activation in two regions of frontal cortex. The first was in the left pars triangularis of the inferior frontal gyrus - a region thought to be involved in mediating selection among competing alternatives in picture naming tasks. A second cluster was observed in a medial superior frontal gyrus region associated with task switching and response selection. Together, these results indicate that semantic interference during naming in the postcue paradigm occurs at a late stage in the object naming system, subsequent to lexical selection.

B94

AUDITORY CONTEXT EFFECTS IN PICTURE NAMING INVESTIGATED WITH EVENT RELATED FMRI Greig de Zubicaray¹, Katie McMahon¹; ¹fMRI Lab, Centre for Magnetic Resonance, University of Queensland – Naming an object entails a number of processing stages, including retrieval of a target lexical concept and encoding of its phonological word form. We investigated these stages using the picture-word interference task in a sparse design event-related fMRI experiment. Participants named target pictures in the presence of auditorily presented semantically, phonologically or unrelated distractor words, or in isolation. As expected, auditory context effects resulted in BOLD signal changes in left hemisphere regions associated with lexical conceptual and phonological processing, including the mid to posterior lateral temporal cortex. However, contrary to predictions, these BOLD responses manifested as signal reductions for all distractor conditions compared to naming alone. Compared to unrelated words, phonologically related distractors showed further signal reductions in these regions, while only the pars orbitalis of the left inferior frontal cortex showed a selective reduction in response in the semantic condition. We interpret these findings as indicating the word forms of lexical competitors are phonologically encoded, and that competition during lexical selection is reduced by phonologically related distractors due to initial word form features overlapping with those of the target. As the extended nature of auditory presentation requires a large portion of a word to be presented before its meaning is accessed, we attribute the BOLD signal changes observed for semantically related words to mechanisms engaged after target name selection has occurred. In addition, we argue that the signal decreases observed could only be accommodated by production models incorporating lateral inhibition to suppress the activity of competitors.

B95

A PARAMETRIC FMRI STUDY OF QUANTIFIER TYPES: MANY, MOST, AND MORE-THAN-HALF Yosef Grodzinsky¹, Stefan Heim^{2,3,4}, Sarah Hautvass⁵, Simon B. Eickhoff^{2,3,4}, Katrin Amunts^{2,3,4}, ¹McGill

University, Linguistics, ²INB3-Medicine, Research Centre Jülich, ³Aachen University, Psychiatry and Psychotherapy, Medical Faculty, JARA, RWTH, ⁴Aachen University, Psychiatry and Psychotherapy, Medical Faculty, RWTH, ⁵Aachen University, Neurolinguistics, Medical Faculty, RWTH – Quantifiers are relational terms whose role in semantic composition is critical. They are classified into first-order (some, many) or higher-order quantifiers (most, more-than-half). These types recruit different computational resources: the former require one calculation of set relations (Some As are Bs=A is a subset of B); the latter require additional calculations (Most As are Bs= the intersection between A and B is greater than A-B). First- and higher-order quantifiers recruit distinct brain regions (Troiani et al. 2008; McMillan et al. 2005). We used a novel fMRI design with two objectives in mind: (1) to explore this distinction via a parametric design varying the processing demands within each quantifier condition; (2) to investigate finer distinctions within higher-order quantifiers (most vs. more-than-half) that are treated equally in Generalized Quantifier Theory, although they might be computed differently (Hackl 2008). Participants heard sentences like most circles are blue or more-than-half of the circles are yellow and then saw scenes in which task difficulty was systematically manipulated by varying the proportion of blue and yellow circles. They decided whether the scene matched the sentence. RTs and BOLD response measures were regressed upon the parametric modulation of the proportion of blue/yellow circles. We found RT and BOLD differences for these regressors for first- vs. higher-order quantifiers, and, most importantly, for most vs. more-than-half. Thus, we may have hints for a semantic brain map. This novel paradigm may be useful to elucidate deficits in patients with either linguistic (e.g. primary-progressive aphasia) or formal thought disorders (e.g. schizophrenia).

B96

COMMUNICATIVE STYLE OF A SPEAKER AFFECTS LANGUAGE COMPREHENSION: AN ERP STUDY Thomas Gunter¹, Stefanie Regel¹, Seana Coulson²; ¹Max-Planck-Institute for Human and Cognitive Brain Sciences, Leipzig, Germany, ²University of California, San Diego – Contextual and pragmatic knowledge has been shown to influence the interpretation of sentences within discourses. Specifically, this information gains importance when sentences have a figurative, e.g. ironic meaning which has to be derived by means of contextual knowledge. The knowledge about speakers, for example, indirectly adds extra-linguistic information that probably facilitates the interpretation of sentences having a non-literal meaning. In an ERP experiment with two sessions, we investigated when and how such pragmatic knowledge can affect the construction of sentence meanings. In the first session the pragmatic knowledge of two particular speakers was established. One speaker was characterized as being highly ironic and making very frequently ironic statements, whereas the other appeared to be low ironic saying mainly literal sentences. In session 2, the influence of this knowledge was explored when the use of irony was balanced for both speakers. Participants were presented with discourses ending in an ironic or literal sentence expressed either by the high or low ironic speaker. ERPs in session 2 showed a clear interaction of irony and speaker on the P2. Whenever the communicative style of a speaker was congruent with a particular statement, P2 was larger compared to when it was not. Interestingly enough, only for the high ironic speaker a LPC was elicited by ironic statements. These results suggest that pragmatic knowledge about speakers is taken into account when comprehending (ironic) sentences.

B97

THE MODULATION OF SEMANTIC PRIMING BY DISCOURSE AND SENTENCE CONTEXTS DURING SPEECH COMPREHENSION: AN ERP STUDY Megan Boudewyn¹, Christine Camblin², Jon Venezia³, Lara Polse¹, Peter Gordon⁴, Tamara Swaab¹; ¹UC Davis, Psychology and Center for Mind and Brain, ²CSU, Division of Social, Behavioral and Global Studies, Monterey Bay, ³UC Irvine, Cognitive Sciences, ⁴UNC, Psychology, Chapel Hill – This study examined the effects of semantic priming in discourse and sentence level contexts in both the

visual and auditory modalities. Specifically, highly associated words (e.g. tables and chairs) and unassociated words were embedded within auditory three-sentence passages (Experiment 1) and in auditory, visual, and compressed, flat-prosody single-sentence contexts (Experiments 2, 3 & 4). In Experiment 1, the discourse was either congruent or incongruent with the final word in the third sentence (which was either associated or unassociated). ERP results for Experiment 1 show early main effects of discourse congruence and delayed traces of lexical association effects. The same pattern of results was found in auditory sentential contexts (Experiment 2), yet classic N400 effects of lexical priming were intact when the same stimuli were presented as text (Experiment 3). In order to establish whether properties unique to spoken language were leading to speech having a 'context-advantage' over text, we removed prosodic cues as well as compressed the naturally spoken stimuli from Experiment 2 (Experiment 4). However, as in Experiment 2, this yielded a null N400 effect of semantic priming. The pattern of results across all four experiments shows strong N400 evidence for the robust modulation of semantic priming in spoken (more than written) three-sentence discourse contexts and in single sentences. This indicates that although the greater effect of context on semantic priming in speech cannot be attributed to prosodic cues alone, the presence of auditory discourse and even sentential context may still be enough to modulate word-level effects like priming.

B98**FMRI-ADAPTATION EVIDENCE OF OVERLAPPING NEURAL REPRESENTATIONS FOR OBJECTS RELATED IN FUNCTION OR MANIPULATION**

Eiling Yee¹, Daniel Drucker¹, Sharon L. Thompson-Schill¹; ¹University of Pennsylvania – According to sensorimotor-based theories of semantic memory, different aspects of an object's meaning are stored in physically distal networks, according to the modality in which the information was acquired. We used fMRI adaptation to test this hypothesis, measuring brain activation as participants read pairs of words, on which they later made a semantic judgment. Pairs shared: shape (marble - grape), function (flashlight - lantern), both (pencil - pen), neither (saucer - needle), or were identical (drill - drill). We observed adaptation for pairs similar in both function and shape in left precentral cortex (premotor cortex). Further, we found that (across all pairs) degree of manipulation similarity was correlated with the degree of adaptation in left premotor cortex and in left intraparietal sulcus (involved in guiding actions). This suggests that manipulation information about concepts is encoded in brain regions involved in performing or guiding actions. There were also three regions in which function (but not manipulation) similarity was correlated with degree of adaptation: two in the left temporal lobe (left medial temporal lobe, left middle temporal gyrus) which has been hypothesized to play a role in multimodal integration, and the left superior frontal gyrus. Unexpectedly, we also found that objects similar in shape showed increased activation (rather than adaptation) in left premotor cortex and left intraparietal sulcus. Overall, we found evidence (in the form of adaptation) that objects that share semantic features have overlapping representations, as well as support (due to the particular regions of overlap) for both sensorimotor and amodal representations.

B99**AN ELECTROPHYSIOLOGICAL INVESTIGATION OF INDIVIDUAL DIFFERENCES IN THE USE OF SENTENTIAL CONTEXT**

Edward W. Wlotko¹, Kara D. Federmeier^{1,2,3}, Marta Kutas^{4,5}; ¹University of Illinois, Psychology, ²University of Illinois, Neuroscience Program, ³Beckman Institute for Advanced Science and Technology, ⁴University of California, Cognitive Science, San Diego, ⁵University of California, Neurosciences, San Diego – Comprehenders differ on a number of dimensions relating to the processes involved in constructing message-level meaning for spoken or written discourse in real time. In several experiments using similar materials, we investigated how some aspects of verbal ability and/or verbal memory may affect the ease or efficiency of message-level processing. We focused on the sentence level by examining event-related brain potential (ERP) responses to words that com-

pleted sentence frames varying in level of constraint. Consistent with prior research, we found that reading span predicted the size of the basic sentence-level expectancy effect on the N400 component of the ERP. We also found that scores on the Magazine Recognition Questionnaire, a measure of exposure to print, predicted the size of a recently-observed late frontal positivity that is larger for unexpected endings in strongly constraining sentence contexts compared to unexpected endings in weakly constraining contexts. We previously linked this positivity to a semantic revision process, needed when a plausible but unexpected word must be integrated into a constraining sentential context that strongly suggests a different word. These results suggest that reading experience may impact the use of predictive contexts in online language comprehension, particularly during reading.

B100**CALLOSAL QUALITY MEDIATES THE BILATERAL PROCESSING ADVANTAGE**

Simon Davis^{1,2}, Jamaur Bronner², Norbou Buchler^{1,2}, Roberto Cabeza^{1,2}; ¹Duke University, Center for Cognitive Neuroscience, ²Duke University, Psychology and Neuroscience – A number of studies have shown the benefit of interhemispheric processing when tasks become increasingly difficult. This bilateral processing advantage (BPA) occurs in older adults at lower levels of matching demands than in younger adults; this result is consistent with the functional compensation account because it suggests that older adults show the benefits of bilateral processing at levels of task difficulty for which a single hemisphere is largely sufficient in younger adults. Our study sought to use functional MRI and diffusion tensor imaging (DTI) to link age effects on cross-hemispheric matching to the quality of the bilateral processing network in older adults. In the perceptual condition participants matched faces that differed in perceptual similarity, whereas in the semantic condition they matched word pairs that differed in semantic relatedness. Consistent with the functional compensation view, BPA in the semantic and perceptual conditions increased with task difficulty; this pattern was even more pronounced in older adults. A parametric analysis of fMRI data weighted by task difficulty indicated that lateral temporal and fusiform activity tracked task difficulty in semantic and perceptual conditions, respectively, while anterior frontal regions tracked task difficulty in both tasks. Consistent with these fMRI results, DTI data indicated that the quality of callosal fibers connecting these anterior frontal regions showed positive relationship with the BPA. Taken together, these results support the view that the hemispheres cooperate during difficult bilateral tasks and that this effect generalizes to complex semantic and perceptual tasks not previously investigated with this paradigm.

B101**THE EFFECT OF LEXICAL AMBIGUITY ON SPOKEN WORD RECOGNITION USING HOMOGRAPHIC AND HETEROGRAPHIC HOMOPHONES**

Jack Rogers¹, William Marslen-Wilson, Matthew Davis; ¹MRC Cognition and Brain Sciences Unit, Cambridge, UK – Faster visual lexical decisions for semantically ambiguous words versus unambiguous controls have been interpreted as evidence for facilitatory feedback from multiple semantic representations (Rubenstein et al., 1970). Yet, more recent experiments have suggested two opposite effects of lexical ambiguity: polysemous words (twist) with multiple related senses show an ambiguity advantage whereas homographic homophones with multiple unrelated meanings (bark) delay word recognition due to semantic competition (Rodd et al., 2002). However, the homophony/polysemy distinction is subjective and further data is valuable. Assessing responses to spoken words allows us to use homographic (bark) as well as heterographic (knight/night) homophones for which two separate representations exist. In both an auditory lexical decision task and semantic categorisation task using 72 matched homographic homophones, heterographic homophones and single-meaning controls subjects show significantly slowed response times for both groups of ambiguous words versus controls. No significant difference between the homographic and heterographic homophones suggests that the ambiguity disadvantage is

largely due to semantic not orthographic competition. This ambiguity disadvantage is consistent with neural network accounts of word recognition (Rodd et al., 2004); ambiguous spoken words activate multiple semantic representations, which compete during identification. Similarly, neural responses to sentences containing multiple ambiguous words produces increased signal in frontal and temporal regions implicated in comprehending and selecting contextually appropriate word meanings (Rodd et al., 2005). We propose that the neural mechanisms that enable the selection of appropriate semantic attributes of ambiguous words within a sentence also allow semantic information to be selected and integrated for single ambiguous words.

B102**WHAT CONSTITUTES A RELEVANT CONTEXT FOR PROCESSING NEGATION? AN EVENT-RELATED POTENTIAL STUDY**

Lea Halá¹, Julie-Ann Marshall¹, Alan Garnham²; ¹Canterbury Christ Church University, United Kingdom, ²University of Sussex, United Kingdom – Several event-related potential (ERP) studies have found when a sentence includes negation ('A robin is not a TREE/BIRD') the amplitude of the N400 is greater for true sentences ('tree') than for false sentences ('bird'), (Fischler et al., 1983). However, Nieuwland and Kuperberg (in press) have shown that in a context appropriate for negation, false words rather than true words elicit a larger N400. This suggests that the context allows readers to relate the incoming words to the negation information immediately. The current study explores what aspects of context are relevant. Our hypothesis is that at least three factors contribute to the immediate processing of negation. First, whether the negated word is in focus. Secondly, whether the negated word is related to 'the implied set of likely worlds' and thirdly, whether the use of negation adds new information. When all three of these factors are present, a negated word will not elicit a large N400. However, when none of these factors are present, a negated word will elicit a large N400. In an ERP study we have tested this prediction by using a five-sentence discourse context followed by one of five continuations that tease apart the independent but correlated influence of focus, the implied set of likely worlds and new information. Our preliminary results support our hypothesis, when all three of these factors are included in a context, the amplitude of the N400 is smallest compared to when some or all of these factors are missing from the discourse.

B103**'BREAKING' LANGUAGE: A PARADIGM THAT DISSOCIATES SEMANTIC AND PHONOLOGICAL FUNCTIONS IN LEFT POSTERIOR TEMPORAL AND PARIETAL BRAIN REGIONS**

Miranka Wirth¹, Ayse At¹, Melanie Fisler¹, Andrea Federspiel¹, Helge Horn¹, Thomas Dierks¹; ¹University of Bern, Bern, Switzerland – Previous functional Magnet-Resonance-Imaging (fMRI) findings suggest a dissociation of language (i.e., phonologic and semantic) functions in posterior temporal and parietal brain areas. However, this assumption is mostly derived from analyses that compare activations patterns across different stimuli and subjects groups. In this study we test a simple block-design paradigm that aims to localise language functions connected to posterior brain areas in group and single subject analyses by demanding semantic and phonological judgements to the same word-stimuli. The subjects judged words according to semantic (living?, yes/no) and phonological (2 syllables, yes/no) features via button press. Preliminary data will be presented.

B104**FINDING AN OPTIMAL TASK FOR TESTING LANGUAGE DEFICITS IN ATTENTION-DEFICIT/HYPERACTIVITY DISORDER CHILDREN**

Jennifer Edens¹, Fan-pei Gloria Yang¹, Daniel Krawczyk^{1, 2}; ¹Center for Brain Health, University of Texas at Dallas, ²University of Texas Southwestern Medical Center, Psychiatry, Dallas, Texas – Attention-Deficit/Hyperactivity Disorder (ADHD) has been studied in areas of language abilities in general. Clear lines have not been drawn on whether ADHD language deficits have to do with vocabulary competence, seman-

tic knowledge or inference ability. It is beneficial to design a language task that can assess performance on different types of linguistic stimuli to identify which cognitive factors are of most concern. The goal of our proposed study was to investigate correlations between vocabulary competence/inference ability and figurative language comprehension using computerized presentation of novel and conventional metaphors and literal sentences. Conventionalized sentences (metaphor and literal) only test semantic knowledge whereas novel metaphors test inference ability. In this study the participants were instructed to rate whether the displayed sentence held a positive or negative meaning by pressing the corresponding key. A written task asked for their interpretation of the sentences. Our results indicated that these children performed significantly better in both the conventional metaphors and the literal sentences relative to the novel metaphor condition. Overall they scored equally well on comprehension of conventional and literal sentences. Compared with normal controls they performed significantly worse in all categories. This study can provide insights for research on ADHD children's higher cognitive functions such as reasoning and language processing. This can help to assess whether conventional neuropsychological measures are appropriate for evaluation and diagnosis. These measures have limitations that our computerized tasks could supplement by allowing better control over familiarity of stimuli and identification of specific cognitive deficits in relation to language comprehension.

B105**REAL WORD PICTURE SET NORMED FOR NAME AND STEM COMPLETION**

Aaron T. Karst¹, Eric S. Clapham¹, C. Mark Wessinger^{1,2,3}; ¹University of Nevada, Reno, ²Charter Oak State College, ³Northcentral University – Experimental investigations utilizing picture stimuli many times suffer from a lack of validity because the picture set being employed was never normed. To avoid this problem many individuals either norm pictures themselves or will use a normed picture set available to the public. Stimuli for one such normed set available for public use consists of pictures of black and white line drawings of objects and animals. These pictures are standardized for name and image agreement, which increases the validity of the stimuli and thus any experiment using the stimuli. Though this picture set provides for a great deal of validity for experimental use, the pictures do not contain many real world characteristics such as color, depth or texture. This confound raises the question of whether these pictures are processed in the same manner as one would process the real world, or as efficiently. Attempting to correct for this confound our lab has standardized a variety of real world, full color pictures for name and image agreement. Consequently, this picture set is being standardized in other areas. Among the various subgroups (e.g. furniture) represented within this picture set, it also contains an equal animate/inanimate grouping. Furthermore, all picture names with five or more letters have been normed for completion percentage. This involved adding additional letters to each root forming the first word that came to mind. Such information will prove useful in many experimental studies investigating object and semantic processing.

Poster Session C

Attentional processes: Visual

C1

EARLY ATTENTIONAL PROCESSES AS PREDICTORS OF RESPONSE CONFLICT AND ERROR COMMISSION

John R. Fedota¹, Craig G. McDonald¹, Raja Parasuraman¹; ¹George Mason University – Are modulations in early attentional ERP components predictive of modulations in later decision related components and the commission of errors? In the present study we evaluate the relationship between early and late stimulus-related ERP components. Recent evidence suggests that the N2 component indexes response conflict in go/no-go tasks. The ERN, an index of error commission, is also elicited in go/no-go tasks. If early attentional processes inform later conflict and error processes, changes in N1 amplitude should be reflected in changes in N2 and ERN following response conflict and error commission respectively. Subjects completed a visual go/no go task with a difficult discrimination between targets and non-targets. Blocked task conditions were 80% target-20% non-target (go/no go) or 20% target-80% non-target (oddball). 64 channel EEG was recorded. Behavioral data show subjects had difficulty making the target/non-target discrimination in both the 20/80 and 80/20 target/non-target conditions. Thus, there were adequate numbers of error trials to enable meaningful comparison of correct and error trial ERP waveforms. ERP results showed that reduced N1 amplitude was predictive of error commission in both tasks and with the ERN associated with the go/no go task. Conversely, greater N1 amplitude was associated with correct performance in both tasks and greater pre-response N2 amplitude for the go/no go task. While previous studies have examined conflict and error processing in relation to N2 and response-ERN, our results tie the manipulation of these components directly to the attentional modulation of the earlier N1 component.

C2

INTEGRATING FEATURES ACROSS AND WITHIN CORTICAL STREAMS IN VISUAL SEARCH: DIFFERENTIAL EFFECTS OF AGING AND ALZHEIMER'S DISEASE

William C. Heindel¹, Elena K. Festa¹, Samantha Set¹, Lindsay A. Miller², Jennifer D. Davis³, Brian R. Ott²; ¹Brown University, Psychology, ²Brown University, Clinical Neurosciences, ³Brown University, Psychiatry and Human Behavior – The selective disruption of corticocortical connections in Alzheimer's disease (AD) should lead to a specific deficit in effectively integrating stimulus features processed within distinct cortical areas. To examine this issue, two visual search tasks identical in their selective attention demands but differing in the demands placed on cross-cortical interactions were developed: Subjects were required to integrate a target's motion with either its luminance contrast (black or white) or its isoluminant color (red or green). Given that luminance and motion information are both processed within the same dorsal cortical stream whereas color identity information is processed within the ventral cortical stream, the motion/color integration task places greater demands on cross-cortical interactions than does the motion/luminance integration task. As expected, healthy elderly participants performed comparably on the two integration tasks, and displayed proportionately larger search times with increasing distractor set size compared to healthy young participants; taken together, these results indicate that aging is associated with a deficit in selective attention but not sensory integration. AD patients, in contrast, not only displayed an additional increase in slope relative to the healthy elderly in both tasks (suggesting a further decline in selective attention), but also showed an additional impairment in the more demanding cross-cortical binding motion/color task that was independent

of set size. These findings not only provide further confirmation of a specific sensory binding deficit associated with neocortical disconnectivity in AD, but also provide empirical support for a fundamental distinction between binding and attentional components of feature integration within visual search.

C3

OBJECT-BASED ATTENTION IN PATIENTS WITH LEFT AND RIGHT HEMISPHERE LESIONS

Alexandra List^{1,2}, Ayelet Landau¹, Joseph Brooks¹, Anastasia Flevaris¹, Francesca Fortenbaugh¹, Michael Esterman¹, Thomas VanVleet³, Alice Albrecht¹, Bryan Alvarez¹, Lynn Robertson^{1,3}; ¹University of California, Berkeley, ²School of Psychology and Wolfson Centre for Cognitive Neuroscience, Bangor University, UK, ³Medical Research Service, Veterans Affairs, Martinez – Since Egly, Driver and Rafal's (1994) pioneering study of object-based attention, their two-object cueing design has been widely used to study space- and object-based attentional orienting. Here, twenty-nine patients with unilateral brain injury (sixteen with RH injury) performed target detection in a modified version of the two-object cueing task. By obliquely orienting the two rectangular objects $\pm 45^\circ$, we were able to measure cueing performance separately at midline, in the contralesional field, and in the ipsilesional field. Cues were 64% predictive and always appeared in an upper or lower midline location. For targets appearing at midline locations, RTs were faster at the cued than uncued locations, as expected. When targets appeared laterally to the right or left of fixation, performance was modulated by the configuration of the objects in the display, but in opposite ways on the contralesional and ipsilesional sides. Reaction times (RTs) on the ipsilesional side were in the predicted direction: faster for targets in cued objects than uncued objects. Conversely, RTs to contralesional targets were slower in cued objects than uncued objects. The left and right hemisphere groups did not differ from each other in this respect. In sum, both patient groups revealed contralesional object-based neglect while demonstrating the opposite, but expected, object-based facilitation effect in their ipsilesional field. The current findings will be related to previous studies of lateralized attentional orienting, patients' performance on bedside tests of space- and object-based orienting, and to theories of hemispheric asymmetries in attentional orienting.

C4

ATTENTIONAL CAPTURE BY SIZE DEPENDS ON FEATURE-SPECIFIC TOP-DOWN TASK SETS: EVIDENCE FROM THE N2PC COMPONENT

Monika Kiss¹, Martin Eimer¹; ¹Birkbeck College London, UK – The question whether attentional capture by salient but task-irrelevant visual stimuli is determined by top-down task set is still a matter of debate. A recent study (Eimer & Kiss, 2008, J Cogn Neurosci) used the N2pc component of the event-related potential to show that spatially uninformative colour singleton cues capture attention only when targets are defined by their colour but not when they were defined in another dimension (onset or size). Here, we used the N2pc as a marker of attentional capture to investigate the role of feature-specific top-down task sets for the attentional capture by size singletons. In separate blocks, participants searched for a pre-defined size target (a small or large bar among medium-sized bars). Circular search displays were preceded by spatially non-predictive circular cue displays that contained either a small or a large item among medium-sized items. N2pc components and behavioural cueing effects were observed only when the relative size of singleton cues and targets matched (e.g., for small cues when participants searched for small targets), demonstrating that attentional capture is not triggered by any size discontinuity, but is determined by feature-specific top-down task sets that

represent relative size. Interestingly, the absence of an item in the cue display triggered behavioural cueing effects and an N2pc both when participants searched for small and for large targets, suggesting that bottom-up factors can affect attentional capture in such extreme cases of feature discontinuity.

C5

ATTENTIONAL CAPTURE AND AWARENESS *Edmund Wascher¹, Christian Beste¹; ¹Leibniz Research Centre for Working Environment and Human Factors* – Visual attention might be driven either by intention or by salient events in the visual field. Models like the "biased competition model" assume that these two mechanisms interact with each other, thereby providing the basis for aware representations. Within this framework, a competition of information is assumed to take place in perceptual and higher prefrontal areas. This process brings incoming information in relation to each other and selects those (strongest) elements of relevance that will subsequently propagate to higher cognitive functions. Attentional control is assumed to modulate this process as a kind of processing filter. Thus, also for intention based selection, the competition mechanism might serve as the main substructure. Therefore, manipulating the saliency of irrelevant elements in a display may essentially modulate the processing of attended information. We run two experiments in which participants had to press a button to a luminance change. In some trials, a motion transient of varying strength (implemented by a 90° rotation of a bar with differing aspect ratios) was presented simultaneously with the 40cd-luminance change. Behavioral data showed that the strength of the task-irrelevant transient modulated the ability of the observer to perceive the luminance transient awarely. Up to 30% errors were committed with the strongest irrelevant stimulus. EEG-recordings support the notion that despite the instruction to attend the luminance transient only, the motion signal captured attention at a first processing step. Intention based attention obviously has to overcome this initial tendency when searching for desired information.

C6

THE NEURAL CONTROL MECHANISMS UNDERLYING MEMORY-GUIDED ATTENTION *Ian C. Gould¹, Mark G. Stokes¹, Kathryn Atherton¹, Anna Christina Nobre¹; ¹University of Oxford* – The control mechanisms that guide selective attention are typically examined in response to explicit attentional cues. In everyday life, however, the focus of attention is more typically guided according to past experiences than direct instruction. We therefore developed a novel behavioural paradigm to examine the neural substrate of memory-guided attentional orienting. Participants first learn the location of target stimuli hidden within naturalistic scenes. After the target locations have been learned, participants then perform an attention-orienting task. Each experimental trial begins with a cue stimulus, consisting of the memory scene presented without the target stimulus. A test scene is then presented, with a 50% probability of a target stimulus being present at the remembered location. Participants are instructed to use their memories to guide the focus of attention. In a previous fMRI study (Summerfield et al., 2006, *Neuron*), trials involving memory-guided attention were shown to engage activity in the same dorsal frontoparietal network that is typically associated with explicitly cued shifts of spatial attention, and in the hippocampus. However, it was not possible to isolate target-related processes from cue-related processes. In the present study, we tested and verified the roles of dorsal frontoparietal cortex and hippocampus activity in the neural control of memory-guided attention, by dissociating mnemonic cue-related activity from target-related activity. These results provide additional insights into the functional neural architecture of memory-guided attention, broadening the neuroscientific foundations for a more generalised account of attentional control during real-world behaviour.

C7

VISUAL REALISM AND EMOTION MODULATE ATTENTIONAL PROCESSING: EVIDENCE AT THE P3 EVENT-RELATED POTENTIAL *Bernadette Sibuma¹, Karen Froud^{2,3}, John Black^{2,3}; ¹State University of New York at Oswego, ²Columbia University, ³Teachers College* – Emotional content and task relevance have been found to modulate the amplitude of the P3 event-related potential (ERP), however little is known about the effects of the visual realism of images on attentional processes. In this study, we examined the P3 amplitude as elicited by cartoon, computer agents, and photographs of faces with and without emotion (fear, neutral). The experiment was conducted using dense array electroencephalography with twenty-five adult participants. A repeated measures design using two perceptual decision-making tasks examined the effects of visual designs on ERPs. Consistent with previous studies (Kiss & Eimer, 2008), the results showed a significant effect of emotion on the P3 amplitude, with fearful faces increasing P3 positivity. Researchers suggest that fear images, in particular, enhance attention due to a hard wired response to threatening stimuli. Secondly, a significant effect of design was found, with photographs eliciting higher P3 amplitudes in comparison to agents or cartoons. The results suggest increased attentional processing to photographs that could be due to activation of higher cognitive processes, such as discrimination of face identity, which are not active when cartoon or computer agents are perceived. The findings are relevant for the selection and equivalency of stimuli across various neurocognitive experiments, in particular those which occur in simulated environments.

C8

NEURAL CORRELATES OF SUSTAINED ATTENTION *Caroline Hilti¹, Kay Jann¹, Dörthe Heinemann², Andrea Federspiel¹, Erich Seifritz¹, Katja Cattapan-Ludewig¹; ¹University Hospital of Psychiatry, University of Bern, Berne, ²University Hospital of Neurology, Inselspital Bern, Berne* – All versions of the Rapid Visual Information Processing task (RVIP) - RVIP0, RVIP000 and RVIP3tarseq - require the participant to sustain attention over 16 min. Whereas the RVIP3tarseq is a high demanding task, RVIP000 and RVIP0 are simple tasks especially designed to measure purer forms of sustained attention. We apply a rapid event related paradigm in fMRI to investigate brain regions recruited by these tasks and the correlation between brain activity and behavioural data. 20 right-handed participants responded to specific target numbers in each task. Reaction times (RT) and the number of hits were recorded. Nullevents were interspersed randomly. Random effects GLM analyses were performed, contrasting targets vs. nullevents. RVIP0 shows the most extended and highest activations followed by RVIP000 and RVIP3tarseq. They all activated the visual areas bilaterally and the medial frontal/cingulate area. RVIP0 is the only task that activates the right dlPFC. The inferior parietal lobules bilaterally are activated in RVIP000 and RVIP3tarseq. Furthermore, RVIP3tarseq shows the most extended deactivations in the default mode network, whereas the same areas are only partly/not deactivated in RVIP000/RVIP0. The three tasks differ in the behavioural data and in the magnitude and extent of the (de)activated brain regions. The activation in the medial frontal gyrus might reflect planning and execution of movement. The RVIP0 could be the purest form of a sustained attention task, as it is the only task where the right dlPFC is activated. The default network might only become visible when highly demanding tasks (RVIP3tarseq) are performed.

C9

FEATURE PRIMING IN CHRONIC METHAMPHETAMINE ABUSERS: EVIDENCE FOR SPATIAL DEFICITS *Ruth Salo^{1,2}, Susan Ravizza³, Thomas Nordahl^{1,2}, Lynn Robertson^{4,5}; ¹UC Davis Imaging Research Center, ²UC Davis Medical Center, ³Michigan State University, ⁴University of California, Berkeley, ⁵Department of Veteran Affairs, Martinez CA* – Long-term methamphetamine (MA) abusers report problems in focusing attention. These attentional problems may be the result of a deficiency in filtering out irrelevant information. The aim of the current study was to assess

whether MA abusers exhibit greater effects of changes to task irrelevant features compared to healthy participants. 21 chronic MA abusers (mean age = 38+ 7.3 yrs) who were currently drug abstinent (range 1 mos to 4 yrs) and eighteen controls (mean age = 34+ 8.8 yrs) were studied. Subjects identified targets whose features could repeat or switch. The task-relevant feature of the target was letter identity whereas color and/or location were always task-irrelevant. Each trial consisted of a brief presentation of a target and distractor letter. Participants pressed the appropriate key associated with the target letter. Of primary interest in this experiment were effects of switches in the irrelevant features (color and location), when target identity remained constant. All participants were slower when color and location switched, however, MA abusers tended to show a bigger location switching effect than controls ($p < .05$). In contrast, color switching effects did not differ between groups ($F < 1$). These results suggest that chronic MA abusers do not exhibit global impairments of feature processing. Instead, impairments appear to be restricted to situations in which task-irrelevant location features vary. These findings are consistent with other studies that have reported spatial processing deficits in patients with damage to dopaminergic systems. Keywords: methamphetamine, feature processing, spatial attention [K01DA16293-01 to RS].

C10

REDUCED SPATIOTEMPORAL RESOLUTION IN CHILDREN WITH CHROMOSOME 22Q11.2 DELETION SYNDROME (22Q11.2DS) Elliott A. Beaton^{1,2}, Margarita Cabral^{1,2}, Joel Johnson^{1,2}, Tony J. Simon^{1,2}, ¹Psychiatry and Behavioral Sciences, ²The M.I.N.D. Institute, University of California, Davis – Children with 22q11.2DS have cognitive impairments on spatiotemporal attention, arithmetical and numerical tasks. We suggest that early atypical neurodevelopment is deleterious to forming representations and processes necessary for typical function in the spatiotemporal domain. We hypothesize that this results in "spatiotemporal hypergranularity"; diminished attentional capacity, increased crowding, and a decrease in the number of elements that can be individuated. To examine spatiotemporal processing impairments and attention capacity in children (7-14 years) with 22q11.2DS versus typically developing (TD) controls, we used a variant of the Multiple Object Tracking (MOI) task in both the laboratory and during a functional magnetic resonance (fMRI) scan. In both versions, children viewed cartoon animations of 0 to 3 aliens hiding behind corresponding target planets in a field of 7 total identical planets. For 12 seconds, the 58 by 58 pixel planets moved at 60 or 120 pixels per second in non-overlapping or occluding motion within a 770 square pixel field. The child reported, via touch screen or button press, whether a planet concealed a target. In the non-scanner task, children with 22q11.2DS but not TD children showed significant decreases modeled capacity as number of targets and speed of motion increased. In the fMRI task, neural activation in children with 22q11.2DS during active object tracking overlapped with but was dissimilar to the canonical frontoparietal network evident in TD controls. Decreased tracking capacity with increased load and atypical functional activation indicate anomalous development of cortical, subcortical, and limbic temporal and spatiotemporal processing circuits in children with 22q11.2DS.

C11

MODULATION OF BRAIN ACTIVATION TO BACKWARD MASKED EMOTIONAL FACES BY TRAIT EMPATHY AND MINDFULNESS Kit Elam¹, Josh Carlson²; ¹Southern Illinois University at Carbondale, ²State University of New York at Stony Brook – Research has shown that individual differences in anxiety modulates brain activation to subliminally presented threatening emotional stimuli in the amygdala. In empathy research, overt emotional scenes activate limbic areas such as the insula, inferior and medial frontal areas, and cingulate areas. Mindfulness, the purposeful attention to the self and surroundings, has been associated with increased emotional processing. However, individual differences in empathy, mindfulness, and subliminal emotion processing

have yet to be assessed. The purpose of this experiment was to investigate how brain activation to backward masked emotional stimuli is related to individual differences in empathy and mindfulness. In the current study, event-related fMRI data was collected while participants viewed backward masked emotional faces. During each trial subjects viewed a fixation cross for 1000ms followed by a happy, fearful, or neutral face for 33ms, which was immediately masked with a neutral face for 100ms. Subjects completed the Interpersonal Reactivity Index as a measure of empathy and the Kentucky Inventory of Mindfulness Skills. Scores from both questionnaires were found to covary with activation in relation to fearful and happy faces. Activation to backward masked happy faces was found to covary with empathy and mindfulness in facial recognition, limbic, medial frontal, and cingulate regions. Fewer areas were found to covary with fearful faces, primarily the thalamus and temporal pole. These results suggest that even backward masked emotional faces activate brain regions involved in empathy. In addition, this activation was predicted by individual differences in empathy and mindfulness.

C12

COGNITIVE CONTROL OF ATTENTION: NEUROIMAGING EVIDENCE SUPPORTING USE OF THE DISTRACTOR CONDITION SUSTAINED ATTENTION TASK IN TRANSLATIONAL RESEARCH Elise Demeter¹, Luis Hernandez-Garcia², Sally K. Guthrie³, Rachel Engelmann⁴, Stephan F. Taylor⁵, Martin Sarter⁴, Cindy Lustig⁴; ¹University of Michigan, Neuroscience Program, ²University of Michigan, FMRI Laboratory, ³University of Michigan, College of Pharmacy, ⁴University of Michigan, Psychology, ⁵University of Michigan, Psychiatry – The dSAT (distractor condition sustained attention task) was originally developed to investigate the neural bases of attention and top-down control in rats. Recent neuropsychological studies validated its use in healthy humans (Demeter et al., 2008). The Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia (CNTRICS) initiative chose the dSAT as a candidate task to investigate attentional control in schizophrenia (Nuechterlein et al., in press). As part of continuing validation we report evidence on the neural correlates of dSAT performance in healthy adults. For each task trial, the participant indicates the presence or absence of a brief, centrally-presented signal. The standard (SAT) condition uses a static grey background; the distraction (dSAT) condition increases attentional challenge by using a strobing (10 Hz) background. Continuous arterial spin labeling (ASL) perfusion functional magnetic resonance imaging (fMRI) of this task in healthy humans ($n = 16$) shows that SAT performance activates regions in bilateral middle frontal gyri, paracingulate and cingulate gyri, and motor and somatosensory regions. The dSAT condition impairs performance and results in extensive right frontal and right parietal activation. Comparison of the dSAT and SAT conditions while controlling for the visual stimulation produced by the dSAT reveals increased activation in right middle frontal gyrus and right frontal pole. These results confirm the general view that sustained attention performance and top-down control of such performance is mediated via a right hemispheric frontal-parietal network. Thus, this evidence supports the usefulness of the dSAT for translational research.

C13

COVERT ORIENTING OF ATTENTION TO A SALIENT DISTRACTOR CAN BE SUPPRESSED DURING VISUAL SEARCH John McDonald¹, Vincent Di Lollo¹; ¹Simon Fraser University – Recent electrophysiological studies of visual search in humans and monkeys have fueled a long-standing debate about the ability of salient visual objects to capture attention. Evidence from event-related potentials (ERPs) indicates that salient-but-irrelevant pop-out items (distractors) capture attention when humans search for less salient pop-out items (targets) (Hickey et al., 2006), whereas evidence from cellular recordings indicates that salient distractors can be ignored when monkeys search for less-salient targets (Ipata et al., 2006). Although the experiments were similar, the

color of the distractor varied randomly in the human ERP study but was fixed in the monkey study. The purpose of the present study was to determine whether advanced knowledge of the distractor helps to guide visual search in humans. We hypothesized that observers can establish a suppressive filter based on a single stimulus feature to reduce the interference from predictable visual distractors. To investigate this issue, we recorded ERPs to search displays containing a target shape singleton and a distracting color singleton whose color was fixed in each block. Crucially, the predictable distractor singleton elicited an ERP component called the distractor positivity (PD), which has been associated with attentional suppression (Hickey, Di Lollo, & McDonald, in press). This finding differed markedly from the ERP results obtained in a related ERP study (Hickey et al., 2006), wherein unpredictable distractor singletons elicited an ERP component associated with attentional deployment (N2pc; Luck & Hillyard, 1994). This demonstrates that while unpredictable distractors capture attention, observers can suppress attentional capture by predictable distractors.

C14

INDIVIDUAL DIFFERENCES IN VOLUNTARY AND INVOLUNTARY ATTENTION Ayelet Landau¹, Deena Elwan¹, Sarah Holtz², Han Duong³, Prinzmetal William¹; ¹UC Berkeley, CA, ²Head-Royce School, ³Southern California College of Optometry – The present study examined whether voluntary and involuntary attention manifest differently in people with differences in impulsivity (measured with the Barratt's Impulsivity survey). We proposed that high and low impulsive participants would display different amounts of voluntary and involuntary attention. We used the spatial-cueing paradigm to assess attention. In each trial a peripheral cue (the thickening of a rectangle) was displayed, followed by a letter target. Participants were required to identify the target (F or T). Targets could either appear in the cued location (valid trials) or in the uncued location (invalid trials). We used two different manipulations to probe voluntary and involuntary attention. The first was the time elapsing between the cue onset and the target onset (SOA). Targets were separated from cues by either 40 or 400 ms. This manipulation was motivated by the finding that involuntary attention is typically transient while voluntary attention takes longer to build up. In addition, the peripheral cues were either predictive of cue location (i.e., mostly valid trials) or non predictive of cue location (i.e., equal probability for valid and invalid trials). While predictive trials probe voluntary and involuntary attention, non predictive trials summon only involuntary attention, since target location is random with respect to cue location. The different SOAs and predictability manipulations were performed in separate blocks within subjects. We found that participants with high impulsivity scores exhibited larger involuntary attention effects whereas participants with low impulsivity scores, exhibited larger voluntary attention effects.

C15

SELECTIVE ATTENTIONAL IMPAIRMENTS IN CHILDREN WITH CHROMOSOME 22Q11.2 DELETION SYNDROME Heather M. Shapiro¹, Yukari Takarae², Elliott A. Beaton¹, Joel Johnson¹, Tony J. Simon¹; ¹M.I.N.D. Institute, University of California, Davis, ²Center for Mind and Brain, University of California, Davis – Children with chromosome 22q11.2 deletion syndrome (22q11.2DS) demonstrate a variety of impairments on tasks involving spatial attention. These include poorer endogenous but less impaired exogenous orienting, delayed inhibition of return, and more impaired space- versus object-based attention compared to similarly aged typically developing (TD) children. To explore this further, we used an "Endogenous-Exogenous" cueing experiment to examine the differential effects of cue type, meridian crossing, and cue presentation time in 34 children with 22q11.2DS and 25 TD children (all aged 7-14 years). The task included both exogenous (luminance change in a peripheral box with 50% valid/invalid probability for an upcoming target) and endogenous (a central arrow with 65/35% valid/invalid probability for an upcoming target) cues. The time lapse from cue to target, or

stimulus onset asynchrony (SOA), was either 200 or 750 ms. Cues oriented attention to equidistant locations either above and below or to the left and right of a central fixation. Overall, children with 22q11.2DS showed larger invalidity costs on endogenously but not exogenously cued trials compared to TD children. Effects were modulated by SOA length and whether orienting required crossing the horizontal or vertical meridians. Both groups produced inhibition of return, which was also modulated by SOA length and which meridian was crossed. Integrated with our other cognitive and neural findings, these results significantly clarify the specific neurocognitive basis of attentional impairments in children with 22q11.2DS.

C16

PERCEPTUAL GROUPING DURING MULTIPLE OBJECT TRACKING Andrew McCollough¹, Trafton Drew¹, Edward Vogel¹; ¹University of Oregon – Previous research has suggested that perceptual grouping may significantly aid performance in Multiple Object Tracking (MOT) tasks. That is, observers may track multiple items by spontaneously grouping disparate items into a single virtual object. According to this hypothesis a virtual polygon is initially created and then updated during tracking, with the vertices of the polygon consisting of the tracked elements. (Yantis 1992) Recently our lab has demonstrated an ERP component, the CDA, sensitive to the number of successfully tracked items in a MOT task such that the amplitude of the component increases with increasing set size up to the individual subject's tracking capacity (Drew & Vogel 2008 J. Neuroscience). Here, we investigated whether a real or virtual polygon between targets in a tracking task would enhance behavioral performance and reduce tracking load (as indexed by a reduction in amplitude of the CDA). We found that the presence of actual grouping lines between three targets in a bilateral tracking task reduced tracking load when the lines were present as compared to when they were absent. These results suggest that perceptual grouping does play a role in tracking but this may be restricted to situations when there are strong bottom-up cues for grouping.

C17

ATTENTIONAL PRIORITIZATION: THE INFLUENCE OF EXPERTISE ON HOW JOURNAL ARTICLES ARE READ Lisa M. Meschino¹, Michael G. Reynolds², Daniel Smilek¹, Grayden Solman¹; ¹University of Waterloo, ²Trent University – Critical to efficient and effective reading is the ability to prioritize what is of central and peripheral importance from text-based sources. The modular format of journal articles is designed to favor this kind of prioritization by standardizing the areas of central and peripheral interest and promoting selective reading. Our study examined how expertise with the journal article format influences attentional prioritization. Participants viewed two 6-page articles from the journal, *Psychological Science*. They were given only five minutes to read each article and each article was followed by a comprehension test. An eye monitor tracked eye movements and recorded the location, frequency, and duration of each fixation. Participants were divided into two groups based on their expertise with the text format: 1) a novice group of undergraduate students and 2) an expert group of graduate students. Our results showed that experts had higher comprehension scores than did novices and that there were substantial differences between the two groups in the frequency and location of their fixations. Experts and novices differed in how they attended to the abstract, introduction, methods, figures and discussion, with some variance across journal articles. The findings suggest that novices are less able than experts to identify and locate the important information in the article. Therefore, expertise with text format includes knowledge of what content is of central importance and where to look for it, and this knowledge guides overt attention in a top-down fashion.

C18

THE EFFECTS OF TMS OVER THE POSTERIOR PARIETAL OR DORSOLATERAL PREFRONTAL CORTEX ON THE ATTENTION NETWORK TASK

June Hung¹, Vincent Walsh², Jon Driver²; ¹Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan, ²Institute of Cognitive Neuroscience, University College London, UK – Arousal, spatial orienting, and conflict resolution represent varieties of attentional functions. These functions seem partially dissociated and usually require separate tasks to measure each. The attention network task is a modified flanker task that consists of three possible flankers (neutral, congruent, and incongruent) preceded by four possible types of cueing (no cue, central cue, double cue, or spatial cue), which allows measurements of the cognitive processes involving conflict resolution, along with those concerning alerting and spatial orienting. Here we investigated the roles of the posterior parietal cortex (PPC) and dorsolateral prefrontal cortex (DLPFC) in these three dimensions of attentional function. Seven healthy participants performed the attention network task before and after 1-Hz repetitive transcranial magnetic stimulation (rTMS) over the left/right PPC and DLPFC. The results showed that, after 1-Hz rTMS over the left/right PPC or left DLPFC for 600 s, all post-rTMS behavioral measures were not significantly different from the pre-rTMS baseline. After 1-Hz rTMS over the right DLPFC, however, accuracy in performing the flanker task was significantly decreased; this effect was only apparent for incongruent-flanker trials that set the highest demand for conflict resolution. Correspondingly, right DLPFC rTMS significantly increased a reaction-time derived parameter, conflict effect (prolongation in reaction times for incongruent-flanker trials relative to those for congruent-flanker ones), without affecting other parameters reflecting alerting or orienting effect. Right DLPFC is thus important in resolving conflict or competition between visual stimuli to achieve visual selectivity.

C19

INDIVIDUAL DIFFERENCES IN MULTIPLE MODES OF VOLUNTARY VISUAL ATTENTION

Marcia Grabowecky¹, KatieAnn Skogsberg^{1,2}, Joshua Wilt¹, William Revelle¹, Satoru Suzuki¹; ¹Northwestern University, ²Centre College – Extensive research has characterized what can be prioritized by attention (e.g., a location, an object, a color, or a motion), and how attention can act (e.g., focused, distributed, or sustained). Neuroscientific approaches have identified both distinct and overlapping patterns of brain activity associated with different modes of attention, suggesting inter-relationships among attention mechanisms. To understand how the many hypothesized attention mechanisms work together to support behavioral goals, it is essential to understand these inter-relationships. To this end, we examined inter-correlations among representative voluntary attention skills by administering an attention battery consisting of 10 common voluntary attention tasks to over 250 participants. Eight of these tasks (except for two Eriksen-flanker-type tests) had sufficient reliability, so we examined their relational structure by performing cluster (using the ICLUST algorithm; Revelle, 1979) and multidimensional scaling (MDS) analyses on their correlation matrix. Results suggested that these tasks formed four distinct clusters of attention skills, (1) rapidly deploying attention, (2) persistently maintaining attention (vigilance), (3) spatially shifting attention or tracking with attention, and (4) attending to global patterns and objects or grouping with attention. In the MDS, the first two clusters defined an axis interpretable as a transient-sustained axis, and the latter two clusters defined an axis interpretable as a spatiotemporal-discrete-global axis. Prior investigations of the neural substrates of some of the attention battery tasks appear consistent with this clustering. Finally, we will demonstrate the utility of the attention battery for investigating group differences in attention abilities using sex differences as a test case.

C20

DO VISUAL SPATIAL ATTENTION-VISUOMOTOR INTERACTIONS EXTEND TO LOCOMOTIVE MOVEMENTS? AN ERP STUDY OF SENIOR FALLERS VS. NON-FALLERS

Lindsay Nagamatsu^{1,3}, Patrick Carolan¹, Teresa Liu-Ambrose^{2,3}, Todd Handy^{1,3}; ¹The University of British Columbia, Psychology, ²The University of British Columbia, Physical Therapy, ³The Centre for Hip Health – Visual-spatial attention has been found to have a central function in visuomotor planning associated with reach and grasp type movements. Our main question was whether this link between motor abilities and visual-spatial attention extends to other types of movement, such as walking, and how it may apply to successful movement through the environment. Because of methodological problems associated with recording event-related potentials (ERP's) during movement, we used a population with deficits in locomotion in order to answer this question. Using a between-groups design, we recorded event-related potentials in a canonical spatial cuing task performed by two groups of senior (aged 65+ years old) participants: those with a recent history of falls (> 2 falls in the past 12 months), and those with no such history (0 falls in the past 12 months). In terms of attentional control systems in cortex, we found no significant differences in function between groups. However, in terms of attentional facilitation of cortical processing, we found that fallers manifest specific abnormalities in the sensory/perceptual processing of targets in the left visual field. Our findings thus suggest that fallers have specific deficits in visuocortical systems associated with attentional enhancement of events on the left side of visual space. These findings are consistent with the hypothesis that visual-spatial attention and visuomotor abilities are critical for successful locomotion through the environment.

C21

SPATIAL TOPOGRAPHY OF HUMAN PREFRONTAL AND PARIETAL CORTICES

Trenton Jerde¹, Adam Riggall¹, Clayton Curtis^{1,2}; ¹NYU, Psychology, ²Center for Neural Science, NYU – We used fMRI to map the spatial topography of the frontal and parietal cortices in humans. To define topographical maps in these higher order association areas, we used modified versions of standard retinotopic methods that tax spatial attention processes. We induced traveling waves of neural activity across cortex in topographical areas with working memory (WM) and motion discrimination (MD) tasks. In the WM task, subjects maintained fixation while faces were presented one at a time circling the visual periphery and indicated when the same face was presented consecutively (one-back). In the MD task, subjects maintained fixation while attending to circular apertures containing varying levels of coherently moving dots. Dot apertures were presented one at a time and circled the visual periphery; subjects indicated the direction of coherent dot motion by pressing a button. By adjusting the percentage of dots moving in the same direction, a staircase procedure kept subject performance at 75% accuracy. Fixation during both tasks was quantified by eye tracking. For both tasks, data were analyzed with standard phase-encoded retinotopic mapping methods. When using WM and MD tasks, similar topographical maps of contralateral space were found in dorsal and ventral prefrontal cortex and in posterior parietal cortex, as well as in early visual areas. Moreover, these topographic areas showed evidence of contralateralized persistent activity during the maintenance of covert spatial attention. Therefore, discrete areas of association cortex are spatially topographic and can be defined by systematic shifts in the locus spatial attention.

C22

THE ALLOCATION OF EARLY VISUAL ATTENTION DURING SMOOTH PURSUIT EYE MOVEMENT

Javier Lopez-Calderon¹, Kathya Torquati², Johanna Kreither³, Francisco Aboitiz¹; ¹Departamento de Psiquiatria, Pontificia Universidad Católica de Chile, ²Dipartimento di Scienze Cliniche e Bioimmagini and ITAB, Istituto di Tecnologie Avanzate Biomediche, Università "G. D'Annunzio", Chieti - Italy, ³Escuela de Psicología, Universidad San Sebastián, Chile – Recent studies suggest that the control of voluntary eye movements relies on specific target selection and decision making pro-

cesses. In particular, the accuracy of smooth pursuit eye movements (SPEMs), which maintain the image of a moving target on the fovea, depends strongly on attentional mechanisms. Nonetheless, the specific nature of the link between visual attention and SPEMs remains to be elucidated. Previous studies have elegantly demonstrated a biased allocation of attention to an area just in front of a constant-speed pursued target. This has been accomplished by measuring the latency and accuracy of saccadic eye movements, or manual reaction times, to stimuli appearing near the location of the moving target. As a further step in this line, we explored the spatial allocation of attention during horizontal sinusoidal SPEMs, using pattern reversal visual evoked potentials (prVEPs), elicited by retinotopically selected bilateral patches in the periphery of a pursued target. Our findings show a higher V1/V2 global response for the pursued right-going compared to left-going movement. Additionally, we found a higher contralateral V1/V2 response for the right-going movement, suggesting an ahead-biased allocation of attention. We discuss a direction-of-reading effect hypothesis.

C23

EARLY AND LATE PRE-STIMULUS ENHANCEMENTS FOR EXPECTATION OF FEARFUL AND NEUTRAL FACES IN FUSIFORM FACE AREA Tracy Jill Doty^{1,2}, Shruti Japee¹, Martin Ingvar², Leslie Ungerleider¹; ¹NIMH/Laboratory of Brain and Cognition, ²Karolinska Institutet, Clinical Neuroscience – The expectation of a behaviorally relevant stimulus can lead to faster and more accurate behavioral responses. Neuroimaging studies have shown that the anticipation of an upcoming visual stimulus enhances activity in visual processing areas even before that stimulus appears. However, few studies have investigated the effect of emotion on this anticipatory activity, and none has studied the expectation of emotional faces. In this event-related fMRI study, we manipulated valence expectation by presenting face images, within 50-trial runs containing different proportions of fearful:neutral faces: 80:20, 50:50, and 20:80. Before each run, subjects were explicitly told the ratio of fearful to neutral faces, and subjects were instructed to categorize each face as fearful or neutral on each trial. A red fixation cue preceded each face by 4 seconds. Behavioral data demonstrated that subjects were significantly faster to categorize the expected face type. A robust early (2-4 seconds post-cue) increase in BOLD activity was found in bilateral fusiform face area (FFA) prior to the presentation of an infrequent fearful face (compared to other trials). While this early activation in response to the cue did not confer a reaction time advantage (subjects were as slow to categorize infrequent fearful as infrequent neutral faces), it may represent a preparatory bias for infrequent emotional images. In contrast, consistent with behavioral data, a late (6-8 seconds post-cue) enhancement was seen in bilateral FFA during certain expectation trials (80:20 and 20:80) as compared to uncertain expectation trials (50:50). This late pre-stimulus enhancement may represent preparatory top-down signals.

C24

SLOW-WAVE AND OSCILLATORY MARKERS OF ANTICIPATORY BRAIN ACTIVITY DURING VISUAL SPATIAL ATTENTION AND THE PERCEPTUAL BIASING OF SENSORY CORTEX Tineke Grent-t-Jong^{1,2}, Marty G. Woldorff¹; ¹Center for Cognitive Neuroscience, Duke University, ²Utrecht University, Psychopharmacology, Netherlands – Two scalp-recorded electrophysiological markers of visual-location-specific anticipatory brain activity -- the slow-wave ERP-component termed the Biasing-Related-Negativity (BRN) and the event-related power decreases (ERDs) in alpha-band oscillatory activity -- have been reported in the literature as reflecting a state of increased excitability of sensory cortical areas (baseline-shift or biasing hypothesis) that results in improved perceptual sensitivity. However, the possibility that they might reflect different frequency components of the same underlying brain mechanism has never been directly tested. The current study attempts to fill this gap by using three variants of a visual spatial-cueing paradigm to test (a) whether the contralateral BRN and alpha-ERDs

respond similarly to different task manipulations, (b) whether their activity levels correlate across the delay period, and (c) whether they similarly affect perceptual processing of the expected stimulus. The results indicated that none of these criteria for accepting the hypothesis of corresponding functional significance were met. The behavior of the contralateral BRN activity was the most consistent with the biasing hypothesis, in that this component was sensitive to the manipulation of expected perceptual difficulty of the target and its activity level correlated with the amplitude of the target N1 sensory component. In contrast, the contralateral alpha-ERDs responded more to motor-preparation instructions and motivational aspects of the task and affected later target processing stages (P3 amplitude). Generally, alpha oscillatory changes appeared to be more indicative of the strength of spatial attention at a particular point in time, rather than reflecting expectancy-driven biasing activity for future processing.

C25

ELECTROPHYSIOLOGICAL EVIDENCE FOR THE TOP-DOWN MODULATION OF ATTENTIONAL ORIENTING ELICITED BY CENTRAL NUMBER CUES Jelena Ristic¹, Barry Giesbrecht¹; ¹University of California Santa Barbara – It has been reported that central numbers elicit an automatic shift of attention to the location corresponding to their relative spatial position on a left-to-right mental number line (Fischer et al 2003). Behaviorally, this effect is revealed as facilitated responses for left targets precued by a small number (e.g., 1) and right targets precued by a large number (e.g., 9). However, because the effect emerges late, about 700ms post-cue, it has been argued that instead of reflecting automatic orienting, it may reflect orienting that is controlled in top-down manner. Here we examined attentional effects of central number cues on visual cortical processing as indexed by the P1 event-related potential (ERP) component. Participants completed a cuing task in which centrally presented digits (3 or 9) served as attentional cues. The numbers were either uninformative or informative of the target location. Analysis of target-evoked ERPs revealed that when the number was uninformative, P1 magnitude was modulated in a manner that is consistent with the mental number line. However, this pattern reversed in the uninformative condition where the spatial location cued by the number contradicted the left-right number line, such that the P1 was largest for left targets cued by a large digit (9) and right targets cued by a small digit (3). These data indicate that the perception of digits may initially bias visual processing according to the mental number line. However, dovetailing with past data, the resulting attentional effect appears to depend on the spatial mental set adopted by observers.

Emotion

C26

VARIATIONS IN TREK1 GENOTYPE LINKED TO ANTIDEPRESSANT RESPONSE ARE ASSOCIATED WITH POTENTIATED NEURAL RESPONSE TO REWARDS IN HUMANS Daniel Dillon¹, Ryan Bogdan¹, Jesen Fagerness³, Avram Holmes¹, Roy Perlis^{2,3}, Diego Pizzagalli¹; ¹Harvard University, Psychology, ²Depression Clinical & Research Program, Massachusetts General Hospital and Harvard Medical School, ³Psychiatric and Neurodevelopmental Genetics Unit, Center for Human Genetic Research, Massachusetts General Hospital – The TREK1 gene has been linked to a depression-resistant phenotype in rodents and antidepressant response in humans. However, the mechanisms underlying these links are unclear. Because TREK1 is expressed in reward-related basal ganglia regions, it has been hypothesized that TREK1 genetic variation may be associated with anhedonic symptoms of depression. To test whether TREK1 genetic variation influences reward processing, we genotyped healthy individuals (n = 32) who completed a monetary incentive delay task during functional magnetic resonance imaging. Three of four TREK1 genotypes previously linked to positive

antidepressant response were associated with potentiated basal ganglia responses to gains, but did not influence activity elicited by penalties or no change feedback. Furthermore, the total number of "protective" TREK1 alleles possessed by individuals was positively correlated with responses to gains in several other regions of the mesocortical reward network, including the dorsal anterior cingulate cortex, orbitofrontal cortex, and mesial prefrontal cortex. These results indicate that variation in TREK1 genotype is associated with individual differences in neural responses to rewards, and suggest that variation in reward processing could mediate the association between TREK1 and antidepressant response in humans.

C27**THE EFFECTS OF ACUTE STRESS ON ATTENTIONAL CAPTURE BY ALCOHOL-RELATED CUES IN SOCIAL DRINKERS** Ryan

Giuliano¹, Natalie Ceballos², Nicole Wicha^{1,3}, Reiko Graham²; ¹University of Texas, San Antonio, ²Texas State University, ³University of Texas Health Sciences Center, San Antonio – Alcohol is often consumed to ameliorate the stress of everyday life. The purpose of this study was to examine the neurophysiological correlates of alcohol-related attentional processes among social drinkers before and after exposure to stress using a 3-stimulus oddball paradigm. Participants (N = 34) were randomly assigned to either an alcohol target (respond to alcohol pictures, ignore other objects or nonsense shapes) or an object target condition (respond to object pictures) while event-related potentials (ERPs) were measured before and after stress induction. Behavioral results indicated that overall, responses to both alcohol and object targets were faster after stress induction. These results were mirrored by changes in the peak latency of the P300, which peaked earlier as a result of stress, irrespective of target type. Amplitude analyses were also conducted after taking latency differences across conditions into account. Regardless of stress, P300 amplitudes were largest for targets, but this was mediated by a target by condition interaction. Amplitudes were larger for targets in the alcohol condition, whereas there was no significant difference between targets and non-targets (alcohol images) in the object condition, suggesting that alcohol images captured attention, regardless of stress or target status. Interestingly, there was a stress by condition by hemisphere effect: the P300 for alcohol targets was bilateral before stress but right-lateralized after stress, supporting the role of right parietal regions in emotion-related arousal (Heller, 1993). Overall, results suggest that stress appears to affect both controlled and automatic processing of alcohol related images.

C28**GOAL INDUCEMENT AND EMOTION CONTROL: THE EFFECTS OF CONSCIOUS AND NONCONSCIOUS GOAL REGULATION ON THE RESPONSE TO EMOTIONAL STIMULATION** Sanda

Dolcos^{1,2}, Keen Sung^{1,2}, Ekaterina Denkova^{1,2}, Florin Dolcos^{2,3}; ¹University of Alberta, Psychology, Canada, ²University of Alberta, Psychiatry, Canada, ³Centre for Neuroscience, University of Alberta, Canada – The ability to regulate emotions is an important coping mechanism in the face of emotionally stressful situations. While previous emotion regulation (ER) studies have focused mainly on conscious/deliberate regulation, recent evidence suggests that non-conscious/automatic regulation could prove as effective while being less costly (Bargh & Williams, 2007). However, it is not clear whether both types of ER are equally effective in controlling varying intensities of emotional challenge. The present study used an experimental design that manipulated both the goal to regulate emotion (conscious vs. nonconscious) and the intensity of emotional challenge (high vs. low). Different groups of participants were either explicitly instructed or non-consciously primed to suppress their response to pictures with varying degrees of emotional content selected from the International Affective Picture System. Participants rated the emotional content of negative and neutral pictures, while skin conductance (SC) responses to viewing the pictures were also recorded. Analyses of behavioural data suggest that both deliberate and automatic ER decreased the subjective response to low-intensity emotional pictures. However, only

deliberate ER was effective in suppressing the response to high-intensity emotional pictures. Preliminary analyses of the SC data are consistent with the subjective rating findings. This study suggests that while automatic ER might be less effortful and less costly, it might also be less effective in the face of highly challenging negative situations. The findings are relevant for understanding mood and anxiety disorders, in which emotion dysregulation is often among the core debilitating features.

C29**SEX-RELATED DIFFERENCES IN EMOTION REGULATION STRATEGIES IN COPING WITH SOCIAL ANXIETY: A COMBINED PERSONALITY AND BRAIN IMAGING INVESTIGATION** Florin Dolcos^{1,2}, Sanda Dolcos^{1,2,3}, Ekaterina Denkova¹, Gloria Wong^{1,2}; ¹University of Alberta, Psychiatry, Canada, ²University of Alberta, Canada, Centre for Neuroscience, ³University of Alberta, Psychology, Canada – The study investigated the role of individual variation in emotion regulation (ER) strategies in response to trait and state social anxiety (SA).

The relationship between the habitual use of two ER strategies (i.e., reappraisal and suppression) and trait SA was first investigated using the Emotional Regulation Questionnaire (ERQ) and the Liebowitz SA scale (LSAS). Correlation analyses on data from 86 participants (49 females) identified a negative relationship of LSAS scores with ERQ-Reappraisal (ERQ-R), but a positive relationship with ERQ-Suppression (ERQ-S). Interestingly, while the former relationship was driven by women, the latter was driven by men. These findings suggest that reappraisal is overall a more effective strategy in coping with SA, and that habitual suppression tends to be inefficiently engaged by men. These findings were next confirmed on a smaller sample (N=18, 10 females) in which SA was transiently induced by viewing angry faces presented as task-irrelevant distracters during a working memory (WM) task. This investigation also revealed that ERQ-R predicts enhanced WM performance in the presence of transiently induced SA in men but not in women. Functional MRI data were also recorded while participants performed the WM task, and preliminary analyses suggest that these sex-related differences in the engagement of ER strategies are linked to dissociable involvement of cognitive control brain regions (e.g., anterior cingulate) in response to transient anxiety-inducing distraction in men and women. Collectively, these findings suggest that women and men engage different ER strategies and brain mechanisms in coping with trait and state SA.

C30**EMOTIONAL DISTRACTION MODULATES THE IMPACT OF TASK DIFFICULTY ON PERFORMANCE IN A PERCEPTUAL TASK** Andrea Shafer¹, Dmitriy Matveychuk¹, Todd Penny¹, Roberto Cabeza², Florin Dolcos¹; ¹University of Alberta, ²Duke University – An

important open question in the emotion literature concerns the impact of task-irrelevant emotional distraction on perceptual processing. According to Lavie (2005), task-irrelevant distracters have a differential impact on task-relevant processing depending on the "processing load" of the main task - i.e., low-perceptual load is susceptible to distraction whereas high-perceptual load eliminates distracter processing. It is unclear, however, whether these effects are also found when the distracters are emotionally-charged. Possibly because of their relevance for survival, emotional stimuli can "capture" attention and reallocate processing resources from processing goal-relevant information to processing irrelevant emotional information. Thus, it is possible that processing of distraction is not eliminated by high perceptual load if the distracters are emotional. This idea was investigated using a shape detection (SD) task in which participants made decisions on the orientation of vertical and horizontal pictures with varying degrees of emotional content. Task difficulty was manipulated by varying the ratio of the horizontal vs. vertical sides, which thus influenced the difficulty in deciding whether the pictures were clearly rectangles (with vertical/horizontal orientation) or closer to squares (with uncertain vertical/horizontal orientation). Preliminary analyses showed that the response speed in the SD task was modulated by both task difficulty and emotional content. Specifically, the

longest reaction times were recorded when the orientation was difficult to identify and the content of the pictures was emotional. These findings shed light on the impact of task-irrelevant emotional distracters on perceptual processing, and have relevance for understanding clinical conditions associated with exacerbated susceptibility to emotional distraction.

C31

ALMOST HUMAN: NEURAL ACTIVATION TO AVATAR AND HUMAN EMOTIONAL FACIAL EXPRESSIONS *Matthias Wieser¹, Antje Gerdes¹, Paul Pauli¹, Peter Weyers¹, Felix Breuer², Andreas Mühlberger¹; ¹University of Würzburg, ²Magnetic Resonance Bavaria (MRB)* – Facial expressions of emotions are important in nonverbal communication. While previous studies have mostly relied on facial images of humans, the effects of computer-generated (avatar) emotional faces compared to natural emotional faces on brain activation were investigated in the present study. Twenty-two healthy subjects (ten females) viewed blocks of facial expressions (anger, fear, happiness and neutral) and scrambled faces in a blocked design, while their brain activation was measured by means of 1.5 T BOLD fMRI. Activations in emotional networks including amygdala, insula, ACC were apparent in response to both avatar and human emotional faces, but the response was significantly stronger especially to human faces of anger in the amygdala. Behavioral data indicate that avatars are rated as less arousing compared to human faces, which might be an explanation of the weaker brain responses. However, as there was an emotional modulation of brain activity present, we suggest that avatars could be a useful tool in neuroimaging studies of facial expression processing because they elicit comparable activations in emotional areas similarly to human faces, yet have the advantage of being highly manipulable and fully controllable. This allows for creating innovative research designs with dynamic facial expressions. However, further investigations are needed to clarify the differences between natural and artificial stimuli and the influence of trait variables like social anxiety.

C32

OPPOSING PATTERNS OF BRAIN ACTIVITY IN PERCEPTUAL AND EXECUTIVE BRAIN REGIONS LINKED TO INDIVIDUAL VARIATION IN SOCIAL ANXIETY: AN FMRI INVESTIGATION *Ekaterina Ninova¹, Gloria Wong², Kristen Sabourin³, Keen Sung¹, Sanda Dolcos^{4,1}, Florin Dolcos^{1,2}; ¹University of Alberta, Psychiatry, Canada, ²University of Alberta, Center for Neuroscience, Canada, ³University of Alberta, Biomedical Engineering, Canada, ⁴University of Alberta, Psychology, Canada* – Mood and anxiety disorders are often characterized by increased susceptibility to emotional distraction. However, the underlying neural circuitry associated with individual differences predicting the response to emotional challenge remains unclear. Here, we investigated the relationship between brain activity in response to anxiety-inducing task-irrelevant distraction (i.e., angry faces) and individual variation in indices of social anxiety (SA). Event related fMRI data were recorded while 18 healthy subjects performed a working memory (WM) task with angry face distractors presented during the delay between the memoranda and probes. Trait SA was also measured with the Liebowitz Social Anxiety Scale (LSAS). Analysis of fMRI data revealed dissociable patterns of brain activity in perceptual (fusiform face area-FFA) and executive (dorsolateral prefrontal cortex-dlPFC) brain regions linked to the nature of distraction and individual variation in SA. Specifically, anxiety-inducing distraction enhanced activity in the FFA while disrupting activity in the dlPFC. Moreover, activity in these regions also showed opposing patterns of co-variation with the trait SA, reflected in positive (FFA) vs. negative (dlPFC) correlations with the LSAS scores. Collectively, these findings provide support for the idea that enhanced activity in perceptual brain regions in response to task-irrelevant emotional distraction may lead to disrupted activity in executive brain regions, and that these effects are mediated by individual variation in the sensitivity to anxiety-inducing stimulation. These findings have implications for understanding alterations in the neural circuitry underlying emotion-cognition interac-

tions in clinical SA, in which exacerbated response to anxiety-inducing social contexts leads to debilitating effects on social behavior.

C33

TRAIT ANXIETY AND IMPOVERISHED PREFRONTAL CONTROL OF ATTENTION *Sonia Bishop¹; ¹University of California, Berkeley* – Many neurocognitive models of anxiety emphasize a hyper-responsive threat-detection system centered on the amygdala, with recent accounts incorporating a role for prefrontal mechanisms in regulating attention to threat. The current study investigated whether trait anxiety is associated with a much broader dysregulation of attentional control. Volunteers performed a response conflict task under conditions posing high or low demands on attention. High trait anxious individuals showed reduced prefrontal activity and slower target identification in response to processing competition when the task did not fully occupy attentional resources. The relationship between trait anxiety and prefrontal recruitment remained after controlling for state anxiety. These findings indicate that trait anxiety is linked to impoverished recruitment of prefrontal attentional control mechanisms to inhibit distractor processing even when threat-related stimuli are absent. Critically, this deficit is observed when ongoing task-related demands on attention are low, potentially explaining the day-to-day difficulties in concentration associated with clinical anxiety.

C34

THE IMPACT OF METHYLPHENIDATE ON EARLY EMOTIONAL PROCESSES IN ADULT PATIENTS WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD) *Eva Woidich¹, Annette Conzelmann¹, Ron F. Mucha¹, Peter Weyers¹, Christian P. Jacob¹, Paul Pauli¹; ¹University of Würzburg* – Background: Emotional- motivational dysfunctions are very likely important in the pathophysiology of attention-deficit/ hyperactivity disorder (ADHD). Although symptoms like hyperactivity and impulsivity seem to be closely related to emotional- motivational functions, few studies about this topic can be found. Even fewer studies examined the influence of methylphenidate on emotional processes, though methylphenidate is the first class medical treatment in ADHD since 1937. Methods: 13 adult ADHD- patients took part twice. During both investigations, objective (affect- modulated startle response) and subjective (valence and arousal ratings) reactions to positive, neutral and negative visual stimuli were affiliated. Every subject had to cope with the same task twice- once without and once after the intake of their own methylphenidate supplement. Results: During the exposure of high arousing visual stimuli and after the intake of methylphenidate, all 13 patients showed improved affective startle- modulation in response to positive and negative pictures. Affective valence and arousal ratings did not differ between both examinations. Conclusion: These findings indicate some positive impact of methylphenidate on early emotional processes in adult ADHD- patients. Results suggest that this improvement is independent of subjective parameters.

C35

INVESTIGATING SEROTONIN'S ROLE IN LINKING BEHAVIOURAL INHIBITION TO PUNISHMENT *Molly Crockett¹, Luke Clark¹, Trevor Robbins¹; ¹Behavioural and Clinical Neuroscience Institute, Experimental Psychology, University of Cambridge* – Serotonin (5-HT) has been implicated in a wealth of psychiatric disorders, including depression, anxiety, and obsessive-compulsive disorder, but its functions in regulating both normal and abnormal behaviour remain poorly understood. Two hypotheses dominate the literature: one suggests that 5-HT signals punishments, and the other proposes that 5-HT facilitates response inhibition. It has recently been suggested that 5-HT is responsible for linking inhibition to punishment, potentiating behavioural suppression in anticipation of negative outcomes. However, existing data cannot rule out either the punishment or the inhibition hypothesis. In this study, we temporarily lowered brain 5-HT levels in healthy human volunteers using the acute tryptophan depletion (ATD) procedure. We employed a novel version of the Go/No-Go task that independently tested the ability to

inhibit responses and the ability to adjust behaviour in response to rewards and punishments. Twenty-two healthy volunteers completed the task, once following ATD and once following placebo. On placebo, volunteers adjusted their response speed in line with feedback valence, speeding up in response to rewards and slowing down in response to punishments. ATD abolished punishment-induced slowing in a context-sensitive manner, while preserving basic response inhibition and the ability to track changes in reward and punishment contingencies. Additional analyses indicate that ATD removed a bias that was present at the start of the placebo session, but was then attenuated, presumably by learning. These data support the hypothesis that 5-HT promotes a bias to inhibit behaviour in the face of potential punishments, rather than simply signalling punishment or facilitating general inhibition.

C36

A ROLE FOR THE VENTROLATERAL PREFRONTAL CORTEX AND VENTRAL BASAL FOREBRAIN IN TRACKING PROXIMITY TO THREAT AND ANXIETY Leah Somerville¹, Paul Whalen¹, William Kelley¹; ¹Dartmouth College – Previous research identifying the neural substrates of emotion processing has typically treated threat as a categorical stimulus, either present or absent from the environment. An associated question that has received less scientific attention is whether an individual's relative level of threat or safety in a given context is represented continuously in the brain. During fMRI scanning, 50 participants viewed a threat line fluctuating in height, with the height of the line representing risk for earning subsequent electrical shocks. The line trajectory was set to vary such that equal amounts of time were spent at different proximities to the threat (categorized as low, medium, and high), as well as times when the threat (e.g., earning the shock) was earned. Random-effects group analyses identified brain regions with increasing responses as the proximity to the shock threshold increased. Regions demonstrating this pattern include the left and right ventrolateral prefrontal cortex extending into the anterior insula, and the left and right ventral basal forebrain. When examining individual differences, we observed that these regions showed an exaggerated response profile in individuals with greater dispositional anxiety. The present findings suggest that these regions may continuously monitor changes in arousal state, and may subserve hyperarousability in potentially threatening situations commonly experienced by anxious individuals.

C37

INTEROCEPTION FOR MENTALIZING: HEARTBEAT-EVOKED BRAIN POTENTIAL SHOWS AMPLITUDE MODULATION IN AN 'EYES TASK' Hirokata Fukushima^{1,2}, Satoshi Umeda¹; ¹Keio University, ²Japan Society for the Promotion of Science – Interoception is a visceral perception or a sensation of the physiological condition of the inner organ (Craig, 2002). Here we investigated whether interoceptive processing in the central nervous system is employed to understanding others' mental states, and it is increased in the individual who was engaged in a mentalizing task. As a neural index of this processing, we examined a pattern on the surface electroencephalogram (EEG), termed heartbeat-evoked potential (HEP). This is a deflection on the brain potential contingent to the most prominent peak of the electrocardiogram (ECG), and which is thought to reflect cortical processing of cardiac afferent input (Schandry et al., 1986). Being measured EEG and ECG, twenty-one healthy adults participated the experiment where they attended to either the mental or physical features of a series of images showing the eyes of other people. Results showed increased HEP amplitude in mentalizing trials compared to non-mentalizing trials. This pattern was observed on the left and medial frontal electrodes around 250-300 ms latency after the R-peak of the ECG. Furthermore, the mean amplitude in this period was found to be associated with a subscore of empathy questionnaire (Interpersonal Reactivity Index; Davis, 1983). The present study suggests the possibility that the external social cognition involves the internal self-monitoring of the bodily states.

C38

RATING AND SEARCHING FOR OCD-CONCERN RELATED IMAGES: ABNORMAL AND NORMAL PROCESSING IN OCD PATIENTS Sharon Morein-Zamir¹, Martina Butt¹, Naomi Fineberg^{2,3}, Trevor Robbins¹, Barbara Sahakian¹; ¹University of Cambridge, ²Queen Elizabeth II Hospital, ³University of Hertfordshire – Whether Obsessive Compulsive Disorder (OCD) is associated with an increased attentional bias to emotive stimuli remains controversial. Additionally, though depression is the main comorbidity of OCD, it is unclear whether it modulates abnormal emotional processing. To examine whether attentional bias may be restricted to individualized concern-related information we employed a visual search task with OCD-relevant images. Following individual ratings of 100 images, the idiosyncratic most positive and negative scenes were selected for each individual. Participants then searched for their positive images amongst their negative distracters, and their negative images amongst their positive distracters. The search task was administered to nondepressed OCD patients, depressed OCD patients and healthy controls (n=18 per group). Whilst the rating values were similar, both OCD groups were slower than controls to rate the images in terms of pleasantness. Visual search performance did not differ between the groups, although the OCD depressed group exhibited a general slowing. All groups demonstrated an attentional bias whereby negative targets were detected faster amongst positive distracters as compared to positive targets amongst negative distracters. A second experiment using pre-selected negative and positive images replicated the visual search results, with no group differences in attentional bias. OCD rating performance following the search now indicated both slower and more negative scoring values. Results indicate that OCD patients, regardless of their depression state, process OCD-relevant scenes differently from controls depending on task demands and previous exposure. The results have implications for the development of emotional responses to concern-related materials in OCD.

C39

FUNCTIONAL CONNECTIVITY OF THE DORSOLATERAL PREFRONTAL CORTEX DURING A FACIAL EXPRESSION VS. IDENTITY N-BACK TASK Maital Neta¹, Erika Ruberry¹, Paul Whalen¹; ¹Dartmouth College, Psychological & Brain Sciences – Facial expressions of emotion are a critical aspect of our social interactions as human beings. Just as important is the identity of the individuals, as this creates the context in which these expressions will be interpreted. Therefore, it is crucial that we monitor both identity as well as expression information and maintain this information in memory. Participants performed an N-back task in which they either tracked the expression or the identity of the same set of face stimuli. During both the expression and identity tasks, we found a significant increase in activity in dorsolateral prefrontal cortex (DLPFC), an area that has been shown to be critical for working memory. Functional connectivity analyses revealed that activity within this region of the DLPFC was coupled with the amygdala during the facial expression N-back, but coupled with the fusiform gyrus during the face identity N-back. Finally, the connectivity of these regions in each task was significantly correlated with accuracy on those trials. Based on these findings, there is evidence for two separate neural circuitries, both involving the DLPFC, supporting working memory for two distinct aspects of face processing/memory.

C40

AMYGDALA VOLUME CORRELATES POSITIVELY WITH FEARFULNESS IN NORMAL HEALTHY GIRLS: AMYGDALA VOLUME AS AN ENDOPHENOTYPE FOR INTERNALIZING DISORDERS? Ellen A.A. van der Plas¹, Aaron D. Boes¹, John Wemmie¹, Peg Nopoulos¹; ¹University of Iowa, Psychiatry – Research into the neural underpinnings of fear and fear-related pathology highlight the role of the amygdala. For instance, bilateral damage to the amygdaloid complex is associated with decreased appreciation of danger and recognition of fear in humans and non-human primates, whereas enlarged amygdala vol-

ume is associated with syndromes such as anxiety disorders and depression. It is unknown whether amygdala volume and fearfulness are directly related in the absence of pathology. To address this issue, we examined the correlation between normal fearfulness and amygdala morphology in 116 healthy children and adolescents (60 boys, 56 girls, age 7-17). Based on the structure-behavior relationship suggested by lesion- and pathological fear studies, we predicted to find a positive correlation between fearfulness and amygdala volume. Fearfulness was measured using the parent ratings on the Pediatric Behavior Scale (Lindgren et al., 1987) and amygdala volumes were determined by manual tracing. Partial correlation analyses indicated a significant positive correlation between right amygdala volume in girls ($r = .29$, $p < .05$). This relationship was more robust and significant for both the left and right amygdala when analyses were limited to girls with a positive nuclear family history of depression ($r = .63$ and $r = .58$ respectively, both $ps < .05$). In boys there was no significant relationship, which may suggest that biological mechanisms and their interactions with the environment differ between sexes. Given the role of the enlarged amygdala volume in pathology, these findings may indicate that variation in amygdala morphology marks susceptibility to internalizing disorders.

C42

UNDERSTANDING THE EFFECTS OF UNPLEASANT DISTRACTERS DURING A FACIAL WORKING MEMORY TASK

Anne Richards¹, Virginia Hon¹, Sammy Aung¹, Richard Hernandez¹, Parveen Hussain¹, Sam London¹, Richard Maddock¹; ¹University of California, Davis – This study investigated the effects of emotion on working memory (WM) and how these effects are related to individual differences, physiological arousal, emotion regulation, and brain activation. We used a facial memory task with unpleasant and neutral distracters. Block instructions alternated between "Regulate Emotions" and "Respond Naturally". We recorded memory accuracy, skin conductance and several individual difference questionnaires from 109 undergraduates. Regulation instructions did not affect working memory performance, so we combined both block types for all analyses. A paired t-test shows improved WM accuracy on trials with unpleasant distracters ($n=109$, $t=6.581$, $p<.0001$, two-tailed). This facilitation of WM is significantly related to low state anxiety ($n=109$, $r=.326$, $Z=3.486$, $p=.0005$). A Wilcoxon Signed Rank test shows that higher arousal measured by skin conductance response to unpleasant distracters predicts better memory accuracy following unpleasant distracters ($n=80$, $Z=1.962$, $p<.05$, two-tailed). A separate group of 20 subjects participated in an fMRI study using a version of the same task. In a contrast between unpleasant and neutral distracters, we found that fMRI activity in the left mid-VLPFC (BA 45) correlated with WM facilitation by unpleasant distracters (cluster-level $p<.05$). In summary, unpleasant distracters unexpectedly improved facial WM accuracy. This effect correlated with low state anxiety and with fMRI activity in the left mid-VLPFC, an area associated with cognitive control in memory. WM accuracy following unpleasant distracters was positively correlated with skin conductance responses to the unpleasant distracters. Thus, emotional distracters can lead to improved working memory via a mechanism influenced by arousal, anxiety, and cognitive control.

C43

MODULATORY EFFECT OF VOICE ON CONSCIOUS AND NONCONSCIOUS PROCESSING OF EMOTIONAL BODY LANGUAGE

Bernard M.C. Stienen¹, Akihiro Tanaka¹, Beatrice de Gelder^{1,2}; ¹Cognitive and Affective Neurosciences Laboratory, Tilburg, The Netherlands, ²Martinos Center for Biomedical Imaging, Massachusetts General Hospital and Harvard Medical School, Charlestown, Massachusetts – Previous studies have shown that affective processing of faces is still possible in absence of visual awareness. Recent results of our group have shown that emotional body language is also processed even if a target body is masked after a short SOA and not consciously visible. As emotional events have multiple correlates and are simultaneously perceived by sev-

eral sensory systems in naturalistic settings, emotional information conveyed by other modalities (e.g. voice) can affect the processing of conscious and nonconscious processing of emotional body language. In the present study, we investigated the effect of emotional voice on conscious and nonconscious processing of emotional body language. A target body (happy or anger) and a mask were presented at 12 different SOAs varying from -50 to +133 milliseconds. Emotional voice (happy or anger) was presented with the onset of the target body. Participants were instructed to ignore the voices and to do two tasks successively. The first task was to categorize the expression of the target body and the second task was to indicate whether they had seen the body or not. Results revealed that emotional voice facilitated categorization of the target body when the emotional valence was congruent between body and voice, whereas it interfered with categorization when the emotional valence was incongruent. Voice did not affect the responses when the body was not presented, while it did affect when the body was presented. These results have implications for multisensory and nonconscious processing of emotion.

C44

THE PROCESSING OF EMOTIONAL PROSODY IN ALEXITHYMIA

Katharina Goerlich¹, Sander Martens¹, André Aleman¹; ¹BCN Neuroimaging Center Groningen, University Medical Center Groningen, University of Groningen, The Netherlands – In the present study, we used event-related potentials (ERP's) to test the hypothesis of aberrant automatic processing of emotional speech in Alexithymia, a personality trait associated with difficulty to interpret emotions. High-scorers on Alexithymia were compared to low-scorers on this personality trait and to a control group with middle scores on Alexithymia. Volunteers watched a silent video while nonsense syllables spoken in neutral emotion (standard) and four different emotional intonations (deviants) were presented in an oddball paradigm. High-scorers on alexithymia were found to show diminished amplitudes of ERP components indicating pre-attentive, automatic detection of changes in emotional prosody. The results of this study suggest that people with Alexithymia show differences in processing emotion conveyed by speech already at very early, automatic processing stages, reflecting a diminished sensitivity to emotional prosody in this personality trait.

C45

HOW THE BRAIN RESPONDS TO SEEING FEARFUL BEHAVIOR IN THE REAL WORLD

Jan Van den Stock^{1,2}, Beatrice de Gelder^{1,3}; ¹Laboratory for Cognitive and Affective Neuroscience, Tilburg University, the Netherlands, ²Old Age Psychiatry, University Hospitals Leuven, Belgium, ³Martinos NMR-MGH Center, Harvard Medical School – Recent studies have examined the role of surrounding contextual information on the processing and recognition of objects, as well as the respective neural mechanisms. There are only a few studies focussing on the mechanisms involved in contextual influence on perception of social stimuli. Although the processing of faces seems to have a 'privileged' status, recent data reports that the early components of the neural processing of faces are influenced by the emotional content of the contextual information. An object category that displays several behavioral and neurofunctional similarities with faces, comprises whole bodies. We used functional Magnet Resonance Imaging (fMRI) to investigate the neural correlates of perceiving emotional whole body expressions in either emotionally congruent or incongruent contexts. We presented fearful and neutral whole body expressions in a fearful, neutral or scrambled context, creating realistically compound stimuli. The stimuli were presented in a blocked design while blood oxygenation level depended brain scans were acquired (3 Tesla). Participants were required to perform an oddball detection task on the presentation of an inverted stimulus. The experiment consisted of four runs with each 31 blocks. In one block, eight stimuli were presented for 800ms with an interval of 350ms. In 10% of the blocks, an oddball stimulus was presented. Finally, a functional localiser for the perception of faces, bodies, houses and tools was performed. The

results show that activity in brain areas that are associated with perception of bodies or perception of scenes, are influenced by the emotional information conveyed by the respective stimuli.

C46**NEURAL CIRCUITRY UNDERLYING EMOTIONAL VS. COGNITIVE CONFLICT AND CONTROL: FACIAL EXPRESSIONS AS A MODEL BEHAVIOUR**

Kimberly S. Chiew¹, Bethany G. Edwards¹, Todd S. Braver¹; ¹Washington University in St. Louis – Recently, the neural basis of emotional control has become a topic of empirical interest; however, overlaps and differences in the neural circuitry underlying emotional and cognitive control have yet to be systematically established. We have identified emotional facial expressions as actions modulated by both emotional and cognitive influences: thus, their use as performance measures in emotional control tasks may provide greater ecological validity than previous tasks, using arbitrary behavioural responses, have permitted. In this study, we examined brain activity during emotional and cognitive versions of the AX-Continuous Performance Task (AX-CPT), a cue-probe task used to examine controlled processing and conflict. Participants responded via facial expressions (smiling or frowning) to emotional probes (IAPS images) or unemotional probes (letters, numbers and symbols). In both tasks, trial frequency and contextual cues introduced a bias towards the target cue-probe combination that leads to two forms of conflict in non-target trials: top-down (i.e., cue-driven) vs. bottom-up (i.e., probe-driven). However, in the emotional condition, the conflict was further amplified by the incongruity between the required facial expression and the emotional valence of the picture. A mixed block/event fMRI design enabled separation of sustained and event-related neural correlates of task activity. The results address the question of whether affective brain regions (e.g., ventral striatum, orbitofrontal cortex, amygdala) are selectively engaged in the emotional conditions, and further whether conflict in this condition engages regions associated with cognitive control (e.g., anterior cingulate cortex and lateral PFC) but in anatomic locations distinct from those activated in the cognitive condition.

C47**ANXIETY AFFECTS LUMINANCE DISCRIMINATION IN THE RIGHT HEMISPHERE**

Caroline Crump¹, Eran Zaidel¹; ¹University of California, Los Angeles – Key features of anxiety include an attention bias toward negative, emotional stimuli and heightened autonomic response to threat. Both negative emotions and autonomic responses are selectively associated with the normal right hemisphere. Consequently, we predicted that the right hemisphere of anxious participants will have a distinct information processing profile, different from the left hemisphere of an anxious participant and from the right hemisphere of a nonanxious participant. We compared the perceptual differences between college students who rated high and low on the Spielberger State-Trait Anxiety Inventory. Participants received identical copies of a color square (the target) and an emotional word in each visual hemifield. Following a brief delay, they received two probes: one identical to the target, the other equally often of a lighter or darker luminance. Participants were required to indicate with a keypress which probe test matched the target. We predicted that anxious participants would more often choose the probe with the lower luminance and that this effect should be selective to left hemifield probes. Both predictions were correct. The results implicate the right hemisphere in anxiety and show a perceptual bias toward the darker (more negative) stimuli. It remains to be determined whether the bias toward darker stimuli occurs in the perceptual stage, reflects short-term memory, or is due to a late-stage response programming bias. The results suggest new, nonverbal measures of anxiety. They also suggest that the right hemisphere is the proper target for both measuring and controlling anxiety.

C48**FURTHER EVIDENCE FOR AN EPISTASIS BETWEEN 5-HTT AND BDNF FROM SELF REPORTED ANXIETY RELATED TRAITS**

Tina B. Lonsdorf^{1,2}, Armita Golkar^{1,2}, Martin Schalling¹, Arne Öhman^{1,2}; ¹Karolinska Institutet, ²Stockholm Brain Institute – Anxiety related traits have been associated with several genetic polymorphisms. The s-allele of an insertion/deletion (5-HTTLPR) in the serotonin transporter (5-HTT) promoter is associated with higher neuroticism, amygdala reactivity and morphological alterations. The met-allele of a polymorphism (BDNFval66met) in the Brain-derived neurotrophic factor (BDNF) pro-domain has been associated with lower scores on anxiety related traits. A study by Pezawas et al. (2008) demonstrated a biological epistasis between BDNFval66met and 5-HTTLPR. The morphological phenotype of 5-HTTLPR s-allele carriers, reduced gray matter volume of the subgenual anterior cingulate, could be compensated by the presence of a BDNF met-allele. We tested this epistasis at the level of self reported traits. 349 healthy individuals, genotyped for 5-HTTLPR and BDNFval66met, filled in the Swedish University Scales of Personality (SSP). Both 5-HTTLPR and BDNFval66met genotype had a main effect on the subscale Stress Susceptibility (SS): 5-HTTLPR s-carriers and BDNF val-carriers reported higher SS than individuals homozygous for the 5-HTTLR l-allele, $p=0.04$, and the BDNF met-allele, $p=0.032$. Furthermore there was evidence for an epistasis effect: 5-HTTLPR s-carriers that also were homozygous for the BDNF met-allele reported significantly less SS than 5-HTTLPR s-carriers that also carried a BDNF val-allele, $p=0.011$. Our data indicate that the BDNF met/met genotype seems to protect against the adverse effect of the 5-HTTLPR s-allele also on the level of self reported traits.

C49**GENETIC SUSCEPTIBILITY TO DEPRESSION AND SELECTIVE ATTENTION FOR NEGATIVE AND POSITIVE INFORMATION: PRELIMINARY FINDINGS**

Iris van Oostrom¹, Barbara Franke², Maaïke Verhagen¹, Annemarie Van der Meij¹, Jan Buitelaar¹, Constance Vissers¹, Armand van Oosterwijk¹, Joost Janzing¹; ¹Donders Institute for Brain, Cognition and Behaviour, Psychiatry, The Netherlands, ²Radboud University Nijmegen Medical Centre, Antropogenetics, Nijmegen, The Netherlands – According to the cognitive theory of depression, individuals susceptible to depression attend selectively to negative information and filter out positive information. Goal of the study was to examine the relationship between candidate genetic susceptibility factors for major depressive disorder (MDD) and selective attention for negative or positive information in formerly depressed patients, their unaffected relatives and unaffected controls. Formerly depressed female patients having at least one first-degree relative with a history of MDD ($n=23$), unaffected female relatives ($n=20$) and female healthy controls screened for lifetime MDD ($n=10$) were administered the emotional Stroop task using negative, positive and neutral words. Attentional biases were calculated using the difference in reaction times (RT's) between neutral and negative or positive words. The CIDI was used to assess current and lifetime diagnosis of MDD. All participants were genotyped for polymorphisms in the 5-HTT/SLC6A4 gene (5-HTTLPR), BDNF (Val66Met) and COMT (Val158Met). Patients and family members demonstrated non-significantly ($p=0.09$) longer RT's for negative compared to neutral words ($m=5.67$; $sd=26.78$), while controls demonstrated shorter RT's for negative compared to neutral words ($m=-13.39$; $sd=46.04$). Groups did not demonstrate differences with regard to positive bias. At the genetic level, no significant differences were observed in attentional biases between groups based on genetic polymorphisms. Findings suggest that formerly depressed patients and their unaffected family members tend to focus more on negative information than controls. Our non-significant findings may be due to small sample sizes and/or the restricted contribution of single polymorphisms. We suggest to use larger sample sizes in future studies.

C50

ATTENTIONAL REDEPLOYMENT AS AN EFFECTIVE EMOTION REGULATION STRATEGY

Martin Herrmann^{1,2}, Andreas Mühlberger², Alexandra Rebban², Maïke Georgs², Paul Pauli², Andreas Fallgatter¹; ¹University of Würzburg, Psychiatry, Psychosomatics and Psychotherapy, ²University of Würzburg, Psychology – Recent studies have shown that cognitive reappraisal can be used as an effective emotion regulation strategy, leading to decreased amygdala activity and to a reduction of the late positive potential (LPP) in the EEG. Van Reekum and colleagues (2007) tested the possibility that people use attentional redeployment rather than, or in addition to, reappraisal as a strategy to regulate emotion. Indeed they found that subjects show a reduced viewing of the emotion-eliciting stimulus when they were instructed to decrease the emotional response. Another study (Dunning and Hajcak, in press) showed that cues leading the visual attention to a non emotional focus within unpleasant images can also reduce the LPP. Both studies suggest that attentional redeployment might be an effective emotional regulation strategy, which should be tested in our study. Therefore we instructed our subjects (n=20) to lead their attention to a non emotional or emotional focus within the displayed images and recorded the event-related EEG potentials with 21 scalp electrodes. As hypothesized we found a reduction of the LPP over Pz while focusing to a non emotional part of the pictures, leading to the suggestion that simply to instruct the subjects not to look at the emotional part of a picture is a useful emotion regulation strategy for healthy subjects.

C51

MOOD AFFECTS SYNTACTIC PROCESSING: EVIDENCE FROM P600

Constance Vissers¹, Daniele Virgillito², Dan Fitzgerald¹, Anne Speckens¹, Indira Tendolkar¹, Iris Van Oostrom¹, Dorothee Chwilla³; ¹Donders Institute for Brain, Cognition and Behaviour, Psychiatry, ²Scuola Superiore di Catania, Catania, Italy, ³Donders Institute for Brain, Cognition and Behaviour – A P600 effect has been reliably reported after syntactic violations (Osterhout et al., 1992) and more recently also to several kinds of semantic anomalies (Kuperberg, 2007). To our view the P600 effect reflects a more general process of reanalysis, triggered by a strong conflict between a highly expected and an unexpected linguistic element (Vissers et al. 2008). In this study we explored the interaction between syntax and emotion. To this aim, we investigated the effects of emotional state on P600. EEG was recorded while female participants (31) read sentences half of which contained subject-verb agreement errors ('The crook who shot[plural] at the cops...') and correct sentences ('The cops who shot[plural] at the crook...'). Mood was manipulated between participants by presenting short film clips that either displayed fragments from a happy movie or a sad movie. The main results were as follows: After watching the happy film clips participants scored significantly higher on a 9 point-mood scale than after watching the sad film clips ($p < .01$). The clips thus effectively induced the intended mood. For P600, measured between 600 to 800 ms, an interaction of syntax with mood was present for both the midline and for the lateral sites ($ps < .02$). The interaction revealed a broad bilaterally distributed P600 effect for the happy mood condition, and a strong reduction of a P600 effect for the sad mood condition. Hence, syntactic processing is affected by mood in healthy subjects. This modulation of syntax by mood challenges modular views of language processing.

C52

DISPOSITIONAL MINDFULNESS AND NEURAL SYSTEMS UNDERLYING REAPPRAISAL OF NEGATIVE EMOTION

Gemma Modinos¹, Johan Ormel², André Aleman¹; ¹BCN Neuroimaging Center, University of Groningen, Groningen, The Netherlands, ²Interdisciplinary Center of Psychiatric Epidemiology, University Medical Center Groningen, Groningen, The Netherlands – Research with functional magnetic resonance imaging (fMRI) has played a crucial role in seeking to determine the neural substrates of the cognitive regulation of negative emotional responses. However, little is known about how activity in these regions is

modulated by individual differences in the tendency to respond emotionally or to regulate emotion. Mindfulness, an enhanced attention to and awareness of current experience, is at the core of meditation practices, and is known to reduce negative affect and promote well-being. The influence of dispositional mindfulness skills, thought of as a form of self-regulation, on the neural systems supporting the cognitive control of emotion remains unknown. To examine the relationship between mindfulness and reappraisal-related neural structures, we imaged 18 healthy subjects (mean age = 20.56; 7 females) while performing a reappraisal task in a 3T MRI scanner. Subjects viewed neutral and negative emotional pictures under three conditions - attend-neutral, attend-negative, reappraise-negative - and provided in-scan emotion experience ratings. Dispositional mindfulness skills were assessed prior to scanning through self-report. When individual mindfulness scores were incorporated in the analysis of brain activity associated with reappraising compared to attending to negative pictures, we observed that mindfulness significantly predicted increased activity in the amygdalae, insula, and dorsal prefrontal cortex. These results suggest a direct link between mindfulness and the neural substrates of emotion processing and its cognitive control, and provide novel neuroscientific support to the potential usefulness of mental training in the effective regulation of negative affect.

C53

MOTOR SYSTEM CONTRIBUTIONS TO SOCIAL INTERACTION SKILLS: EVIDENCE FROM EEG ACTIVITY IN THE MU FREQUENCY RANGE

Anat Perry¹, Shlomo Bentin^{1,2}, Nikolaus F. Troje³; ¹Hebrew University, Psychology, Jerusalem, Israel, ²The Interdisciplinary Center of Neural Computation, Hebrew University, Jerusalem, Israel, ³School of Computing, and Centre for Neuroscience Studies, Psychology, Queen's University, Kingston, Canada – Motor actions suppress the EEG activity over the sensory-motor cortex, in a frequency range between 8-13 Hz, a range labeled Mu rhythms. Mu-suppression is induced not only by actual movements but also while the participant observes actions executed by someone else. This characteristic of Mu rhythms putatively associates them with the Mirror-Neurons System, which has been implicated in humans with social skills abilities and ToM. Further evidence for association between mu rhythms and social skills comes both from studies of individuals with Autistic Spectrum Disorders, and from a few studies with typical participants. These studies showed different mu rhythms modulations depending on the degree of social content of an observed human action. We further explored the basic relation between mu rhythms and social interaction. Specifically, using point-light biological motion, we manipulated the observer's task while keeping the stimuli identical across tasks. In separate blocks EEG was recorded while observers were instructed to process either the gender or the emotion or the intention of a moving pattern revealing the same biological motion of humans. The participants also completed two questionnaires - The Interpersonal Reactivity Index, and The Empathy Quotient. Mu suppression was found in all conditions relative to a baseline consisting of a moving circle. The suppression was modulated by task, strengthening the proposed association between mu rhythms and social interaction skills. Significant correlations between mu suppression and the scores on the personality scales unveiled theory-based individual variability in the activation of the mu-suppression mechanism.

C54

SITUATED CONCEPTUALIZATION OF EMOTION AND ABSTRACT CONCEPTS

Christine Wilson¹, Lisa Feldman Barrett^{2,3}, W. Kyle Simmons⁴, Lawrence Barsalou¹; ¹Emory University, Psychology, ²Boston College, Psychology, ³Harvard Medical School, Psychiatric Neuroimaging Research Program, Massachusetts General Hospital, ⁴National Institutes of Mental Health, Laboratory of Brain and Cognition – Evidence increasingly suggests that the human conceptual system is situated and dynamic. From this perspective, situational content, such as setting, event, and thematic information, shapes concepts dynamically, including emotion concepts like fear and anger. This approach to emotion concepts motivates

different questions than traditional views that focus instead on trying to identify a diagnostic biological pattern in the body and brain for each emotion category. To investigate whether situational context shapes emotion concepts dynamically, we developed an fMRI paradigm in which a mental state concept is processed in physical situations (where participants imagined being in physical danger brought on by their own poor judgment) and in social situations (where participants imagined being socially evaluated in an unfair manner by another individual). Two emotion concepts (fear, anger), and two abstract concepts (plan, observe), were assessed in each situation type. On a given trial, participants listened to the description of a situation, heard one of the four mental state words, and rated how easy it was to experience the mental state in the situation. We predicted that different activation patterns would occur for the same mental state concept in the two situation types. Results support these predictions, indicating that conceptualizing an emotion or abstract concept is a context-sensitive, dynamic process.

C55

DIFFERENTIAL NEURAL RESPONSES TO EMOTIONAL STIMULI ASSOCIATED WITH MOOD CONGRUENT VS MOOD INCONGRUENT DELUSIONS Ayana Gibbs¹, Paul Fletcher², Anthony David¹; ¹Institute of Psychiatry, King's College London, ²University of Cambridge – Delusions in psychosis have been divided into those that arise from underlying mood disturbance (mood congruent - MC) and those arising in the absence of mood abnormalities (mood incongruent - MI). Abnormal responses to emotional stimuli may play a role in the formation of delusional beliefs. However this role may differ for MC compared to MI delusions. To investigate this, fMRI data were collected while participants (8 MC, 9 MI and 15 controls) viewed 46 aversive-arousing pictures and 46 neutral pictures. In the AVERSIVE > NEUTRAL contrast MC patients demonstrated a similar pattern to controls with activation in visual cortical areas and limbic areas, while the MI group demonstrated activity in ventral striatal regions. In the alternate NEUTRAL > AVERSIVE contrast there was a pattern of ventral striatal activation in the MC group, mirrored to a lesser extent in the controls, suggesting relative suppression of striatal responses to aversive pictures. Between group comparisons of the AVERSIVE > NEUTRAL contrast revealed increased activation of the ventral striatum in MI relative to MC patients. Taken with the within group findings, this suggests that the MI group may be less effective at suppressing activity in this reward-associated region in the presence of a non-rewarding or aversive stimulus. There was also increased activation of the precuneus in MC relative to MI patients. These findings suggest that abnormal patterns of brain activation to emotional stimuli may play a role in the formation of mood congruent and mood incongruent delusions however the neural mechanisms may differ.

C56

EARLY AND LATE EFFECTS OF EMOTIONAL WORDS AND FACES IN THE EVENT-RELATED BRAIN POTENTIAL Annkathrin Schacht¹, Julian Rellecke¹, Werner Sommer¹; ¹Humboldt-University at Berlin, Psychology – Several studies have shown emotional stimuli to involuntarily draw attentional resources, resulting in a preferential and sustained processing. The underlying neural mechanisms are suggested to be reflected in two different components of event-related brain potentials (ERPs): the early posterior negativity (EPN) and the late positive potential (LPC). However, as yet it remains mostly unclear, under which boundary conditions emotional processing depends on the availability of central attentional resources and specific stimulus characteristics. In a series of experiments, we investigated the time course of emotion effects in word and face processing by using ERPs. In line with studies on affective picture processing, both EPN and LPC components - distinguishable in their scalp topographies and latencies - were elicited by emotional words and facial expressions, although their emotional meaning was irrelevant for the tasks. Importantly, EPN effects appeared later to words than faces, but showed comparable scalp distributions in both domains, and were independent of the level of processing. More-

over, the EPN to angry faces appears to benefit from the withdrawal of central resources by an additional task. In contrast, LPC effects were modulated by a variety of different factors and dependent on specific task demands. Furthermore, these late emotion effects appeared at comparable latencies but with different scalp distributions to words and faces, indicating contributions of domain-specific brain systems. These results indicate both ERP components to reflect different mechanisms of emotional processing at early and late stages.

C57

RECOGNIZING EMOTIONS FROM OUR OWN FACES: HOW GOOD ARE WE? Bhismadev Chakrabarti¹, Jorrit de Kieviet^{1,2}, Zanna Szlachta^{1,3}, Simon Baron-Cohen¹; ¹Autism Research Centre, University of Cambridge, ²Vrije University, Amsterdam, The Netherlands, ³MRC Cognition and Brain Sciences Unit, Cambridge, UK – Background: Our own face has special status as an instrument for interacting with the external social world, using expressions of emotion that we rarely see. Humans, from birth, perceive expressions of emotion in the faces of others but have limited visual experience of their own emotion expressions (via mirrors and film). In two experiments we tested emotion recognition from one's own face compared to those from others' faces. Sample and Method: 34 volunteers were photographed making expressions of five basic emotions, and tested one week later using their own face and those of unknown others (taken from a standardized stimuli set), in an emotion recognition task. Results: In Experiment 1, people were quicker to correctly recognize all emotions from their own face, compared to others' faces. In Experiment 2 replicated these results, using a set of morphed faces between self and others, and showed that the degree of self-similarity in a faces is positively correlated with speed of accurate emotion recognition. Conclusions: This is the first demonstration of a self-effect in relation to basic emotion recognition from faces. The results are consistent with an account based on simulation theory and have possible clinical implications for conditions marked by difficulties in self and emotion processing, such as autism spectrum conditions.

C58

CUE-DEPENDENT NEURAL REPRESENTATIONS OF VOCAL AFFECT PERCEPTION David Leitman¹, Tim Campellone¹, Daniel Ragland², Daniel Wolf¹, James Loughhead¹, Jeffery Valdez¹, Cameron Carter², Bruce Turetsky¹, Daniel Javitt^{3,4}, Ruben Gur¹; ¹Brain Behavior Laboratory, Neuropsychiatry Section, ²Imaging Research Center, UC DAVIS, ³Nathan S Kline Institute for Psychiatric Research, ⁴New York University, Psychiatry – Affective communication through vocal tone (prosody) is a core channel of interpersonal interaction, which, like its facial analogue, relies on gestural changes. Such vocal changes involve modulation of specific aspects of the speech signal including perceived pitch, voice intensity, and spectral energy. The stage in the information processing cascade where perception and integration of these cues occur in the brain is the topic of intensive debate. Using functional magnetic resonance imaging, we show that right primary and secondary auditory cortices are already sensitive to valence-related vocal features. These auditory regions in conjunction with limbic regions show a reciprocal pattern of activation with inferior frontal gyrus. The balance of activation is determined by the degree of cue salience in an emotion-specific manner.

C59

EARLY EXPERIENCE AND CHANGES IN BRAIN STRUCTURE AND FUNCTIONS FOR MATERNAL LOVE Pilyoung Kim^{1,2}, James Leckman², Linda Mayes², Michal-Ann Newman³, Ruth Feldman⁴, James Swain²; ¹Human Development, Cornell University, ²Child Study Center, Yale University, ³Howard University, ⁴The Leslie and Susan Gonda Brain Science Center, Bar-Ilan University, Israel – Early experience such as maternal care can influence development of stress reactivity and the ability to bond with others. Animal studies suggest that early maternal care is related to heightened stress reactivity in the hippocampus. Maternal care may also have long-term effects on brain areas related to social competence and attachment. To examine whether early experience may affect neurologi-

cal correlates of maternal love, we studied effects of perceived quality of maternal care in childhood on brain structure and functional responses to salient infant stimuli among human mothers in the first postpartum month. Higher maternal care in childhood was linked to larger gray matter volumes in the superior and middle frontal gyri, orbital gyrus, superior temporal gyrus and fusiform gyrus. These areas have been found to be important for social information processing. Furthermore, in response to infant cries, mothers with higher maternal care in childhood showed increased activations in the dorsolateral prefrontal cortex, middle frontal gyrus, superior temporal gyrus, and fusiform gyrus; whereas mothers with lower maternal care showed increased hippocampal activations. The areas with greater brain activations were considerably overlapping with the areas with larger gray matter volumes among the high maternal care group. These findings suggest an association between maternal care in childhood and neurobiological substrates of stress reactivity, social attachment, further maternal love in human mothers.

C60

NEURAL SUBSTRATES OF FEAR EXTINCTION DUE TO EXPOSURE THERAPY *Katherina Hauner¹, Susan Mineka¹, William Revelle¹, Ken Paller¹*; ¹Northwestern University, Psychology – Specific phobias, characterized by excessive and unreasonable fear of an object or situation, are the third most prevalent of all mental disorders. Exposure therapy for specific phobias can lead to fear extinction, usually within two hours of treatment. The neural mechanisms by which this remarkable clinical outcome is accomplished are not currently understood. The chief goal of the present study was to identify the functional neuroanatomical substrates of fear extinction following exposure therapy in a group of participants meeting diagnostic criteria for spider phobia. An additional goal was to determine the extent to which extinction and habituation (a non-associative decrease in fear due to repeated stimulus presentation) are neuroanatomically distinct. Before treatment, neural correlates of phobic fear were obtained as differential fMRI responses to alternating sequences of phobic images (spiders) versus neutral images (moths), particularly in the amygdala. A detection task performed during all scanning required subjects to maintain attention to all stimuli. Neural correlates of habituation were obtained using repeated phobic images. Participants then completed a 2-hour exposure therapy session (or 2-hour sham therapy session), followed by a subsequent fMRI session during which they viewed a novel set of phobic and neutral images. Results yielded pre- versus post-treatment changes in the processing of phobic versus neutral stimuli. These findings are relevant for hypotheses regarding neurocognitive mechanisms for fear extinction, which appears to involve both changes in the perception of fear and in the strategic use of fear inhibition. Ramifications for neurobiological models of fear extinction will be discussed.

Higher level cognition: Executive functions

C61

SEPARATE SYSTEMS IN ATTENTIONAL SWITCHING AND SELECTION: EVIDENCE FROM FMRI *Benjamin O. Turner¹, F. Gregory Ashby¹*; ¹University of California, Santa Barbara – In the Wisconsin Card Sorting Test (WCST), subjects learn to sort cards using a series of simple one-dimensional rules. Perseverative responding on this test is a classic symptom of frontal dysfunction. Even so, perseverative errors on the WCST could be due to a failure to select the appropriate dimension that needs attending, or to a failure to switch attention from the current dimension to the newly selected dimension. The present study used a modified version of the WCST in which errors of selection and switching had separate observable effects. Healthy normal college students performed this modified WCST in a rapid event-related fMRI experiment, experiencing approximately 100 rule changes over the course of the scan-

ning session. The results strongly supported the hypothesis that selection and switching are separate neural and cognitive processes. For example, relative to rule switching, rule selection was associated with increased activation in anterior cingulate cortex and in the striatum. Further, these areas were shown to be components in partially-overlapping networks that mediated the selection and switching operations. Overall, the results were generally consistent with the COVIS model of category learning, which proposes that selection is mediated by a network that includes the anterior cingulate and the prefrontal cortex and that switching is mediated by a reduction in the prefrontal activation of the striatum.

C62

NEURAL NETWORKS THAT MONITOR RESPONSE UNCERTAINTY *Erick J. Paul¹, David Smith², F. Gregory Ashby¹*; ¹University of California, Santa Barbara, ²University at Buffalo, State University of New York – Humans and some animals (but not all) display the ability to monitor uncertainty about the environment, and to cope with such uncertainty by escaping or by seeking more information. In most categorization and discrimination experiments, participants are forced to make a decision on each trial regardless of their uncertainty. Some paradigms, however, have been designed specifically to elucidate the nature of uncertainty monitoring during such tasks. Researchers have successfully observed strategic use of uncertainty (or escape) responses from humans and some animals, but the neural substrates of uncertainty monitoring are not entirely known. Using fMRI, the present study sought to detect active brain regions related to uncertainty in a categorization task. Human subjects were asked to categorize visual patterns according to whether the pixel density was sparse or dense; they were also allowed to use an uncertain response on every trial. Correct responses were rewarded, incorrect responses were punished, and uncertainty responses allowed participants to escape to the next trial. On trials when uncertain responses were given, we identified activity unique to uncertainty responses and unrelated to task difficulty. This network included areas of bilateral frontal cortex, anterior cingulate cortex, and right posterior insular cortex, which have been implicated in state monitoring, self-awareness and attention. These results help to describe the neural components of uncertainty and metacognition and may clarify what distinguishes humans and animals that can consistently use uncertainty responses from those that cannot.

C63

INFLUENCE OF CONFLICT SIZE AND ERROR TYPES ON POST-ERROR SLOWING *Carolin Dudschig^{1,2}, Ines Jentzsch¹*; ¹University of St Andrews, ²Universität Tübingen – In order to achieve optimal performance, people are able to adjust their response threshold on a trial-to-trial basis, becoming increasingly faster until committing an error and slowing down immediately after the error. Such adjustments are usually explained by shifts along the speed-accuracy trade-off function, triggered by conflict in previous trials (Botvinick et al., 2001). Some researchers assume that conflict is particularly large in error trials, especially when the erroneous and correct responses are similar (e.g. left foot instead of left hand, see Gehring & Fensick, 2001). However, the influence of conflict strength on post-error slowing, and the link between the error-related negativity (ERN) and post-error slowing, is still unclear. In two experiments conflict size and its influence on post-error slowing and on the ERN were investigated. If conflict strength determines post-error slowing, slowing should increase the more response features are shared by the erroneous and correct response. We found the ERN and post-error slowing to increase with increasing conflict, but only when different effectors (hand, foot) were involved. When only hand responses were required (hand, finger), the data did not follow the predictions of the conflict strength hypothesis. We conclude that the conflict account as well as the relationship between ERN amplitude and post-error slowing is limited to specific task settings.

C64

INDIVIDUAL VARIABILITY IN WORKING MEMORY CAPACITY PREDICTS SUCCESS IN ATTENTION-RELATED PROCESSING OF VISUAL STIMULI

Jesse J. Bengson^{1,2,3}, George R. Mangun^{1,2,3,4}, ¹Center for Mind and Brain, University of California, Davis, ²University of California, Davis, ³University of California, Davis, Psychology, ⁴University of California, Davis, Neurology – We investigated the hypothesis that working memory capacity (WMC) supports a subject's ability to generate expectancies for the characteristics of upcoming stimuli. In a cuing paradigm (Handy et al., 2001) participants were cued to expect both the location and orientation of a square-wave grating stimulus. Performance in the cuing task was measured as the difference in reaction time (RT) and accuracy between validly cued orientations and invalidly cued orientations at validly versus invalidly cued spatial locations. The Operation Span (OSPAN) task (Turner & Engle, 1989) indexed variations in subjects' WMC. The design included two between-subjects conditions: a response cued condition, in which the grating orientation cue also cued the hand of response, and a feature cued condition, in which the orientation cue did not predict the hand of response. A total of 111 subjects were tested. In the response-cued condition, independent of WMC, we found that RTs were faster for validly cued orientations, at both validly, ($t(54) = 10.599$, $p < .000$), and invalidly cued spatial locations, ($t(54) = 5.501$, $p < .000$). In contrast, in the feature-cued condition, the benefits of cueing were observed at validly cued spatial locations only for those subjects in the top third of WMC, ($t(17) = 4.134$, $p = .001$). In conclusion, these findings show that the ability to develop expectancies for complex stimuli is critically dependent on individuals' WMC. As a result, individuals with higher WMC are better able to utilize selection mechanisms to enhance performance under demanding perceptual conditions.

C65

EFFECTIVE AND STRUCTURAL CONNECTIVITY OF THE EXECUTIVE AND MOTIVATIONAL CORTICOSTRIATAL LOOPS UNDERLYING FEEDBACK PROCESSING

Dan Lopez-Paniagua¹, Carol Seger¹, ¹Colorado State University – Previous research indicates that feedback is crucial for successful category learning. The head of the caudate and ventral striatum have been shown to be sensitive to feedback across different types of learning, including category learning. Several cortical areas work collectively with these striatal regions; the head of the caudate connects with prefrontal and posterior parietal cortex to form the 'executive' corticostriatal loop, while the ventral striatum connects with orbitofrontal and mediofrontal cortex to form the 'motivational' corticostriatal loop. In this study, both effective and structural connectivity of the executive and motivational loops were examined. First, BOLD responses associated with feedback processing were measured during trial and error learning in a categorization task. Diffusion tensor mapping (DTM) identified frontostriatal pathways between regions implicated in feedback processing. Effective connectivity between striatal and cortical regions sensitive to feedback was then assessed using Granger Causality Mapping (GCM). Directed influence was observed from ventral striatum to mediofrontal cortex, from mediofrontal cortex to the head of the caudate, which in turn exerted directed influence on lateral prefrontal, posterior parietal cortex, and posterior regions of the caudate. The effective and structural connectivity results of the present study provide further insight as to how the striatum and cortex interact to subservise feedback processing. In particular, GCM results demonstrate that information from one corticostriatal loop can be relayed to another loop in a "feed-forward" fashion, and are consistent with animal models showing that interactions between loops occur in a ventroanterior to laterosuperior direction beginning in the ventral striatum.

C66

DISSOCIABLE COMPONENTS OF COGNITIVE CONTROL: AN ELECTROPHYSIOLOGICAL INVESTIGATION OF RULE-SWITCHING

Matthew Waxer¹, J Bruce Morton¹, ¹The University of Western Ontario, Psychology – Rule-switching is thought to involve distinct preparatory and response-related processes. The current study

investigated these potentially dissociable aspects of cognitive control by mean of high-density event-related potentials (ERP's). Adult ($n=20$) participants performed a deductive rule-switching task with distinct preparatory and response-related trial periods. To investigate differences in preparatory processes underlying rule-switching, we compared ERP's in the preparatory period of switch trials and repeat trials. To investigate differences in response-related processes underlying rule-switching, we compared ERP's in the response period of conflict trials and non-conflict trials. Participants were slower and more error-prone on switch trials and conflict trials than on repeat trials and non-conflict trials. There was no interaction between switching and conflict. Analysis of ERP's time-locked to the preparatory period revealed a late negativity over frontal sensors whose amplitude was greater on switch than repeat trials. Source localizations of these ERP data with Low Resolution Electromagnetic Tomography (LORETA) revealed increased current density activations of the anterior cingulate cortex (ACC), left dorsolateral prefrontal cortex (DLPFC), and left parietal cortex for switch trials relative to repeat trials. Analysis of ERP's time-locked to the response-period revealed a fronto-central N2 whose amplitude was greater on conflict than on non-conflict trials. Distributed cortical source localizations of these data with LORETA revealed increased current density activations of the ACC for conflict relative to non-conflict trials. These findings provide further insight into differences in dissociable processes involved in rule-switching.

C67

WHO TO MARRY OR TO CHOOSE AS A FRIEND?: EFFECT OF SOURCE INFORMATION AND SOCIAL CONTEXT ON THE BRAIN MECHANISMS OF PERSON-PREFERENCE JUDGMENT

Motoaki Sugiura^{1,2}, Risa Funayama², Yuko Sassa^{1,3}, Hyeonjeong Jeong^{1,4}, Keisuke Wakusawa^{1,5}, Kaoru Horie^{6,7}, Shigeru Sato^{6,7}, Ryuta Kawashima^{1,3}; ¹IDAC, Tohoku University, Sendai, Japan, ²Faculty of Education, Miyagi University of Education, Sendai, Japan, ³RISTEX, JST, Kawaguchi, Japan, ⁴Japan Society for the Promotion of Science, Tokyo, Japan, ⁵Graduate School of Medicine, Tohoku University, Sendai, Japan, ⁶Graduate School of Intercultural Studies, Tohoku University, Sendai, Japan, ⁷LBC Research Center, Tohoku University, Sendai, Japan – Person preference is critical to the dynamics of our society. In making judgments, the face and behavior are two important sources of information, and choice of spouse and of friends are different decisions. We used functional magnetic resonance imaging to identify brain areas involved in person-preference judgment, based on paired information in two contexts. Normal subjects were shown pictures of two different faces of the opposite sex (Fa), or shown one actor performing two different routine behaviors (Bh). Each subject selected the person they would prefer to marry (Mr) or to be a friend with (Fr). As a control task, brightness of the picture was judged. All the preference-judgment conditions activated the anterior cingulate and caudate nucleus more than the control task. The Bh condition activated the bilateral temporoparietal junction and anterior temporal sulcus more than the Fa condition. Activation in the right ventral striatum and left amygdala was conspicuous in the FaMr condition. Activation in the right dorsolateral and medial prefrontal cortices was prominent in the BhMr condition. Our results showed that, in addition to the common decision-making mechanism, person-preference judgments recruit different brain areas, depending on the type of source information and social context. Behavior-based judgment involves the neocortical networks for social perception. Choice of a spouse, which is of critical evolutionary importance, recruits the limbic networks in face-based judgment and the neocortical cognitive integration and inhibition networks in behavior-based judgment, presumably reflecting different evolutionary stages, when the two types of source information were relevant to the judgment.

C68

INDEPENDENT MODULATORS OF REGIONAL EEG ALPHA SUB-BAND POWER DURING A WORKING MEMORY TASK

Julie Onton¹, Scott Makeig¹, ¹University of California, San Diego – Previous studies have suggested that upper and lower alpha-band power are sepa-

rately regulated during certain cognitive processes. A shortcoming of those studies was that alpha power was summed across several scalp channels. Here we show that alpha sub-bands are, indeed, separately regulated and occur within single EEG independent component or source domains. EEG data from a "two-back" working memory task was first decomposed by extended-infomax independent component analysis (ICA) to isolate temporally independent EEG activities from the signal mixtures recorded at the scalp channels. Activation time series of brain-generated independent component (IC) processes were transformed into log spectrograms using 4-cycle (at 4 Hz) to 42-cycle (at 125 Hz) wavelets moved at 50-ms intervals through each stimulus-response trial. The mean log power spectrum over all time windows was removed for each IC, leaving spectral fluctuations from the mean log spectrum in each window. Spectral data from all ICs were reduced by principal component analysis (PCA), and then again decomposed by ICA to separate the spectral data into a log mixture of independent modulator processes (IMs) with maximally distinct spectral profiles across ICs and frequencies. Some of the resulting IM templates accounted for activity in distinct alpha sub-bands. Because each IM template was associated with IM time weights for each trial and latency, we could test whether these alpha sub-band modulators had different mean time courses relative to task events and whether the patterns of alpha power modulation were brain-region specific.

C69

THE EFFECTS OF EXPECTED VALUE AND RISK LEVEL ON BEHAVIORAL AND ELECTROPHYSIOLOGICAL RESPONSES IN A MODIFIED IGT Nai-Shing Yen^{1,2}, Chang-Hao Kao¹, I-Chen Chou¹, Hui-Kuan Chung¹; ¹Psychology, National Chengchi University, Taipei, Taiwan, ²Research Center for Mind, Brain, and Learning, National Chengchi University, Taipei, Taiwan – The somatic marker hypothesis (SMH) proposed that decision making is a process that depends on emotion and deficits in emotional signaling will lead to poor decision making (Damasio, 1994). An Iowa Gambling Task (IGT) was used to support SMH. In the IGT, somatic marker (i.e. anticipatory SCR) is interpreted as correlates with the bad decks, and it operates as an alarm to make subjects withdraw from bad decks. Compared with normal controls, patients with VMPFC damage showed less anticipatory SCR and chose more cards from bad decks. However, the bad decks in IGT are also more risky decks. Thus, another factor which may influence the performance on the IGT is risk level (Dunn et al., 2006). In order to further clarify the SMH, the expected values and risk levels were manipulated in a modified IGT. In good decks, the immediate gain and delayed loss are smaller, which leads to positive expected values. In bad decks, the immediate gain and delayed loss are larger, which leads to negative expected values. The risk level was manipulated by the magnitude of coefficient of variation. Behavioral data, SCR and alpha activity in the EEG were collected. In our modified IGT, a significant interaction between decks and risk levels was found. Participants chose more cards from bad decks in high risk condition and chose more cards from good decks in low risk condition. Furthermore, the anterior alpha activity showed the same pattern as the behavioral data. But the anticipatory SCRs were not. Therefore, the SMH is not supported.

C70

A FUNCTIONAL MAGNETIC RESONANCE IMAGING STUDY OF LIST-WIDE VS. ITEM-SPECIFIC CONTROL IN THE STROOP TASK Julie Bugg¹, Bethany Edwards¹, Todd Braver¹; ¹Washington University in St. Louis – The magnitude of Stroop interference is smaller when attentional conflict occurs frequently, as in a mostly incongruent condition. In a previous study using a state-item fMRI design, we found that decreases in list-wide proportion congruence (the percentage of congruent trials within a list) were selectively associated with increased state-related activation of right ventrolateral prefrontal cortex. We interpreted this sustained pattern as reflecting increased utilization of proactive control: expectancy-driven attentional adjustments that biased

attention away from word reading even prior to stimulus onset. While recent behavioral evidence suggests a single control mechanism may underlie both the list-wide and item-specific proportion congruence effect (i.e. smaller interference for mostly incongruent items in a 50% congruent list), this idea has not been tested using fMRI. In the current study, we used a state-item fMRI design to examine the degree to which similar or dissociable neural activation patterns characterize list-wide and item-specific proportion congruence effects. Participants (N = 20) were scanned while performing Stroop trials in blocks for which proportion congruence was manipulated in a list-wide manner (mostly congruent, mostly incongruent, mostly neutral, and equal ratio) as well as in an item-specific manner (list = equal ratio). Both types of proportion congruence manipulations influenced behavioral interference effects. The imaging results address whether these manipulations differentially affect activity in control regions, including the anterior cingulate cortex and lateral prefrontal cortex response to conflict. We consider several explanations for our findings including the role of stimulus repetition.

C71

MOTIVATIONAL INFLUENCES ON INHIBITION-RELATED BRAIN ACTIVITY Lauren Leotti¹, Tor Wager¹; ¹Columbia University, Psychology – The stop-signal paradigm provides a sensitive measure of response inhibition (SSRT) that is assumed to be independent of strategic and motivational biases. However, our recent work has shown that SSRT varies systematically when adopting different strategic tradeoffs between speed and accuracy. The present study examines stop-signal performance in 14 participants in a mixed-block/event-related design, which allowed us to separate responses on stop and go trials (phasic changes) with sustained strategy-related activity (tonic changes). Consistent with previous studies, successful inhibition of responses to the stop-signal was associated with increased activity in inferior frontal cortex (IFC) and striatum. Controlling for activity due to phasic responses, we observed tonic increases in response inhibition-related regions (right IFC) when subjects adopted an accuracy bias and tonic increases in motor preparation regions (basal ganglia, substantia nigra, motor cortex) when subjects adopted a speed bias. Furthermore, strategy-induced differences in tonic activity predicted differences in phasic response on successful inhibition trials. Greater tonic activation of right IFC (accuracy > speed) predicted greater phasic activation of the globus pallidus on successful stop trials. Greater tonic increases in the substantia nigra (speed > accuracy) predicted less phasic activity in control regions in the lateral PFC. Collectively, the results suggest that strategic shifts alter the recruitment of regions involved in response inhibition and response selection. Separating the influences of motivation from inhibitory processes is important for understanding the neural bases of inhibitory control in normal cognition and in populations with presumed inhibitory deficits.

C72

REGULATORY FOCUS AND EXECUTIVE FUNCTIONS Brian D. Glass¹, J. Vince Filoteo², Arthur B. Markman¹, W. Todd Maddox¹; ¹The University of Texas at Austin, ²VA San Diego Healthcare System & University of California, San Diego – Executive functions (EF) encompass cognitive processes that allow flexible and adaptive behavior in the face of novel or changing situations. The anterior cingulate cortex (ACC) and head of the caudate nucleus have been proposed as critical brain regions in rule based tasks involving set shifting (Maddox & Ashby, 2004; Monchi et al., 2006). The Wisconsin Card Sorting Task is the gold standard measure of EF in cognitive assessment and has been used extensively in experimental settings. We test the hypothesis that EF is affected by the interaction of global incentive structure and the local task reward structure in a group of normal participants. This prediction is based on the possibility that the ACC is differentially activated by the interaction between global incentive structure and local task components (Cunningham et al., 2005). Global incentive structure was manipulated by requiring participants to earn a raffle entry (promotion focus) or keep a raffle entry from being revoked (prevention focus). Reward structure was framed as maximizing point

accrual (gains structure) or minimizing point reduction (losses structure). A regulatory mismatch (promotion-losses, prevention-gains) is predicted to impair cognitive flexibility relative to regulatory fit (promotion-gains, prevention-losses). As predicted, participants in a regulatory mismatch showed worse EF than participants in a regulatory fit. These findings suggest that accurate assessment of EF must consider motivational and task reward factors that could be influenced by various neural systems, and have important implications for the relationship between executive function and regulatory focus.

C73

NEUROCOGNITIVE CORRELATES OF ERROR INDUCED POSITIVITIES REVEALED BY MEG Päivi Helenius¹, Marja Laasonen^{2,3}, Laura Hokkanen², Ritva Paetau⁴, Markku Niemivirta⁵; ¹Brain Research Unit, Helsinki University of Technology, Finland, ²Helsinki University, Psychology, ³Helsinki University Central Hospital, Phoniatrics, ⁴Helsinki University Central Hospital, Pediatric Neurology, ⁵Education, Helsinki University – The cognitive and physiological processes related to successful Go/NoGo task performance and error detection were investigated using magnetoencephalography (MEG) and event-related potentials (ERPs at Fz, Cz, Pz). Our stimuli were visual arrays composed of 5 items (apples and animals). The relative position of items was randomized between successive stimuli presented once every 2 seconds. The 12 participants were instructed to make a rapid manual response to a target stimulus (wolf facing a pig) and avoid responding to a non-target stimulus (17%) (wolf facing an apple). Erroneous responses elicited an ERP component peaking 60 ms after button press and an enhanced positivity peaking around 230 ms (error positivity, Pe). The infrequent non-target stimuli evoked a more negative going deflection 390 ms after stimulus onset and a more positive going deflection at 530 ms (late positive component, LPC) compared to the target stimuli. The Pe and LPC components were coupled with functionally and temporally equivalent activation in the MEG channels. This activation was localized bilaterally in the posterior temporal cortex. In the response-locked averages, the temporal activity was enhanced if errors were committed. In the stimulus-locked averages, the activation was also enhanced after infrequent non-target stimuli and delayed for the initially miscategorized non-targets accompanied with erroneous response. Thus, the results suggest that the cortical correlates of LPC and Pe are not specifically related to commission of an error, but these components, and bilateral temporal cortices, are more generally involved in conflict resolution and memory updating triggered by the incoming stimuli.

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C74

ASSOCIATING EVENT-RELATED BRAIN DYNAMICS WITH EVENT CONTEXT Scott Makeig¹, Julie Onton¹; ¹University of California San Diego – Active human agents both create and respond to events in 'real' time without the luxury of delay. Ongoing EEG source signals and their event-related perturbations index processes that maintain or adjust the distribution of attention between sensory, mnemonic, and imaginative processes in response to the perceived significance of events -- which may be heavily influenced by the context in which they occur. To determine from the data themselves which event contexts are linked to which brain dynamics changes, we decomposed event-related log spectrograms from maximally independent EEG components (IC) processes time locked to delivery of auditory feedback signals in a 'Two-back with feedback' visual working memory paradigm. Before decomposition of the (frequencies * latencies by trials) matrix for each IC, we appended a matrix of 'answers' to 19 questions about the trial context, in the form of a (questions by trials) matrix of ('yes|no') 1s and -1s. Maximally independent components of the joint data matrix gave independent factors (IFs) comprising a log spectral time/frequency modulation template, a loading on each of the questions, plus a weight specifying the relative effect of the template in each trial. Sorting the individual trial context vectors by their IF trial weights revealed significant across-trials trends, even for IFs predominantly linked to relatively simple event contrasts. Context ICA

decomposition appears likely to allow new insights in the connection between events in context and the complex spatiotemporal patterns of local cortical field synchrony that produce the ongoing EEG.

C75

THE ROLE OF OVERALL VALENCE IN EVALUATIVE DECISION MAKING Andries Van der Leij¹, Steven Scholte², Ap Dijksterhuis¹; ¹Behavioural Science Institute, Radboud University Nijmegen, ²University of Amsterdam, Psychology – Evaluative decision making, for instance deciding which of two political opinions to prefer, involves forming a relation between the alternatives and one's internal values and goals, a comparison between the alternatives, and a choice. The characteristics of these goal-directed decisions change when both alternatives are judged as positive or negative, the former leading to a decision in terms of anticipated benefits and the latter to a decision in terms of costs ('Which alternative will benefit/harm me the most?'). It has been shown that the evaluative judgment of a stimulus (e.g. self-referential processing) involves activation of the anterior frontomedian cortex. However, the neuronal underpinnings of decision making between multiple evaluative stimuli are still largely unknown. We hypothesized that the potential harmfulness of choosing the wrong alternative between two negative options would be associated with additional prefrontal activity. We used functional magnetic resonance imaging to investigate the neuronal processes underlying these types of decisions. While scanned, participants made dichotomous choices between political statements. In a behavioral session the participants rated each statement on a negative to positive visual analogue scale, which allowed for estimation of the overall valence of the choices. When contrasted with choices between two positive statements, choices between two negative statements led to the activation of the frontopolar cortex. These data support the notion that the differences in overall valence of evaluative decisions are associated with differences in brain activation patterns and suggest a special role of the most frontal regions in choosing between undesirable alternatives.

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C76

IS YOUR ERROR MY CONCERN? AN EVENT-RELATED POTENTIAL STUDY ON OWN AND OBSERVED ERROR DETECTION IN COOPERATION AND COMPETITION Ellen de Bruijn¹, Daniel von Rhein¹, Harold Bekkering¹; ¹Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, the Netherlands – For successful goal-directed behavior it is essential for humans to continuously monitor one's actions and detect errors as fast as possible. EEG studies have identified an error-related ERP component known as the error-related negativity or ERN. Theories on error monitoring propose a direct relation to reward processing. Whenever an error is made, the outcome of an action turns out to be worse than expected, resulting in a loss of reward and hence eliciting the ERN. However, as own errors are always associated with a loss of reward, disentangling whether the ERN is error- or reward-dependent has proven to be an extremely difficult endeavor. Recently, an ERN has also been demonstrated following the observation of other's errors. An important difference with own errors is that other people's errors can be associated with loss or gain depending on the cooperative or competitive context in which they are made. We conducted an ERP study to disentangle whether the ERN is error- or reward-dependent. Eleven pairs (N=22) of participants performed and observed a speeded-choice reaction task in two contexts. Own errors were always associated with a loss of reward. Observed errors in the cooperative context also yielded a loss of reward, but observed errors in the competitive context resulted in a gain. The results showed that the ERN was present following all types of errors independent of who made the error and the outcome of the action. Consequently, the current study demonstrates that the ERN is error-specific and not dependent on reward.

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C77

FUNCTIONAL CONNECTIVITY OF THE DORSOLATERAL PREFRONTAL CORTEX IN CHILDREN WITH AUTISM

SPECTRUM DISORDERS: A FUNCTIONAL MRI STUDY OF WORKING MEMORY

Benjamin E. Yerys¹, Alicja U. Kreczko¹, Kathryn F. Jankowski¹, Philip S. Lee², Peter Daniolos¹, John VanMeter³, Lauren Kenworthy¹, Chandan J. Vaidya^{1,2}, William D. Gaillard^{1,3}; ¹Children's National Medical Center, Washington, DC, ²Georgetown University, Washington, DC, ³Georgetown University Medical Campus, Washington, DC – Functional connectivity studies of working memory in adults with ASD have yielded reduced neural synchrony between neural regions expected to support task performance. No studies to date have examined functional connectivity of working memory networks in children with ASD. The current study included 24 children (12 with ASD and 12 age, IQ, and gender matched controls) who completed an N-back working memory task (2-back and 1-back blocks) at 3T using echo planar imaging. The left and right dorsolateral prefrontal cortex (BA 9/46; DLPFC) served as seeds, given their importance in working memory. The time series of seed locations were extracted via MarsBar and entered as a covariate of interest in a whole-brain voxel-wise regression in SPM5. Within the control group, the expected fronto-striatal loop was observed with both DLPFC seeds. In contrast, the ASD group exhibited atypical increased prefrontal connectivity. Taken together, these findings extend atypical functional connectivity to include working memory networks in childhood samples of ASD.

C78**NEURAL CORRELATES OF REWARD-BIASED PERCEPTUAL DECISION-MAKING**

Kartik Kesavabhotla¹, Shruti Japee¹, Aurora Ramos¹, Leslie Ungerleider¹; ¹Laboratory of Brain and Cognition, NIMH, NIH – Studies suggest that higher-level cortical areas may compute perceptual decisions by comparing outputs of different pools of selectively tuned lower-level sensory neurons. A factor that may influence this decision-making process is the reward value associated with making a particular response choice. To study the effect of incentive on the decision-making process, we conducted an fMRI study, in which 19 subjects performed a face-house categorization task involving noise-degraded stimuli and multiple levels of monetary reward. Two noise levels: 46% and 58% were used for degradation of images. To study the effect of incentive, four reward levels were used: No Reward, Equal Reward, High Face Reward (higher reward for correct face than house), and High House Reward (higher reward for correct house than face). Behavioral data showed that subjects shifted their decision criterion towards the more profitable response choice, especially at the higher noise level. Preliminary fMRI data showed that frontal regions, such as BA9/44, were generally more engaged when subjects processed noisy stimuli and when their decisions were influenced by reward. Specifically, these regions showed greater activity during high house compared to equal reward trials. Furthermore, when subjects incorrectly identified a face as a house (i.e., decision aligned with reward-induced bias toward houses), differential activity (high house relative to equal reward) in this region was negatively correlated with the magnitude of decision-criterion shift (for high house relative to equal reward trials). These results indicate that frontal regions may combine reward-induced response bias with sensory evidence when computing perceptual decisions.

C79**SEARCHING FOR THE MAJORITY: ALGORITHMS OF VOLUNTARY CONTROL**

Jin Fan^{1,2}, Kevin G. Guise², Xun Liu², Hongbin Wang³; ¹Mount Sinai School of Medicine, Psychiatry, ²Mount Sinai School of Medicine, Neuroscience, ³University of Texas Health Science Center at Houston, School of Health Information Sciences – Voluntary control of information processing is crucial to allocate resources and prioritize the processes that are most important under a given situation; the algorithms underlying such control, however, are often not clear. We investigated possible algorithms of control for the performance of the majority function, in which participants searched for and identified one of two alternative categories (left or right pointing arrows) as composing the majority in each stimulus set. We manipulated the amount (set size of 1, 3, and 5)

and content (ratio of left and right pointing arrows within a set) of the inputs to test competing hypotheses regarding mental operations for information processing. Using a novel measure based on computational load, we found that reaction time was best predicted by a grouping search algorithm as compared to alternative algorithms (i.e., exhaustive or self-terminating search). The grouping search algorithm involves sampling and resampling of the inputs before a decision is reached. These findings highlight the importance of investigating the implications of voluntary control via algorithms of mental operations.

C80**ERROR SWITCH COST AS GOAL NEGLECT: FAILURE OF VOLUNTARY TOP-DOWN CONTROL AND ITS RELATION TO FLUID INTELLIGENCE**

Koki Ikeda¹, Ryo Tamura², Toshikazu Hasegawa¹; ¹University of Tokyo, ²Saitama Gakuen University – Altmann proposed the randomized-runs task switching paradigm, where a run consists of several trials, and a task cue is presented only in the first trial of a run but not in the following trials (Altmann & Gray, 2008). Subjects are required to execute the same task throughout a run. When the task assigned in a run differs from the previous one, it is defined as a "switch" run. In this paradigm, "latency" switch cost (or "switch cost" as commonly termed) is observed only in the first trial of a run, whereas "error" switch cost occurs all through a run and only after switching. Apparently, there are two distinct mechanisms that underlie these two types of switching cost, but only few attempts have been made to understand the nature of error switch cost. In this study, we explored several aspects of this phenomenon. First, we showed that error switch cost was eliminated either by explicit error feedback or voluntary effort to reduce error. Secondly, individual differences in error switch cost were correlated with the psychometric scores of fluid intelligence. These results suggested that error switch cost closely resembles a phenomenon called "goal neglect," which was found in frontal damaged patients (Duncan et al., 1996). Possible mechanisms underlying this phenomenon are discussed.

C81**FRONTAL EEG POSITIVITIES DURING A SIMPLE STERNBERG TASK PREDICT TASK ERROR RATE IN OLDER ADULTS**

William Tays¹, Jane Dywan¹, Lesley Capuana¹, Sidney Segalowitz¹; ¹Brock University – There is evidence that enhanced frontal activation in older adults during cognitive tasks may serve a compensatory role in sustaining high level performance. We have recently shown that a Sternberg short-term memory task with familiarity-based interference manipulations produced a unique frontal positivity in the ERP waveforms of older adults rather than the interference-based negativities typically observed in the young. However, in contrast to the compensation account, these positivities were related to higher error rates on the task. We hypothesized that these interference-related positivities in older adults may represent a strong response to familiarity that does not easily resolve itself, thus making older adults more susceptible to familiarity-based interference. In the present study, we recorded EEG responses of younger and older adults in a simple Sternberg task without interference manipulations such that familiarity would be beneficial to performance. We hypothesized that frontal positivities in older adults in this circumstance would be predictive of enhanced performance. In contrast to expectations, unique frontal positive activations in older adults appeared to once again predict poor Sternberg memory accuracy thus replicating previous work. These data suggest that deviations from the medial prefrontal negativities that emerge in younger adults during the Sternberg task may represent a less efficient form of information processing which is inconsistent with the compensatory frontal activation reported in imaging data.

C82**CONTROLLING MENTAL IMAGERY: BRAIN ACTIVITY UNDERLYING MENTAL IMAGE GENERATION AND INHIBITION**

Courtney Clark^{1,2}, Adam Safron¹, Ken Paller¹; ¹Northwestern University, ²St. Andrews University – A pink elephant! Upon reading this, does a Dumbo-like image pop into your mind's eye? Through sheer will power, could you prevent that elephant from entering your visual consciousness? To explore the extent to which people can avoid visual imagery on command, we studied two conditions. In the IMAGE condition, subjects were asked to form vivid visual images for the referents of 96 concrete, highly imageable spoken nouns. In the REFRAIN condition, subjects were asked to focus attention on the sound of each of 96 similar words and not to think of anything visual at all. EEG data were collected so that we could analyze a specific brain potential associated with visual imagery in prior experiments (e.g., Gonsalves & Paller, 2000ab). EEG results suggested that subjects were successful at inhibiting imagery, in that occipital potentials were larger in the IMAGE than in the REFRAIN condition, with maximal amplitude differences about 800 ms after spoken-word-onset. Given that different views of imagery control were provided by EEG measures and self-assessments (subjective ratings, attention-control questionnaire, and visual imagery ability), it is unclear which method provides the best account of whether the mind's eye is full or empty, and of the ability to achieve control of mental imagery. More work will be needed to cohesively relate subjective measures to EEG measures, but these EEG methods nonetheless provide a new way to investigate the degree of control people have over this sort of visual imagery that normally comes to mind so swiftly and naturally.

C83**A COMMON ROLE FOR LEFT INFERIOR FRONTAL GYRUS (BA45) IN PROACTIVE AND SEMANTIC INTERFERENCE IN A WORKING MEMORY TASK?**

Alexandra S. Atkins¹, Patricia A. Reuter-Lorenz¹, John Jonides¹, Marc G. Berman¹; ¹University of Michigan, Psychology – Proactive interference (PI) in short-term item recognition tasks causes participants to be slower to correctly reject familiar negative probes that were members of the memory set on a recent trial (see Jonides & Nee, 2006). Numerous brain imaging studies of this recent-probes task have shown increased activations in left inferior frontal gyrus, BA45, associated with this form of familiarity-based PI (Jonides et al., 1998; Nelson et al., 2003). Using a short-term variant of the Deese, Rodeiger and McDermott false memory paradigm, we recently demonstrated within-trial semantic interference and false recognition in response to lure probes using semantically themed memoranda (Atkins & Reuter-Lorenz, 2008). In this task, subjects are slower to correctly reject lure probes that are semantically related to items in the memory set compared to non-related negative probes. Given the importance of left BA45 in mediating interference related to familiarity, we predicted this region might also mediate the processing of semantically related lures. Here we present results from an event-related fMRI investigation which show increased activation in left BA45 associated with the correct rejection of lure vs. unrelated negative probes presented 3 seconds following study of 4-item semantically themed memory set. ROI analyses indicate a positive relationship between the magnitude of semantic interference and BA45 activity. Findings suggest left BA45 may serve a common role in both familiarity-based PI and semantic interference in working memory tasks.

C84**THE INFLUENCE OF PROPORTION CONGRUENCY ON STROOP INTERFERENCE IN THE PRESENCE AND ABSENCE OF AWARENESS**

Chris Blais¹, Eddie H. Nahabet¹, Silvia A. Bunge; ¹University of California, Berkeley, Helen Wills Neuroscience Institute – The magnitude of the Stroop effect increases as the proportion of congruent trials in a block increases. The most common interpretation of this finding is that participants detect and use the contingency between the color and the word to optimize performance. Accordingly, many accounts assume that participants are aware of the proportion of congruent trials. The

present investigation directly assesses the role of awareness of the proportion of congruent trials on the magnitude of the Stroop effect, using principles from psychophysics. Participants performed 228 blocks, each containing 100 Stroop trials. The number of congruent trials in each block varied from 5 to 95, in increments of 5. Following completion of each of these 2-3 minute blocks, participants were asked (1) were there more congruent trials than incongruent trials, (2) are you sure, and (3) out of the 100 trials, how many were congruent. The results reveal a strong linear relationship between (a) the size of the Stroop effect and the proportion of congruent trials and (b) the estimated number of congruent trials and the actual number of congruent trials. Assuming that the confidence ratings are an accurate measure of awareness, these results indicate that an entirely "unaware" mechanism can drive the proportion congruency effect, given the fact that participants were only confident of the proportion at the extremes (i.e., >85 and <20).

C85**RESPONSE INHIBITION MEDIATED BY PREFRONTAL CORTEX DISTINGUISHES HEAVY SMOKERS FROM 'CHIPPERS'**

Viswanath Venugopalan¹, Marco Leyton^{1,2}, Lesley K. Fellows¹; ¹Montreal Neurological Institute, McGill University, ²McGill University – Addiction to tobacco is the largest preventable cause of death in the world. Not everyone who smokes, though, becomes addicted. A subset of smokers retain better control over their cigarette use, typically smoking no more than 4 or 5 cigarettes per smoking day and not necessarily smoking everyday. We hypothesized that these cigarette 'chippers' would be less impulsive, or exert better inhibitory control (or both), compared to heavy smokers. These possibilities were tested in 27 addicted smokers (12.4±2.1 cigarettes/day) and 27 chippers (3.3±1.3 cigarettes/day) matched for age, gender and education. Group assignment was based on the combined score on two self-report measures of the degree to which individuals can control their smoking behavior. Prefrontally-mediated inhibitory control was measured with the stop-signal task, and in terms of commission errors in a working memory task. Two aspects of impulsivity, temporal discounting and risk-taking, were tapped with a standard delay-discounting task for money, and the Balloon Analog Risk Task (BART), respectively. Participants were tested twice, once while smoking at their usual rate, and once after an 18 h withdrawal period. The groups differed significantly on both measures of inhibitory control: chippers had faster stop-signal reaction times, and made fewer errors of commission on the working memory task. The groups performed similarly on the two measures of impulsivity. Abstinence did not substantially affect performance on any of the tasks. These findings suggest that individual differences in prefrontally-mediated response inhibition may be an important protective factor in retaining control over cigarette use.

C86**TO GRIP OR NOT: ACTION VALUATION BASED ON PHYSICAL EFFORT AND MONETARY GAIN**

Irma Triasih Kurniawan¹, Deborah Talmi², Wako Yoshida², Ben Seymour², Nick Chater¹, Raymond J. Dolan²; ¹University College London, Cognitive, Perceptual, and Brain Sciences Research ²University College London, Wellcome Trust Centre for Neuroimaging – Contemporary decision making focus on incentives that determine the value of an action, but little is known how values are discounted by physical effort. Animal and recent human studies suggest that effort costs influence action choices and that the Anterior Cingulate Cortex (ACC) is crucial in integrating effort and reward. Using functional magnetic resonance imaging, we investigated how our brain calculates the physical effort involved in gripping against the monetary benefit attained by that grip action. We employed a choice task wherein eighteen healthy participants (Mean age 23; SD = 3.4) chose to do nothing or to exert effort by gripping for a sum of money. Choices were followed by the execution of the selected actions. We manipulated effort (low and high) and reward (low and high) levels, and tested if participants' willingness to grip is influenced by effort, reward, and the integration of effort and reward. We assessed BOLD responses in regions implicated in action valuation,

namely the ACC and the striatum. Behaviourally, we found main effects of effort and reward; as expected, participants were more willing to grip when the gain is higher and when the effort is less. The neural results of this paper extend animal findings about calculating action costs and benefits and provide insights about the role of effort costs in amotivation symptoms such as apathy.

C87**EFFECTS OF CONVERSATION COMPLEXITY OF CELL PHONE CONVERSATIONS ON DRIVING: ERP LAB AND ON-ROAD DRIVING STUDIES**

Sean Seaman^{3,2,1}, Li Hsieh^{2,1}, Richard Young^{2,4},¹Wayne State University, Communication Sciences and Disorders, ²Wayne State University, Institute of Cognitive and Applied Neuroscience, ³Wayne State University, Psychology, ⁴Wayne State University, School of Medicine, Psychiatry and Behavioral Neurosciences – How does the complexity of a conversation affect driving performance? Previous work (Hsieh et al., 2008; Bowyer et al., 2008) has revealed that small, reliable effects of conversation on driving performance can be observed using simulators, but data concerning the kind of conversation - and the specific effects on driving performance it may have - has been lacking. We addressed this research gap in a series of studies designed to measure driving performance while engaged in a secondary conversation task. In the first study, we looked at simulator responses to visual events during a live conversation task. The cognitive complexity of the conversation was manipulated to reflect two naturalistic levels of speech complexity. In addition to measuring behavioral measures of driving performance, such as reaction times to visual stimuli and lane maintenance, we also measured ERPs and subjective workload estimates. In the second study, we took the task on-road to evaluate the effects of live speech, and its varying levels of complexity, in a real-world driving task. Here, we also measured driving performance (in terms of visual event reaction times and lane maintenance), ERPs, and subjective workload estimates. These studies reveal a pattern of the subtle ways in which different conversation demands can interact with the network of cognitive processes that underlie proficient driving performance.

C88**PAYING ATTENTION WHEN IT COUNTS: THE EFFECT OF MOTIVATION ON FMRI ACTIVITY DURING ATTENTIONAL CONTROL**

Tracy L. Luks¹, Ashley Kopeck², Corby L. Dale¹, Gregory V. Simpson¹, Anthony Kavel³,¹University of California, San Francisco, ²Carroll University, ³University of California, Berkeley – Attentional control is the goal-driven allocation of attention to task-appropriate stimuli and responses, and away from distractions. Motivation is the ability to anticipate and appreciate the consequences of behavior, such as rewards or punishments. We examined interactions between neurobiological systems underlying motivation and attentional control using a Rewarded Counting Stroop task during an fMRI scan. Subjects made a button press response indicating the number of lines of text presented. The content of the text could be neutral, number words congruent with the number of lines of text, or number words incongruent with the number of lines of text. Subjects were notified at each block start that performance would (Reward Condition) or would not (No Reward Condition) be rewarded (25 cents per correct response within 500msec, indicated at the end of each Reward block). Relative to the No Reward condition, Stroop task performance in the Reward condition was associated with greater activation of striatum, thalamus, insula, orbitofrontal cortex, right dorsolateral prefrontal cortex and the intraparietal sulcus area. During Incongruent trials, greater activity occurred in anterior cingulate cortex and orbitofrontal cortex in the Reward than the No Reward condition. During Congruent trials, there was greater activity in the pre-supplementary motor area in the Reward than the No Reward condition. These results suggest that motivation modulates attentional control via increased activity in orbitofrontal and anterior cingulate cortex, as well as increasing arousal and sustained attention by increasing activity in thalamus and right dorsolateral prefrontal cortex.

C89**EFFECTS OF EMOTIONAL SPEECH TONE OF CELL PHONE CONVERSATIONS ON DRIVING: ERP LAB AND ON-ROAD DRIVING STUDIES**

Li Hsieh^{1,2}, Sean Seaman^{1,2,3}, Richard A. Young^{1,4},¹Wayne State University, Institute of Cognitive and Applied Neuroscience, ²Wayne State University, Communication Sciences and Disorders, ³Wayne State University, Psychology, ⁴Wayne State University, School of Medicine, Psychiatry and Behavioral Neurosciences – We present an investigation into multitasking, using an ecologically valid task: a simulation of driving while conversing on a hands-free cellular phone. Specifically, we look at what factors influence multitasking performance; in this case, we investigated emotional prosody. Recent investigations into the visual processing of emotional stimuli are suggestive of overall enhanced processing of visual information in emotionally-salient contexts. Because the majority of investigations into the effects of phone conversation on driving performance have used emotionally neutral conversation contexts, they may be lacking ecological validity and wrongly assessing the impact of speech on performance. We used behavioral, ERP and other measures to assess performance and physiological differences between two types of multitasking situations. We employed a validated event-detection paradigm with lane-tracking to measure driving performance. Participants viewed a video recording of a driving scene while using a foot pedal to respond to visual events occurring in the periphery of the display. Lane-tracking was employed to ensure participants were engaged with the video recording. RTs to visual events were recorded, and ERPs were averaged on these events. Behavioral analyses showed the expected pattern of events occurring during simulated conversations being associated with slightly longer RTs. However, this effect was moderated by the emotional tone of the conversation; events occurring during angry conversations were responded to significantly faster than events occurring during neutral conversations, and were only marginally slower than events occurring in absence of conversation. ERP analysis confirms this distinction between events occurring during angry and neutral events.

C91**RESPONSE INHIBITION AND THE INFERIOR FRONTAL GYRUS: ARE THERE TASK DIFFERENCES IN LATERALIZATION?**

Diane Swick^{1,2}, Victoria Ashley¹, And Turken¹,¹VA Northern California Health Care System, ²University of California, Davis – An influential theory holds that motor response inhibition is strongly lateralized to the right prefrontal cortex (PFC), based on evidence from neuroimaging and neuropsychology (Aron et al., 2004). The human lesion evidence is based entirely on results from the Stop-Signal RT task, where patients with lesions in right IFG, but not left IFG, were impaired in SSRT. However, we recently reported that 12 patients with focal damage in left IFG and insula showed response inhibition deficits in the Go/NoGo task, particularly when responses were more prepotent (90% vs. 50% Go probability; Swick et al., 2008). This raises the possibility that the two tasks might be tapping different elements of response inhibition. Here, we present new data from patients with R PFC lesions in GNG. Three of the four had increased numbers of missed Go trials, suggesting a deficit in sustained attention rather than response inhibition. This pattern was exaggerated in the patient with the most extensive RIFG damage. This patient also had increased NoGo errors in the 50/50 condition but not the 90/10 condition, which does not suggest impairment in response inhibition alone. We also conducted separate meta-analyses of neuroimaging results from GNG (620 foci) and SSRT (130 foci) using the Activation Likelihood Estimation method (Laird et al., 2005). Activations in SSRT were actually more bilaterally represented in PFC and insula than in GNG. Combined, these results demonstrate the importance of obtaining behavioral data from both GNG and SSRT in the same groups of patients and the same fMRI experiments.

C92**LOAD EFFECTS ON ENCODING, MAINTENANCE, AND RETRIEVAL PROCESSES IN YOUNGER AND OLDER ADULTS**

Brian Gordon^{1,2}, Carrie Brumback³, Gabriele Gratton^{1,2}, Monica Fabiani^{1,2},
¹University of Illinois Urbana-Champaign, ²Beckman Institute, ³University of California Irvine – Neuroimaging research indicates that tasks utilizing working memory (WM) draw upon a complex cortical network including sensory areas and several regions of frontal and parietal cortex. These regions are involved in different elements of task performance including information encoding, maintenance, and retrieval. Most neuroimaging methods are limited to attaining either high spatial resolution or high temporal resolution. Here we use a brain imaging method with high spatial and temporal resolution, the event-related optical signal (EROS), to measure brain activation during each of these phases in a highly-practiced, fast-paced memory search task. Experimental manipulations included load (2-6 items) and age (young: 18-30; old: 65-85). By incorporating both spatial and temporal information, it was possible to locate areas in prefrontal cortex that show sustained activity during the maintenance interval dissociated from areas in anterior parietal, occipital and prefrontal cortex that show responses during encoding then again during retrieval. The activity was graded both in both latency and amplitude during encoding, and amplitude alone during maintenance and retrieval phases. The older adults showed a more widespread and bilateral pattern of activity than younger adults. The data support the idea that a network of dorsal fronto-parietal structures is involved in maintaining information in WM (Corbetta & Shulman, 2002).

C93**INTERACTIONS BETWEEN TOP-DOWN COGNITIVE CONTROL AND BOTTOM-UP MNEMONIC EVIDENCE IN PRIMING AND DECISION-MAKING**

Elizabeth Race¹, Gwen Lawson², Anthony Wagner^{1,2},
¹Stanford University, Neurosciences Program, ²Stanford University, Psychology – Multiple levels of learning from past experience can have dissociable neural and behavioral consequences during subsequent decision-making. Specifically, recent fMRI data (Race et al., 2008) indicate that stimulus processing is facilitated by learning at three distinct representational levels, with dissociable patterns of BOLD repetition suppression obtained for conceptual learning, stimulus-decision associative learning, and stimulus-response associative learning. While these data demonstrate that different levels of learning yield neural 'benefits' during subsequent decision-making, mnemonic information may also produce behavioral and neural 'costs' when goals change. Indeed, Race et al. reported that neural processing demands increased when a previously learned response was no longer goal-appropriate. However, this neural 'cost' was not accompanied by behavioral (RT) evidence for response-switch costs, raising the possibility that response-switch costs may be offset by stimulus-level facilitation. To investigate this possibility, the current study manipulated top-down preparatory control (cue-to-stimulus interval, CSI), providing a means of temporally separating the influences of learning at distinct levels of representation. Behavioral priming (RT facilitation) due to stimulus-decision learning was observed at both short (300ms) and long (1100ms) CSIs, as was priming due to stimulus-response learning when current responses were congruent with the previously learned response. By contrast, incongruent responses produced an RT cost after short CSI, whereas there was no evidence for stimulus-level facilitation nor response conflict after long CSI. Collectively, these results suggest that retrieval of learned stimulus-response associations occurs rapidly, but that increased top-down preparatory control can reduce the influence of stimulus-response mnemonic conflict to enable faster, task-appropriate responding.

C94**INVESTIGATING THE UNDERLYING COGNITIVE PROCESSES OF THE N-BACK TASK: A REGRESSION STUDY**

Martin Buschkuhl¹, Susanne Jaeggi¹, Marc Berman¹, Kirti Thummala¹, Courtney Behnke¹, John Jonides¹,
¹University of Michigan, Psychology – Recently, we were able to show that a 4-week long training intervention with a dual n-back task leads to improvements in fluid intelligence. Although the n-back task is widely used, especially in studies involving functional brain imaging, surprisingly little is known about the cognitive processes that are involved in this task. Although many researchers have hypothesized the processes required to successfully perform an n-back task, there are few studies that have examined these hypotheses operationally. Furthermore, there are no published studies that have investigated the processes engaged by the dual n-back task that we used to show training effects on fluid intelligence. Consequently, we have little knowledge about the processes underlying dual n-back training which eventually promote transfer to fluid intelligence. In this study, we used multiple hierarchical regression analyses to account for n-back performance with tasks representing different constructs such as working memory capacity, interference resolution, task switching, processing speed, and fluid intelligence. Our results show that dual n-back task performance is best predicted by fluid intelligence and processing speed providing further evidence for the close relationship between fluid intelligence and n-back performance. Our data shed light on the nature of the observed transfer effects that we obtained previously.

C95**GLUTAMATE AND GLUTAMINE, NOT WHITE MATTER INTEGRITY, UNDERLIE THE ANTERIOR CINGULATE'S ROLE IN EXECUTIVE FUNCTION**

David Ruhl^{1,2,3}, Charles Gasparovic^{1,4}, Arvind Caprihan¹, Mollie Monnig³, Paul Mullins^{1,5}, Jessica Pommy³, David Hampton³, Per Lysne³, Robert Thoma^{1,2},
¹Mind Research Network, ²University of New Mexico, Psychiatry, ³University of New Mexico, Psychology, ⁴University of New Mexico, Neurology, ⁵University of Bangor, School of Psychology – Functional neuroimaging studies have implicated the anterior cingulate (AC) in executive functioning, but the mechanisms by which this is supposed to occur remain unclear. To investigate this issue, several measures of AC structure and function were assessed with respect to neuropsychological test scores. Neuropsychological measures, high-resolution structural, diffusion-tensor imaging, and single-voxel MR spectroscopy (MRS) data of the anterior cingulate were collected in thirteen healthy individuals. Gray matter thickness (GM) and fractional anisotropy (FA; a measure of white matter integrity) in bilateral cingulate gyri tracts were computed. GM and FA values for the area within the spectroscopy voxel (GMv & FAv) were also derived to facilitate inter-modal comparisons. Glx, a composite measure of glutamate and glutamine, was quantified from MRS data. Linear regression revealed a significant negative relationship between Glx and an executive function score derived from the Trail Making Test (TMT A-B), such that higher Glx levels were associated with better executive performance (adj R-square = .63). Neither age, nor Full Scale IQ moderated this relationship. FAv and GMv were also entered into the regression, but did not account for significant additional variance in TMT B-A. No other MRS-derived metabolite concentrations were predictive of executive function. Collectively, these results suggest that it is specifically glutamate and glutamine content, and not gray or white matter structure that mediate the cingulate's contribution to executive functioning.

C96**THE NEURO-ECONOMICS OF AGING IN POLITICAL PREDICTION**

Kanchana Ramchandran¹, Dhananjay Nayakankuppam², Joyce Berg², Eric Axelsson³, Daniel Tranel¹, Antoine Bechara⁴, Natalie Denburg¹,
¹University of Iowa, Neurology, ²Tippie College of Business, University of Iowa, ³University of Iowa, Psychiatry, ⁴University of Southern California, Psychology – As America ages, its elderly have a strong voice in political prediction polls and in political outcomes. Deficits in predic-

tion among older adults would affect how they engage and influence politics. Older adults (90% male; $M=74.0$ years, $SD=5.6$) were asked to predict the winners of the Presidential primary elections in a repeated measures (Jan, Feb, March, and April 2008) experiment involving the Iowa Electronics Market (IEM). Participants traded shares (amongst themselves) of candidates in the primaries race as if they were market stocks. During the nominee race, their task was to weigh candidates' ability to win the nomination and assign share price. Their performance was compared against the simultaneous, primary election market administered by the IEM, involving approximately 1000 younger, experienced traders (90% male; $M=45.8$ years, $SD=14.4$.) Of the older adult sample, approximately 50% had been characterized as poor and 50% as strong decision-makers. Brain MRI volumetric data was available on a subset of the older adult sample. Data revealed that the older adult, strong, decision-makers were comparable to the younger traders in accurately predicting the winning nominees and their share prices. Both samples outperformed the older adult poor decision-makers. Prediction accuracy and rate of updating information were predicted by caudate ($p = .02$) and putamen ($p = .0002$) volumes respectively, in older adults. We conclude that a subset of older adults may suffer from prediction deficits that correlate with striatal volume. These findings imply deficits in how older adults may pick political candidates and invest in stock markets.

C97

EXAMINING THE NEURAL EFFECTS OF CONFLICT ADAPTATION DURING WORKING MEMORY Amishi Jha¹, Pauline Baniqued¹, Ling Wong¹, Kartik Sreenivasan; ¹Center for Cognitive Neuroscience, University of Pennsylvania – Distracting information can cause conflict at many levels along the information processing stream. Increases in cognitive control following conflict typically lead to decreases in the subsequent behavioral costs of conflict. This "conflict adaptation" effect is thought to be subserved by anterior cingulate cortex (ACC) activity on high conflict trials which signals the need for increased cognitive control. Conflict adaptation has been investigated in paradigms (e.g., Stroop and flanker) in which the need for cognitive control is punctate. In the current study, we investigated if conflict adaptation would occur when conflict occurred at the representational level and the need for cognitive control was sustained. Participants ($n = 26$) performed a working memory delayed-recognition task during fMRI recording. Representational conflict was manipulated by presenting distracting items during the delay that shared many or few perceptual features with the memory items (high conflict [HC] and low conflict [LC] trials, respectively). Accuracy increased following HC relative to LC trials. Random-effects fMRI analysis revealed a compatible pattern in the ACC; activity was greater following HC trials than following LC trials. Additionally, we investigated the magnitude of the conflict effect (LC accuracy - HC accuracy) and found reduced conflict effects following HC trials. This corresponded to larger neural control effects following HC trials in the inferior frontal gyrus, previously shown to be preferentially activated by HC trials. Our results demonstrate relatively long-lasting conflict adaptation effects in the context of working memory, and suggest a common neural profile for the sequential recruitment of control across tasks.

C98

DISSOCIATING CONTROL OVER TASK SET VERSUS CONTROL OVER SPEED-ACCURACY EMPHASIS IN PREFRONTAL CORTEX Vincent Van Veen¹, Sheila Loharuka¹, Mark DeSposito¹; ¹University of California, Berkeley – People are able to control whether they place emphasis on speed during task performance, or accuracy. Modulation of this speed-accuracy tradeoff (SAT) is thought to be obtained by the modulation of baseline activity in decision-related brain regions; speed emphasis is associated with an increase in baseline activity, such that less neural "evidence" is needed to reach the decision threshold during speed emphasis. In this study, we compared the control of SAT to the control over task set. In a 4T MRI scanner, participants performed a Simon task, in which a red or green square was presented to the

left or right of fixation. Prior to each Simon stimulus, a cue was presented instructing the participants to emphasize speed or accuracy, and whether to respond to the color or location of each Simon stimulus with a left or right hand button press. Preparing to make a response based on location is more automatic than making a response based on color; therefore, making a response based on color requires more task control. Thus, task set and SAT were independently modulated. We replicated our previous results concerning SAT (e.g., Van Veen et al., 2008); speed emphasis, compared to accuracy emphasis, was associated with increased baseline activity and reduced transient response-related activation, in SMA, premotor and parietal cortices, while SAT control was associated with left prefrontal activation. In contrast, control over task set was associated with right prefrontal activation. Thus, different prefrontal regions are required for these different types of control.

C99

INTERNAL PERFORMANCE MONITORING INTERACTS WITH EXTERNAL SITUATION Shun Itagaki¹, Kazuo Hiraki¹; ¹The University of Tokyo – External information provides us clues in understanding social and emotional situations, as exemplified by when we understand others' emotion by their facial expressions. Additionally, internal processing such as performance-monitoring is essential for one to adapt to the environment. It has been unknown how they interact with each other, independently of incentive effects. To investigate this issue, we evaluated event-related potential (ERP) components called error-related negativity (ERN), which is elicited by error responses in choice response task such as the flanker task and thought to reflect performance-monitoring that derives from the anterior cingulate cortex activities. Participants ($N=13$) performed face flanker task constructed by central target and flanker distracters. Stimuli were either Angry and Neutral faces (AN condition) or Smile and Neutral faces (SN condition). The results of ERPs time-locked to choice responses showed a clear ERN for error responses, regardless of stimulus congruency. We found that the ERN was more sensitive to the error responses in the presence of relatively positive emotional stimuli than negative ones. In AN condition, a larger ERN was elicited when the central target was neutral expressions than angry ones. On the other hand, positive expressions elicited a larger ERN than neutral ones in SN condition. These results suggest that the ERN reflects multiple monitoring functions, which are associated not only with the mismatch-detection between the goal and the actual performance, but also with the evaluation of external emotional valence. We conclude that the performance-monitoring function reflected by the ERN interacts with the external situation.

C100

EXAMINING THE LIFESPAN EFFECTS OF REPRESENTATIONAL CONFLICT DURING WORKING MEMORY Anastasia Kiyonaga¹, Ling M. Wong², Amishi P. Jha¹; ¹University of Pennsylvania, Center for Cognitive Neuroscience, ²University of California, Davis – It is well-established that behavioral performance following task conditions of high conflict is better than task performance following low conflict, in healthy young adults. This 'conflict adaptation' effect is subserved by anterior cingulate cortex (ACC) signaling the need for increased cognitive control to be implemented by lateral prefrontal cortex (Egner, 2007). In the current study we investigated: 1) If conflict adaptation is observed during working memory tasks when the need for cognitive control is sustained over longer intervals; 2) If the influence of conflict on subsequent cognitive control differs over the lifespan. Three groups of volunteers (adolescents ($N=86$), young adults ($N=46$), and older adults ($N=44$)) were recruited to perform a working memory delayed-recognition task in which conflict was manipulated. Distracting items were presented during the delay which either shared many or few perceptual features with the memory items (high conflict [HC] and low conflict [LC] trials, respectively). Consistent with previous results, overall task accuracy was highest in young adults, followed by adolescents, and lowest within older adults. Importantly, young adults demonstrated reliable conflict adapta-

tion effects, such that current trial accuracy was greater on trials preceded by HC vs. LC trials. In contrast, accuracy was worse on trials following HC vs. LC trials in adolescents and older adults. These results suggest that recruitment of cognitive control in response to conflict has a developmental trajectory that may follow the integrity of the prefrontal cortex during normal lifespan development.

Higher level cognition: Other

C101

UNDERSTANDING AND EMPATHIZING WITH DISSIMILAR

OTHERS: A CASE STUDY OF A CONGENITAL AMPUTEE *Lisa*

Aziz-Zadeh¹, Tong Sheng¹, Lei Liew¹, Henryk Bukowski¹, Hanna Damasio¹, Antonio Damasio¹, ¹University of Southern California – How do individuals

born without limbs understand actions performed by others with limbs they themselves have never had? In such individuals, which neural processes correlate with empathy for pain when observing pain in limbs that the congenital amputees are missing? Using fMRI we studied an individual born without arms and legs (DD), in two conditions: action observation and observation of physical pain. In the action observation condition, DD saw videos of normal individuals performing simple actions using their foot, hand, and mouth. Some actions were possible for DD, albeit with the mouth rather than the hand or foot; other actions were impossible for DD. We found that, like normal controls, DD showed activity in premotor and parietal regions for action observation of the hand, foot and mouth. However, when DD observes actions impossible for her, she additionally activates the bilateral superior frontal and bilateral cingulate regions. This may indicate that for impossible actions, regions involved in reasoning and conflict processing are also recruited. In the pain empathy condition, DD observed others receiving an injection in the mouth, upper arm and hand. In normal individuals, these stimuli usually activate components of the "pain matrix" (insula, ACC, and SI/SII). DD displays a similar pattern but with no activity in SI/SII for the hand condition, and increased activity in SI/SII for the mouth condition. This finding indicates that sensory experience is essential for activating SI/SII during pain observation. Broader implications for how we process actions and empathize with physically dissimilar others are discussed.

Poster Session D

Higher level cognition: Problem solving

D1

ROSTROLATERAL PREFRONTAL CORTEX INTEGRATES BOTH SEMANTIC AND VISUOSPATIAL RELATIONS

Carter Wendelken¹, David Chun¹, Silvia A. Bunge^{1,2}; ¹Helen Wills Neuroscience Institute, UC-Berkeley, ², UC-Berkeley, Psychology – The ability to reason with complex relational structure is a central feature of higher-level human intelligence. Recent fMRI studies have implicated rostrolateral prefrontal cortex (RLPFC) is in a key component of this capacity: the ability to perform second-order relational processing, or relational integration (Christoff et. al. 2003, Bunge et. al 2005, Wendelken et. al. 2008). These studies, involving different tasks and different kinds of stimuli, have variously shown activation in left or right RLPFC, dorsally in some cases and more ventrally in others. We have speculated that differences in the specific locus of activation within RLPFC may be due to privileged access of some areas to information from a particular stimulus domain (Wendelken et. al. 2008). However, in its strongest form, the theory that RLPFC supports processing at the highest levels of complexity suggests that this region should be domain-neutral. We set out to test for domain generality or specificity of RLPFC activation by collecting fMRI data from subjects as they performed two versions of a relational matching task, one involving semantic relational judgments and another involving visuospatial relational judgments. Preliminary evidence (N=12) indicates that both semantic and visuospatial tasks strongly engage the same region of left RLPFC. In addition, right RLPFC is strongly activated by the integration of visuospatial relations, but only weakly activated by the integration of semantic relations. These findings support the hypothesis that RLPFC implements processing at the highest level of abstraction, far removed from the input domain.

D2

INTUITION AND INSIGHT PROBLEM SOLVING

Azurii Collier¹, Mark Jung-Beeman¹; ¹Northwestern University – Often when failing to solve insight problems, people report some idea of the solution or that the problem is solvable, but cannot explicitly access the idea. We investigated whether intuition would relate to overnight incubation effects and solvers' ability to make coherence judgments when working on Compound Remote Associate (CRA) problems, where they view three words and must think of another word that forms a compound word with each of the trial words (crab, sauce, pine; solution- apple). When investigating incubation, on Day 1, participants (n=48) attempted to solve 96 CRAs. For problems that were unsolved, participants reported whether they had a tip of the tongue (TOT). On Day 2, participants were given each of the problems they did not solve on Day 1, and 48 new problems. Participants were more likely to solve a new problem compared to an unsolved Day 1 problem. Interestingly, on Day 2, participants were more likely to solve old problems if they reported a TOT for those problems on Day 1. We investigated whether intuition would relate to solvers' ability to judge whether a CRA was coherent or incoherent. Participants (n=43) had 5 seconds to judge the coherence of a problem and afterwards were asked for the solution. There was a significant association between participants' judgments and the coherence of the problem. Of the unsolved problems, participants had a significantly greater percentage of hits and correct rejections than false alarms. This suggests solvers' intuition showed some sensitivity to discriminate between coherent and incoherent problems.

D3

COMPARING EVIDENCE FOR MULTIPLE HYPOTHESES RECRUITS THE LEFT MIDDLE TEMPORAL GYRUS AND THE LEFT INFERIOR FRONTAL GYRUS

Jennifer Whitman¹, Todd Woodward²; ¹University of British Columbia, ²Provincial Health Services Authority – To determine the cause of an event, one must consider multiple hypotheses and evaluate the strength of the evidence supporting each. Next, one must compare this information to determine the hypothesis most strongly supported by the available evidence. We investigated the brain regions involved in this comparison using fMRI in a probabilistic reasoning task. Each trial of this task showed one visibly empty lake and two upstream lakes filled with black fish and white fish. On each trial either a black or a white fish jumped from the otherwise empty downstream lake. This fish could have come from either the lefthand or the righthand upstream lake. On evidence evaluation trials, participants rated the strength of evidence for just one of the hypotheses (e.g. the likelihood of a black fish coming from the lefthand upstream lake). On evidence comparison trials, participants rated the likelihood of one of the potential explanations being correct rather than the alternate explanation (e.g. the likelihood that the jumping black fish came from the lefthand rather than the righthand upstream lake). Regions more active in the evidence comparison condition than in the evidence evaluation condition included the left middle temporal gyrus, which has been shown to play a role in making comparisons in word problems (i.e. taller / shorter, better / worse). We also found clusters in primary visual cortex, which may reflect elaborative visual processing of the two lakes, and the left inferior frontal gyrus, thought to be involved in selecting among competing representations.

D4

INVESTIGATION OF FUNCTIONAL CONNECTIVITY IN A VISUOSPATIAL REASONING TASK USING GRANGER CAUSALITY

Ehsan Shokri Kojori¹, Michelle McClelland¹, Michael Motes¹, Bart Rypma¹, Daniel Krawczyk¹; ¹Center for BrainHealth, University of Texas at Dallas – We studied the role of cortical regions in visuo-spatial reasoning by assessing the connectivity of cortical influences using multiple measures including connection density and directionality. Participants performed a visuo-spatial reasoning task that included three complexity levels during fMRI scanning. In each trial, multiple shapes with different changing patterns were shown simultaneously to subjects. Then they were asked to judge whether or not the changes occurred in accordance with predefined rules. The complexity level was manipulated by increasing or decreasing the number of shapes that changed together. Response time and accuracy were used as discriminators between subjects. The fMRI data analysis demonstrated strong activation peaks in right anterior prefrontal cortex, motor cortex, and left and right parietal cortices. Since the exact location of peaks differs across subjects, ROI analyses were performed for each individual subject. Using average response times, subjects were grouped into fast and slow performers. The time series associated with peaks of activations were extracted for further connectivity investigations. Granger causality analysis (Roebroeck et al., 2005 & Seth, 2005) was used to identify the connectivity pattern for the defined ROI sets. Results indicated that faster performers showed greater prefrontal connectivity to posterior cortical regions compared to slow performers. These findings will be contrasted to other studies (Rypma, 2006) that have found greater PFC connectivity to posterior cortical regions in slower performers.

D5

WHITE MATTER CONTRIBUTIONS TO BROAD COGNITIVE DYSFUNCTION IN SCHIZOPHRENIA Rex Jung^{1,2,3,4}, Robert Chavez¹, Arvind Caprihan¹, Jeremy Bockholt¹; ¹Mind Research Network, ²University of New Mexico, Neurosurgery, ³University of New Mexico, Psychology, ⁴University of New Mexico, Neurology – Schizophrenia (Sz) is a heterogeneous brain disorder characterized by broad cognitive decline. While numerous studies have established white matter abnormalities in Sz (Kubicki et al., 2005), none have specifically linked broad cognitive decline to specific white matter pathology. Based upon our previous work linking intellectual functioning to integrity of the parieto-frontal network (Jung & Haier, 2007), we hypothesized that white matter connections underlying this network would predict broad cognitive functioning in schizophrenia. The sample consisted of twenty-four first episode and chronic Sz patients scanned at 1.5 Tesla. Patients underwent a broad neuropsychological battery from which the first unrotated principal component g was obtained (Jensen, 1998). Diffusion Tensor Imaging data was processed using Tract-Based Spatial Statistics (Smith, et al. 2006) from which each subject's FA image was registered to a group skeletonized FA image. Major white matter tracts measured included bilateral uncinate, superior longitudinal, cingulum, inferior longitudinal, anterior thalamic radiation, forceps major/minor, corticospinal, and inferior fronto-occipital. Applying a white matter atlas to obtain regions of interest, FA values were average across each voxel within each subject's particular fiber tract to calculate the mean FA of that tract. When we regressed all tracts against g, we found that higher average FA in the right superior longitudinal fasciculus, linking the parietal and frontal lobes, was associated with higher g across patients diagnosed with schizophrenia [$F = 9.45$, $p = .006$; $r2 = .31$]. To our knowledge, this is the first report linking white matter integrity to broad cognitive functioning in schizophrenia.

Higher level cognition: Other**D6**

SELF-CONTROL INVOLVES TOP-DOWN MODULATION OF THE BRAIN'S COMMON VALUE SYSTEM Todd Hare¹, Colin Camerer¹, Antonio Rangel¹; ¹California Institute of Technology – Self-control problems in value-based decision-making are at the core of a large number of social and public policy problems, and play an important role in diseases and public health concerns such as addiction and obesity. Despite decades of research, we still lack answers to many basic questions regarding self-control and decision-making. To address these questions, we used fMRI to examine the neural correlates of self-control during a 'real life' decision-making task. We recruited individuals who were dieting to lose weight and non-dieting controls and had them decide whether or not to eat healthy and unhealthy food items. We show that ventral medial prefrontal cortex (vmPFC) activity correlated with value computations during decision-making. Furthermore, in dieting subjects who exercised self-control, vmPFC activity also correlated with the separate taste and health aspects of a food item consistent with the idea of a common valuation system in goal-directed choice. When subjects used self-control, activity in dorsolateral prefrontal cortex (DLPFC) increased and this increased activity correlated with changes in vmPFC activity. An analysis of psychophysiological interactions suggested that DLPFC might modulate activity in vmPFC and influence value computations during the exertion of self-control in decision-making.

D7

SEX DIFFERENCES IN REAL-LIFE SPATIAL COGNITION Claudia Wolf^{1,2}, Sebastian Ocklenburg¹, Beyza Oeren¹, Andrea Hofstaetter³, Christa Boes³, Markus Popken⁴, Truls Thorstensen³, Onur Guentuerkuen¹; ¹Institute of Cognitive Neuroscience, Biopsychology, Ruhr-University Bochum, Germany, ²Faculty of Life Sciences, Neurobiology and Biology of Cognition, University of

Vienna, Austria, ³EFS Unternehmensberatung GmbH, Vienna, Austria, ⁴Audi AG, Ingolstadt, Germany – Sex differences in cognitive abilities have been investigated in numerous psychological studies. Whereas women outperform men in certain verbal tasks, men tend to be superior in some tests for spatial cognition. Most stable differences in favour of men are found in the Mental Rotations Test, a paper-and-pencil test requiring the comparison of highly abstract 3-dimensional figures. However, the ecological validity of results obtained in such artificial and controlled experimental procedures has been questioned. To obtain a more ecologically valid measure of spatial cognition, we investigated parking, a complex real-life situation. Participants parking speed and accuracy were recorded during three different parking manoeuvres: forward and backward bay as well as parallel parking. In addition, participants were tested in the Mental Rotations Test and asked to self-assess their parking skills. We found that men outperform women in parking accuracy by about 2.1%. Sex differences in parking speed were much more marked: On average, men parked about 35% faster than women. This difference, however, is not necessarily an indicator for women's inferior parking skills. It may also reflect greater cautiousness while parking. Performance is related to mental rotation skills in driving beginners and self-assessment in more experienced drivers. We assume that this shift in related variables is due to training and feedback effects. Taken together, our findings show that the Mental Rotations Test possesses some ecological validity. However, real-life spatial cognition is a much more complex process that is also influenced by other factors.

D8

DURATION MATTERS: DISSOCIATING NEURAL CORRELATES OF DETECTION AND EVALUATION OF SOCIAL GAZE Bojana Kuzmanovic¹, Alexandra Georgescu¹, Simon Eickhoff^{2,3}, Nadim Shah^{2,4}, Gary Bente⁵, Gereon Fink^{2,4,6}, Kai Vogeley^{1,4}; ¹University Hospital Cologne, Psychiatry/Psychotherapy, ²Institute of Neurosciences Medicine (INB3), Research Center Juelich, ³University Hospital Aachen, Psychiatry, Psychotherapy, ⁴Brain Imaging Center West, Research Center Juelich, ⁵University of Cologne, Psychology, ⁶University Hospital, Neurology, Cologne – As a salient nonverbal signal for social interest and the intention to communicate, direct gaze indicate mental states of significant others. Despite of this assumed relation to higher-order cognitive processes, no consistent evidence as indexed by the recruitment of medial prefrontal neural regions is existent so far. The present functional magnetic resonance imaging (fMRI) study tries to clear up this discrepancy by considering additionally to the direction also the duration of gaze behavior. Direct gaze displayed by virtual characters was, firstly, compared with averted gaze and, secondly, systematically varied with respect to gaze duration (i.e., 1, 2.5 or 4 seconds). Consistent with prior findings, behavioural data showed that likeability was higher for direct than for averted gaze and correlated positively with gaze duration. On the neural level, distinct brain regions were associated with the processing of gaze direction and gaze duration: (i) the comparison between direct and averted gaze revealed activations in bilateral occipito-temporal regions including the posterior superior temporal sulcus (pSTS), (ii) whereas increasing direct gaze duration evoked differential neural responses in the medial prefrontal cortex (MPFC) including orbitofrontal and paracingulate regions. The results suggest two complementary cognitive processes related to different gaze parameters. On the one hand, the recruitment of multimodal sensory regions in the pSTS indicates detection of gaze direction via complex visual analysis. On the other hand, the involvement of the MPFC associated with outcome monitoring and mentalizing indicates higher-order social cognitive processes related to evaluation of the ongoing communicational input conveyed by direct gaze duration.

D9

EVENT-RELATED POTENTIALS OF EMOTIONAL PICTURES Alana Campbell¹, Deana Davalos¹; ¹Colorado State University – The negativity bias is a robust response in which people value negative components of information more than positive. The negativity bias appears in

both behavioral and electrophysiological research and affects a number of cognitive processes including decision making and value judgments. The current study uses event-related potential (ERP) to investigate if this bias can be manipulated and diminished using framing in younger adults. Participants' brainwaves are recorded in response to positive, neutral and negative images. Participants are split into two conditions; the positive condition must respond if the image viewed is positive or not while the negative are asked if the image is negative are not. Comparisons between the groups are made based on changes in amplitude and latency of the late positive potential wave for the three types of images. Preliminary results suggest that framing may significantly alter the amplitude of ERPs.

D10

MODULATION OF MOTOR AREA ACTIVITY DURING OBSERVATION OF COMPETITIVE GAMES *Sotaro Shimada¹, Ryosuke Abe¹, ¹Meiji University* – Observing competitive games, such as sports, is a pervasive entertainment for humans. It is reasonable to consider that this inclination to watch others play is based on our social cognitive ability to understand the internal states of others. The mirror neuron system, which is activated when a subject observes the actions of others, as well as when they perform the same action themselves, seems to play a crucial role in this process. However, how the mirror system responds during the observation of competitive games has not yet been fully investigated. In the present study, we measured the activity of motor areas using near-infrared spectroscopy (NIRS) when a subject watched short movie clips in which two models played a simple competitive game with physical gestures (rock-paper-scissors game). Motor areas were significantly activated when the subject observed the movie, as well as when they performed the same action. Interestingly, the activity in the motor areas was significantly greater when the player concordant with the subject's viewpoint won against the opponent, compared with when the player lost ($P < 0.01$) or the game ended in a draw ($P < 0.05$). This result indicates that mirror system activity is modulated by the outcome of the game, a higher-level evaluation of an action. We suggest that the observer is likely to share the winner's internal motor representation, but not that of the loser.

D11

THE ANTERIOR CINGULATE CORTEX CODES A NEGATIVE REWARD PREDICTION ERROR IN ACTIVE BUT NOT OBSERVATIONAL FEEDBACK-BASED LEARNING *Christian Bellebaum¹, Stefan Thiele¹, Irene Daum¹; ¹Institute of Cognitive Neuroscience, Ruhr-University Bochum, Germany* – Performance feedback in learning tasks is accompanied by a negative event-related potentials component, the so-called feedback-related negativity (FRN), which is generated in the anterior cingulate cortex (ACC). According to a recent theory, the FRN codes a prediction error, providing a learning signal to guide action selection and optimize future behaviour. The present study aimed to determine, if the neural processing of monetary feedback stimuli for active learning differs from monetary feedback processing in observational learning. Two groups of 15 subjects matched for age and IQ participated in this study. Subjects of the first group performed an active feedback learning task in which a rule could be learned to maximize reward. Each participant of the second group observed the performance of one active subject. Observers were first required to learn the reward-determining rule based on the observed reactions and feedback stimuli to later implement it in blocks of test trials. As expected, FRN amplitude appeared to reflect a negative prediction error in active learners, being significantly enhanced in response to unexpected negative compared to positive feedback. In observers, no significant difference between the valence conditions was found. As revealed by their choice behaviour in active learning and test trials, respectively, the groups did not differ with respect to the level of insight into reward contingencies. These findings suggest that active and observational feedback learning are based on dissociable neu-

ral mechanisms, with the ACC receiving a feedback-locked learning signal from the basal ganglia for active choice behaviour only.

D12

THE ROLE OF THE NORADRENERGIC SYSTEM IN THE TRADE-OFF BETWEEN EXPLOITATION AND EXPLORATION: EVIDENCE FROM PUPILLOMETRY *Marieke Jepma^{1,2}, Sander Nieuwenhuis^{1,2}; ¹Leiden University Institute for Psychological Research, ²Leiden Institute for Brain and Cognition* – Recent studies have suggested an important role for the locus coeruleus-norepinephrine (LC-NE) system in regulating the trade-off between exploitative and exploratory behavioral strategies. The evidence for this theoretical progress is largely based on cell recordings in nonhuman primates. In order to further develop theories about LC-NE function, it is important to investigate the role of the LC-NE system in human cognition. It has recently been shown that pupil diameter is a reliable marker of LC activity in humans, reflecting both its tonic and phasic character. We measured participants' pupil diameter while they performed a gambling task with a gradually changing pay-off structure (Daw et al., 2006). Each choice in this task can be classified as exploitative or exploratory, by means of a computational model of reinforcement learning. Recent theories of the role of the noradrenergic system in the regulation of behavioral strategy would predict that exploratory choices are preceded by a larger baseline pupil diameter than exploitative choices. Our results are consistent with this prediction. Interestingly, part of the baseline pupil effect already developed during the preceding trial, which suggests that changes in the tendency to explore or exploit develop gradually. Together, our findings provide evidence for the idea that the LC-NE system mediates behavioral strategy (exploitation versus exploration), and reinforce the notion that pupillometry is a promising method for investigating the role of the noradrenergic system in human cognition.

D13

HUMAN BRAIN CODES THE PROBABILITY OF ACTIONS *Roger D. Newman-Norlund¹, Kim Bruggink¹, Raymond H. Cuijpers², Harold Bekkering¹; ¹Donders Institute for Brain, Cognition and Behavior, ²Eindhoven University of Technology* – The capacity to make informed decisions in ambiguous situations is critical to human survival. Computational neuroscientists often use probabilistic equations (Empirical Bayes) to model and predict human behavior in such situations. The questions of how, where, and even if such probabilities are represented in the human brain remain largely unexplored. Two possible candidates for the neural implementation of probability coding are the human mirror neuron system (MNS), hypothesized to play a key role in action understanding, and the theory of mind (ToM) network, which is believed to be involved in the understanding of intentions. Here, we manipulated the probability of a simple bottle pouring action along two dimensions, the relative fullness of two wine glasses (here we assumed that pouring into a relatively less full glass would be most probable) and the relative distance between the bottle and the glasses (here we assumed that the combination of spatially proximate objects would be more probable than the combination of spatially distant objects). Participants underwent whole-brain fMRI while viewing pouring actions of varying probability. Observation of improbable actions elicited relative increases in BOLD signal at core sites in the theory of mind (ToM) network including the mSTS and MFC. Observation of probable actions was associated with relative increases at sites in the left SMG, the precuneus and the visual cortex. These data are consistent with claims that the human brain distinguishes between high and low probability actions and provide novel support for computational models which assume this capability.

D14

NO EVIDENCE OF MIRRORING IN THE HUMAN 'MIRROR SYSTEM' *Eunji Huh¹, Susan Jones¹, Karin James¹; ¹Indiana University, Psychological and Brain Sciences, Bloomington* – This study examines the response properties of the putative 'mirror system' in human adults in 2 conditions comparable to those in which mirror neurons were originally

identified in the cortex of the rhesus macaque. We hypothesized that if the human mirror system was actually the homologue of the mirror neurons found in the macaque, then one should observe similar activation patterns in the same 2 conditions: 1) performing specific actions; and 2) watching another individual performing the same actions. Previous studies have found activation of 5 brain regions both when subjects imitate and when they are imitated, but no previous studies have looked for mirroring properties in the absence of imitation. To this end, we compared neural activation, using fMRI, during performance and observation of the same actions. We also recorded activation while subjects were imitating and being imitated, to confirm that our task recruited the cortical areas previously identified as the mirror system. During both imitation conditions, the classic human mirror system was active. However, during performance and observation of the same action, neural activation overlapped in only one (superior temporal sulcus) of the five brain regions of the 'mirror system'. These results demonstrate that the human mirror system does not display the same mirroring properties in the same tasks as monkey mirror neurons. The findings suggest that imitation, which does activate the human mirror system, is therefore not produced by a population of mirror neurons like those identified in the cortex of the rhesus macaque.

D15

A NEUROCOMPUTATIONAL MODEL OF AUTOMATICITY IN RULE-GUIDED BEHAVIOR *Sebastien Helie¹, F. Gregory Ashby¹; ¹University of California, Laboratory for Computational Cognitive Neuroscience, Psychology, Santa Barbara* – Rule-guided behavior is essential in quickly adapting to one's ever-changing environment. In particular, learned rules can quickly be used in new contexts or applied to new stimuli (which confers an advantage over restricting behavior to associations). Here, we propose a new neurocomputational model of automaticity in rule-guided behavior. The proposed model assumes two parallel neural pathways corresponding to naïve and automatic rule use. In the longer pathway, stimuli activate object representations in the inferotemporal cortex, which in turn activates categorical object representations in the prefrontal cortex (PFC). PFC object representations then activate response units in the premotor cortex (PMC), while PFC rule units inhibit inappropriate PMC response units. In a second shorter pathway, visual areas of parietal cortex project directly to the PMC response units. Plasticity at parietal-PMC synapses is mediated by Hebbian learning. During training, the longer pathway through the PFC is used to strengthen the appropriate parietal-PMC synapses. The development of automaticity is characterized by a transfer of control of rule-guided behavior from the PFC mediated pathway to the direct parietal-PMC pathway. The model includes differential equations that describe voltage changes in the relevant brain areas and difference equations that describe the Hebbian learning. A variety of simulations are described, showing that the model accounts for some critical single-cell recording data from several key brain areas as well as some important behavioral results.

D16

DAMAGE TO THE HUMAN HOMOLOGUE OF V6A IMPAIRS POINTING IN PERIPERSONAL BUT NOT PERSONAL SPACE *Lana Goldberg¹, Carol Broderick¹, James Danckert¹; ¹University of Waterloo* – We examined pointing movement in near space in a patient with optic ataxia resulting from right superior parietal damage encompassing the human homologue of macaque area V6A. In an earlier study, the patient demonstrated deficits in pointing along the sagittal plane. More specifically, higher deceleration times and longer 'dwell times' (i.e., a period of time in which the hand rests on a target before commencing the next movement in a sequence) were found for movements made with either hand back toward the body. Here we examined movements made back toward the body to a variety of targets in either peripersonal space (near the patient's body midline) or personal space (three targets on the patient's body; chest, lips and nose). Participants first made a pointing movement to a target away from the body and then pointed to one of the four possi-

ble target locations (i.e., three proprioceptive and one visual target). Examination of dwell time for movements made to the first target (i.e., prior to initiating the movement back towards peripersonal or personal space) provided an index of movement difficulty. The patient demonstrated longer dwell times for the visually specified target when contrasted with the proprioceptively specified targets suggesting more time spent planning movements to be made in peripersonal space. In addition, dwell time decreased as the degree of specificity for the proprioceptive targets increased. These results suggest that damage to the human homologue of V6A impairs visually guided movements more so than movements made towards a proprioceptively specified target.

D17

CONSCIOUS OF CONFLICT BUT NOT OF THE ELICITING STIMULUS: IMPLICATIONS FOR THE NEUROSCIENCE OF COGNITIVE CONTROL *Taylor Rigby¹, Tim Gerrits¹, Travis Riddle¹, Christopher Berger¹, Ezequiel Morsella^{1,2}; ¹San Francisco State University, Psychology, ²University of California San Francisco, Neurology* – Recent developments in neuroscience (e.g., Pessiglione et al. 2008, Neuron, 2008) suggest that one can be aware of urges and other metacognitions while being unaware of the stimuli provoking these states (cf., Morsella 2005, Psychological Review). Yet, it has never been demonstrated that one can experience conscious conflict from a subliminal stimulus. To investigate this, we used a version of the subliminal Stroop color-naming task (Tzelgov et al. 1997, AJP) and found that, replicating previous studies, the Stroop response-time effect fails to occur for masked stimuli (17 msec word exposure, pre-mask). However, building on prior research on neural processing of subliminal stimuli, we found that when participants (n = 33) were faced with subliminal stimuli, they were still able to report conflict-related urges as a function of Stroop condition, $F(3, 96) = 3.538, p = .0176$: Stronger urges to err were reported for incongruent stimuli than for any other kind of stimuli (congruent, neutral, and control), $ps < .05$. In addition, for supraliminal Stroop stimuli, we examined whether the presence of intra-psychic conflict influences the sense of agency (e.g., when urges conflicting with the current goal of color-naming are perceived as foreign to the self), and whether the strength of the stimulus-evoked urge is inversely related to the overall number of action plans associated with that stimulus (a 'fan effect' of sorts). Together, these findings complement recent psychophysiological findings and constrain theories regarding the neuroscience of cognitive control, addiction, and the cognitive construction of the self.

D18

DOES POST-DECISION WAGERING REFLECT AN ONSET OF CONSCIOUS AWARENESS OR RISK AVERSION? *Shuo Wang¹, Naotsugu Tsuchiya², Ian Krajbich², Ralph Adolphs²; ¹Faculty of Science, National University of Singapore, Singapore, ²Division of the Humanities and Social Sciences, Caltech* – In the Iowa Gambling Task, subjects start employing an optimal decision-making strategy before they can explicitly verbalize their strategy. To probe when subjects consciously notice their strategy, Persaud et al (2007) proposed a technique, called 'post-decision wagering', where subjects bet high or low depending on the confidence they have in their decision. Persaud et al showed that subjects start betting optimally many trials after they start to consistently select from the good decks, implying a period of unconscious optimal deck selection. To characterize the nature of post-decision wagering, we implemented it in several gambling tasks and compared the results with behaviorally derived measures of risk-aversion. Our goal was to determine whether subjects select cards optimally before they bet optimally 1) because they are unaware of the card-reward contingency or 2) because they are risk averse. First, we tried to replicate the Persaud et al finding. For our subject population, we could not replicate their findings. Second, we applied post-decision wagering to a different gambling task, where the card-reward contingency switches after subjects select the best card several times in a row. In this task, subjects did start betting optimally after several trials of optimal card selection. Interestingly, some subjects

continued to bet low even after they selected from the good decks 5-7 trials in a row. However, our behavioral results are unlikely to be explained by risk aversion; we found no correlation between the individual risk-aversion measures and differences in betting strategy.

D19

WHEN VISUAL KNOWLEDGE CAN MODULATE THE MOTOR CORTEX *Mirra Fiorio¹, Maria Carla Bresciani¹, Paola Cesari¹, Giampaolo Rodi¹, Mattia Gambarin¹, Antonio Fiaschi¹, Michele Tinazzi^{1,2}*; ¹Neurological and Vision Sciences, University of Verona, Italy, ²Neurology Unit Borgo Trento Hospital Verona, Italy – We aimed at unveiling any modulation of the motor system associated to the onlooker's visual, but not motor, expertise of observed actions. Two groups of subjects were recruited, with different visual expertise on a particular kind of action, i.e. a dystonic movement. Group 1 (Naïf): 8 subjects without expertise in neurological diseases and without previous exposure to the view of dystonic movements. Group 2 (Neurologists): 8 qualified neurologists working in the movement disorder divisions and dealing with dystonic patients. Single-pulse TMS was applied over the left M1 and motor evoked potentials (MEPs) were recorded from the FDI, AMD and FCR muscles, while subjects observed the following stimuli: 1) static hand; 2) healthy writing; 3) dystonic writing; 4) grasping, presented with a blocked design and with random order across subjects. Each condition consisted of 12 trials. Analysis (ANOVA) showed that naïf subjects had higher MEP amplitudes than neurologists only during observation of the dystonic writing ($p = 0.0007$). Higher activation in the FDI and FCR muscles were found in naïf subjects during observation of the dystonic compared to the healthy writing ($p < 0.0002$). Neurologists did not show different activation between the two writing conditions. Visual expertise can modulate motor cortex excitability during action observation. A future step of this study is to unveil the influence of action observation on the motor system of dystonic patients.

D20

NEURAL CORRELATES OF TAILORED MESSAGE PROCESSING: A SMOKE CESSATION CASE STUDY *Emre Demiralp¹, Hannah Faye Chua², Vic Strecher²*; ¹University of Michigan, Psychology, ²University of Michigan, School of Public Health – Research has shown that individually tailored health programs are more successful than generic one-size-fits-all programs. That is, people are more likely to quit smoking or eat more vegetables when the message of the program is highly tailored to them. Moreover we have shown in the past that highly individually tailored messages engage rostral medial prefrontal cortex (rMPFC) and precuneus/posterior cingulate compared to low-tailored or generic smoking cessation statements. In the current study we investigate whether this differential activation for highly tailored smoking cessation messages can be operationalized in terms of self-related processing. Specifically the medial prefrontal cortex and precuneus/posterior cingulate has been implicated in processing information about the self, as well as performance of complex cognitive functions such as inferring other's mental and emotional states. In the current study, during one of the experiments smokers who are interested to quit smoking received messages with personalized feedback ('You are a 45 year old smoker'), targeted messages ('Looking better is a common reason for quitting.'), and neutral messages ('About 90 percent of people on Earth live north of the equator.'). Participants also completed a self-appraisal task. Participants judged whether an adjective describes them or not, or whether the adjective is of positive or negative valence. Our preliminary analysis of 20 subjects indicate significant overlap between tailored message processing and self related processing in rostral medial prefrontal cortex and precuneus. Further analysis will involve data from more subjects as well as connectivity, ROI, and further overlap analyses.

Higher level cognition: Numerical processing

D21

COUNT ME IN! ON THE AUTOMATICITY OF ENUMERATION PROCESSES *Sharon Naparstek¹, Avishai Henik¹*; ¹Psychology and the Zlotowski Center for Neuroscience, Ben-Gurion University of the Negev, Beer-Sheva, Israel – Enumeration processes are a basic component of mathematical abilities and are the subject of numerous studies. We have recently developed a task that gives rise to an enumeration congruity effect, enabling examination of both explicit and implicit processes of enumeration. Participants were presented with displays containing a variable number of digits and were asked to pay attention to the number of digits or to their identity in separate blocks. In two experiments we employed numerical comparison or parity judgment tasks. In the comparison task, participants were asked to report whether the number or the identity of the presented digits was larger or smaller than 5. In the parity judgment task, participants were asked to report whether the number or the identity of the presented digits was even or odd. When the number of items was relevant and identity irrelevant, there was a congruity effect regardless of task (comparison or parity judgment). In contrast, when identity was relevant and the number of items irrelevant, the congruity effect was present solely in the comparison task. These results provide further information on the representation and processing of numerosities, as well as expand our knowledge regarding the mental processes underlying enumeration.

D22

HEARING 9 ATTENDING RIGHT - INSIGHTS FROM NUMBER-FORM SYNESTHESIA *Limor Gertner¹, Avishai Henik¹*; ¹Ben-Gurion University of the Negev, Psychology and Zlotowski Center for Neuroscience, Israel – In number-form synesthesia, numbers are experienced in spatially-defined configurations. A similar association between numbers and space appears also in the non-synesthete population in the form of a spatial mental number line. Recent researches have suggested that attending numbers may trigger shifts of spatial attention according to number magnitude. We examined this issue in 2 number-form synesthetes and a matched control group. In separate tasks, participants were presented with an auditory or a visual digit (cue) followed by an asterisk (target). Participants were asked to ignore the digit and press a key as soon as the target appeared. In both tasks, the synesthetes exhibited a validity effect: a shorter reaction time when the number-cue was valid (e.g., 8 followed by a right side asterisk) than when it was invalid (e.g., 2 followed by a right side asterisk). Validity was defined according to the synesthete's number-form (left-to-right or bottom-to-top). In contrast, no such effect was found for the controls. Our results reveal that: 1) number-form synesthesia can orient attention according to the specific spatial configuration without attending to the number-cue; 2) number-form synesthesia is a conscious yet involuntary condition that might restrain the flexibility of number representation; and 3) the presence of automaticity is contingent upon the existence of a strong relationship between stimulus features in the current case, between numbers and space.

D23

AN MEG STUDY OF SYMBOLIC NUMBER COMPARISON *Silke M. Göbel¹, Johan D. Carlin², Isabella Paul³*; ¹Psychology & York Neuroimaging Centre (YNIC), University of York, UK, ²Medical Research Council Cognition and Brain Sciences Unit, Cambridge, UK, ³Clinical Psychology and Neuropsychology, University of Konstanz, Germany – Neuroimaging studies of number comparison (NC) have consistently found activation in the parietal lobes, often related to numerical distance. Numerical effects have been observed at frontal and parietal electrode sides within the first 200 ms post-stimulus. The current study investigated the time-course and location of parietal brain activity related to NC with Magnetoencephalography (MEG). During the NC condition, subjects ($n = 18$) had to indicate

whether visually presented digits (1, 4, 6, 9) were greater or smaller than a reference (5). In two control conditions they were asked to perform a perceptual task (vertical line present/absent) either on numerical or non-numerical stimuli. MEG signals were recorded using a 248-channel Magnes 3600 whole-head MEG device (4D Neuroimaging Inc., San Diego). Prior to recording, individual scalp landmarks were spatially co-registered using a Polhemus Fastrak system. These landmarks were matched with the subjects' anatomical magnetic resonance scans and spatially normalized into standard space. Time-locked event-related fields were derived by averaging over epochs for each condition after artifact rejection. MEG source analysis was performed using a minimum variance beamformer (Van Veen et al., 1997). Nonparametric Permutation Tests were employed for statistical comparisons. Significant differences in activation between NC and control conditions were found in right (from 135 ms onwards) and left (from 125 ms onwards) parieto-occipital cortex. Numerical distance had a significant effect on left parieto-occipital cortex from 172 ms onwards. Our results shed further light on the timing of parietal activity related to symbolic number processing.

D24

THE ODD EFFECT: REVIEW AND SUGGESTED MODEL Terence Hines¹; ¹Pace University, Pleasantville, NY – The odd effect refers to the fact that under certain conditions it takes longer to make judgments about odd than even digits. The effect is found when subjects make explicit same/different judgments of digits or digit names based on parity and when explicit odd/even judgments are made. Children learn even / even addition and subtraction problems faster than they learn problems using two odd digits. This does not occur for multiplication problems. These latter are learned and performed using rote memory, not always the case for addition and subtraction problems. The internal code(s) responsible for the odd effect are not activated when retrieving solutions to multiplication problems. The odd effect is not due to a strategy in which subjects first test whether a stimulus is even and only then test for oddness. A model is presented in which the internal representations of the even digits are more closely linked than the representations of odd digits. Priming studies support this model. An even digit prime speeds responses to even digits significantly more than an odd prime speeds responses to odd digits. The model makes predictions about observed hemispheric differences in the odd effect depending on the type of stimuli (digits, words or dot patterns) being judged.

D25

THE INFLUENCE OF NUMERICAL MAGNITUDE ON TIME PERCEPTION AND REPRODUCTION Acer Y.-C. Chang^{1,2}, Ovid J.-L. Tzeng^{1,2,3,4}, Daisy L. Hung^{1,2,3}, Denise H. Wu³; ¹Laboratories for Cognitive Neuroscience, National Yang-Ming University, Taipei, Taiwan, ²Institute of Neuroscience, National Yang-Ming University, Taipei, Taiwan, ³Institute of Cognitive Neuroscience, National Central University, Jhongli, Taiwan, ⁴Institute of Linguistics, Academia Sinica, Taipei, Taiwan – Access to magnitude information in different quantity dimensions, such as numbers and time, has been assumed to rely on generalized magnitude representations underlying these dimensions. Recent research also demonstrated that task-irrelevant numerical information influenced temporal perception in a duration comparison task. However, empirical findings have suggested that the functions of time perception and reproduction have distinct characteristics and neural substrates. Therefore, whether numerical information modulates the abilities to perceive and reproduce time is still an open question. In the current study, perception and reproduction of the duration of different numbers were examined. In Experiment 1, we found that the duration of a large number was judged to be longer than the same duration of a small number. Similarly, in Experiment 2 we found that reproduction of the duration of a large number was longer than that of the same duration of a small number. In Experiment 3, numerical information only appeared as a result of the key-press action to reproduce a fixed duration. It was also found that magnitude of the number indicative of the reproduced duration modulated the reproduc-

tion of the same duration. These results clearly demonstrate the influence from magnitude information of numbers on time perception and reproduction, and are consistent with the proposal of generalized magnitude representations subserving numerical and time processing. Further neurophysiological experiments are carried out to examine the number-duration congruency effect and to determine whether ERP components related to temporal processing (e.g., frontal negative potential) is modulated by numerical magnitude.

D26

THE DEVELOPMENT OF AUTOMATED SYMBOLIC NUMEROSITY PROCESSING IN CHILDREN, AN ERP STUDY

Titia Gebuis¹, Leon Kenemans^{1,2}, Edward de Haan³, Maarten van der Smagt¹; ¹University of Utrecht, Experimental Psychology, ²University of Utrecht, Psychopharmacology, ³University of Amsterdam, Faculty of Social and Behavioural Sciences – Infants can visually detect changes in numerosity, which suggests that a (non-symbolic) numerosity system is already present early in life. Children acquire knowledge about symbolic Arabic numerals around the age of five, and this knowledge gradually becomes automated. The resulting automatic link between the number symbols and their meaning is necessary for the acquisition of arithmetic skills. It is often suggested that before the Arabic numerals are fully automated, additional frontal processes are recruited when children process Arabic numerals. In the current study we investigated the development of automated symbolic number processing in children from second (age 5-6) and fourth grade (age 7-8) using a symbolic and non-symbolic size congruity task and event related potentials (ERP) as a measure. The comparison between symbolic and non-symbolic size congruity effects (SCE) allowed us to disentangle processes necessary to perform the task from processes specific to symbolic number processing. In contrast to previous studies, second grade children already revealed both a symbolic and non-symbolic SCE similar to that of adults. The concurrently measured ERP data revealed that the two magnitudes interfered at an early stimulus level in all age groups. In addition, we found no evidence for the additional recruitment of frontal processes in the early stages of symbolic number automatization. Apparently, already at the age of five automatic symbolic number processing mirrors that of adults.

D27

SPATIAL ORGANIZATION OF MAGNITUDE IN THE REPRESENTATION OF ABSTRACT DOMAINS

Kevin J. Holmes¹, Stella F. Lourenco¹; ¹Emory University – There is converging behavioral and neural evidence that numerical representations are spatially organized from left-to-right, the so-called mental number line. When judging parity (odd/even), for example, smaller and larger numbers produce faster left- and right-side responses, respectively ('SNARC' effect). Three experiments revealed that this left-to-right organization of magnitude extends to the representation of emotional valence. In Experiment 1, participants made parity judgments to numbers (0 to 9) and gender judgments (male/female) to human faces whose expressions ranged from neutral to happy. Results replicated the canonical SNARC effect for number. In the face task, there was a similar, albeit weaker, pattern of spatial organization, with right-side responses becoming increasingly faster as happiness increased. In Experiment 2, emotion ranged from angry to happy (and included neutral). Faster right-side responses were observed as the magnitude of either emotion, relative to neutral, increased (i.e., more happy or angry), suggesting that magnitude, even when instantiated as emotional expression, is spatially organized. In Experiment 3, participants made explicit emotion judgments (i.e., happy/not happy or angry/not angry). For happiness judgments, faster right-side responses were observed with increasing happiness, and for anger judgments, faster right-side responses with increasing anger, demonstrating that the left-to-right organization is flexible and depends on the magnitude-related representation of emotion. Together, our findings suggest that people automatically extract magnitude information in the mental organization of abstract domains, and that number is but one example of a

more general representational system linking space and other magnitude dimensions, perhaps with neural correlates in posterior parietal cortex.

D28

DIFFUSIVITY IN LEFT ANTERIOR SUPERIOR LONGITUDINAL FASCICULUS PREDICTS ARITHMETIC ABILITY IN CHILDREN

Jessica Tsang¹, Robert Dougherty², Gayle Deutsch³, Brian Wandell², Michal Ben-Shachar^{4,5}; ¹School of Education, Stanford University, ²Stanford University, Psychology, ³Stanford University Medical Center, Neurology and Neurological Sciences, ⁴BAR-ILAN University, English, ⁵BAR-ILAN University, Gonda Brain Research Center – Studies of mental arithmetic consistently report fMRI activation in the inferior parietal, inferior frontal, and precentral cortex (Dehaene et al., 2004). To determine whether white matter pathways connecting these regions are related to mental arithmetic ability, we tested 28 children (10-15 years, 14 girls) on mental exact addition, approximate addition, and simple math facts. Using diffusion tensor imaging, we measured the anterior superior longitudinal fasciculus (antSLF), which connects inferior parietal with inferior frontal and precentral cortex. These regions are thought to support quantitative, linguistic, and working memory aspects of mental arithmetic. We used deterministic tractography and manual path labeling to identify the left and right antSLF in each child, and then extracted diffusion properties from a portion extending between two coronal planes defined by the central sulcus and a plane 7mm posterior. We found that approximation abilities positively correlate with fractional anisotropy in left antSLF ($r=0.47$, $p=0.016$). Right antSLF showed a similar, but non-significant, trend ($r=0.31$, $p=0.11$). Exact addition showed a similar, but non-significant, relationship with left antSLF ($r=0.33$, $p=0.10$), but no relationship with right antSLF ($r=0.01$). A diffusion simulation on the observed pattern of diffusion tensor eigenvalues suggests that children with higher arithmetic scores had fewer crossing fibers and higher fiber density in antSLF. Our findings indicate that connections between parietal and frontal areas are important in mental arithmetic ability. Funding: NIH EY015000; Stanford Interdisciplinary Graduate Fellowship to J.T.

D29

SITUATIONAL SOCIAL POWER AND THE NEUROCOGNITIVE MECHANISMS OF MATH PERFORMANCE

Donna J. Bridge^{1,2}, Joan Y. Chiao^{1,2}; ¹Northwestern Interdepartmental Neuroscience Program, ²Northwestern University, Psychology – Heightening one's sense of social power has been shown to facilitate certain cognitive processes, including executive functions, cognitive flexibility, and abstract processing. Here we examined the influence of priming social power on the neurocognitive bases for two kinds of mathematical computations: exact and approximate calculation. Convergent evidence from electrophysiology and neuroimaging studies demonstrates that exact calculation (e.g. $3+4=7$ or 6) relies on language-dependent neural substrates, such as the left inferior frontal gyrus, whereas approximation (e.g. $3+4=6$ or 9) relies on language-independent neural circuitry within bilateral inferior parietal lobules. Based on prior evidence that priming high power enhances abstract processing, we hypothesized that priming high social power would enhance math performance, particularly for approximate calculations. Twenty-two participants were randomly primed with either high power (HP) or low power (LP) and then completed a series of small and large exact and approximate equations. Accuracy results revealed a marginally significant three-way interaction of power by type by size $F(1,20) = 3.91$, $p = .06$. HPs accurately computed more small approximate problems ($M=.98$, $SE=.03$) than LPs ($M=.90$, $SE=.03$), while LPs correctly answered more small exact problems ($M=.98$, $SE=.03$) relative to HPs ($M=.93$, $SE=.03$). For large equations there was a slight trend for HPs to have higher levels of accuracy for exact ($M=.89$, $SE=.03$) and approximate ($M=.86$, $SE=.04$) equations, relative to LPs ($M=.85$, $SE=.03$; and $M=.85$, $SE=.04$, exact and approximate respectively). Implications of these findings for the role of situational social power on neurocognitive routes to mathematical performance will be discussed.

D30

ANATOMICAL AND STRUCTURAL CONNECTIVITY DEFICITS IN YOUNG CHILDREN WITH MATH DISABILITY

Elena Rykhlevskaia^{1,2}, Lucina Uddin¹, Leeza Kondos¹, Vinod Menon¹; ¹Stanford University, Psychiatry and Behavioral Sciences, ²Stanford University, Psychology, CA – Do math disabilities (MD) in young children have an anatomical correlate? Previous neuroimaging studies have indicated the involvement of a distributed network of parietal, prefrontal and inferior temporal cortices in numerical and mathematical information processing. We hypothesized that anatomical and brain connectivity impairments within this network may underlie MD. We acquired T1-weighted structural and diffusion-weighted images from well-characterized 7-9 year old children with MD ($N = 23$) and age-, IQ-, gender- and reading ability-matched typically developing (TD) children ($N = 24$). Optimized voxel-based morphometry (VBM) analyses revealed reduced grey and white matter volume in MD compared to TD. Children with MD group showed reduced gray matter volumes in the right occipito-temporal cortex, fusiform, parahippocampal and lingual gyri, and bilaterally in the cerebellum. They also showed reduced white matter volumes in the splenium of corpus callosum, and within a continuous cluster in the right hemisphere including portions of the retroventricular part of internal capsule, sagittal stratum, posterior corona radiata and superior longitudinal fasciculus. Analysis of diffusion tensor imaging data revealed significantly reduced fractional anisotropy in children with MD in a right hemisphere region of interest obtained from the VBM analysis of white matter. No such differences were observed in a homologous region of the left hemisphere. These results, together with visualization of fiber tracts, suggest significant deficits in inferior-temporal and parietal connectivity in children with MD and provide compelling evidence that structural deficits in anatomy and brain connectivity may contribute to math disability in young children.

D31

FUNCTIONAL OPTICAL SIGNAL ANALYSIS OF CALCULATION AND LANGUAGE LATERALITY

Teresa Iuculano¹, Peck Hui Koh², Clare Elizabeth Elwell², Brian Butterworth¹; ¹Institute of Cognitive Neuroscience, UCL, London, UK, ²Medical Physics and Bioengineering, UCL, London, UK – Neuropsychological studies have shown selective number processing deficits following unilateral cerebral lesions suggesting that calculation may be a lateralized process similar to language. Cerebral dominance is often related to handedness, however, how this lateralization is genetically determined and its link to language and calculation is currently unknown. We aimed to investigate the influence of genes and handedness on the lateralization of calculation and language in Monozygotic and Dizygotic twins who were either concordant or discordant for handedness. During functional Near Infrared Spectroscopy recordings we tested twin pairs on addition, semantic word classification and letter classification tasks. Second level analyses comparing task effects in relation to zygosity and handedness revealed that monozygotic twins with discordant handedness showed the same pattern of lateralization for both the addition and the word tasks, while opposite patterns of lateralization were found in Dizygotic twins regardless of handedness. Our results suggest that calculation abilities may share the same pattern of lateralization as language processes and that zygosity has a more profound effect on the neural organization of these networks than handedness.

D32

THE ARITHMETIC INCONGRUENCY EFFECT: SAME PROCESSING FOR DIFFERENT SYMBOLIC REPRESENTATIONS

Kristie Fisher¹, Miriam Bassok¹, Lee Osterhout¹; ¹University of Washington, Psychology – The incongruency effect is well-established by language research using the event-related potential (ERP) methodology (N400 component; e.g., Kutas & Hillyard, 1998). The N400 effect occurs when a word is incongruent with the words that precede it, and it is assumed to indicate the degree of integration of a word with its semantic context. Investigations of this effect have been extended to

measure conceptual integration in arithmetic. It has been found that incorrect answers to arithmetic problems elicit a similar incongruity effect, and that the patterns of latency and amplitude reflect the organization of arithmetic facts in memory (e.g., Niedeggen & Rosler, 1999; Szucs & Csepe, 2005; Zhou et al., 2006). Most studies have shown that this effect occurs slightly earlier in arithmetic (N300). This difference raises the question of whether the incongruity effect in arithmetic is truly analogous to that in language. We examined whether this difference is due to the format of the respective symbols in these two domains - digits vs. words. Participants in this study verified the correctness of arithmetic problems presented as digits (e.g., $12 + 3 = 15$) and as words (e.g., Twelve plus three equals fifteen). In both conditions, we compared ERP responses to correct answers (e.g., 15) with numerically close and far incorrect answers (e.g., 14 and 4). We found that the processing of mathematical information presented in two different symbolic formats is remarkably similar, indicating that conceptual integration does not depend on the symbolic form used to represent the relevant concepts.

D33**THE IMPORTANCE OF LOLA: BRAIN AND BEHAVIOR INDICES OF THE ORGANIZATION OF ARITHMETIC FACTS IN BILINGUALS**

Elena Salillas¹, Nicole Wicha^{1,2}; ¹University of Texas at San Antonio, ²University of Texas Health Science Center at San Antonio – How arithmetic is related to language is a question of intense debate. According to Campbell and Epp (2004) arithmetic facts are represented in the bilingual brain as three modular codes (L1, L2 and Digits). Our findings indicate that the proposed memory networks supporting arithmetic are more strongly and accurately represented in both the Digits format and the Language of Learning Arithmetic - LoLA, which may or may not coincide with L1, than in the other language (toL). In a series of 8 behavioral and ERP experiments using the error-priming method (Niedeggen, et al 1999) we explored the organization of the three arithmetic codes in balanced bilinguals and, through code switching, the connections between the representations. Specifically, judging the correctness of a solution lead to a congruency effect with faster times for correct ($3 \times 2 = 6$) than incorrect ($3 \times 2 = 7$) solutions, but only for the Digit and LoLA formats. Convergent ERP data showed larger N400 congruency effects for Digit and LoLA formats. Moreover, a relatedness effect modulated the N400 only in the LoLA and Digit formats, with a larger N400 congruency effect for related ($3 \times 2 = 8$, where 8 is a factor of 2) than unrelated ($3 \times 2 = 7$) incorrect solutions. Switching across codes ($3 \times 2 = \text{six}$) elicited a late positive component, as did using the toL, indicating that translation across codes may be necessary when processing in a language other than LoLA. Based on these findings, we propose modifications to the Encoding Complex Model for bilinguals and address the general format dependencies for arithmetic (e.g., Dehaene, 1997).

Linguistic processes: Lexicon**D34****DE COLORES: AN ERP STUDY OF CROSS-LANGUAGE INTERFERENCE USING A BILINGUAL COLOR-STROOP TASK**

Nicole Wicha^{1,2}, Lavelda Bradley¹; ¹University of Texas at San Antonio, ²University of Texas Health Science Center at San Antonio – Bilinguals can experience cross-language interference from an inhibited language, and exhibit changes in brain activity related to this inhibitory process. We tested the timing of lexical interference in the first and second languages of fluent bilinguals using a modified Stroop task - an event-related potentials (ERP) extension of previous behavioral findings (Stanley, Kothmann and Wicha, 2007, JCN Supplement). Spanish-English balanced bilinguals named the ink color of color words that either matched in color or not. The color words were presented in English or Spanish, and naming was performed either in the same language as the text or not, across alternating blocks. In keeping with the bilingual Stroop literature, both between-

and within-language interference was found. Additionally, ERPs showed that both color incongruent and language incongruent trials elicited an increased negativity between 250 to 450 ms, with language interference effects occurring earlier than Stroop interference effects. The negativity was largest in amplitude when naming incongruent ink colors in one language while reading in the other language, reflecting dual interference from both color and language. However, the negativity was more frontally localized for color interference and more broadly distributed for language interference. These findings suggest partially overlapping neural substrates for cross-language inhibition and Stroop-related inhibition for balanced bilinguals, with joint inhibitory effects at frontal sites. Additionally, a late positive component reflected differences across conditions. Results will be discussed in light of models of bilingual lexical activation and inhibitory control.

Linguistic processes: Other**D35****THE TALE OF THE PERRO AND THE BONE: READING CODE-SWITCHED NOUNS AND VERBS IN DISCOURSE**

Christian Gonzalez¹, Nicole Wicha^{1,2}; ¹University of Texas at San Antonio, ²University of Texas Health Science Center at San Antonio – Switching between two languages while comprehending a single sentence elicits a Late Positive Component (LPC), with larger amplitude for the switched than the non-switched word (Moreno, et. al, 2002). However, the majority of code switching studies have used target nouns, even though the literature indicates that nouns and verbs are processed differently (Federmeier, 2000; Pulvermuller, 1999). The goal of the current study is to look at code-switching in a discourse context, and to compare the brain's response to code-switched nouns and verbs. Spanish-English bilinguals read short Aesop's tales in English with occasional switches into Spanish. The target words were both nouns and verbs and were presented either early or late in the story. Preliminary data from six participants show a LPC effect for both nouns and verbs, possibly reflecting a processing cost when interpreting a switch. The LPC code-switch effect was larger for nouns than verbs over central and parietal recording sites; verbs also elicited increased N400 amplitude. An effect of discourse was also observed, with a larger LPC code-switching effect for words that were switched later in context than earlier. In contrast, only earlier code-switches elicited increased N400 amplitude. These data support the hypothesis that the brain treats nouns and verbs differently even when code-switching. In addition, whereas the N400 effect shows that more context helps process the meaning of the switched word, the increase in the LPC effect with additional context potentially reflects a difference in activation between the story language and the language of the code-switched word.

Linguistic processes: Semantics**D36****BOOSTING THE N400: SYNTACTIC GENDER MODULATION AS A FUNCTION OF CONTEXTUAL CONSTRAINT**

Lourdes Guajardo¹, Nicole Wicha^{1,2}; ¹University of Texas at San Antonio, ²University of Texas Health Science Center at San Antonio – A central issue in psycholinguistics is how we process semantic and grammatical information and how these processes interact during online comprehension. Previous studies have yielded inconclusive results on how and when this interaction occurs; it is unclear whether these processes are continuously interacting or if they only interact at a later stage. The purpose of this study was to examine this interaction using the N400 and P600 as indices of semantic and grammatical processing, respectively. Native speakers of Spanish were presented with Spanish sentences containing a target adjective that was either semantically and grammatically correct or disagreed in meaning, grammatical gender, or both with the preceding noun. The

advantage of using gender-marked adjectives in Spanish is that they allow us to compare both types of processes at a single word. The adjectives were embedded in a range of weakly to strongly constraining sentences in order to compare the interaction effect as a function of contextual constraint. Semantic violations elicited a robust N400 effect followed by a late positivity, while grammatical gender violations elicited a P600 effect. Combined violations elicited a larger N400 and a reduced P600 compared to the individual violations. Crucially, this boosting effect on the N400 was significant for high, but not low cloze sentences. The findings support fully interactive models whereby semantic and grammatical processes are continuously interacting as they unfold in time. However, the interaction may be modulated by the amount of contextual information available, as both processors are combining efforts to predict upcoming words.

Linguistic processes: Lexicon

D37

NEURAL CORRELATES OF MEANING IN THE ACQUISITION OF NOVEL WORDS M. Gareth Gaskell¹, Shane Lindsay¹, Jakke Tamminen¹, Yuanyuan Chen^{1,2}, Ruowen Li¹, Jennifer Wolfson¹, Matthew H. Davis²; ¹University of York, Psychology, UK, ²Medical Research Council Cognition and Brain Sciences Unit, Cambridge, UK – Recent behavioral and neuroimaging data suggest that acquiring novel words (without meanings) involves two components of learning: immediate acquisition of phonological representations, followed by sleep-associated integration of novel words with lexical neighbors (Dumay & Gaskell, 2007; Davis, Di Betta, Macdonald & Gaskell, in press). The current study examined the meaning side of vocabulary acquisition using event-related fMRI. Adult participants learned different sets of visually presented novel words and associated meanings on two consecutive days. On the second day, BOLD responses to both sets of stimuli, plus untrained novel and existing words, were measured during a one-back meaning comparison task. Retrieval of the meanings of novel words learned that day engaged a broad brain network including bilateral inferior temporal regions, and left inferior and middle frontal gyrus. The pattern for novel words learned the previous day was similar, suggesting that sleep had not led to major restructuring of the representations. Behavioral post-test data supported this conclusion. However, both sets of novel words also exhibited substantially different patterns of activity from the pre-existing words in bilateral occipital and superior temporal regions. The results suggest that learning novel word meanings, like learning their forms, involves fast and slow aspects of learning. However, unlike learning of form, the representation of novel meanings does not change substantially after a single night's sleep, with further consolidation presumably taking place over subsequent weeks or months. We interpret the similarities and differences between form and meaning acquisition with respect to the systematicity of the mappings to be learned.

D38

THE NEURAL CORRELATES OF MORPHOLOGICAL PRIMING DURING OVERT LANGUAGE PRODUCTION Dirk Koester^{1,2}, Niels O. Schiller¹; ¹Leiden Institute for Brain and Cognition, Leiden, The Netherlands, ²Donders Institute for Brain, Cognition and Behaviour, Nijmegen, The Netherlands – Findings about the neuroanatomical correlates of morphological processing in language are sparse and partially inconsistent (e.g. Devlin et al., 2004; Joanisse et al., 2005; Bozic et al., 2007) and the contributions of production processes have not been strictly dissociated from comprehension processes. Moreover, it has been suggested that morphological effects emerge from an interaction of semantic and phonological factors (e.g. Gonnerman et al., 2007). To investigate the neural correlates of morphological priming during overt production of Dutch, we used a long-lag word-picture priming paradigm. With this paradigm it has been shown that the production of morphologically complex words (primes)

facilitates the subsequent production of picture names (targets) that were part of the complex word prime (e.g. Koester & Schiller, 2008). A morphological priming effect is expected in the left middle temporal gyrus if morphological priming relies on lexically stored information. However, if such priming involves combinatorial lexical operations, a priming effect is expected in the left inferior frontal gyrus (IFG). Native speakers of Dutch named line drawings that were primed by semantically transparent or opaque compounds, or by monomorphemic nouns that fully contained the target picture name. Significantly increased brain activity was observed in the left IFG (BA 47) for the transparent and opaque priming conditions, but not for pure form overlap. These results suggest that morphological priming involves combinatorial operations that are supported by the left IFG. On the basis of the present data, we therefore propose that morphological information about words has a neurocognitive correlate.

D39

A COMPUTATIONAL CASE-SERIES APPROACH TO FREQUENCY EFFECTS IN APHASIC WORD PRODUCTION

Nazbanou Nozari¹, Audrey Kittredge¹, Gary Dell¹; ¹Beckman Institute, University of Illinois at Urbana-Champaign – How do we retrieve words when speaking? Comparing retrieval during picture naming and auditory word repetition can answer this question. In the 2-step model of lexical access, both the word retrieval and phonological retrieval steps are involved in naming, but the former has no role in repetition. We computationally implemented four accounts of word repetition, using the interactive 2-step model of Foygel and Dell (2000). Assuming accurate recognition of the to-be-repeated word, repetition could consist of retrieving the word's output phonemes from the lexicon (pure lexical route model), or words could be repeated via a direct route from input phonology to output phonology (pure non-lexical route model). Alternatively, both routes might be used, either by summing their activation (summation dual route model) or choosing one route on any given repetition trial (independent dual route model). We empirically tested these four models by comparing the size of the word frequency effect (an index of lexical retrieval) in aphasic naming and repetition. Using multinomial hierarchical logistic multiple regression, we analyzed the naming and repetition errors from 59 patients, and from simulations of the four repetition models. A comparison of the patient and simulation data supported the pure lexical and summation dual route models: the effect of frequency in repetition was at least as strong as in naming, demonstrating that the lexical-to-phonological mapping, required for naming, is equally influential in repetition. We further claim that cognitive neuropsychological questions can be addressed by doing comparable analyses on patient data and output of computational models.

D40

NEURAL MECHANISM UNDERLYING ORTHOGRAPHIC INFLUENCE ON SPEECH PROCESSING: A COMBINED TRANSCRANIAL MAGNETIC STIMULATION AND BEHAVIORAL STUDY

Chotiga Pattamadilok^{1,2,3}, Iris, N. Knierim^{1,4}, Keith, J. Duncan¹, Joseph, T. Devlin¹; ¹University College London, UK, ²Université Libre de Bruxelles, Belgium, ³Fonds de la Recherche Scientifique-FNRS, Belgium, ⁴Université Pierre et Marie Curie, and Ecole Normale Supérieure, Paris, France – Several behavioral studies have demonstrated that learning to read and write affects the way spoken language is processed. The present study investigates the neural mechanism underlying the emergence of such orthographic effects during speech processing. rTMS was used to tease apart two competing hypotheses considering the orthographic influence either as a consequence of online co-activation of the phonological and orthographic representations during speech processing or as a consequence of a profound modification of the very nature of the phonological representations during literacy acquisition. Precisely, rTMS was applied to disrupt the function of the brain regions involved either in phonological (left supramarginal gyrus-SMG) or orthographic processing (left ventral occipito-temporal cortex-vOTC) during the auditory lexical decision task in which the orthographic consistency of spoken words was

manipulated. If the orthographic effect results from the co-activation of the auditory and visual systems during speech processing, interrupting the function of left vOTC would reduce the orthographic consistency effect. On the contrary, if the orthographic effect reflects a modification of the very nature of the phonological representations via the contact with written code, interrupting the function of left SMG would reduce the effect. By demonstrating a disruptive effect of rTMS on the magnitude of the orthographic influence only when the stimulation was delivered over SMG, we provided first direct evidence for a profound modification of the nature of the phonological representations as a consequence of literacy acquisition and argues against the widely accepted idea that written code simply co-exists with spoken code of language.

D41

AN ERP STUDY OF CASE AND LOCATION INVARIANCE IN ORTHOGRAPHIC PROCESSING *Janelle LaMarche¹, Phillip J. Holcomb¹, Jonathan Grainger²*; ¹Tufts University, Medford, MA, ²LPC-CNRS, University of Provence, Marseilles, FR – In an experiment combining masked repetition priming and the recording of event-related potentials, the visual similarity of prime target pairs as well as prime location were manipulated. Single-word items were composed of letters that were either similar (c-C) or dissimilar (a-A) in lower- and uppercase formats (i.e. cook-COOK, area-AREA). The location of prime stimuli relative to centrally located target words was also manipulated so that prime words could appear at the same target location, or shifted to the right or left by 20 pixels. Repetition priming effects were found in a series of early visual ERP components - the N/P150, the N250, and the N400. Critically, results indicate an interaction between repetition and similarity, where items with similar features show priming patterns in all three windows similar to previous findings, while items with dissimilar features show repetition priming effects that emerge later. Results provide further evidence for shape and location invariant orthographic representations, and elucidate the nature of the processes that underlie the mapping of retinotopic visual features onto higher-level location invariant representations during visual word recognition.

D42

THE INTERPLAY OF FREQUENCY, PREDICTABILITY, AND SOA IN WORD RECOGNITION: EVIDENCE FROM EVENT-RELATED POTENTIALS AND EYE MOVEMENTS *Michael Dambacher^{1,2}, Mario Braun², Sarah Risse¹, Olaf Dimigen^{1,3}, Kristin Göllner, Arthur Jacobs², Reinhold Kliegl¹*; ¹Universität Potsdam, Psychology, Germany, ²Freie Universität Berlin, Germany, Experimental and Neurocognitive Psychology, ³Humboldt Universität zu Berlin, Biological Psychology, Germany – In linguistic research, word frequency is commonly regarded as major bottom-up determinant for the speed of lexical access. However, the temporal role of top-down processes is debated: There is uncertainty whether context-based predictions about incoming words affect lexical or solely post-lexical phases. Here, we used event-related potentials (ERPs) to delineate the interplay of bottom-up and top-down processes during sentence reading. In 144 sentences, frequency (low/high) and predictability (low/high) were experimentally manipulated on target words; sentence frames were kept constant. Compatible with most ERP reading studies, sentences were displayed word-by-word with an SOA of 700 ms. However, normal reading speed with a faster rate of four to five words per second challenges the generalizability of such data. The influence of input rate was examined with the same stimuli in a second experiment approximating normal reading speed with an SOA of 280 ms. ERPs revealed interactions of frequency and predictability within 200 ms post-stimulus in both experiments. Furthermore, presentation rate affected the timeline: At SOA700, frequency effects emerged with a shorter latency for high (90-140 ms) than for low predictability words (240-290 ms). SOA280 yielded frequency effects for both predictability conditions in an intermediate epoch (140-190 ms). The results indicate that early lexical processes are directed by bottom-up as well as top-down information. This interplay is modulated by the time available for word processing and prediction. We

present an approach that reconciles the findings and discuss their link to eye movement data from left-to-right reading.

D43

TIME AND MONEY VERSUS MONEY AND TIME: AN ERP STUDY OF BINOMIAL EXPRESSIONS IN ENGLISH *Anna Siyanova¹, Kathy Conklin¹, Walter J. B. van Heuven²*; ¹School of English Studies, University of Nottingham, ²School of Psychology, University of Nottingham – It is generally accepted that we store representations of words in our mental lexicon. However, what exactly is stored remains an open question. Previous research has looked at whether multi-word units (e.g., idioms, phrasal verbs, and compounds) are stored holistically or computed on-line. In previous behavioural and eye-tracking studies, we have investigated the processing of binomials, which are recurrent expressions formed by two words from the same lexical class connected by a conjunction (e.g., time and money). In such expressions, a particular word order is more frequent and considered more acceptable (e.g., time and money vs. money and time). Results showed a processing advantage for binomials over their reversed forms. The current investigation looks at the processing of binomials in sentence context using ERP. Of greatest interest is the N400 component, which has been shown to be sensitive to the processing of lexical-semantic information and frequency, as well as real-world knowledge (e.g., Hagoort et al., 2004). Our results revealed larger N400 amplitudes for reversed binomials (e.g., money and time) and binomials with semantic violations (e.g., time and party) relative to high frequency binomials (e.g., time and money). These findings support a view in which lexical storage is maximised, while on-line computation is minimised. However, a more computational view of the mental lexicon cannot be ruled out, where the processing advantage for time and money is the result of a very quick, almost simultaneous activation of money upon reading time. On this account, binomials are strongly linked but computed on-line.

D44

AN ELECTROPHYSIOLOGICAL STUDY ON WORD AND PICTURE PROCESSING IN MANDARIN CHINESE SPEAKERS *Yen Na Yum¹, Katherine Midgley^{1,2}, Jonathan Grainger², Phillip Holcomb¹*; ¹Tufts University, Medford, MA, ²LPC-CNRS University of Provence, Marseilles, France – A number of previous studies have looked at similarities and differences between word and picture processing, but not many of them have made direct comparisons between the two. These differences are particularly interesting in languages with non-alphabetic scripts like Chinese because of the arguably more pictographic nature of the words. This study investigated how pictures and Chinese characters are processed by native Mandarin Chinese speakers and native English speakers using the Event-Related Potential (ERP) technique. Both groups of participants performed a semantic categorization task with the same set of stimuli, which consisted of pictures of objects and concrete one and two character Chinese words, pseudo-randomly mixed to minimize priming and expectation effects. Pictures and words were presented for 400 ms, and participants were instructed to respond whenever the stimulus was a human body part (~15% of trials). Results on the non-body part critical words showed large ERP effects in the 300-600 ms time range. For native Chinese speakers, large N400-like negativities were found for both words and pictures, with the effects greater for words than for pictures especially late in the N400 epoch. For monolingual English speakers there were clear negativities for pictures, but as expected, there was no evidence of N400 activity for Chinese words. This pattern of effects is consistent with the possibility that Chinese speakers have a system for word processing that is similar to that of picture processing. The results will be discussed with respect to their implications for models of visual word and picture processing.

D45

CORPUS CALLOSUM MORPHOLOGY AND LATERALIZATION IN WILLIAMS SYNDROME *Tiffany Nash¹, Katherine Roe¹, Shane Kippenhan¹, Christopher Coutlee¹, Carolyn Mervis², Colleen Morris³, Philip*

Kohn¹, Andreas Meyer-Lindenberg^{1,4}, Karen Berman¹; ¹Section on Integrative Neuroimaging, CBDB, NIMH IRP, NIH, DHHS, Bethesda, MD, ²Neurodevelopmental Sciences Laboratory, Psychological and Brain Sciences, University of Louisville, Louisville, KY, ³University of Nevada School of Medicine, Pediatrics, Las Vegas, NV, ⁴Central Institute of Mental Health, Mannheim, Germany – Williams syndrome (WS) is a rare genetic condition caused by a micro deletion of ~1.6 megabases on chromosome 7q11.23. Although language is relatively preserved in WS, language acquisition is delayed, and previous research suggests reduced hemispheric specialization and interhemispheric cooperativity during lexical processing. The corpus callosum (CC), critical for mediating cross-talk between the two hemispheres, is known to be atypical in volume and shape in WS. The current study investigated the relation between CC volume and hemispheric specialization during a lexical processing task in WS. We used oxygen-15 water PET to measure regional cerebral blood flow (rCBF) in 14 normal-IQ participants with WS (mean age 27.7, seven female) performing a verbal fluency task. For each participant, six high-resolution, 1.5T structural images were averaged, and corpus callosum volumes (as segmented by FreeSurfer) were divided into five equal-length segments along the rostral-caudal axis. These sub-volumes, adjusted for total intracranial volume, were entered into a correlation analysis with laterality indices and functional connectivity maps derived from the verbal fluency rCBF data. Reduced functional lateralization of rCBF in the left frontal and parietal lobes was associated with decreased anterior CC (genu) volume ($p < .001$, uncorrected). Moreover, functional connectivity between Broca's area and right inferior parietal regions, previously found to be reduced in this population, was correlated with the volume of anterior corpus callosum ($p < .001$, uncorrected). These findings suggest a strong relation between compromised white matter tract integrity in the CC and aberrant functional lateralization during language processing in WS.

D46

SHEDDING NEW LIGHT ON READING IN BILINGUAL AND MONOLINGUAL CHILDREN Melody S. Berens¹, Ioulia Kovelman², Matthew Dubins¹, Mark Shalinsky¹, Laura-Ann Petitto¹; ¹University of Toronto, ²Massachusetts Institute of Technology – Little is known about the neural basis of reading and language development in typical bilingual and monolingual children. We ask whether and how early systematic exposure to two languages modifies brain tissue underlying reading and language capacities, and across important time periods of neural reading and language development. English-Spanish bilingual children in the Second and Third grades (ages 7-9; $n=7$) and English monolingual children ($n=11$) read aloud words during English and Spanish reading tasks while undergoing functional Near Infrared Spectroscopy (fNIRS, Hitachi ETG-4000) brain-imaging. All children read aloud Regular words (high sound to letter correspondence), Irregular words (low sound to letter correspondence), and Non-words in English. Bilinguals read aloud Spanish Regular and Non-words. fNIRS measures changes in the brain's oxygen level density (BOLD), and also its building blocks, deoxygenated and oxygenated hemoglobin, with 10-Hz temporal resolution. fNIRS' spatial resolution is excellent for cortical studies of language (~3-4 cm depth), child-friendly, quiet, portable, and tolerates movement. Results Behavioral. Bilingual and monolingual children performed similarly on the English reading tasks ($p > .05$). Imaging. Consistent with our published discoveries comparing bilingual and monolingual adult brains, we predict differences between bilingual and monolingual children's recruitment of left inferior frontal tissue and bilateral posterior superior temporal gyrus. Significance. Using innovative fNIRS allows first-time examination of the neural underpinnings of reading in bilingual and monolingual children providing important information both for neuroscientists about the extent and variability of reading/language in the developing bilingual brain and for educators. Funding Petitto (P.I.): NIHR01HD04582203, NIHR21HD05055802.

D47

THE SPATIOTEMPORAL DYNAMICS OF BILINGUAL LEXICO-SEMANTIC REPRESENTATIONS Matthew Leonard^{1,4}, Tim Brown^{3,4}, Katie Travis^{3,4}, Lusineh Gharapetian⁴, Matt Erhart⁴, Eric Halgren^{2,4}, Jeff Elman¹; ¹University of California, San Diego, Cognitive Science, ²University of California, San Diego, Radiology, ³University of California, San Diego, Neurosciences, ⁴University of California, San Diego, Multimodal Imaging Laboratory – More than two-thirds of the global population is proficient in more than one language, yet we do not understand how the brain organizes and processes multiple lexicons. It has been shown behaviorally that the first (L1) and second (L2) languages can both facilitate and interfere with each other, however the existing neuroimaging literature on bilingual lexico-semantic representations is inconclusive and contradictory with regard to shared versus separate neural substrates (Simos et al., 2005; Indefrey, 2006). We used a multimodal imaging method that combines the millisecond temporal resolution of magnetoencephalography (MEG) with the spatial resolution of structural magnetic resonance imaging (MRI) to examine these cortical representations in a group of Spanish-English bilingual adults. Participants viewed single concrete nouns presented visually in both languages, and made size judgments to the words. Using a distributed source anatomically-constrained MEG analysis (Dale et al., 2000), we found that while the L1 and the L2 share neural representations in classical left hemisphere frontal regions, the L2 additionally recruits right hemisphere and posterior areas. These results suggest that there are both separate and shared representations for lexico-semantic information between the two languages in relatively high proficiency adult bilinguals. The nature of the additional bilateral posterior activity for the L2 relative to the native language also suggests that the second language, prior to achieving native-like proficiency, may be represented in a manner similar to a school-age child's developing L1 (Brown et al., 2005). These findings pose potentially important questions concerning L2 instruction, acquisition, and bilingual language disorders.

D48

EVIDENCE OF MOTOR ENCODING DURING SIGN LANGUAGE PERCEPTION Nicole Spotswood¹, David Corina¹; ¹Center for Mind and Brain, University of California, Davis – Of fundamental concern in the cognitive neuroscience of language is how speakers understand words. There has been a renewed interest in theories which ground language understanding in biological substrates of bodily senses. According to one such theory, the motor theory of speech perception, words are encoded, in part, in reference to one's internal motor representations utilized in speech production. Our interests were to examine whether this link between perception and production could be found in sign language processing. We collected data from 20 fluent signers as they performed a lexical decision task. Right- and left-handed signers were asked to perform lexical decisions to right- and left-handed tokens of well formed American Sign Language (ASL) words and non-lexical, yet phonologically possible 'non-signs.' To the extent that there is a mapping between one's internal production of sign forms and the perception of another's signing, we asked whether handedness would affect this task. Each subject saw video clips showing either an ASL sign or non-sign - half of the videos displayed a left-handed signer signing, the other half showed a right-handed signer. Reaction times (RTs) were recorded while subjects made lexical decisions to these stimuli. RTs for signs were significantly faster than for non-signs. RTs for left- versus right-handed signs did not differ significantly; however, we did find highly significant differences between RTs for right-handed and left-handed non-signs. These results suggest that motoric properties of language form may be brought to bear as discriminations become more difficult, as in the case of non-signs.

D49

FROM NUMBERS TO LETTERS: FEEDBACK REGULARIZATION IN VISUAL WORD RECOGNITION

Nicola Molinaro¹, Jon Andoni Duñabeitia¹, Alejandro Marín-Gutiérrez¹, Manuel Carreiras^{1,2}; ¹Instituto de Tecnologías Biomédicas, Universidad de La Laguna, Spain, ²BCBL - Basque Research Center on Cognition, Brain and Language, Spain – Alphabetic word reading involves letter identification based on elementary visual features, independently of the format of the written letters. This process is sensitive to the word context, leading to the regularization of the input even when numbers that resemble letters are inserted among letters (e.g., A=4, E=3, S=5, I=1; Perea et al., 2008). Here we investigate the electrophysiological correlates of number-to-letter regularization by means of the masked priming paradigm: target words were preceded by alphabetic primes (e.g., MATERIAL-MATERIAL), primes with letter-like numbers (e.g., M4T3R14L-MATERIAL), or primes with unrelated numbers (e.g., M7T6R28L-MATERIAL). The ERP patterns (N=26) were different in three consecutive time windows. The P150 component was more positive for the unrelated numbers condition compared to the two other conditions in occipital areas. Then, target words preceded by primes with numbers elicited a more negative N200 compared to the fully alphabetic condition, showing that the ERP effects are not due to visual overlap between prime and target. Finally, a positive component peaking around 260 ms was more positive for targets preceded by alphabetic primes and primes with letter-like numbers, compared to the condition with unrelated numbers. We explain these results as reflecting top-down feedback activation from word units, which strongly influences the activation of the letter units at a format-independent abstract level. Moreover, we propose an extension of the Local Combination Detectors model (Dehaene et al., 2005).

D50

THE PROCESSING OF CONSONANTS AND VOWELS DURING LETTER IDENTITY AND LETTER POSITION ASSIGNMENT IN VISUAL-WORD RECOGNITION

Manuel Carreiras^{1,2}, Marta Vergara³, Alejandro Marín², Manuel Perea⁴; ¹Basque Research Center on Cognition, Brain and Language, Spain, ²Instituto de Tecnologías Biomédicas, Universidad de La Laguna, Spain, ³Center for Brain and Mind, UC Davis, ⁴University of Valencia, Spain – Recent research suggests that there is a processing distinction between consonants and vowels in visual-word recognition. To further investigate the neural bases of consonant and vowel processing, Event Related Potentials (ERPs) were recorded while participants read words and pseudowords in a lexical decision task. To assess the time course of vowels and consonants in letter identity/position assignment, the stimuli were displayed in six different conditions in a masked priming paradigm with a 50-ms SOA: i) identity condition; ii) vowels-delayed condition (e.g., choc?l?te-CHOCOLATE), iii) consonants-delayed condition (cho?o?ate-CHOCOLATE); iv) transposed-consonant condition (chocolate-CHOCOLATE); v) transposed-vowel condition (chocolate-CHOCOLATE), and vi) unrelated (baseline) condition. Results showed that the consonant- and vowel-delayed conditions differed in early ERP windows (over frontal areas), while consonant- and vowel-transposed conditions differed in a later window (over right frontal areas). Furthermore, the comparison between delayed and transposition conditions showed a larger negativity for transpositions starting at around 300 ms over central areas. In addition, the identity and unrelated conditions differed from the consonant and vowel manipulation conditions in the N250 and the N400 components, respectively. The time course and scalp distribution of these effects seem to reflect different stages on the process of letter coding during lexical access. Finally, RTs were longer in the conditions involving consonants than vowels and in the delayed-letter conditions than the transposed-letter conditions. The RTs in these four delayed/transposed-letter conditions differed from the identity and the unrelated conditions. We examine the implications of these findings for computational models of visual-word recognition and reading.

D51

LANGUAGE USE AFFECTS LONG-TERM SEMANTIC PRIMING IN CHILD BILINGUALS: EVIDENCE FROM EVENT-RELATED POTENTIAL

Arturo Hernandez¹, Manfred Gugler², Isabell Wartenburger^{2,3}; ¹University of Houston, Psychology, ²Berlin NeuroImaging Center, Charite Berlin, ³University of Potsdam, Linguistics – The present study investigated and examined the effects of language use on neurophysiological activity during auditory word recognition. Participants were early German-English bilingual children, ages 6 to 7, who learned both languages from birth and were currently living in Germany. Participants were asked to listen passively to auditorily presented words in English and German while EEG activity was being monitored. Each word was presented twice with varying lags between repetitions. Results revealed an N400 for all words presented. However, a reduction in the N400 was only observed upon the second instance of a repeated German word when it had been preceded earlier in the experiment by its English translation. No other modulation of the N400 was observed for repetition in any of the other conditions. Hence, repetition priming was observed in only one direction and only when items were repeated first in English and then in German. These results suggest that immersion in a language may modulate the magnitude of semantic processing. The findings are consistent with the view that lexical-semantic processing in bilingual children, even those who exhibit high proficiency in two simultaneously learned languages, are sensitive to factors such as language use.

D52

EFFECTS OF MORPHOLOGICAL COMPLEXITY ON LEXICAL PROCESSING: EVIDENCE FROM MEG

Caroline M. Whiting¹, Yury Shtyrov¹, William D. Marslen-Wilson¹; ¹MRC Cognition and Brain Sciences Unit, Cambridge UK – The role of morphological structure and semantic transparency during visual word processing was investigated in a magnetoencephalography (MEG) study. Recent evidence has suggested that morpho-orthographic cues - the presence of a potential stem and affix - can be sufficient to trigger morphological segmentation, regardless of the semantic relationship between the stem and whole form (Longtin et al., 2003). In this study we aimed to examine the spatiotemporal pattern of lexical processing, in particular the point at which stems and affixes can cue the presence of morphological complexity. Furthermore, we investigated how the semantic transparency of complex forms could influence attempts at segmentation. Stimuli co-varied on the presence and absence of a potential stem and affix in English. Source analysis using L2 minimum norm estimates (MNE) revealed a left-lateralised fronto-temporal network activated during word recognition. Using a region-of-interest analysis, we found activity at the M170 associated with visual string processing within left fusiform gyrus, but no difference between complex and non-complex forms. At approximately 250ms, anterior temporal regions showed differential processing for forms containing both a stem and affix (e.g. farmer) from those that could not be morphologically complex (e.g. scandal). A late transparency effect appeared in the 400ms time-window, associated with the semantic relatedness between the stem and whole form. Our results support recent behavioural and neuroimaging results pointing to early processing based on the presence of orthographic cues to morphological structure.

D53

NATIVE LANGUAGE SEMANTIC ACTIVATION IN NON-NATIVE SPEECH COMPREHENSION: EVIDENCE FROM EVENT-RELATED POTENTIALS

Ian FitzPatrick^{1,2}, Peter Indefrey^{1,2}; ¹Max Planck Institute for Psycholinguistics, ²Radboud University Nijmegen, Donders Institute for Brain Cognition and Behaviour – Converging evidence suggests that there is language non-selective access to the bilingual lexicon in the domain of written word comprehension. For auditory comprehension the situation is less clear-cut. The current study further investigated the availability of first language (L1) semantic features in second language (L2) speech processing. We recorded EEG from 30 Dutch-English bilinguals who listened

to spoken sentences in their L2 (English). Experiment 1 used sentences in which the critical word was a: (a) semantically congruent L2 word, (b) semantically incongruent L2 word, (c) congruent L1 word, or (d) an incongruent L1 word. Incongruent L1 and L2 words elicited a canonical N400 effect. Furthermore, the N400 to congruent L1 words had a substantially earlier offset than the N400 to incongruent L1 and L2 words. Experiment 2 the critical word in the sentence was an L1-L2 interlingual homophone. In separate conditions: (a) the L2 meaning, (b) the L1 meaning, or (c) neither meaning was congruent with the sentence context. Whenever the L1 meaning was congruent with the sentence context we observed an N400 with an earlier offset than the N400 to incongruent homophones. When the L2 meaning of the homophone was congruent a negativity emerged, but substantially later than the N400 to incongruent homophones. Taken together these results firstly show that interlingual homophones activate semantic features from L1 and L2, however L1 semantic features become available later. Secondly, while L1 words are not initially available for semantic integration, congruent L1 words are nevertheless eventually successfully integrated.

D54

FRACTIONATING THE N400 EFFECT WITH SIMULTANEOUS MEG AND EEG Ellen Lau¹, Diogo Almeida¹, Nuria Abdulsabur^{2,1}, Allen Braun², David Poeppel^{1,3}, ¹University of Maryland, College Park, ²National Institutes of Health, NIDCD, ³NYU – Contextual modulation of the N400 evoked response to words has been demonstrated in sentential contexts and word priming manipulations. Conditions lacking in contextual support (incongruent sentence completions and unrelated word pairs) elicit higher N400 amplitudes than contextually supportive conditions (congruous sentence completions and related word pairs). The difference in amplitude appears in the ERP as a single broad peak lasting 200-300 ms. However, different localization techniques (intracranial recording, fMRI, MEG) have implicated different sources in generating the N400. We hypothesized that the N400 MEG response fractionates multiple processes that are temporally and spatially smeared in the ERP response. To explore this, we simultaneously recorded participants' brain activity from 275 MEG channels and 34 EEG electrodes in response to (i) congruous or incongruous sentence endings and (ii) semantically related or unrelated word pairs. Participants performed a probe detection task (single words in the sentence block, single letters in the word pair block). The EEG data (n=12) replicate the typical N400 effect, a centro-parietal, slightly rightward monophasic amplitude difference from 250-600ms. The MEG data replicate previous work (Lau et al 2008) and reveal a biphasic, left-lateralized response, involving two distinct stages: The first (250-350ms) is left lateralized, whereas the second (350-550ms) has right anterior hemispheric activity in addition to the left hemisphere pattern observed in the first stage. These results suggest that the spatial dimension of MEG may be used to derive more detailed information about the time course of contextual processing within the N400 effect observed in ERP.

D55

BILINGUAL LEXICAL ACCESS: INDIVIDUAL DIFFERENCES IN WORKING MEMORY CAPACITY AND LEVEL OF PROFICIENCY Gicele Vieira Prebianca¹, Mailce Borges Mota², Thomas Redick³, ¹Universidade Federal de Santa Catarina, ²Universidade Federal de Santa Catarina; Georgetown University, ³Georgia Institute of Technology – In order to produce speech, bilinguals need to manage two linguistic systems so as to verbalize thoughts in just one intended language at a time. Although the ability to avoid interference from the unintended language seems to be crucial to this endeavor, it is not the only one a bilingual speaker must develop. Bilinguals also need to deal with within-language competition since a concept may be lexicalized in different ways in the intended language (De Bot & Schreuder, 1993). The set of experiments reported in this study explores the role of working memory capacity (WMC) and second language (L2) proficiency level in bilingual lexical competition. One-hundred L2 speakers of American English were submitted to three WM span

tests, two L2 proficiency tests and one L2 picture-naming task carried out under the semantic competitor paradigm in a control and an experimental condition. WMC and L2 proficiency both significantly predicted bilingual lexical access. Higher spans retrieved lexical items faster than lower spans. In addition, more proficient bilinguals presented faster reaction times during the retrieval of L2 lexical items than less proficient ones, regardless of doing the control or the experimental condition first. These data are compatible with the proposal that bilingual lexical access is affected by the ability to control attention and by level of proficiency. Findings are discussed in the context of the controlled-attention view of working memory capacity (Kane, Bleckley, Conway & Engle, 2001) and the Inhibitory Control Model (Green, 1998).

D56

THE NEUROBIOLOGY OF ADAPTIVE LEARNING IN READING LOW-FREQUENCY CHINESE PHONOGRAMS: A CONTRAST BETWEEN PHONOLOGICAL AND SEMANTIC TRAINING CONDITIONS Jingjing Zhao¹, Jay Rueckl¹, Stephen Frost², Xiaoyi Wang³, Wan Sun³, Hua Shu³, Shin-Yi Fang¹, W. Einar Mencl², Kenneth Pugh²; ¹University of Connecticut & Haskins Laboratories, Psychology, ²Haskins Laboratories, ³State Key Laboratory for Cognitive Neuroscience and Learning, Beijing Normal University – fMRI used to investigate the influence of phonological and semantic training on the cortical circuitry of Chinese skilled readers recruited to read low-frequency Chinese regular phonograms. The experiment provide direct evidence of the neural basis of reading in Chinese, and present indirect evidence about the similarities and differences of division labor of phonological and semantic processing between readers of different writing system (Chinese vs. English). The experiment happened in two stages. During the training phase, subjects made phonological or semantic judgments about 84 Chinese phonograms (42 in each task, each phonogram 8 exposures). Subsequently, subjects were scanned while naming the trained 84 phonograms and 84 additional untrained phonograms (42 regular and 42 irregular). Behaviorally, subjects' reaction time decreased and accuracy increased along 8 exposures during both training conditions; phonological and semantic training both resulted in transfer facilitation in naming. In addition, we found regularity effect for untrained phonograms: regular phonograms named faster and better than irregular phonograms. Brain imaging data mirrored the behavioral regularity effect: irregular phonograms showed higher activation in inferior frontal gyrus and occipitotemporal junction than regular phonograms. Phonological training and semantic training of Chinese phonograms yielded different functional activation patterns comparing to English study (Sandak, et al., 2004). The findings indicate that even though in some sense the neural circuits of reading Chinese may show the same pattern to English (regularity effect), the division labor of the neural circuits in reading Chinese still differ from reading English.

D57

ERP EFFECTS OF SUBLEXICAL PROCESSING IN VISUAL WORD RECOGNITION: ARE SYLLABIC EFFECTS MODULATED BY SYLLABIC STRUCTURE? Marta Vergara-Martínez¹, Alejandro Marín², Manuel Carreiras^{2,3}, ¹University of California, Davis, ²Instituto de Tecnologías Biomédicas, University of La Laguna, Spain, ³Basque Research Center on Cognition, Brain and Language, Spain – The aim of this study was to investigate electrophysiological correlates of sublexical processing in visual word recognition in Spanish. Previous work using event-related potentials (ERPs) to examine syllabic processing has shown very early effects; however, only consonant-vowel (CV) syllabic structure was considered. We recorded ERPs while participants made lexical decisions to words and pseudowords in two priming experiments. Target word pairs were selected that shared the first 3 graphemes but differed in their syllabic structures (CV; ca.mi.no; or CVC: cam.po). They were preceded either by unrelated syllabic primes (po/ren-ca.mi.no; ren/po-cam.po) or by related primes. When primes were related, they were either syllabically congruent primes (ca-ca.mi.no; cam-cam.po) or syllabically incongruent primes (cam-ca.mi.no; ca-cam.po). This allowed us to disentangle

syllabic from orthographic overlap priming effects. If syllables play a role during lexical access, early ERP differences would be expected for our syllabic manipulation. Experiment 1 had a 200 ms SOA, and replicated P350 effects for prime-target relatedness (P350: lexical access; Friedrich et al., 2004). No effect of the syllabic manipulation emerged. Early effects (P200) were observed for the type of prime (CV vs CVC). Experiment 2 tried to overcome the problem of conscious priming by masking the prime with a shorter SOA of 55 ms. Early effects of relatedness and prime type were present; however, syllabic congruency effects were not observed. These results are discussed in terms of the primary role that the consonant-vowel syllabic structure plays in the Spanish language.

D58**DIRECT ELECTROPHYSIOLOGICAL EVIDENCE OF A NEURAL SUBSTRATE FOR MORPHOLOGICAL RULE APPLICATION**

Riadh Lebib¹, Andrea Krott¹; ¹School of Psychology, University of Birmingham - United Kingdom – A critical issue for understanding language processing in the brain is whether linguistic rule application is subserved by a distinct neural substrate. One of the evidence supporting this hypothesis comes from studies employing electroencephalographic measurements during the processing of rule misapplication. This evidence is inconclusive because it might reflect processes caused by the violation such as error handling rather than application of rules per se. Here we provide first evidence that correct regular formations, i.e. German past participles, are associated with left frontal negative-going activity, i.e. a LAN, providing direct encephalographic evidence for rule application in the brain. Moreover, a LAN response is present regardless of the participles' frequency, suggesting that independently from the mode of lexical access (i.e. decomposition or full-form activation), the cerebral structures associated with rule-based mechanisms are activated. We will discuss how our results shed further light on the functional cerebral mechanisms associated with the LAN response during the information processing stream.

Linguistic processes: Syntax**D59****ATTENTION MAKES THE DIFFERENCE - A SYNTAX ERP-STUDY WITH 3-4-YEAR-OLD CHILDREN**

Franziska Suess¹, Angela D. Friederici¹; ¹Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany – In a recent event-related potential (ERP) study we showed that the syntactic sentence processing in 3-4-year-old children is influenced by varying the proportions of syntactically incorrect sentences (20% vs. 80%). In this passive listening task we found an early negativity for the 20% condition but no effect for the 80% condition. In a prior study with adults Hahne and Friederici (1999) had used the same manipulation and found an ELAN for both conditions and a P600 only for the 20% condition. They interpreted this result to indicate automaticity of the first pass parsing process reflected by the ELAN, and more controlled syntactic revision processes reflected by the P600. In their study, Hahne and Friederici had used a grammaticality judgement task. In order to be able to compare children with adults we tested 30 children at the age of 3-4 years in an ERP study with the same sentence material, now using a grammaticality judgment task. Under this task children showed an ERP pattern similar to that reported by Hahne and Friederici for adults. In a nutshell these findings indicate that children at the age of 3-4 years similar to adults show an automatic first pass parsing process and a more controlled syntactic revision process, depending on the amount of attention induced.

D60**AN INVESTIGATION OF THE NEURAL GENERATORS OF ERP INDICES OF SYNTACTIC PROCESSING USING PROFICIENCY-RELATED ERP MODULATIONS IN AN ERP-fMRI PARADIGM**

Eric Pakulak¹, Mark Dow¹, Helen Neville¹; ¹University of Oregon – Event-related potential (ERP) studies of syntactic violations typically report a biphasic response in which an earlier negativity, often maximal over left anterior sites (LAN), is followed by a later positivity usually maximal over posterior sites (P600). Evidence bearing on the neural generators of these components is limited: evidence from functional magnetic resonance imaging (fMRI), magnetoencephalography dipole modeling, and ERP studies of patients with focalized brain lesions (e.g., Friederici et al., 2000; Friederici et al., 2003; Friederici & Kotz, 2003; Kotz et al., 2003) has implicated inferior frontal and anterior temporal regions as possible neural generators of the LAN and the basal ganglia and posterior temporal regions as possible neural generators of the P600. Here we take a novel approach to this question. Using an auditory syntactic violation paradigm, we gathered ERP and fMRI data from monolinguals who varied on measures of English proficiency and used individual proficiency-related modulations of the LAN and P600 as covariates in the analysis of fMRI data from the same participants. Results suggest that multiple neural generators may contribute to both effects. Implicated in the generation of the anterior negativity were left inferior frontal gyrus and left temporal pole, while several posterior temporal and temporoparietal areas were implicated in the generation of the P600. These results illustrate the potential for the use of individual modulations in ERP components in conjunction with fMRI to provide valuable insight into the interplay between ERP and fMRI data and the neural generators of ERP indices of syntactic processing.

D61**TENSOR PRODUCT MODELS FOR LANGUAGE-RELATED BRAIN POTENTIALS**

Sabrina Gerth¹, Peter beim Graben², Shraavan Vasishth¹; ¹Institute for Linguistics, University of Potsdam, Germany, ²School of Psychology and Clinical Language Sciences, University of Reading, UK – An important online measure of language processing is event-related brain potentials (ERPs) that are currently interpreted purely phenomenologically. We use tensor product representations (TPR) of symbolic structures to model syntactic parsing as nonlinear dynamics in neural activation space. In an ERP experiment on the processing of German subject-object ambiguities, we observed a P600 ERP for object first sentences reflecting an initial garden path interpretation. Starting with a Government and Binding formulation of the sentences, we construct a locally ambiguous context-free grammar from the phrase structure trees. This grammar is decomposed into its unambiguous parts representing the two alternative processing strategies, namely subject preference against object preference in order to construct two appropriate deterministic pushdown recognizers. Using the TPR, the syntactic categories of the disambiguated grammars are mapped onto filler vectors, while positions in a labeled binary tree are represented by three role vectors. In order to build a parallel processor the two parses for the subject-object sentence (regular vs. garden path) and the other two for the object-subject sentence respectively were linearly superimposed in activation space. Then, model ERPs are obtained as the first principal component. Our model is able to describe, at least qualitatively, the obtained ERP results by trajectories that explore functionally and causally different regions in activation space while pursuing different language processing strategies. During its transient evolution, the trajectories of the model diverged exactly when the garden path was encountered which shows remarkable resemblance with the P600 effect in the ERP.

D62

BIMODAL ASPECTS OF THE FUNCTIONAL ORGANISATION OF LANGUAGES AS REVEALED BY GERMAN/GERMAN SIGN LANGUAGE BILINGUALS: AN EVENT-RELATED POTENTIAL STUDY Monique Kügöw^{1,2}, Nils Skotara^{1,2}, Uta Salden^{1,2}, Barbara Hänel-Faulhaber^{2,3}, Brigitte Röder^{1,2}; ¹Biological Psychology and Neuropsychology, University of Hamburg, ²Research Centre 538: Multilingualism, University of Hamburg, ³Educational Sciences, Section II: Perception & Communication, University of Hamburg – Brainimaging studies in early bilinguals have provided evidence that two oral languages learned simultaneously from birth activate overlapping brain systems. Thus, studying people who grew up with an oral and a signed language provide the unique opportunity to investigate modality-specific aspects of the neural systems mediating language comprehension. German and German Sign Language (DGS) sentences were presented to hearing adults, who were born to deaf parents (CODAs) and who, thus, were exposed to both German Sign Language (DGS) and German from birth. The electroencephalogram was recorded throughout the experiment. Task of the participants was to decide whether or not the just seen sentence had been correct. Half of the sentences were correct while either a semantic violation or a syntactic violation was embedded in the other half of the sentences. The German and the DGS ERP data of the CODAs were compared to those of hearing native German speakers and a group of deaf native signers of DGS. At the behavioural level the CODAs did not differ in either language. For German, the typical ERP correlates of semantic and syntactic processing were observed in both groups. For DGS both, the CODAs and the native signers showed a P600 while only for the native signers a bilateral central negativity prior to a P600 was observed after syntax. Thus, these results suggest that language processing in CODAs and native signers recruits partially similar (P600), and partially distinct brain systems. We discuss in how far hearing status might contribute to the ERP differences.

D63

PHONOLOGY PLAYS A ROLE IN MORPHOSYNTACTIC PROCESSING: EVIDENCE FROM ERPS Cheryl Frenck-Mestre^{1,2}, Haydee Carrasco²; ¹Centre National de Recherche Scientifique, ²Université de Provence – Herein we show that when morphosyntactic agreement is phonologically realized, native French readers process agreement more systematically than when it is silent. We manipulated the presence versus absence of phonological cues to morphosyntactic agreement in written French for gender concord between a noun and immediately following adjective in short sentential contexts. Both our behavioural and ERP results show a clear role of phonological cues, which, furthermore, interacted with grammatical gender. Gender concord errors produced a graded ERP response, with a larger P600 response elicited by phonologically realized errors (stylo(masc) verte*(fem)) than by silent errors (stylo(masc) bleue*(fem)); however, the difference between silent and orally realized gender concord errors was more marked for masculine than feminine nouns (stylo(masc) verte*(fem) vs. table(fem) vert*(masc), stylo(masc) bleue*(fem) vs. table(fem) bleu*(masc)), in line with the hypothesis that default gender in French is masculine (Nelson, 2005). These results further the finding of a role of phonological cues in processing verbal person agreement in written French (Frenck-Mestre et al., 2008), and add to the existing evidence of the importance of phonological cues in reading.

D64

WHY THE METRIC NEGATIVITY IS NOT AN N400: AN ERP STUDY ON METRIC AND SYNTACTIC PROCESSING USING JABBERWOCKY SENTENCES Kathrin Rothermich¹, Maren Schmidt-Kassow¹, Sonja A. Kotz¹; ¹MPI CBS, Leipzig, Germany – Meter and syntax are assumed to be principles governing the arrangement of discrete structural elements in sequences (Patel, 2003). Recent ERP data support these principles and show that processes underlying these principles interact during language processing (Schmidt-Kassow and Kotz, in press). Listening to metrically violated sentences leads to a biphasic pattern consisting

of an early negativity and a late positivity (Schmidt-Kassow and Kotz, in press; Magne et al., 2007; Knaus et al., 2007). In particular, the function of the early negativity is a matter of debate as it is unclear whether the negativity reflects an N400 as a result of misplaced stress in lexical access or mirrors deviance detection of a rule-based principle comparable to the LAN elicited by syntactic violations. The current experiment addressed this conflict by using German jaberwocky sentences, thus omitting lexical information. These sentences were metrically, syntactically, or syntactically and metrically violated. If the initially reported metric negativity is an electrophysiological index of effortful lexical access (N400), no negativity should be elicited by metric violations in jaberwocky sentences. Our results show that both metric and syntactic violations elicited an anteriorly distributed negativity. This implies that the metric negativity is not an N400 but rather a response to metric deviation comparable to the LAN elicited by syntactic violations.

D65

ERP EVIDENCES IN WORD ORDER PROCESSING BY BASQUE-SPANISH BILINGUALS Kepa Erdozia¹, Itziar Laka¹; ¹University of the Basque Country – We present results from a series of behavioral and ERP experiments investigating processing preferences in bilinguals of two languages with opposite word orders (Basque-ObjectVerb/Spanish-VerbObject). We compare very fluent and proficient groups of bilinguals. In one group, the first language (L1) of bilinguals is Basque, in the other group L1 is Spanish. The L1Spanish population learnt Basque starting at 3 years. We compare processing of canonical (SOV) versus non-canonical (OSV) sentences in Basque, a language never explored with this methodology. Experimental materials consist of (a) a set of transitive sentences in Basque containing a Subject, an Object and a Verb: OSV sentences are syntactically derived from canonical SOV. (b) Syntactically fully ambiguous sentences which can be disambiguated as OSV order resorting to world-knowledge. Comparison of canonical (SOV) and derived (OSV) sentences in L1Basque bilinguals shows a modulation of anterior negativities and P600 components in derived word order (OSV) suggesting the load of increased syntactic complexity with respect to canonical (SOV) word order. Results on ambiguity resolution show that ambiguous stimuli were processed as canonical SOV sentences; frontal negativity distinguished simple SOV and complex ambiguous OSV sequences. These results show a sharp processing contrast between basic SOV and derived OSV word order in L1Basque speakers. Results from the group of L2Basque bilinguals who are native of Spanish will determine whether their SVO native preferences modulate their word order processing in Basque, and hence will shed light on how early language processing mechanisms impact on nonnative language processing.

D66

PARAMETERS OF GRAMMAR AND MATURATIONAL EFFECTS: AN ERP STUDY ON ERGATIVITY AND OBJECT VERB AGREEMENT PROCESSING BY NATIVE VERSUS NONNATIVE SPEAKERS OF BASQUE Adam Zawiszeński^{1,2}, Itziar Laka²; ¹MPI for Human Cognitive and Brain Sciences, Leipzig, Germany, ²University of the Basque Country, Bilbao/Vitoria-Gasteiz, Spain – The extent to which specific aspects of human grammars show maturational effects is still not well known: some studies report Age of Acquisition (AoA) effects (Weber-Fox and Neville, 1996; Hahne, 2001) whereas others do not find them for very proficient nonnatives (Rossi et al., 2006; Kotz et al., 2008). We study specific grammatical parameters (Chomsky 1981) absent in the native language of very proficient nonnatives (ergativity and object-verb agreement). We find a difference in processing between natives and nonnatives in one parameter (ergative case) but not in the other (OV agreement). This suggests that different parameters of grammar may have different acquisition windows, and that AoA versus proficiency studies must carefully control for language distance. We conducted an Event-Related Brain potentials (ERP) study on ergative case and OV agreement processing in Basque, an isolate typologically very distant from Spanish, to determine how natives and very proficient nonnatives (AoA = 3 years)

process these grammatical parameters (Baker 2001). Spanish, native language of the nonnative group, has no ergative case or OV agreement, so our study controls not only for AoA and proficiency but also for language distance. ERP data revealed no differences in processing of OV agreement violations across groups. However, nonnatives did not show a P600 component elicited by the native group for ergative case violations. We thus report maturational effects for one parameter of the grammar but not the other, which suggests that AoA can have an asymmetrical impact, depending on the grammatical parameter at play, independent of proficiency.

D67

GRAMMATICAL GENDER PROCESSING IN FRENCH AS A FIRST AND SECOND LANGUAGE: AN ERP STUDY OF THE EFFECT OF PHONOLOGICAL REALIZATION

Haydee Carrasco¹, Cheryl Frenck-Mestre¹; ¹Université de Provence – The present study further examined how phonological cues may impact grammatical gender processing in French as a first and second language. Recent ERP studies have shown that native and non-native readers benefit from the presence of phonological cues during grammatical processing (Osterhout et al., 2006; Frenck-Mestre et al., 2008). Herein, ERPs were recorded while French natives (N=14) and Spanish-French learners (N=14) read sentences that varied according to the presence versus absence of phonological cues to gender agreement in the determiner phrase (e.g. la musique française/français* vs. la musique espagnole/espagnol*). Grammatical gender was held constant across languages. Results for both natives and learners showed a P600 effect for gender concord errors, which was larger for errors that involved phonological cues. However, differences between groups were observed. Spanish-French learners showed a greater response to orally realized than silent errors independent of noun gender. For French native speakers phonology and grammatical gender interacted; the P600 effect was larger for phonologically realized errors that violated masculine than feminine gender concord, whereas for silent errors the P600 effect was of equal magnitude for both genders. These results suggest that native readers are more sensitive to the statistical probability of errors than are learners; gender concord errors on the adjective are indeed least likely for masculine in the presence of phonological cues. Together, our results show that native and non-native readers alike benefit from the phonological realization of morphosyntax and provide further evidence of the role of phonology in processing written language (Harm & Seidenberg, 2005).

D68

SYNTACTIC PROCESSING IN PROGRESSIVE NON-FLUENT APHASIA: THE FUNCTIONAL STATUS OF THE LEFT INFERIOR FRONTAL GYRUS

Stephen M. Wilson¹, Jennifer M. Ogar¹, Federica Agosta¹, Bruce L. Miller¹, Nina F. Dronkers², Maria Luisa Gorno-Tempini¹; ¹Memory and Aging Center, Neurology, University of California, San Francisco, CA, ²Center for Aphasia and Related Disorders, Veterans Administration Northern California Health Care Service, Martinez, CA – Progressive non-fluent aphasia (PNFA) is a clinical syndrome characterized by motor speech impairments along with expressive and receptive agrammatism. Patients show left-lateralized atrophy of inferior frontal, motor and insula regions, typically resulting from taopathies. A recent voxel-based morphometric study of syntactic comprehension in a mixed neurodegenerative cohort suggested that the left inferior frontal gyrus (IFG), pars triangularis, is crucial for comprehension of syntactically complex sentences (Amici et al., 2007, J. Neurosci). We used fMRI to investigate functional activity in this region in agrammatic PNFA patients during a syntactic comprehension task. Six patients and eleven healthy age-matched controls were scanned as they performed a sentence-picture matching task with seven conditions varying in degree of syntactic complexity. Controls performed well on all but the hardest sentences; imaging results showed that they differentially recruited several perisylvian regions as sentences became more difficult, including the left IFG. PNFA patients failed on the harder conditions, but performed well on the easier

ones. Our central finding was that even while processing these easier sentences, patients exhibited much more extensive activity than controls in the left IFG. This increased activity was likely not due to difficulty alone, since it was observed even when contrasting (different) syntactic conditions on which patients and controls performed comparably. These data suggest that in the earlier stages of PNFA, when tissue is atrophied but not entirely lost, the left IFG is still involved in sentence processing and actually demonstrates excessive BOLD activity, possibly as a consequence of its structurally compromised state.

D69

ADAPTING TO COMPLEXITY: FMRI ADAPTATION DISTINGUISHES SYNTACTIC SPECIFICITY IN SUBREGIONS OF BROCA'S AREA

Andrea Santi¹, Yosef Grodzinsky¹; ¹McGill University – We know Broca's area demonstrates greater activation for noncanonical ("The boy [who the tall girl is smiling at _] is Derek") than canonical ("The boy [who _ is smiling at the tall girl] is Derek") sentences, but is this due to a general complexity contrast or a more specific one? The current fMRI adaptation study sought to distinguish between general and selective syntactic accounts of Broca's area by comparing two complexity factors: canonicity (ie, subject vs object extraction) and relative clause position (ie, right-branching vs center-embedding). According to global syntactic accounts, Broca's area is responsible for computing all syntactic representations, but is recruited more the greater the syntactic complexity (Caplan et al., 2000; Just et al., 1996; Stromswold et al., 1996; Friederici, 2006). General syntactic accounts of Broca's area contrast with ones that stipulate it is sensitive to a selective dimension of syntactic complexity represented by the canonicity contrast (Bornkessel et al., 2005; Grewe et al., 2005, 2006; Grodzinsky, 2000; Santi & Grodzinsky, 2007b). In this experiment we investigated adaptation to the two complexity factors - canonicity and relative clause position - in a fast-event related design. A deconvolution analysis demonstrated that posterior Broca's area (BA 44) adapted to both canonicity and relative clause position, whereas anterior Broca's area (BA 45) adapted to canonicity only. Therefore, the results suggest a parcellation of Broca's area with it being general syntactically posteriorly and selective syntactically anteriorly.

D70

OPTIONAL INFINITIVE: EVIDENCE OF HOW THE ADULT BRAIN PROCESSES GRAMMATICAL ERRORS THAT ARE TYPICAL AND ATYPICAL OF CHILDHOOD LANGUAGE ACQUISITION

Ioulia Kovelman¹, Satrajit S. Ghosh², Patricia K. O'Loughlin¹, Irina Ostrovskaya¹, Tyler K. Perrachione¹, John Lymberis¹, Elizabeth S. Norton¹, Sonia Cosman¹, Kenneth Wexler¹, John D. E. Gabrieli¹; ¹Brain & Cognitive Sciences, Massachusetts Institute of Technology, ²Research Laboratory of Electronics, Massachusetts Institute of Technology – Child language acquisition in many languages is marked by an Optional Infinitive (OI) stage (ages 2-4) during which children use nonfinite (infinitival) verb-forms and finite verb-forms interchangeably in grammatical contexts that require finite forms. In English, children's errors include omissions of past-tense /-ed/ and 3rd singular /-s/. The OI stage phenomenon is well established, but little is known about its neural basis or the impact it may have on adult language use. We compared behavior and fMRI brain activation of grammaticality judgments for sentences with OI-developmental errors (He tall) versus Non-developmental errors (He am tall), that do not occur in typical child language acquisition. Previous imaging studies found that left inferior frontal (LIFG) regions participate in grammaticality judgment, and we hypothesized that LIFG would participate in OI-error judgments. METHODS: In fMRI, fifteen adult English speakers completed a grammaticality judgment task with OI-developmental errors, Non-developmental errors, and Correct sentences. RESULTS: Participants were significantly slower and less accurate on OI-developmental errors relative to other sentences. Consistent with our predictions, OI-developmental errors yielded greater activation in LIFG relative to Correct and Non-developmental error sentences. Sentences with Non-developmental errors yielded greater activation in left inferior parietal cortex relative to

Correct sentences. **CONCLUSIONS:** This study shows for the first time that processing OI grammatical errors in adulthood results in increased response time and LIFG activation relative to other grammatical errors that are not made in childhood. These findings suggest that the OI stage of child development influences grammatical mental and neural function in adulthood.

D71

AN EVENT-RELATED POTENTIAL STUDY OF VERBAL MEMORY SPAN EFFECTS ON GAP FILLING Arild Hestvik¹, Evan Bradley¹, Catherine Bradley¹, Tyler Prescott¹, Lauren Sparacino¹, Megan Kaufmann¹; ¹University of Delaware – The goal of this study was to examine the relationship between verbal memory span and antecedent reactivation in syntactic gap-filling. Whereas a working memory cost is known to be incurred during the storage stage of this process, less is known about the completion stage of the dependency resolution. (Roberts et al., 2007) reported that only subjects with high verbal memory span exhibited antecedent priming at gap-positions in a cross-modal lexical decision task. This suggests that low-span subjects require more time to integrate the filler, and reactivate the antecedent later. We aimed to measure the time course of gap-filling in different working memory groups by using a continuous event-related potentials measure of the completion stage process. 27 college aged subjects were divided into a low vs. high verbal memory span group based on the Listening Span Test (Daneman & Carpenter, 1980). EEG was recorded from 128 channels while subjects heard sentences like (i) and (ii): (i) *The zebra that the hippo kissed the camel on the nose... (ii) The weekend that the hippo kissed the camel on the nose... We predicted that 'the camel' in (i) should elicit an Early Left Anterior Negativity (ELAN), followed by a P600 (Friederici, 2002), when compared to the grammatical 'the camel' in (ii), and that low-span subjects should show a latency delay. However, both groups exhibited a P600 to the ungrammatical noun phrase, with no group interaction. This suggests that differences in verbal memory span do not affect the completion stage of gap-filling.

D72

TIME-FREQUENCY ANALYSIS OF LATE POSITIVE COMPONENTS DURING LANGUAGE COMPREHENSION José Corral¹, Horacio Barber^{2,1}, Maartje van der Meij^{2,3}, Manuel Carreiras^{4,1}; ¹Instituto de Tecnologías Biomédicas, Universidad de La Laguna, Spain, ²Psicología Cognitiva, Universidad de La Laguna, Spain, ³Neuropsicología, Universidad de Oviedo, Spain, ⁴Basque Research Center for Cognition, Brain and Language, Spain – Event-Related Potential (ERP) analysis is a robust technique for investigating the temporal brain dynamics related to cognitive processes. In this study we combine this approach with time-frequency analyses of two similar language-related late positivities. Subjects read sentences that involved code switching from L2 (English) to L1 (Spanish), which resulted in a Late Positive Component (LPC). They also read L1 sentences that included a morphosyntactic violation, which again produced a late positivity (P600 effect). Both effects occurred in the same time window and had a similar topographical scalp distribution. We extracted the power and phase of the frequency components active during the ERP effects, for possible differences that could be hidden when comparing the averaged wave amplitudes. Event-Related Synchronization (ERS) in the delta frequency band and Event-Related Desynchronization (ERD) in the alpha frequency band reflect both positivities. Phase information allowed us to compare the topography and strength of synchronization between electrodes in the two experimental tasks. Similarities and differences between both types of effects are discussed in relation with the different interpretations of the late positivities associated to language comprehension.

D73

THE NEUROCOGNITION OF MORPHO-SYNTACTIC PROCESSING IN SECOND LANGUAGE: AN ARTIFICIAL LANGUAGE STUDY Kara Morgan-Short¹, Karsten Steinhauer², Cristina Sanz³, Mandy Faretta¹, Michael Ullman³; ¹University of Illinois at Chicago, ²McGill University, ³Georgetown University – Recent research has shown that artificial language learning can provide a useful model of second language acquisition (e.g., Friederici, Steinhauer and Pfeifer, 2002). Here we use an artificial language to examine the acquisition of morpho-syntax, which is particularly problematic in second language learning (White, 2003). Adult native English speakers learned to speak and comprehend to advanced levels of proficiency an artificial language with both noun-adjective and noun-article gender agreement. Half the subjects learned the artificial language under explicit (classroom-like) training conditions and half learned under implicit (immersion-like) training conditions. Event-Related Potentials (ERPs) were measured in response to auditorily-presented sentences with correct or incorrect agreement twice within each subject, once at low proficiency and once at high proficiency. At low proficiency both types of agreement violation (adjective, article) yielded N400s, but only for the group with implicit training. At high proficiency noun-adjective agreement violations elicited N400s for both the explicit and implicit groups, whereas noun-article agreement violations elicited P600s for both groups. The results suggest that various factors can influence the neurocognition of morpho-syntactic processing in second language acquisition, including training condition (classroom-like vs. immersion-like), proficiency level (low vs. high), and type of morpho-syntactic structure (e.g., article vs. adjective gender agreement). Implications for second language acquisition will be discussed.

D74

READING FLUENCY IN PHONOLOGICAL ALEXIA: FROM SINGLE WORDS TO PHRASES Kathleen Baymes¹, Eunike Jonathan², Christine H. Davis³; ¹Center for Mind and Brain, University of California at Davis, ²University of California at Davis, Psychology, ³University of California, Speech Pathology and Audiology, Davis – Phonological alexia is an acquired reading disorder that results in an inability to read out loud function words, verbs and grammatical morphemes whereas concrete nouns and other words with greater semantic content are relatively spared. In the second of a series of interventions, a 46-year-old male with phonological alexia was trained for two weeks for about 1 hour per day. The use of semantic cues at the single word level and intensive implicit practice on sound recognition of function words, verbs, and grammatical morphemes in short sentences were combined in this intervention. Data from reading out loud 20 probe sentences demonstrated a trend toward an increased number of correctly read sentences and a decrease in the number of errors overall. However, some targeted items remained impossible for our participant to read accurately in a sentence context. Generalization of changes in fluency, comprehension and error types were also tracked using the Gray Oral Reading Test pre and post training. Reasons for the difficulty in making a useful improvement in reading specific aspects of text will be discussed in terms of the psycholinguistic source of the deficit and the intended target of the intervention.

D75

THE DYNAMIC ACTIVATION AND RESOLUTION OF SYNTACTIC AND SEMANTIC AMBIGUITY IN SPOKEN LANGUAGE COMPREHENSION: A MEG STUDY Guosheng Ding^{2,1}, Billi Randall¹, Barry Devereux¹, Anna Shestokova¹, Lorraine K. Tyler¹; ¹Experimental Psychology, University of Cambridge, ²State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University – Ambiguity is an ubiquitous property of language. Here we investigate when and how ambiguity is resolved during language processing using magnetoencephalography (MEG) to probe the moment-by-moment processing of sentences containing semantic (greasy locks) or syntactic (playing cards) ambiguities. Ambiguous phrases vary in the strength of preference for one reading or another, therefore all sentences were presented twice

with each ambiguous phrase being immediately followed by a disambiguating verb which was consistent with the subordinate (least preferred) reading and therefore inconsistent with the dominant (most preferred) reading. Participants passively listened to the sentences while we recorded activity using MEG (306-channel Vectorview system). Event-related magnetic fields (ERF) were analyzed after MEG epochs were aligned to key points in the speech stream. Neural generator sources were localized using the MNE software. We analysed data from 2 VOIs (LIFG, LpMTG) based on our previous fMRI study (Rodd et al, 2004). Semantic and syntactic ambiguity showed different effects of dominance and disambiguation. Semantic ambiguity produced increased activity for the dominant meaning starting during the ambiguous phrase, which persisted even when the disambiguating word (consistent with the subordinate meaning) was heard. The subordinate meaning became more strongly activated only 900 msec after the disambiguating word. Both LMTG and to a lesser extent LIFG showed this pattern. In contrast, syntactic ambiguity produced minimal effects of preference strength in LMTG, but LIFG showed early and stronger activity for the dominant reading, with a rapid switch to the subordinate reading as soon as the disambiguating word was heard.

D76**ELECTROPHYSIOLOGICAL RESPONSES INDEX GRAMMATICAL ACQUISITION IN SECOND LANGUAGE LEARNERS** Darren

Tanner¹, Lee Osterhout², Julia Herschensohn¹; ¹University of Washington, Linguistics, ²University of Washington, Psychology – Previous findings on language processing using event-related potentials (ERPs) have shown a neurocognitive dissociation between processing of lexical/semantic violations and morphosyntactic violations, which elicit N400 and P600 ERP components, respectively (Osterhout & Nicol 1999). The current study investigates processing of morphosyntactic (subject-verb agreement) violations in German native speakers (n=13) and low- and intermediate-proficiency second language (L2) learners of German (n=33). Findings show that while morphosyntactic violations elicited the expected P600 component in natives and intermediate L2 learners, the lowest proficiency group showed only an N400 effect. We interpret these results as indicating that L2 learners initially memorize morphologically complex, inflected words as unanalyzed wholes and later decompose these forms into stem+affix sequences, having induced a productive syntactic rule. The low-proficiency learners showed sensitivity to the unexpected forms in the agreement violation condition both behaviorally and electrophysiologically; however, the N400 response indicates difficulty integrating a whole word form into a preceding context. The P600 response in intermediate learners is indicative of more native-like morphosyntactic processing and application morphological decomposition mechanisms in parsing agreement. Moreover, learners', but not native speakers', individual P600 amplitudes showed a significant linear correlation with performance on a grammaticality judgment task. This contrasts with previous ERP findings on L2 learning, which showed no relationship between behavioral and electrophysiological responses (McLaughlin, Osterhout & Kim 2004).

D77**WHAT DOES IT MEAN TO BE PROMINENT? AN ERP INVESTIGATION OF FOCUS** Clinton L. Johns^{1,2}, Peter C. Gordon³,

Debra L. Long^{1,2,4}, Tamara Y. Swaab^{1,2}; ¹University of California, Davis, ²Center for Mind and Brain, ³University of North Carolina, Chapel Hill, ⁴University of Central Lancashire, Preston, England – Repeated name anaphors refer to previously mentioned discourse entities (antecedents). When antecedents are in discourse focus (Debra taught the class because Debra...), processing difficulty results (repeated name penalty, RNP). Discourse focus, which in this case results from syntactic prominence, is a linguistic property that is encoded relatively automatically during sentence comprehension. Non-linguistic devices may also be employed to focus a comprehender's attention on elements of a discourse. However, little is known about the extent to which non-linguistic focus influences

the encoding of antecedent representations, or subsequent processing of anaphoric references to them. To study this, we manipulated linguistic and non-linguistic prominence in a series of ERP studies. Linguistic prominence was a function of antecedents' embedding in sentences' syntactic trees (Debra vs Debra and Clint). Non-linguistic prominence was established by transposing the first two letters of the antecedent (eDbra) and asking subjects to generate the name. For the linguistic prominence conditions an RNP effect was found; a reduced N400 effect to coreferential repeated names preceded by non-prominent, normal antecedents. In contrast, when prominent antecedents were generated, increased priming for repeated names was found. Interestingly, memory performance was enhanced for both linguistic and non-linguistic focus conditions. In our last experiment we investigated whether previous results reflect the match of encoding and retrieval processes. Critical names either were read following normal antecedents, or were letter-reversed following generated antecedents. Results reveal differences between the match conditions (normal vs. generation) and strongly suggest that language processing does not simply follow the principles of recognition memory.

Memory: Memory systems**D78****DLPFC DISRUPTION FACILITATES PROCEDURAL MEMORY CONSOLIDATION AND IMPAIRS DECLARATIVE KNOWLEDGE** Neil B. Albert^{1,2}, Joseph M. Galea^{1,3}, R. Chris Miall¹;

¹University of Birmingham, Psychology, UK, ²University of Chicago, Psychology, ³Johns Hopkins Medical Institution, Physical Medicine and Rehabilitation – In procedural learning tasks, an improvement in skill is typically seen after sleep - leading to the recent literature on sleep-dependent motor consolidation. Procedural consolidation can also occur during wakefulness if the declarative memory system's competitive encoding of the sequence is reduced through a secondary cognitive task. Here we used continuous theta-burst transcranial magnetic stimulation (cTBS) to disrupt the dorsolateral prefrontal cortex (DLPFC) immediately after learning a 12-item sequence. We hypothesize that disruption of the DLPFC immediately after sequence learning would degrade declarative memory systems and thus facilitate wakeful skill improvement. Inhibitory cTBS was applied to the left DLPFC (n=10), right DLPFC (n=10), or to an occipital cortical control site (n=10) immediately after sequential reaction time task (SRTT) training. All three groups were retested after 8 daytime hours without sleep. cTBS to the DLPFC degraded recall of the sequence but led to a significant increase in skill. No within day improvement was observed in the control group. These results confirm that processes that interfere with declarative knowledge of recent events allow procedural consolidation during wakefulness. Moreover, we show that the DLPFC is directly involved. Accordingly, sleep-independent procedural consolidation may be driven by processes which thrive in the absence of declarative memory systems.

D79**DELINEATING PERCEPTUAL AND CONCEPTUAL CONTRIBUTIONS TO REPETITION SUPPRESSION WITHIN OCCIPITAL AND TEMPORAL CORTICES** Aidan Horner¹, Rik

Henson¹; ¹MRC Cognition and Brain Science Unit – Prior exposure to a stimulus can facilitate its subsequent identification and classification. This behavioural facilitation is usually accompanied by a reduction in neural response within distinct cortical regions (Repetition Suppression - RS) (Grill-Spector, Henson, & Martin, 2006). Despite previous research suggesting RS within Occipital/Temporal regions reflects repetition of perceptual and/or conceptual processes (Henson et al., 2003; Horner & Henson, 2008; Race, Shanker, & Wagner, in press) delineating these two possible contributions has not yet been possible. Previous research has suggested RS within left, as opposed to right, Fusiform cortex is less sensitive to changes in view-point (Vuilleumier, Henson, Driver, & Dolan,

2002) and exemplar (Koutstaal et al., 2001). Although these data suggest RS within the left Fusiform may reflect repetition of conceptual processes to a greater degree than right Fusiform it is also possible that such effects are attributable to the repetition of more high-level perceptual processes (e.g., the extraction of three-dimensional object properties). To control for such a possibility we visually presented the names of concrete objects at Study whereas we presented object pictures at Test. Results from two fMRI experiments demonstrate significant RS within left Fusiform and left Lateral Occipital cortex. Furthermore, RS within the equivalent right hemisphere regions do not demonstrate significant RS (indeed, a significant Region-by-RS interaction is present). These results suggest that RS within left Fusiform and Lateral Occipital cortex can result from the repetition of conceptual processes, whereas RS within the equivalent right hemisphere regions is primarily driven by the repetition of perceptual processes.

D80**RESOLVING RETRIEVAL CONFLICT THROUGH INHIBITION**

Justin Hulbert¹, Michael Anderson¹; ¹University of St. Andrews, Scotland – The very act of retrieving a particular memory can reduce the accessibility of related items, a finding termed Retrieval-Induced Forgetting (RIF). According to the inhibition account of RIF, a retrieval cue (e.g., FRUIT-O_) activates the target memory (ORANGE), as well as its competitors (BANANA), creating conflict, which is detected by the ACC, and resolved by inhibiting the interfering competitor through the intervention of the prefrontal cortex (Kuhl et al., 2007). Non-inhibitory accounts of RIF have largely struggled to account for the finding that RIF generalizes to novel test cues, such as MONKEY-B_. Recently, however, it has been suggested that the cue-independent impairment reflects associative interference arising from the covert retrieval of study cues (FRUIT) while trying to access the competitor from the independent probe. If true, strengthened competitors (ORANGE) might then impede retrieval. In the current series of experiments, we demonstrate that strengthening a target in the absence of retrieval fails to generate the predicted impairment, indicating that associative blocking is insufficient as an account of cue-independent impairment. Moreover, the results support an inhibitory account, in that RIF is found to be cue-independent, retrieval-specific, and interference-dependent. Methods for further specifying the neural underpinnings of cue-independent forgetting are discussed.

D81**BRAIN ELECTROPHYSIOLOGICAL CORRELATES OF RECOGNITION WITHOUT IDENTIFICATION**

Anne Cleary¹, Anthony Ryals¹, Carly Yadon¹, Jason Nomi¹, Faith Williams², Madeline Krawzoff¹, Chris Boreson¹, Joshua Rooney¹; ¹Colorado State University, ²Capital University – Old-new recognition memory is typically characterized by two ERP signatures, an earlier FN400 old-new effect that is thought to be related to familiarity, and a later parietal old-new effect that is thought to be related to recollection. The present study demonstrates a very early ERP old-new effect related to the recognition without identification (RWI) effect. RWI is the finding that people can discriminate between old and new items on a recognition test when the items themselves cannot be identified. For example, when participants study a list of words and are tested with word fragments, they can discriminate between unidentified fragments of studied and of unstudied words. The present study searched for ERP correlates to this effect. ERPs were recorded at test using a 128-channel Hydrocel Geodesic sensor net. Our primary interest was in ERPs for word fragments that went unidentified. ERP old-new differentiation among unidentified items began to emerge as early as 100-150 ms post-stimulus. This ERP old-new differentiation was characterized by a polarity reversal across hemispheres such that unidentified old items led to greater positivity than unidentified new items in the left hemisphere and new items led to greater positivity than old items in the right hemisphere. This old-new polarity reversal across hemispheres was significantly greater over inferior sites than over superior sites and persisted across the entire 1000 ms recording window once

it emerged. These findings suggest that, among items that are not identified, the brain can differentiate old and new items very early on in processing.

D82**IMPAIRED CATEGORY FLUENCY IN MEDIAL TEMPORAL LOBE AMNESIA: THE ROLE OF EPISODIC MEMORY**

Daniel Greenberg¹, Margaret Keane^{1,2}, Lee Ryan³, Mieke Verfaellie¹; ¹VA Boston Healthcare System, Boston University, Boston, MA, ²Wellesley College, Wellesley, MA, ³University of Arizona, Tucson, AZ – Memory tasks are often classified as semantic or episodic, but recent research shows that semantic and episodic memory are highly interactive. Category fluency, for example, is generally considered to reflect retrieval from semantic memory, but behavioral evidence suggests that episodic memory is also involved: Participants frequently draw on their autobiographical experiences while generating exemplars for certain categories. Neuroimaging studies accordingly have reported increased medial temporal lobe (MTL) activation during exemplar generation. Studies of MTL amnesics have yielded mixed results, but these studies were not designed to examine potential contributions of episodic memory. We addressed this issue by asking MTL amnesics and controls to generate exemplars for three types of categories. One type tended to elicit autobiographical and spatial strategies (AS). Another type elicited strategies that were autobiographical but nonspatial (AN). The third type elicited neither autobiographical nor spatial strategies (N). 9 patients and 10 controls generated exemplars for 8 categories of each type. Patients were impaired on all three category types but showed greater impairment on AS and AN categories. After covarying for verbal fluency (total FAS score), the N category impairment was not significant, but the impairment on AS and AN categories remained. The same results were seen when patients with damage extending into lateral temporal regions were excluded. We conclude that patients' episodic memory impairment hindered their performance on this putatively semantic task. This interaction between episodic and semantic memory might partially account for the fluency deficits seen in aging, depression, mild cognitive impairment, and Alzheimer's.

D83**AGE EFFECTS ON NEURAL CORRELATES OF CUED RECALL: AN EVENT-RELATED POTENTIAL STUDY**

Séverine Fay¹, Lucie Angel¹, Badiâa Bouazzaoui¹, Laurence Taconnat¹, Lionel Granjon¹, Michel Isingrini¹; ¹UMR CNRS, Université François-Rabelais de Tours – A hallmark of cognitive aging is a deficit in episodic memory, which reflects structural and functional cerebral changes. The purpose of the present study was to investigate age differences in electrophysiological correlates of retrieval success in a word-stem cued recall task. To do so, event-related potentials (ERPs) were recorded while young (M ± SD: 21.4 years ± 1.9) and older (M ± SD: 65.1 years ± 3.3) adults tried to complete stems with a previously studied item or with any other suitable word if a studied item cannot be recalled. Behavioural data indicated that correct recall rate was significantly lower for older than for young participants. Robust event-related brain potential (ERP) old/new effects were identified in both age groups: event-related potentials evoked by stems completed with studied words were more positive than those evoked by stems completed with unstudied items. The main age differences were observed in latency and lateralization of old/new effects. Young adults exhibited a parietal effect that became focused over left parietal electrodes, whereas no asymmetry was observed in older adults. These results are congruent with the hemispheric asymmetry reduction in older adults model. Moreover, ERP effects were delayed in the older group relative to the young group. Overall, these findings provide some evidence of the reduction of processing speed during aging and suggest that young and older adults may recruit distinct cerebral patterns during episodic cued recall.

D84**PROTECTIVE ROLE OF EDUCATIONAL LEVEL ON MEMORY AGING: AN EVENT-RELATED POTENTIAL STUDY** Lucie Angel¹, Michel Iningrini¹, Séverine Fay¹, Badiâa Bouazzaoui¹, Laurence Taconnat¹;

¹UMR-CNRS University François-Rabelais of Tours, France – The present experiment aimed at investigating whether educational level could modulate age effects on episodic memory and on the electrophysiological correlates of retrieval success (old/new effects). Participants were dissociated into four groups of 14 adults according to age (young vs. old) and educational level (high vs. low). Event-related brain potentials (ERPs) were recorded while participants were performing a word-stem cued recall task. A significant interaction between education and age indicated that age-related memory deficits were greater for the less educated individuals. Old/new effects differed according to age and education. The young groups exhibited effects on both frontal and parietal areas. For the young-high group, the parietal effect was predominant over the left hemisphere whereas for the young-low participants, it was entirely left-sided. In addition, the parietal effect was earlier, longer and greater for the more educated young adults. Long-lasting old/new effects that were symmetrically distributed on both hemispheres were also reported in the old-high group on frontal and parietal electrodes. No age effect was observed on frontal areas whereas the magnitude of the parietal effect was reduced in old-high relative to young-high participants. Old-low adults showed a late and short ERP effect on the right parietal site, smaller than for young-low participants. This study demonstrated that age effects on episodic memory and ERP correlates of retrieval success were reduced in high-educated relative to less-educated individuals. These findings provide support for the brain reserve hypothesis and raise the need for considering individuals differences when studying cognitive and cerebral changes in aging.

D85**FORGETTING OF EMOTIONAL VERSUS NEUTRAL IMAGES IN THE AGING BRAIN** Håkan Fischer¹, Stuart MacDonald², Anna Rieckmann¹, Joachim Gavazzeni¹, Lars Bäckman¹;

¹Karolinska Institute, Sweden, ²University of Victoria, Canada – Forgetting is a memory-related process that begins immediately following the initial encoding of information and proceeds across time. Our objective was to investigate the neurobiological basis of the forgetting process by means of event-related functional magnetic resonance imaging (fMRI). Of chief interest was the extent to which aging and the emotional valence of images affect patterns of functional brain activation over time. Twenty younger (20-30 years) and 20 older (65-75 years) adults were scanned during encoding. Episodic memory performance was assessed on three separate occasions, and forgetting slopes were regressed on BOLD activations at encoding. Initial results indicate that both aging and emotionality influence the neural correlates of forgetting. Countering previous claims, the present results indicate that (a) rate of forgetting is not uniform across individuals, and (b) the neurobiological basis of forgetting varies as a function of both age and the emotional content of images.

D86**THE UN-RESTED RESTING BRAIN: SLEEP-DEPRIVATION AS A STATE OF ABERRANT DEFAULT-MODE ACTIVITY** Ninad Gujar¹, Seung-Schik Yoo², Peter Hu¹, Matthew Walker¹;

¹Sleep and Neuroimaging Laboratory, Psychology and Helen Wills Neuroscience Institute, University of California, Berkeley, California, ²Brigham and Women's Hospital, Radiology, Harvard Medical School, Boston, MA – The sleep-deprived brain has principally been characterized by examining dysfunction during cognitive-task performance. However, far less attention has been afforded the possibility that sleep deprivation may be as, if not more, accurately characterized on the basis of abnormal resting-state brain activity. Here we report that one night of sleep deprivation significantly disrupts the canonical signature of task-induced deactivation, resulting in a double dissociation within the dorsal medial frontal cortex and precuneus of the default network. Indeed, deactivation within these regions alone discrim-

inated sleep-deprived from sleep-control subjects with a 93% degree of sensitivity and 92% specificity. In addition, the relative balance of deactivation within these default nodes significantly correlated with the amount of prior sleep in the control group (and not extended time awake in the deprivation group). Therefore, the stability and balance of task-induced brain deactivation in key default-mode regions may be dependent on prior sleep, such that a lack thereof disrupts the intrinsic mode of resting brain activity; findings that may offer explanatory insights into conditions associated with sleep loss at both a clinical as well as societal level.

D87**RELATIONAL AND NON-RELATIONAL MEMORY: ELECTROPHYSIOLOGICAL CORRELATES OF NOVELTY DETECTION, REPETITION DETECTION, AND SUBSEQUENT MEMORY** Eleonore Xian-Chay Soei^{1,2}, Christian Bellebaum¹, Irene Daum^{1,2};

¹Institute of Cognitive Neuroscience, Neuropsychology, Ruhr-University Bochum, Universitätsstrasse, Bochum, ²International Graduate School of Neuroscience, Ruhr-University Bochum – The dissociability of novelty detection in relational and non-relational memory is currently under debate. To further address the time courses and underlying brain correlates of novelty detection, event-related potentials were analysed for encoding and retrieval on three memory tasks in healthy subjects. Spatial and non-spatial relational as well as non-relational memory were assessed separately. The event-related potentials related to relational and non-relational memory were dissociable for hits and correct rejections in an early and late time window. An early old/new effect was observed for non-relational memory. A late old/new effect replicated the frequently reported recollection-associated old/new effect in terms of direction and amplitudes. Four different novelty types (spatial relational, non-spatial relational, horizontal non-relational and inverted non-relational) were examined. The P3a related to novelty detection differed in horizontal vs. inverted distractors in non-relational memory but not in spatial vs. non-spatial relational memory. Event-related potentials for repetition detection (hits during retrieval) and also for subsequent hits (encoding phase) differed between relational and non-relational memory. These findings are discussed in relation to potential brain correlates in relational and non-relational memory during encoding and retrieval.

D88**NEURAL CORRELATES OF IMPLICIT LEARNING - EFFECTS OF PERFORMANCE AND AGE** Anna Rieckmann¹, Håkan Fischer¹, Lars Bäckman¹;

¹Aging Research Center, Karolinska Institute, Sweden – There is evidence that increases in striatal activation are accompanied by decreases in hippocampal activation over time during implicit learning (IL) in young adults. This study investigates this interaction in relation to (a) performance and (b) to striatal integrity as a function of aging. Twenty-seven adults (14 young and 13 old) performed a Serial Reaction Time task (SRTT) during fMRI acquisition. Both groups showed comparable IL, but age differences appeared on the neural level. For young adults, better IL performance was related to a larger increase in striatal activation and a larger decrease in hippocampal activation over time. For older adults, better IL performance was linked to a parallel increase in both striatal and hippocampal activation. This interaction is interpreted in terms of competing memory systems that may become more cooperative in advanced age for compensatory purposes. We also present preliminary data on the effects of a hippocampal-dependent dual task on performance in the SRTT for both younger and older adults.

D89

THE OPAQUE RECOLLECTION: AN ERP STUDY OF THE ROLE OF SEMANTIC TRANSPARENCY IN THE RECOGNITION MEMORY OF CHINESE TWO-CHARACTERS COMPOUND WORDS Shih-kuen Cheng¹, Shuo-Chieh Huang¹, Daisy L. Hung¹, Ovid J.-L. Tzeng^{1,2}; ¹Institute of Cognitive Neuroscience, National Central University, Taiwan, ²Institute of Linguistics, Academia Sinica, Taiwan – The Remember/Know judgments and ERP old/new effects were used in two experiments to investigate how the recognition memory for Chinese compound words is modulated by the words' semantic transparency. At study, participants made lexical decisions to 46 semantic transparent words [e.g., ? (/cha/, tea) ? (/bei/, cup): teacup], 46 semantic opaque words [e.g., ? (/yang/, sun) ? (/chun/, spring): plain], and 92 two-characters nonwords. At test, they made old/new judgments to the 92 studied real words and 92 non-studied new words, among which half were transparent and the other half were opaque. The frequency, neighborhood size, and concreteness were matched for the transparent and opaque words. The behavioral results showed that opaque words gave rise to a higher hit rate than transparent words. In addition, the proportion of Remember response was higher for opaque words than transparent ones. The ERP results showed that the mid-frontal old/new effect, thought to index familiarity-based recognition, was of similar magnitudes for both types of words. Opaque words, when compared with transparent words, yielded a larger parietal old/new effect, which has been thought to index recollection-based recognition. These results demonstrated that opaque words are better remembered than transparent ones, and the advantage for opaque words is related to the contribution of recollection processes. The greater recollection for opaque words than semantic ones may result from the different morphological structures between the two types of words.

D90

CORTICAL-MTL CIRCUITRY DURING LONG-TERM MEMORY FORMATION Katherine V. Roe¹, Karen F. Berman¹; ¹Section on Integrative Neuroimaging, Clinical Brain Disorders Branch, National Institute of Mental Health, National Institutes of Health – The hippocampus and adjacent medial temporal structures are critical to the formation of contextually rich, multi-featured long-term memory (LTM) representations. The current study used event-related fMRI to investigate hippocampal-cortical interactions necessary for binding different information types together in LTM. Functional T2*-weighted gradient echo, echo planar images were acquired at 3T while 24 participants performed a delayed match to sample task. Test items were drawn from a small, fixed set of distinct object-classes (letters, shapes, and line-orientations), allowing for repeated exposure to each item. Color and location of each item remained constant across each presentation, and participants' recollection of this contextual information was assessed at the end of the session. Random effects analyses ($p < .01$, corrected) were used to identify regions differentially active during short-term maintenance of different stimulus types and regions crucial for encoding and recall of different contextual information (color, location). Hippocampal-cortical interactions during successful multi-feature learning were also assessed. Results suggest regions involved in learning item-context associations are similar to those needed for short-term maintenance, with greater hippocampal involvement during successful multi-feature binding, independent of specific feature or context type. Context recall varied across stimulus types, including greater IFG recruitment during recall of letter-context information but greater parahippocampal (PHG) and parietal recruitment during recall of shape-context associations. Functional connectivity analyses demonstrated greater coherence between hippocampus-PHG-parietal regions during shape-context association formation, but greater hippocampal-fusiform coherence learning letter-context association learning. These data suggest the MTL-cortical networks crucial for creating multi-faceted LTM representations depend on the specific associations being learned.

D91

PROCESSING OF LIVING AND NONLIVING OBJECTS DIVERGES IN OCCIPITO-TEMPORAL CORTEX: EVIDENCE FROM MEG Jessica Gilbert¹, Laura Shapiro¹, Gareth Barnes¹; ¹Clinical and Cognitive Neurosciences Research Group, Aston University, Birmingham, UK – We explored the time-course of category-specific effects using magnetoencephalography (MEG) in order to assess when processing living and nonliving objects diverges in the visual object-processing system. We used a superordinate categorization task in which participants (N=10) were shown a category label followed by a target object and were instructed to decide whether the object and category label matched. A total of 78 target objects were displayed, drawn from 3 living and 3 nonliving categories. Each object was displayed twice, once as a congruent trial and once as an incongruent trial. The behavioral data revealed no difference in performance between living and nonliving objects. Utilizing a 400 ms window beginning at target object onset, we directly contrasted living and nonliving objects using a wide-band (1-80Hz) source analysis. This group analysis identified a region in left occipito-temporal cortex showing greater power for living compared to nonliving objects. We then constructed virtual electrodes at the peak location in this region for each subject to assess the time at which these category differences occurred. Time-frequency findings from this region identified a peak difference at roughly 180-200 ms after a target object, driven by low-frequency (~1-20 Hz) differences in processing living and nonliving objects. These findings suggest an early, perceptually-driven difference in processing living versus nonliving objects, which should be considered in current theories of category-specificity. The influence of this early difference on later, semantic processing will be discussed.

D92

COMPARISON OF THE NEURAL CORRELATES OF RETRIEVAL SUCCESS IN TESTS OF CUED RECALL AND RECOGNITION MEMORY Kaia Vilberg¹, Kayoko Okada¹, Michael Rugg¹; ¹Center for the Neurobiology of Learning and Memory, University of California, Irvine – While numerous event-related fMRI studies have characterized the neural correlates of successful recognition memory, almost none have studied cued recall, and none have directly contrasted the correlates of successful recall and recognition. The present study addressed this issue by identifying commonalities and differences between retrieval success effects in these two tasks. Participants (N = 19) underwent two study-test blocks. The two study phases were identical, but one test phase involved word-stem cued recall, whereas the other involved a yes/no recognition test. Retrieval success (Hit > Correct Rejection (CR)) effects common to the two tasks were found in bilateral medial (BA 7) and lateral parietal cortex (BA39/40), and the right entorhinal cortex. The reverse contrast revealed common CR > Hit effects in anterior cingulate/medial BA6, left inferior prefrontal cortex (PFC), and left anterior intraparietal sulcus. Interaction contrasts revealed greater Hit > CR effects for cued recall in a left inferior lateral parietal region abutting the region showing the common effect. More striking, the contrasts also revealed a cross-over interaction in right dorsolateral and lateral anterior PFC, these regions demonstrating CR > Hit effects for recall, and Hit > CR effects for recognition. These findings suggest that medial and lateral parietal regions support processes engaged by successful episodic retrieval regardless of how retrieved information is accessed. The findings for the right PFC are consistent with a role for this region in evaluating the outcome of a retrieval attempt.

D93

TWO PATHS TO ATTRIBUTING TRUSTWORTHINESS: NEURAL SIGNALS OF PERCEPTUAL- AND MEMORY-DRIVEN INFLUENCES John Rudoy^{1,2}, Ken Paller^{1,2}; ¹Northwestern University Interdepartmental Neuroscience Program, ²Northwestern University, Psychology – When people rate the trustworthiness of a novel face, their judgments tend to resemble the consensus ratings made by others. Therefore, something about the appearance of a person's face can bias one's

estimate of another's trustworthiness. Fortunately, one can also use memory for past events when deciding who should be trusted. When participants in fMRI experiments view faces, amygdala activation correlates more closely with consensus ratings more than with idiosyncratic trustworthiness ratings made by the participant (Engell, Haxby, & Todorov, 2007, *J Cog Neurosci*). Two processes may thus compete for control of trustworthiness judgments: 1) a fast, amygdala-associated process of perceptual analysis, corresponding to consensus judgments, and 2) a slow process of conscious retrieval, corresponding to idiosyncratic judgments. We recorded EEG responses to faces to determine the relative timing of these two hypothesized processes. First, faces were paired with positive or negative attributes, such that attribute valence varied orthogonally with consensus ratings of face trustworthiness. Subsequently, trustworthiness ratings for these faces were found to vary as a function of both consensus trustworthiness and the previous attribute pairings. During this rating phase, frontal brain potentials at about 400-600 ms were associated with consensus trustworthiness, independent of ratings, and posterior brain potentials at 800-1000 ms were associated with the valence of the word paired with the face earlier. These findings thus provide evidence of both an early path to trustworthiness judgments based on perceptual analysis and a later path to trustworthiness judgments based on memory retrieval.

D94

EFFECTS OF AGE AND MEMORY FUNCTION ON THE NEURAL CORRELATES OF SUCCESSFUL ASSOCIATIVE MEMORY ENCODING Marianne de Chastelaine¹, Tracy H. Wang¹, Brian Minton¹, Heekyeong Park¹, Michael Rugg¹; ¹University of California, Irvine – Studies of age-related differences in the neural correlates of successful memory encoding often report encoding-related activity that is more bilaterally distributed in older adults compared to young individuals. This tendency towards bilateral distribution of encoding-related activity has recently been associated specifically with relatively low levels of memory function rather than with the effects of age per se. These findings are inconsistent with proposals that the relative preservation of memory performance with increasing age depends upon right prefrontal 'over-recruitment'. Here, we used an associative memory task to further investigate the relationship between the lateral distribution of encoding-related activity and memory function in older adults. Eighteen young, and 36 older, adults were scanned while they made relational semantic decisions on a series of visually presented word pairs. Participants later made associative recognition judgments on studied, rearranged and new pairs. Older adults were segregated according to a median split of their performance on a standard neuropsychological test of memory function, the California Verbal Learning Test (CVLT). Analyses of subsequent memory effects in left prefrontal and homotopic right prefrontal voxels revealed that the effects were more bilaterally distributed in the older adults. As was found previously, this age-related laterality difference was confined to low-performing older adults. Additionally, CVLT performance was positively correlated with the level of asymmetry of prefrontal subsequent memory effects, and was negatively correlated with the magnitude of the right prefrontal effect. These findings are consistent with proposals that right prefrontal over-recruitment reflects age-related degradation of cortical function.

D95

HUMANS DISPLAY CONDITIONED PLACE PREFERENCES FOR VIRTUAL ROOMS PAIRED WITH NICOTINE Robert Astur^{1,2}, Seth Shipman¹, Heather Breslawski¹, Albert Rizzo³, Shepard Seigel⁴; ¹Olin Neuropsychiatry Research Center, Institute of Living, Hartford, CT, ²Yale University School of Medicine, Psychiatry, New Haven, CT, ³Institute for Creative Technologies, School of Gerontology, University of Southern California, Los Angeles, CA, ⁴McMaster University, Psychology, Neuroscience and Behavior, Hamilton, Ontario, Canada – Within human research, there has been a lack of research aimed at elucidating how environmental or contextual factors provoke drug cravings. Within rodent research, these

factors are studied using a conditioned place preference (CPP) paradigm, whereby a specific environment is paired with a positive reinforcer such as cocaine, alcohol, sex, or food, and via classical conditioning, a preference exists for the reinforcer-paired environment in the absence of the reinforcer. To study this in humans, we have created a virtual analogue of the CPP to examine whether such a preference can be established in a virtual reality environment. In this study, 34 social or heavy nicotine smokers were given repeated pairings of nicotine via cigarettes in one specific virtual environment, and a placebo in a different virtual environment. We also collected data on how much the participants enjoyed their laboratory drug use and also how negative they felt about their overall drug use. Accounting for the relative reinforcement strength of the nicotine strongly predicts the extent to which participants display a CPP. Specifically, the more that the participants preferred the nicotine cigarettes, the stronger their place preference for the nicotine-paired room, $r = 0.83$, $p < 0.001$. Interestingly, this effect is different for the social vs. the heavy smokers. We discuss how reinforcement and design factors account for these differences. Nonetheless, we can establish a CPP in humans using nicotine, and we are now poised to attempt to block CPPs in humans.

D96

MEDIAL TEMPORAL LOBE CONTRIBUTIONS TO RAPID ACQUISITION AND FLEXIBLE TRANSFER OF EPISODIC MEMORIES Dagmar Zeithamova^{1,2}, Nicolaus Schmandt^{1,2}, Alison Preston^{1,2}; ¹University of Texas at Austin, Psychology, ²University of Texas at Austin, Center for Learning and Memory – The medial temporal lobe (MTL) is thought to support rapid acquisition of episodic experience and to create memories that are flexible in nature, allowing for generalization from previous experiences to novel events and stimuli. One theory suggests that such generalization stems from inference based processes at the time of retrieval, while a competing hypothesis proposes that generalization results from integrative processes at the time of encoding of overlapping events. The goal of the present study was to test these competing hypotheses by using an associative inference paradigm (AIP) where participants rapidly learned overlapping associations in a single trial and were subsequently probed with novel stimulus combinations that required flexible transfer of learned information. Functional MRI revealed MTL regions, including hippocampus and surrounding MTL cortices, that were preferentially active during encoding of the overlapping associations. Subsequent memory analyses further revealed that encoding activation in MTL regions predicted later transfer performance both within and across participants, consistent with the integrative encoding hypotheses. During flexible transfer, we identified MTL regions distinct from those at encoding whose activation differed based on correct transfer performance, consistent with the hypothesis of inferential processes during retrieval. Additional high-resolution fMRI data further localized these encoding and retrieval effects to specific MTL subregions. These findings suggest that flexible generalization of rapidly acquired episodic experience depends on integrative processes during encoding as well as inferential processes during retrieval.

D97

DEEP BRAIN STIMULATION OF THE SUBTHALAMIC NUCLEUS IMPROVES IMPLICIT SEQUENCE LEARNING AND LEARNING-RELATED CORTICO-STRIATAL ACTIVATION IN PARKINSON'S DISEASE. EVIDENCE FROM A [15O]H2O-PET STUDY Leonora Wilkinson¹, Gary Hottot², Yen Tai², Nicola Pavese², David Brooks², Marjan Jahanshahi¹; ¹Sobell Motor Neuroscience, Institute of Neurology, UCL, ²MRC Cyclotron Building, Faculty of Medicine, Imperial College, London – Implicit sequence learning during the serial reaction time task (SRTT) has been shown to be mediated by the cortico-striatal circuits. Patients with Parkinson's disease (PD) show attenuated learning on the SRTT, which is completely abolished following surgical lesioning of the internal segment of the globus pallidus. The present study examined the effect of deep brain stimulation (DBS) of the subthalamic nucleus (STN) on SRTT learning in PD and on associated patterns of brain activation. 7 PD patients

with DBS of the STN assessed after overnight withdrawal of dopaminergic medication and 9 matched controls were studied with a [^{15}O]H $_2$ O-PET. PD patients completed the SRTT (5 scans) or a control random sequence (1 scan) with DBS on and off, with order counterbalanced and using parallel sequences. Controls also performed the SRTT (5 scans) and random sequences (2 scans) twice during PET scanning. Controls showed significant SRTT learning-related activation in the -striatal circuits. In contrast, with DBS off, PD patients, showed no learning and no learning-related activation in the striatum. However, with DBS on, PD patients showed significantly more learning and more learning-related activation in the cortico-striatal circuits. The results provide evidence for the modulation of the cortico-striatal circuits involved in implicit sequence learning by DBS of the STN in PD. The differing effects of DBS of the STN and pallidotomy on SRTT in PD suggest that their mechanisms of action are different.

D98

NEURAL CORRELATES OF SEMANTIC AND EPISODIC MEMORY IN HEALTHY ELDERLY SUBJECTS: A MAGNETOENCEPHALOGRAPHIC (MEG) STUDY Valentina La Corte^{1,2,3,4}, Nathalie George^{2,3,4}, Bruno Dubois^{1,3}, Line Garnero^{2,3,4}, Gianfranco Dalla Barba^{1,3,5}; ¹INSERM Unité 610, Hôpital de La Salpêtrière, Paris, France, ²CNRS, UPR 640, Laboratoire de Neurosciences Cognitives et Imagerie Cérébrale, Hôpital de La Salpêtrière, Paris, France, ³Université Pierre et Marie Curie-Paris 6, France, ⁴Centre MEG/EEG, Hôpital de La Salpêtrière, Paris, France, ⁵AP-HP, Hôpital Henri Mondor, Service de Neurologie, Créteil, France – The hierarchical hypothesis assumes that episodic memory is a specific subsystem of semantic memory and that the neural networks implicated in the two systems largely overlap. In this study, we used MEG in 17 healthy elderly subjects who performed a semantic and an episodic memory task. The aim of this work was to determine the neural correlates and the temporal dynamic underlying the semantic and episodic components of face recognition in cognitive aging. In the semantic task, 56 faces (28 famous and 28 unknowns) were presented and subjects had to decide for each face whether it was famous or unknown. In the episodic task, subjects were asked to recognize among distracters the faces they had seen in the semantic task. Behavioral results show that the level of semantic awareness of an item affects the recognition of that same item in the episodic memory task. At physiological level, in the semantic task, evoked fields associated to famous faces were stronger than those associated to unknown faces, in the right temporal region between 400 and 600 ms and in the left fronto-temporal region between 600 and 800 ms. During episodic task, evoked fields associated to the recognition of the studied faces were stronger than those associated to new faces, between 400 and 600 ms, and between 600 and 800 ms in temporo-parietal sensors (old/new effect). Consistently with the hierarchical hypothesis, our results show that episodic memory strongly relies on semantic memory and that the neural correlates of the two systems largely overlap.

D99

DIFFERENTIAL PATTERNS OF HIPPOCAMPAL ACTIVITY DURING CONTINUOUS RECOGNITION: A HIGH-RESOLUTION FMRI STUDY Maki Suzuki¹, Jeffrey D. Johnson¹, Michael D. Rugg¹; ¹Center for the Neurobiology of Learning and Memory & Neurobiology and Behavior, University of California, Irvine – In a previous study (Johnson and Rugg, 2008, Hippocampus), it was reported that different hippocampal regions responded to multiple repetitions of items in a continuous recognition task in two distinct ways. Some regions demonstrated repetition-related response reductions that were 'graded' (gradually diminishing responses across repetitions), whereas other regions demonstrated a 'categorical' repetition effect (asymptotic response reduction on the first repetition). Here, we used high-resolution functional magnetic resonance imaging (fMRI) to investigate whether medial temporal lobe (MTL) activity varies across successive item presentations when the requirement was to track the number of presentations of each item. While being scanned, 16 subjects were presented with a series of pictures and were required to

respond with one finger to items presented for the first or the third time, and with another finger to items appearing for the second or the fourth time. Repetitions were separated by a mean of 23 trials. Consistent with previous findings, new items elicited larger fMRI responses than repeated items in both bilateral hippocampus and parahippocampal cortex. There were no MTL regions where activity was greater for old items. Both graded and categorical response profiles were evident within adjacent hippocampal regions. Other regions, however, demonstrated profiles that varied between these two extremes. These findings highlight the ubiquity of hippocampal 'recognition suppression effects' during continuous recognition, and add to the evidence that different hippocampal regions respond to the relative novelty/familiarity of stimulus events in very different ways.

D100

WHAT DOES THE POSTERIOR PARIETAL CORTEX (PPC) TELL US ABOUT EPISODIC ENCODING? A META-ANALYSIS OF PPC SUBSEQUENT MEMORY EFFECTS Melina Uncapher¹, Anthony Wagner^{1,2}; ¹Stanford University, Psychology, Stanford CA, ²Stanford University, Neurosciences Program, Stanford CA – The formation of episodic memories -- memories for life events -- is affected by attention during event processing. A leading neurobiological model of attention posits two separate yet interacting systems that depend on distinct regions in lateral posterior parietal cortex (PPC). From this dual-attention perspective, dorsal PPC is thought to support the goal-directed allocation of attention, whereas ventral PPC is thought to support reflexive orienting to information that automatically captures attention. To advance understanding of how parietal mechanisms may impact event encoding, we present a meta-analysis of functional MRI studies that document the relationship between lateral PPC activation during encoding and subsequent memory performance (e.g., later remembering or forgetting). This meta-analysis reveals that (a) encoding-related activity is frequently observed in human lateral PPC, (b) increased activation in dorsal PPC is associated with later memory success, and (c) increased activation in ventral PPC predominantly correlates with later memory failure. From a dual-attention perspective, these findings suggest that allocating goal-directed attention during event processing increases the probability that the event will be remembered later, whereas the capture of reflexive attention during event processing may have negative consequences for event encoding. The prevalence of encoding-related activation in parietal cortex suggests that neurobiological models of episodic memory should consider how parietal-mediated attentional mechanisms regulate encoding.

D101

MODULATION OF THE EMOTIONAL MEMORY NETWORK DURING FREE VIEWING OF A BASKETBALL GAME Anne Botzung¹, Kevin S LaBar¹, Amanda Miles¹, Philip Kragel¹, David C Rubin¹; ¹Duke University, Psychology & Neuroscience – Our aim was to investigate brain activity associated with the encoding of realistic, highly emotional and self-relevant stimuli. A 30-minute portion of a basketball game involving a traditional college basketball rivalry, Duke vs. UNC, was presented in the fMRI scanner to dedicated fans from the two opposing schools. During a subsequent recognition memory task outside the scanner, the participants were shown eighty 15-s video clips depicting plays from the most exciting periods of the game, stemming either from the portion viewed before (targets), or from non viewed portions of the same game (foils). Half the clips were emotionally positive and half emotionally negative for fans of each team. After an old-new judgment, participants provided memory confidence, and emotional valence and intensity ratings for each clip. fMRI signal acquired during the entire free-viewing session was decomposed into spatially independent networks using independent component analysis. A correlation analysis was performed between neural activity associated with each component during the previously selected 15-s portions of the game and corresponding post-viewing ratings. Interestingly, the component showing the highest level of correlation with intensity included key regions of both memory and emo-

tional circuitries: respectively, the hippocampus bilaterally, visual cortex, medial posterior cingulate and precuneus, medial and orbital prefrontal cortex, as well as the amygdala. These findings contribute to our understanding of the effects of emotion on the encoding process of real-life emotional stimuli.

D102

EFFECT OF SUBCHRONIC NOISE STRESS ON SPATIAL MEMORY AND LEARNING IN WISTAR RATS Leonardo Hernandez¹, Jassica Soria-Fregoso¹, Alma Cisneros-Esparza¹, Gabriela Camargo¹; ¹Neurociencias, CUCS, Universidad de Guadalajara – Background: Central Nervous System is (CNS) strongly involved in response to chronic and acute stress. If a stressful event is intense and long, the limbic, hypothalamus-pituitary-adrenal system undergoes changes which depend on intensity and duration of stimulus. However, in case of non extreme conditions of stress is not clear. In this sense, we explore implications on spatial memory and learning in rats undergoing subchronic noise stress. Methods: We used 16 young male Wistar rats were distributed as following: a) Control, 8 animal in standard conditions of vivarium and b) Test, 8 rats in noise condition. Noise exposition consisted in expose animals to high frequency tones (22KHz, at 80-90 dB) 8 hours at day during 10 days. Spatial memory and learning were evaluated in both groups using Morris water maze (MWM), in its classic and reverse learning variant. The quantified parameters were Latency, Spatial specificity, navigation velocity, and locomotion. Results: Noise exposed rats show a better performing in relation of control in both variants of MWM in both variants, classical and reverse learning. Conclusion: Apparently, subchronic noise stress conditions improve the construction of cognitive maps in Hippocampus, (which able to spacial navigation in rats), and optimize the synaptic plasticity mechanisms at hippocampus. These results are different from those reported for chronic or acute stress, where the cognitive impairment and hippocampus plasticity constriction were found.

D103

AUTOBIOGRAPHICAL, EPISODIC, AND SEMANTIC MEMORY: MODELING OF A COMMON FUNCTIONAL NETWORK Hana Burianova^{1,2}, Cheryl L. Grady^{1,2}; ¹The Rotman Research Institute, ²University of Toronto – The objective of this study was to delineate a functional network common to autobiographical, episodic, and semantic types of retrieval. Autobiographical retrieval was defined as the recollection of personally relevant events, episodic retrieval as the recollection of stimuli presented in the laboratory, and semantic retrieval as the recollection of factual information and general knowledge about the world. Young adults participated in an event-related functional magnetic resonance imaging (fMRI) study in which pictorial stimuli were presented as cues for retrieval. By manipulating retrieval demands, autobiographical, episodic, or semantic memories were extracted in response to the same stimulus. We conducted a three-seed partial least squares (PLS) analysis to determine whole-brain functional connections with the left hippocampus, left lingual gyrus, and right caudate nucleus. We delineated a large-scale functional network common to the three memory conditions that comprised 21 functionally connected neural areas (i.e., their activity covaried during any type of declarative retrieval), including the inferior and medial frontal gyri, as well as a number of temporal and parietal areas. These findings lend support to the notion of a common network, which is hypothesized to give rise to declarative memory retrieval, regardless of the type of information processed, along a contextual continuum (i.e., highly contextualized or highly decontextualized).

D104

EVENT-RELATED POTENTIAL CORRELATES OF MEMORY STRENGTH FOR SOURCE JUDGMENTS Brion Woroch¹, Brian Gonsalves¹; ¹Beckman Institute, Univ. of Illinois Urbana-Champaign – Event-related potential (ERP) studies of recognition memory have shown dissociations between item recognition and source memory, wherein item recognition is associated with the mid-frontal FN400 component, which varies continuously with item memory strength, while source memory is

associated with the late parietal effect (LPC). There is current debate about whether source memory can vary along a continuum of memory strength or is a threshold process. The LPC has been shown to be generally sensitive to correct versus incorrect source judgments, but varying levels of 'source strength' have not been tested. The current experiment had participants encode novel visual objects in one of two different task contexts by performing either a conceptual or perceptual judgment about the object. On a subsequent memory test, 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. ERPs from the memory test were examined for electrophysiological correlates of both item and source memory strength. Item memory was associated with differences in the 300-500ms time window, consistent with the timing of the FN400. Differences in the amplitude of the LPC were observed between correct and incorrect source decisions, consistent with previous findings. Comparing low and high confidence source decisions also revealed differences, suggesting that the LPC is also sensitive to variations in the strength of source memory.

D105

BEHAVIOURAL AND ERP MEASURES OF FAMILIARITY AND RECOLLECTION: EVIDENCE AGAINST THE DOMAIN DICHOTOMY VIEW OF ASSOCIATIVE RECOGNITION Iain M. Harlow¹, Graham MacKenzie², David I. Donaldson³; ¹University of Edinburgh, Neuroinformatics DTC, ²University of Glasgow, Psychology, ³University of Stirling, Psychology – Episodic recognition memory is mediated by familiarity and recollection, whose relative engagement depends on both the nature of the stimuli being retrieved and the manner in which memory is tested. For associative retrieval tests, it is unclear exactly what stimulus parameters determine the engagement of familiarity and recollection. One recent proposal, the Domain Dichotomy view (Mayes et al., 2007), states that familiarity should contribute more to associative recognition when pairs of stimuli are similar (i.e., within-domain) than when they are distinct (i.e., between-domain). We tested this prediction using neuroimaging and behavioural measures of familiarity (Event-Related Potentials or ERPs; the Modified Remember Know procedure; and Receiver Operator Characteristics). Participants studied stimulus pairs, and at test discriminated intact from rearranged pairs. Stimuli were either within-domain (word-word or image-image pairs) or between-domain (word-image pairs), allowing familiarity to be estimated for each condition. Contrary to the Domain Dichotomy view, behavioural measures revealed that the contribution of familiarity (and consequently recognition performance overall) was at least as high for the between-domain condition as either within-domain condition. Moreover, ERPs measured at retrieval did not reliably differ between conditions; each revealed a central positivity between 500-1000ms for hits to intact pairs compared to correct rejections of rearranged pairs. When pairs of new items were included as a baseline (in an otherwise identical follow-up study) standard early mid-frontal and left parietal old/new effects were observed in each condition. The results provide convergent evidence that familiarity and recollection support associative retrieval, but not in the way Domain Dichotomy predicts.

D106

BEHAVIOURAL AND EVENT-RELATED POTENTIAL EVIDENCE FOR A DOUBLE DISSOCIATION BETWEEN WORKING AND LONG-TERM MEMORY Chia-Yun Wu¹, David E. J. Linden¹, Christoph Klein¹, Stephan G. Boehm¹; ¹School of Psychology, Bangor University, United Kingdom – Working and long-term memory have long been considered distinct memory types. Based on recent neuroimaging studies and a critical re-evaluation of earlier lesion studies, a high degree of overlap between the areas subserving both types of memory has been highlighted, raising doubts on a double dissociation of working and long-term memory. Furthermore, it is widely accepted that working memory is the pathway to long-term memory. Here, we investigated whether

working memory encoding is indeed a pre-requisite for successful formation of long-term memory. Additionally, we used event-related potentials to investigate whether similar neural processes support both types of memory. Participants were engaged in a working memory task for famous faces, which was followed by a long-term memory test for faces presented during the working memory task. Behavioural results showed a considerable degree of independence between performance in working memory and long-term memory. Clear neural signatures of successful encoding into working and long-term memory were present between 550-1100 ms; the spatial distributions of these potentials indicate different encoding between working and long-term memory. Positive old/new effects were present for both working (300-500 ms, 500-700 ms) and long-term memory (500-800 ms). The topographies of all these old/new effects were significantly different from each other. Both our behavioural and event-related potential results support at least partially distinct memory systems for working and long-term memory. Our results raise questions on the idea of working memory as the pathway into long-term memory and support a high degree of dissociation between working and long-term memory.

DI07**IMPLICIT SEQUENCE LEARNING: BEHAVIORAL AND FMRI EVIDENCE FOR DISTINCT UNDERLYING REPRESENTATIONS AND NEURAL STRUCTURES**

Freja Gheysen¹, Filip Van Opstal¹, Chantal Roggeman¹, Hilde Van Waelvelde¹, Wim Fias¹; ¹Ghent University, Belgium – Sensitivity for serial order has been the topic of cognitive psychology research for many years. The cognitive ability to encode serial information from the environment allows us to predict and prepare for upcoming events, even without the need of having full conscious knowledge of this information. In this study, the question concerning which representation (stimulus or response) contributes to the implicit learning process and which brain structures play a significant role in the acquisition and storage of these representations is addressed. In the original Serial Reaction Time task (Nissen & Bullemer, 1987), many types of sequential information are intermixed. To distinguish perceptual from motor sequencing, we developed a new serial reaction task and controlled for confounds occurring in previous studies. First, behavioral results from this serial color matching task demonstrated that both stimulus and response contingencies contribute to sequence acquisition. However, perceptual sequence learning seems less robust than the learning process of motor sequences. Next, this behavioral work was related to brain function. The distinct areas engaged in the early and advanced stages of sequence acquisition were investigated using a blocked fMRI design with the same paradigm. Subjects were scanned over two sessions with additional sequence training in between. Moreover, the study aimed at exploring specifically the role of the cerebellum in learning different types of sequential information.

Poster Session E

Memory: False memory

E1

NEURAL ACTIVITY PREDICTS TRUE AND FALSE MEMORIES IN THE MISINFORMATION PARADIGM

*Carol Baym¹, Brian Gonsalves^{1,2},
¹University of Illinois at Urbana-Champaign, Psychology, ²Beckman Institute, University of Illinois at Urbana-Champaign* – False memories occur when people report having encountered something they have not actually experienced. Of interest here are the neural mechanisms that underlie this type of memory failure. In the current study, 18 healthy young adults viewed vignettes of common activities such as preparing dinner while we monitored their brain activity using functional magnetic resonance imaging. In the Original Event Phase (OE) participants viewed photographs of actors portraying the scenarios. Later, in the Misinformation Phase (MP), participants viewed sentences describing the previously seen photographs and were instructed to visualize the corresponding photograph. Critically, some of the verbal presentations contained information conflicting with that depicted in the photographs. Twenty-four hours later, participants returned for a memory test for what they had seen in the photographs. Our manipulation showed reliable creation of false memories, defined as instances where the participant reported information that was not in the photographs, but was presented in the verbal information. Consistent with previous findings (Gonsalves, 2004), participants who were most susceptible to false memory formation showed activity in medial prefrontal cortex, right parietal cortex, and visual areas during the MP when they would later report a false memory compared to a true memory. Region-of-interest analyses showed that activity in several regions during the OE predicted later accurate memory and resistance to misinformation. These findings suggest that different patterns of neural activity at encoding predict subsequent accurate and false memory.

E2

THE FUNCTIONAL LOCUS OF MEMORY DISTORTIONS: ENCODING OR RETRIEVAL?

Eve Attali^{1,2}, Victoria Cristancho^{1,2}, Gianfranco Dalla Barba^{1,3}, ¹INSERM U 610 Paris, ²UPMC Université Paris VI, ³Hopital Henri Mondor Créteil – Many current accounts of the origin of intrusions and other confabulatory-like phenomena emphasize the role of a retrieval or postretrieval deficit in these disorders. Our previous experiments showed that the probability of false memories production was associated with the quality of the memory trace. However, this memory trace is elaborated during encoding processes. One might then ask the question whether the origin of memory distortions is located at encoding or at retrieval. We propose to disturb differentially these two stages of processing by the addition of a divided attention (DA) task at encoding and at retrieval. Methods Forty young and 40 older adults participated in two studies. The first task consists in a free recall of three different types of stories, and the second one is a words recognition test based on High and Low frequency words. These two tasks were administered under three conditions: -1: full attention at encoding/ full attention at retrieval -2: DA at encoding/ full attention at retrieval -3: full attention at encoding/ DA at retrieval Results In both tasks, DA at encoding was associated with both a decrease of memory performance and an increase of false memories whereas DA at retrieval had little effect on both the accuracy of the retrieval and the probability in creating memory distortions. Conclusion The greater number of confabulations and false recognitions when divided attention was provided at encoding than at retrieval suggests that encoding processes might be strongly involved in the generation of memory distortions.

E3

TRUE MEMORY, FALSE MEMORY, AND THE EFFECT OF REPEATED ITEMS ON EVENT-RELATED POTENTIALS REGARDLESS OF MEMORY

Matthew Burden¹, Alissa Westerlund², Gina Muckle³, Pierre Ayotte³, Eric Dewailly³, Charles Nelson², Sandra Jacobson¹, Joseph Jacobson; ¹Wayne State University School of Medicine, ²Children's Hospital Boston, Harvard Medical School, ³Laval University – Event-related potential (ERP) studies often show a larger late positive component (LPC) associated with repeated, successfully remembered items. Little is known, however, about how the LPC and preceding components are influenced by repetition in true vs. false memory. We recorded ERPs during a continuous recognition memory task in which children (N = 103; mean age = 11.3 yr) determined if each visually presented object was "new" (seen once) or "old" (repeated). ERPs were analyzed with respect to hits (old/correct), misses (old/incorrect), false alarms (new/incorrect), and correct rejections (new/correct). Bonferroni-adjusted comparisons showed that, as expected, LPC peak amplitude (500-650 ms) at Pz was larger for mean (?V) hits (18.3) vs. correct rejections (14.1), false alarms (14.5), and misses (15.6; ps < .01); planned comparisons showed that the peak for misses was also larger than correct rejections (p < .05), which did not differ from false alarms (p = .63). By contrast, the P2 peak (250-400 ms) at Pz was virtually identical for mean (?V) hits and misses (14.2 vs. 14.1, respectively, p = .99), and both were larger than the corresponding P2 for correct rejections (11.5; ps < .001), which did not differ from false alarms (12.6; p = .74). These findings suggest that the early P2 component is sensitive to repetition effects ("old" vs. "new") regardless of memory, perhaps reflecting equally successful visual encoding of repeated items, and the LPC, which is partially enhanced by repetition alone (misses) but unaffected by false memory (false alarms), reflects true memory retrieval.

Memory: Memory disorders

E4

TEMPORAL REPRODUCTION AS AN EARLY MARKER OF ALZHEIMER'S DISEASE

*Ashley Bangert¹, Jeremy Missuk¹, David Balota¹;
¹Washington University in St. Louis, Psychology* – Early stages of dementia of the Alzheimer's type (DAT) are marked by deficits in attentional control (Balota & Faust, 2001). Changes in attention and executive control influence the temporal perception of supra-second durations (Lewis & Miall, 2003). In the current study, young adults (YA), healthy older adults (OA), and individuals classified as very mildly demented (CDR .5) on the Clinical Dementia Rating Scale (Berg, 1988) performed a continuous tapping task with 500, 1000, and 1500 ms intervals. We hypothesized that CDR .5 would show poorer performance than YA and OA especially on longer durations as a consequence of higher attentional demands. Despite equivalent performance to YA during paced tapping, both OA and CDR .5 individuals produced significantly less accurate reproductions compared to YA during 1000 ms and 1500 ms unpaced tapping. Additionally, CDR .5 were less accurate than OA for the 1500 ms condition. Performance in this condition also discriminated carriers from non-carriers of the APOE e4 allele in a subset of OA. These results suggest that CDR .5 and OA who are at risk for developing DAT due to e4 status have difficulty continuously monitoring and updating the passage of time in order to maintain the appropriate temporal task set. Moreover, finding that a simple repetitive timing task is sensitive to differences between OA and CDR .5 individuals as well as e4 status has implications for the development of simple diagnostic tools for early detection of DAT. This work was supported by NIA PO1 AG03991 and T32 AG000030-32.

E5

RELATIONS BETWEEN STM DEFICITS AND EXECUTIVE FUNCTION Corinne Allen¹, Randi Martin¹; ¹Rice University, Psychology – Hoffman and colleagues (2008) claimed that executive function (EF) deficits cause semantic and semantic short-term memory (STM) impairments in aphasic patients. Consistent with this claim, Hamilton and Martin (2007) demonstrated a verbal inhibition deficit in a patient with a semantic STM deficit. The present study investigated whether EF deficits are related to semantic but not phonological STM deficits. We used complex EF tasks and tasks tapping basic EF components (inhibition, updating, and shifting). Seventeen aphasic patients with varying degrees of semantic or phonological STM deficits were tested on semantic, STM, and EF tasks. Wisconsin Card Sorting Task (WCST) performance correlated with phonological retention and semantic ability whereas Tower of Hanoi (TOH) performance did not, suggesting a greater verbal component to the WCST than the TOH. For basic EF components, inhibition correlated with semantic retention, but also correlated with phonological retention. Interestingly, verbal and nonverbal updating tasks correlated with several span tasks tapping phonological retention, despite the fact that the updating tasks only required retaining one item. Finally, shifting was unrelated to semantic or phonological retention. These results provide little support for the notion that global EF deficits cause STM deficits, given that TOH performance was unrelated to STM. Instead, causation may go in the other direction—deficits in phonological retention may cause deficits on complex and simple EF tasks that have verbal components. The claim that verbal inhibition deficits are the source of semantic STM deficits remains viable; however inhibition deficits also appear to be related to phonological STM.

E6

GENERALIZATION GRADIENTS IN HUMAN CATEGORY LEARNING: AMNESIC PATIENTS CAN OUTPERFORM CONTROLS ON HIGH-DISTORTION EXEMPLARS Catherine Myers¹, Ramona Hopkins^{2,3}, A. J. Wills⁴, Mark Gluck⁵; ¹Rutgers University, Psychology, Newark, NJ, ²Brigham Young University, Psychology, UT, ³Medicine, LDS Hospital and Intermountain Medical Center, Salt Lake City, UT, ⁴University of Exeter, Psychology, Exeter, UK, ⁵Center for Neuroscience, Rutgers University, Newark, NJ – Prior work has suggested that the hippocampal region is important for contextual and configural processing, but is not required for simple stimulus-response learning. We tested 9 amnesic patients with bilateral hippocampal damage and 9 healthy controls on a categorization task (Wills & McLaren, 1997) in which subjects learn by trial and error to categorize prototype-structured patterns of 12 symbols; symbols are selected from two sets, A and B, and each pattern belongs to the category from which a majority of its symbols are taken. This task can be solved by configural learning about groups of symbols that reliably co-occur and signal category membership, or by forming individual symbol-category associations and then using a majority rule to deduce category membership. If the hippocampal region mediates contextual/configural learning, the configural strategy should be hippocampal-dependent but the associational strategy should not. Training was followed by a test phase in which subjects categorized new patterns including prototypes (all 12 symbols from one class) as well as high- and low-distortion exemplars. On the test phase, controls showed high accuracy for prototypes, with a generalization gradient that declined smoothly for progressively more distorted exemplars. Consistent with prior findings, amnesic patients performed as well as controls on classifying prototypes and low-distortion exemplars; but on high-distortion exemplars, amnesics actually outperformed controls. This is consistent with the idea that the amnesic patients are biased to form individual cue-category associations, leading to good performance on high-distortion exemplars, since categorization is made by majority vote based on the symbols present.

E7

EFFECTS OF COGNITIVE REHABILITATION ON MEMORY-RELATED FUNCTIONAL BRAIN ACTIVATION IN PEOPLE WITH EARLY STAGE ALZHEIMER'S DISEASE Jorien van Paasschen¹, Linda Clare¹, Robert T. Woods¹, David E.J. Linden¹; ¹School of Psychology, Bangor University – Recent studies show that using learning strategies in combination with teaching personally relevant information can be effective in improving memory for that information in people with Alzheimer's disease (AD). Six people participating in an eight-week cognitive rehabilitation intervention programme were taught a mnemonic strategy to (re)learn the names of familiar people. Using functional magnetic resonance imaging (fMRI), possible changes in brain activation during face-name learning were examined pre and post treatment while participants learned and recognised unfamiliar face-name pairs, and engaged in a control task (making decisions about the gender of a face). Behaviourally, we observed small improvements on immediate recognition of the face-name associations as well as on the control task. On a neural level, brain activity was generally higher prior to than following the treatment during memory-related processing. During encoding, activation decreases following treatment occurred mainly in visual areas. The most prominent alterations occurred during recognition, where activation was lower following the intervention period in mainly parietal, occipital and temporal regions. Changes in brain activity during the control task were minimal. Although preliminary, the results were suggestive of more effective inhibition of regions comprising a default mode network. The approach adopted here to study the neural bases of cognitive rehabilitation has not been reported before, and the present findings indicate that this method can feasibly be employed with people with AD.

E8

EFFECTS OF INTIMATE PARTNER VIOLENCE ON MEMORY Carolyn Edwards¹, Robert Astur², Sarah Raskin¹; ¹Neuroscience Program, Trinity College, Hartford CT, ²Olin Neuropsychiatry Research Center, Institute of Living, Hartford CT – This study examined prospective, spatial and verbal memory deficits in female victims of intimate partner violence (IPV). Eighteen women who had experienced IPV were given tests of memory, posttraumatic stress disorder, daily stress inventory, a brain injury screening measure, Beck Anxiety Inventory, Beck Depression Inventory, the Cognitive Difficulties Scale and a quality of life measure. Memory tests included the Memory for Intentions Screening Test (MIST), the virtual radial arm maze, and the Hopkins Verbal Learning Test (HVLT). The aim of the study was to determine how various health outcomes such as brain injury, post-traumatic stress disorder, and depression affect memory in these women. Results indicated that women with increased stress performed better on the memory tasks than women reporting less stress. Other results verified previous findings that women who had suffered more severe IPV were more likely to be experiencing PTSD, depression, anxiety, and a lower quality of life. Women who had undergone more severe IPV were more likely to report having cognitive difficulties, however, there was no correlation between increased IPV severity and performance on standardized memory tests.

E9

REDUCED ERP WORD REPETITION EFFECTS IN PATIENTS WITH FRAGILE X-ASSOCIATED TREMOR/ATAXIA SYNDROME John Olichney^{1,2}, Shiao-hui Chan^{1,2}, Andrea Schneider³, Adam Niese^{1,2,4}, Kelsey Laird⁵, Rawi Nanakul^{1,2}, Flora Tassone³, Randi Hagerman³; ¹UC Davis, Neurology, ²Center for Mind and Brain, UC Davis, ³MIND Institute, UC Davis, ⁴University of Iowa, Psychology, ⁵UC Davis, Neuroscience – Fragile X-associated tremor/ataxia syndrome (FXTAS), a neurodegenerative disorder associated with premutations of the FMR1 gene, affects many carriers in late-life. Patients with FXTAS typically have cerebellar ataxia, neuronal intranuclear inclusions (especially in hippocampus), and cognitive impairment. Neuropsychological tests have shown similar deficits in FXTAS dementia and AD. Thus, we sought to characterize the P600 and N400 word repetition effects in patients with FXTAS. We hypothesized

that FXTAS patients with poor declarative verbal memory will have pronounced abnormalities in the P600 repetition effect. Methods: Auditory category statements were each followed by an associated visual target word (50% "congruous" category exemplars, 50% "incongruous" nouns) while 32 channel ERPs were recorded during a category decision task. Two-thirds of the stimuli were repeated, either at short-lag (~10-40 seconds) or long-lag (~100-140 seconds later). Results: Preliminary group ANOVAs showed a highly significant reduction of the N400 repetition effect ($F=12.7$; $p=0.001$), but not of the P600 repetition effect, in FXTAS ($n=16$, mean age=68.7, MMSE=26.4). However, the FXTAS patients with abnormal verbal memory also had reduced P600 word repetition effects, with significant within-group correlations (r 's > 0.55 with free and cued recall measures). The relationship between P600 and N400 effects, CGG repeat length, FMR1 mRNA expression levels, and memory performance will be discussed. In conclusion, ERP word repetition effects appear sensitive to the memory dysfunction present in patients with FXTAS. Their more severe reduction in N400, than P600, repetition effect is in contrast to the reverse pattern found in amnesic MCI (Olichney et al 2002 JNNP).

E10

DIFFERENTIAL IMPAIRMENT OF RELATIONAL VERSUS ITEM-SPECIFIC MEMORY IN SCHIZOPHRENIA J. Daniel Ragland¹, Robert Blumenfeld², Ian Ramsay¹, Marjorie Solomon¹, Stefan Ursu¹, Michael Minzenberg¹, Jong Yoon¹, Cameron Carter¹, Charan Ranganath³, ¹UC Davis, Psychiatry and Behavioral Sciences, ²UC Berkeley, Psychology, ³UC Davis, Psychology – Although individuals with schizophrenia have severe long term memory (LTM) deficits, they are not densely amnesic. Like frontal lobe lesion patients, individuals with schizophrenia are most impaired when required to generate strategies to organize information during encoding, and to control and monitor search processes during retrieval. There is also evidence for a relative deficit in recollection versus familiarity-based retrieval. This study tests the hypothesis that strategic memory deficits in schizophrenia are due to specific impairment in control of relational processing, whereas item-specific processing is relatively intact. This hypothesis was tested by administering a previously validated relational and item-specific encoding task during fMRI to 16 individuals with schizophrenia and 15 healthy volunteers. Subsequent memory performance was evaluated using signal-detection analysis of receiver operator characteristics (ROC). This revealed predicted group by task interactions. Specifically, controls showed better LTM performance following relational than item-specific processing, whereas patients showed no performance benefit from relational processing. This was true for a standard measure of recognition accuracy (d_a) and for a measure sensitive to relational binding (Triplet Memory). The ROC analysis revealed that patients had a specific impairment in recollection (R) but not in familiarity (d-prime) following both item-specific and relational encoding. These convergent behavioral results reveal a relative preservation of item-specific encoding and familiarity based retrieval in schizophrenia that has important implications for developing behavioral and pharmacological interventions to target the remaining severe deficits in recollection and relational memory that limit these individuals' daily function.

E11

MEMORY FAILURE AND SLEEP DISRUPTION IN AMNESIC MILD COGNITIVE IMPAIRMENT Carmen E. Westerberg¹, Bryce A. Mander¹, Susan M. Florczak¹, Sridhar Jatta¹, Sandra Weintraub¹, M.-Marsel Mesulam¹, Phyllis C. Zee¹, Ken A. Paller¹; ¹Northwestern University – Declarative memories are not static. Rather, they undergo a consolidation process whereby memory fragments stored in distinct neocortical zones can become more effectively bound together. If memory processing during sleep contributes to consolidation, poor sleep may exacerbate memory problems in patients with Alzheimer's disease (AD). Sleep disruptions are common in AD, but a direct link between disease-related sleep disruptions and memory dysfunction has not been established. It is unknown whether sleep is also disrupted in amnesic mild cognitive impairment (a-MCI), a condition that may precede AD and that is charac-

terized by circumscribed memory deficits not severe enough to disrupt daily living activities. To explore possible connections between memory dysfunction and sleep, we used polysomnography (PSG) to obtain electrophysiological measures of sleep in patients with a-MCI and cognitively healthy age- and education-matched individuals. Two declarative memory tests (for word pairs and for fictitious biographical facts associated with studied faces) and a priming test (speeded decisions for common-object pictures) were administered prior to sleep and after waking each morning in a 4-night protocol. PSG data revealed reduced stage-2 sleep and reduced sleep efficiency in a-MCI. Across-subject correlations showed that declining sleep efficiency was associated with declining declarative memory accuracy for information learned the previous night, but not with priming. Thus, mild alterations of sleep architecture are present in a-MCI and may interfere with declarative-memory consolidation. Additional findings supporting the possibility that the forgetfulness of a-MCI patients partly stems from deficient memory processing during sleep will also be discussed.

E13

IMAGINING THE PAST AND THE FUTURE: SIMULATION DEFICITS IN HEALTHY AGING Donna Rose Addis¹, Regina M. Musicaro², Ling Pan², Daniel L. Schacter^{2,3}; ¹The University of Auckland, Psychology, New Zealand, ²Harvard University, Psychology, Cambridge MA, ³Athinoula A. Martinos Center for Biomedical Imaging, Charlestown MA – We recently reported that older adults generate fewer episodic details than younger adults when remembering past events and simulating future events. Moreover, performance on the remembering and imagining tasks was tightly correlated. We suggested that the simulation findings reveal an age-related deficit in recombining episodic details into novel events, but they could also result from older adults simply 'recasting' entire past events as future events. In the current study, we used an experimental recombination paradigm to prevent 'recasting' while imagining, and to compare imagining the future with imagining the past. Eighteen young and eighteen older adults imagined future and past events using event details taken from memories recalled in a prior session and randomly recombined. Subjects also recalled past events. Event transcriptions were segmented into internal (episodic) and external (non-episodic) details. Older adults generated fewer internal episodic details for imagined and recalled events than younger adults. Both groups generated more episodic detail during recall relative to imagining, and more episodic detail for events imagined in the past versus future. We also replicated the finding that older adults generate significantly more external detail than younger adults. Across both groups, imagined future events were associated with more external information than imagined past events. Importantly, the number of internal and external details both showed correlations between recalled and imagined events. This study extends the age-related simulation deficit to conditions of recombination, and shows that deficits in imagining episodic detail are evident for imagined past events, and not specific to imagining the future.

E14

SEMANTIC MEMORY AND TRAUMATIC BRAIN INJURY Fanpei Yang¹, Navid Khodaparast¹, Kouros Zakeri¹, Daniel Krawczyk^{1,2}; ¹Center for Brain Health, University of Texas at Dallas, ²University of Texas Southwestern Medical Center, Psychiatry, Dallas – Figurative language (e.g., irony, metaphor, and idiom) comprehension has been identified as a domain of impairment in adults that have sustained Traumatic Brain Injuries (TBI). Declines in working memory and in figurative language comprehension in TBI patients are inferred based on observed deficits in higher-order comprehension skills, such as inference understanding, as well as a reported correlation between working memory and several types of figurative language in older adults. No previous studies have employed functional neuroimaging techniques in order to test the hypothesis that impaired complex language comprehension is directly dependent on working memory efficacy. In a previous fMRI experiment on metaphor comprehension in normal subjects, we established that the left inferior

frontal gyrus (LIFG) was most involved with novel metaphor comprehension. This finding is consistent with results reported in other imaging studies of complex language processing. The purpose of the present research was to uncover the most influential cognitive factor for TBI patients' deficits in figurative language processing. Our results indicated that patients with TBI, regardless of lesion location, showed lowered LIFG activation, which is a primary control region involved in processing semantic memory representations. We observed no differences in activation related to subjects' working memory ability. Based on the regional activation observed in this study, we suggest that semantic memory rather than working memory may have the greatest efficacy in terms of isolating potential biomarker regions in the brain related to the degeneration of complex language processing due to injuries.

E15

THE S.M. STORY: EPISODIC, BUT NOT SEMANTIC, AUTOBIOGRAPHICAL MEMORY IMPAIRMENT IN A HEALTHY PERSON Daniela Palombo^{1,2}, Allison Mackey², Hedvig Söderlund², Namita Kumar², Brian Levine^{1,2}; ¹University of Toronto, ²Rotman Research Institute – We report the case of S.M., a healthy woman who is unable to re-experience her past. S.M.'s development was normal, with no evidence of trauma, psychiatric history or brain injury. Autobiographical memory tests revealed dysfunction of episodic memory (re-experiencing of events), while semantic memory (factual information) was well preserved. Importantly, S.M. did not show any other cognitive deficits, with normal performance on standardized neuropsychological tests. Structural MRI revealed volume loss in a number of brain regions, including extra-hippocampal medial temporal lobe (MTL) structures (i.e., perirhinal and entorhinal cortices). During functional MRI of autobiographical memory retrieval, S.M. showed reduced activation relative to control participants in midline frontal regions and the MTL. These regions have been consistently identified as part of the autobiographical memory network. We also collected event-related potential (ERP) measures of recognition memory. Previous research has shown that ERPs can be used to topographically dissociate recollection and familiarity. Recollection is closely tied to episodic memory, whereas familiarity is thought to be an expression of semantic memory. In the present study, S.M. did not show the ERP index associated with recollection, whereas control participants reliably did. By contrast the ERP index of familiarity, was found in both S.M. and control participants. These data provide support for a dissociation between episodic and semantic memory systems. Further, to our knowledge, S.M. is the first reported case of a healthy person to show an episodic memory deficit and, as such, is of great significance in our understanding of the neural correlates of memory.

Memory: Memory systems

E16

AGE-RELATED CHANGES OF ITEM AND SOURCE MEMORY FOR EMOTIONAL FACES: EVENT-RELATED POTENTIAL EVIDENCE Maria Gruno¹, Sophia Wilhelm¹, Katja Werheid¹, Norbert Kathmann¹; ¹Institute of Psychology, Humboldt Universität zu Berlin, Berlin, Germany – Negative emotion boosts episodic memory. However, it is still debated whether negative emotion enhances memory for the central event (item memory) or memory for its contextual details (source memory) and how aging influences the emotion memory coupling. The present study used event-related potentials (ERP) to examine the impact of emotion and age on retrieval processes underlying item and source memory. Young (n = 18; mean age = 25) and older adults (n = 18; mean age = 67) studied negative and neutral faces along with context information. In a later recognition test they were asked to classify faces as studied or non-studied and assign them to their proper context. Results showed enhanced source memory for negative faces in both age groups, despite generally reduced memory performance in the elderly. ERP correlates of

source memory were reduced in older compared to younger adults. Moreover, the effects of negative emotion on item and source memory varied as a function of age as reflected in the ERP old/new effects. Thus, these findings suggest that aging affects the action point of negative emotion on source memory.

E17

NEURAL DYNAMICS OF CONTROLLING CONFLICT FROM INTERFERING REPRESENTATIONS DURING LONG-TERM MEMORY RETRIEVAL Patrick Khader¹, Kerstin Jost¹, Frank Rösler¹; ¹Experimental and Biological Psychology, Philipps-University Marburg, Germany – Psychobiological research on long-term memory (LTM) representations primarily focused on brain structures where information is consolidated and reactivated, but paid less attention to processes that control memory retrieval by amplifying relevant and suppressing interfering information. Therefore, we developed an experimental paradigm suited to evoke conflicts between LTM representations. During an acquisition phase words became associated to either a face stimulus, a spatial position, or to both. During recall participants had to decide whether two words are linked to each other via a common association. Prior to every block of six trials a cue indicated the to-be-compared material type. Retrieval conflict arose when the words were associated with two material types, but only one was task-relevant. In an EEG and an fMRI study with the same participants we were able to detect co-activation of the irrelevant associations on a behavioral and neurophysiological level. First, response times were prolonged when irrelevant associations had to be suppressed. Second, the topography of event-related slow potentials differed in a material-specific way depending on the type of irrelevant information. Finally, material-specific fMRI activations were found for the irrelevant material type in posterior brain areas that are assumed to house the representations of positions and faces. In addition to the posterior differences stronger fMRI activation was found in the left prefrontal cortex during conflict trials, suggesting a role of this region for control processes that serve to solve conflict and interference during LTM retrieval.

E18

IMPLICIT SWITCH TO MEMORY RETRIEVAL: A CORTICAL TOOL FOR BOOSTING PERCEPTION Mor Nahum¹, Luba Daikhin^{2,3}, Yedida Lubin⁴, Yamit Cohen³, Merav Ahissar^{1,2}; ¹Interdisciplinary Center for Neural Computation (ICNC), Hebrew University, Jerusalem, Israel, ²Hebrew University, Psychology, Jerusalem, Israel, ³Institute of Medical Sciences, Hadassah Medical School, Hebrew University, Jerusalem, Israel, ⁴Hebrew University, Cognitive Science, Jerusalem, Israel – One of the hallmarks of human perception is our remarkable discrimination ability: numerous studies documented very fine resolution along basic physical dimensions, when two stimuli are compared, with best resolution typically achieved when one of the stimuli is consistently repeated across trials ("reference"). Here we tried to decipher whether this resolution indeed reflects accurate comparison mechanisms, as commonly assumed. We measured subjects' behavioral thresholds and ERPs, while they performed a two-tone frequency discrimination task under different protocols, with the reference stimulus either having a fixed temporal position (first or second), alternating between positions, or eliminated altogether. We found that the advantage of the temporally-consistent reference protocols was quickly obtained, following only a few trials, and resulted in more than a three-fold advantage in thresholds over the no-reference protocol. Although subjects reported comparing the two tones, their ERPs showed that a decision wave (the P3) always followed the informative, non-reference interval, even when it preceded the reference. When the reference alternated between intervals, thresholds (and corresponding P3) were as good only for the reference in the initial interval, indicating that the mere presence of a reference does not suffice. We conclude that best resolution is achieved quickly and implicitly, but only when online comparisons are avoided and replaced with memory-based tagging. Our perceptual system attempts to perform this switch to memory retrieval,

yet cannot track simple temporal structures that boost performance. Such conditions reveal simple heuristics for detecting stimulus consistencies which are necessary for replacing online comparisons with stimulus-response tagging.

E19**SUBSEQUENT MEMORY EFFECTS PREDICTIVE OF SUCCESSFUL CUED RECALL ARE SENSITIVE TO STUDY TASK** Lauren J.

Gottlieb¹, Michael D. Rugg¹; ¹Center for the Neurobiology of Learning and Memory, and Neurobiology and Behavior, University of California at Irvine – Several studies have demonstrated that encoding-related activity (subsequent memory effects) predictive of successful recognition memory is sensitive to the nature of the study task. However, it is not yet known whether subsequent memory effects predictive of successful cued recall are similarly task-sensitive. The present fMRI study addressed this issue by contrasting the subsequent memory effects associated with successful versus unsuccessful cued recall for items encoded in two study tasks previously shown to generate dissociable effects for recognition. Subjects studied words presented in the context of either a semantic (pleasant/unpleasant decision) or a syllabic (odd/even number of syllables) study task. In the subsequent memory test, subjects used three-letter word stems to attempt to recollect the studied words, completing the stems with the first word to come to mind if recollection failed. They were further required to explicitly endorse each completion as 'old' or 'new'. Subsequent memory effects were estimated for study words associated with successful versus unsuccessful recollection on the recall test. Effects unique to the semantic task were identified in left ventromedial prefrontal cortex and right hippocampus. By contrast, syllabic subsequent memory effects were found bilaterally in posterior cingulate cortex. These findings extend prior observations of task-selective subsequent memory effects to cued recall, and add weight to the proposal that episodic encoding of a stimulus event is supported by enhanced activity in cortical regions engaged during the on-line processing of the event.

E20**ERP CORRELATES OF SOURCE MEMORY: UNITIZED SOURCE INFORMATION INCREASES FAMILIARITY-BASED RETRIEVAL** Rachel A. Diana¹, Wijnand Van den Boom², Andrew P. Yonelinas¹, Charan Ranganath¹; ¹University of California, Davis, ²Leiden University – Performance on tests of source memory is typically based on recollection of contextual information associated with an item. Receiver operating characteristic (ROC) analyses have indicated that unitization of item and source information, defined as encoding of source information as a detail of the item being processed, may increase the role of familiarity in source memory (Diana, Yonelinas, & Ranganath, 2008, *Journal of Experimental Psychology: Learning, Memory, & Cognition*). However, the interpretation of ROC analyses is controversial. To assess converging evidence, we conducted an event-related potential (ERP) study testing the hypothesis that unitization leads to contributions from qualitatively different recognition processes in source memory. Participants studied associations between words and background colors either in a unitized manner ("Imagine this item being red/green") or in a nonunitized manner ("Imagine this item associated with a stop sign/dollar bill"). ERPs were recorded while participants were given a source memory test in which they were shown each studied item and asked to make a confidence judgment about whether it was studied with a red or green background. ERP results revealed two topographically and temporally distinct neural correlates of source recognition, one that was associated with familiarity-based source memory in the unitized condition only and another that was associated with recollection-based source memory in both the unitized and nonunitized conditions. These findings converge with the ROC analyses, indicating that familiarity can contribute to source recognition when item and source information are unitized.
E21**NEURAL CORRELATES OF VISUAL MEMORY FOR SPATIAL AND NON-SPATIAL MATERIALS IN AN OBJECTIVE MANIPULATION PARADIGM** Dorian Pustina^{1,2}, Boris Suchan¹, Irene Daum^{1,2}; ¹Institute of Cognitive Neuroscience, Ruhr-University Bochum, Germany, ²International Graduate School of Neuroscience, Bochum, Germany – Previous research has suggested a dual process model of human memory. In behavioural terms subjects exhibit a graded range of memory confidence for the memorized items, which is used to estimate "familiarity" and "recollection" through receiver operating characteristic curves (ROCs). In our paradigm we present morphed stimuli similar to targets in controlled steps of 0% (identical), 20%, 40% or 60% different. By manipulating the stimuli we introduce an objective experimental manipulation which is shown to affect linearly the memory performance. Neural correlates of such manipulation are investigated with magnetic resonance imaging (fMRI) and event related potentials (ERPs). Faces and scenes constitute two types of material under investigation. The classical comparison of Hits vs. Correct Rejections (CRs) is expanded to include Hits0%, Hits20% and Hits40%. There is no difference in Hits for scenes, while the classical dissociation of CRs vs. Hits is significant from N400 to later components. The relation of ERP components to memory performance is thus independent of visual morphing and visual priming doesn't seem to affect ERPs. Face stimuli exhibit a more complex pattern still under investigation. The fMRI results show a preliminary pattern of linear activation of the right hippocampus and bilateral posterior cingulate for scenes, and left hippocampus and left fusiform face area for faces. The behavioural results show a gradual shift both in familiarity and recollection estimates for each morphing step. The existence of a recollection process even at low memory rates is discussed along with physiologic evidence from ERPs and fMRI.

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E22**NEURAL ACTIVATION IN SEMANTIC, EPISODIC AND AUTOBIOGRAPHICAL MEMORY RETRIEVAL IN YOUNG AND OLDER ADULTS** Marie St-Laurent^{1,2}, Hana Burianova^{2,3}, Cheryl Grady^{2,3}; ¹Toronto Western Research Institute, Toronto, Ontario, CA, ²University of Toronto, Psychology, Ontario, CA, ³Rotman Research Institute, Baycrest, Toronto, Ontario, CA – Our goal was to assess the effects of healthy aging on the neural correlates of declarative memory retrieval. Young (age = 21-31) and older adults (age = 63-77) were tested on a functional magnetic resonance imaging paradigm designed to contrast the neural correlates of autobiographical (i.e. personal events), episodic (i.e. events presented in the laboratory) and semantic memory (i.e. general knowledge) retrieval. Memory was cued by a pictorial stimulus, and retrieval demand was manipulated to extract one of the three memory types. A Spatial Temporal Partial Least Square (ST-PLS) analysis was conducted on data from both age groups to identify the patterns of brain activity that best characterized the different task conditions. Brain regions including the left inferior and middle frontal gyri, the thalamus, and the right temporo-parietal junction were activated by all three memory conditions in both groups, although younger adults had more activity than older adults for autobiographical memory. An additional pattern of activity was found in both groups that included activation of the precuneus and the inferior and medial prefrontal cortex for autobiographical, and temporal poles and occipital regions for semantic memory. Activity in these regions differentiated the conditions to a greater degree in young adults. These results suggest that networks recruited during declarative memory may not change markedly with age but degree of activation in these areas is reduced, consistent with less differentiation of function in older adults.

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E23**THE ROLE OF FAMILIARITY AND RECOLLECTION IN FAME JUDGEMENTS: A RECEIVER OPERATING CHARACTERISTICS (ROC) ANALYSIS** Ben Bowles¹, Melissa Gordon¹, Stefan Köhler¹; ¹University of Western Ontario, Psychology – Recognition memory is supported by two processes, recollection and familiarity. Recollection pro-

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vokes recall of contextual detail with respect to a prior episode, and familiarity signals a sense of prior occurrence in the absence of such recall. The experimental study of familiarity and recollection is typically based on the study-test paradigm, in which subjects are required to reference a specific study session when making their recognition judgments. An influential view is that the assessment of familiarity is supported by a signal-detection process whereas recollection relies on a high-threshold discrimination process. Here, we ask whether familiarity and recollection also operate according to these principles when recognition demands lack a discrete reference to any particular study episode. In two experiments, subjects discriminated between famous and non-famous names, and indicated their confidence for each decision. Subsequently, the basis of their fame decisions was probed by examining the availability of specific recollections and of semantic knowledge. ROC analyses showed that recognition of famous names is largely supported by a high-threshold process. This was true even when responses associated with available recollections were excluded from the analysis. To the extent that these memory decisions reflect recognition of prior occurrence without recollection our finding suggests that familiarity contributes to name recognition in a high-threshold manner. Additional analyses revealed that this high-threshold process is closely linked to the availability of semantic knowledge. This suggests that generation of semantic knowledge may contribute to name recognition in a way similar to that of recollection in the typical study-test paradigm.

E24

CONTRIBUTIONS OF THE PERIRHINAL CORTEX TO ASSOCIATIVE MEMORY FORMATION *Bernhard Staresina¹, Lila Davachi^{1,2}; ¹New York University, Psychology, ²Center for Neural Science, New York University* – Many neuroimaging studies using the subsequent memory paradigm have consistently reported a role of the human perirhinal cortex (PrC) in non-associative item encoding. More recently, however, evidence has been accumulating that certain types of associations recruit PrC encoding operations. In particular, PrC activation has been found to correlate with the associative binding of item-related details (Staresina and Davachi, 2006; 2008) and the formation of a unitized representation from two separate elements (Haskins et al., 2008). What is the exact function of PrC engagement during associative encoding, and how does it interact with hippocampal binding operations? One possible mechanism by which PrC contributes to associative encoding is by creating and/or maintaining an item representation from separate constituents, which may then be further processed by the hippocampus. In this fMRI study, we presented objects and a to-be-associated color in three different ways: While the object was always surrounded by a color square, the object itself was presented either intact or scrambled into two or four pieces. Thus, in order to bind the same color detail to the object, the object had to be assembled and maintained in the scrambled condition. Preliminary data from 10 subjects reveal hippocampal, but not PrC, activation correlating with successful binding of the color to intact object representations. Critically, however, for scrambled object presentations, both PrC and the hippocampus appear to correlate with successful object/color binding. This may suggest that the PrC is needed to establish and maintain item representations while the hippocampus effectively binds associated details.

E25

HIPPOCAMPAL CONTRIBUTIONS EXTEND BEYOND LONG TERM MEMORY TO INCLUDE ON-LINE PROCESSING *David Warren¹, Unni Jensen², Aashesh Verma¹, Melissa Duff², Daniel Tranel², Neal Cohen¹; ¹Beckman Institute, University of Illinois at Urbana-Champaign, ²University of Iowa Carver College of Medicine, Neurology* – The current research examines the possibility that the medial temporal lobes (MTL), and more specifically the hippocampus, may be involved in aspects of memory critical for processing of certain kinds of information across very brief intervals, perhaps even within the span of processing a single item. Several different experimental paradigms were employed to test the abil-

ity of neurological patients with hippocampal damage to generate and maintain on-line representations as compared to healthy comparison participants. Among the stimuli we used were fragmented outlines of familiar objects presented either simultaneously or sequentially, overlapping outlines of novel or familiar objects, and fragmented novel and familiar objects. The patients with hippocampal damage were impaired relative to the comparison group on many measures indicating that they may lack the capacity to maintain complex or fragmentary information normally even within the span of working memory. We suggest that the role in memory of the hippocampus extends across timescales and includes the formation and maintenance of on-line representations critical for processing complex objects.

E26

'MATCH' AND 'MISMATCH' SIGNALS IN THE HUMAN HIPPOCAMPUS: A HIGH-RESOLUTION FMRI STUDY *Katherine Duncan¹, Nicholas Ketz¹, Lila Davachi^{1,2}; ¹New York University, Psychology, ²New York University, Center for Neural Science* – Although it is well established that the hippocampus is involved in both the formation and retrieval of episodic memories, the mechanisms by which it performs these functions are still poorly understood. The degree to which an environment matches previous experience has been found to modulate the response of hippocampal neurons (Lee, 2004). These results are in line with computational models predicting that hippocampal subfields will switch between encoding and recall states depending on the degree of 'match' and 'mismatch' between cues and stored representations (Hasselmo, 1995). We sought to examine the role of different human hippocampal subfields in 'match' and 'mismatch' signals and to further explore the nature of these signals. Using fMRI at conventional resolution, we recently found that 'match' signals in the human hippocampus reflected matches to goal states while 'mismatch' signals were driven by salient perceptual changes (Duncan, in press). The current study uses high-resolution (1.5 x 1.5 x 2mm voxels) fMRI to investigate the contributions of different hippocampal subfields to these complementary signals while further investigating their links to intentional states. To this end, we modulated the number of relational and item changes made to previously studied scenes. Subjects performed two memory tasks while undergoing functional scanning, one based on relational changes and one based on item changes, while ignoring changes to the irrelevant dimension. Preliminary imaging results from ten subjects provides evidence for both 'match' and 'mismatch' signals throughout the hippocampus, but also suggests that the predominate type of signal differs across hippocampal subfields.

E27

THE IMPACT OF DISTRACTION DURING LONG-TERM MEMORY RETRIEVAL *Peter Wais¹, Adam Gazzaley¹; ¹University of California, San Francisco* – Episodic memory depends upon the retrieval of contextual information that is associated with a specific prior experience. This recall process can be conceived as mental time travel (Tulving, 1985) and as involving mental imagery for a detailed reconstruction of the event from one's past (O'Craven & Kanwisher, 2000). Interference from environmental stimuli can disrupt the mental imagery evoked during recall and, consequently, diminish the fidelity of episodic memory. In our experiment, we tested the hypothesis that visual distraction diminishes recall performance. Participants studied pictures that contained one to four images of a common object and then, after a delay, were probed with auditory cues that either matched a study object or were lures. Participants' recall of the number of study objects was tested in three alternate conditions: eyes held shut (SHUT); eyes open with constant gaze at a solid gray screen; and eyes open with constant gaze at a visual distractor (VD). The behavioral results show that the VD condition was accompanied by reduced recall in comparison to the SHUT condition and, therefore, that recall performance suffers when irrelevant stimulation is not ignored. fMRI data will be presented to explore the hypothesis that interference with mental imagery during recall is diminished by cognitive control processes that

suppress the bottom-up influence from environmental distraction (i.e., top-down modulation).

E28

THE ROLE OF THE INFERIOR PARIETAL LOBULE DURING INCIDENTAL RETRIEVAL Pamela Perschler¹, Reza Habib¹; ¹*Southern Illinois University, Carbondale* – Most prior research on the role of the inferior parietal lobe (IPL) in episodic memory has focused on intentional retrieval tasks (i.e. recall, recognition). The goal of the present study was to determine, with fMRI, whether activity in the IPL was modulated by stimulus familiarity during an incidental retrieval task. Subjects were scanned while incidentally encoding novel and repeated picture-word associations. Repeated associations were scanned on their second, fourth, and eighth presentation. On half of the repeated trials, the word associated with each picture was replaced with a new word at the time of scanning, resulting in repeated-intact and repeated-new conditions. Relative to novel associations, repeated associations activated bilateral IPL. In addition, activity in the left IPL increased linearly as a function of repetition ($8 > 4 > 2$) in the repeated-intact but not repeated-new condition. In addition to the well-established role of the IPL during intentional retrieval, these results indicate that activity in the IPL is also enhanced during incidental retrieval (encoding of familiar picture-word associations) and modulated by the relative familiarity of the associative information.

E29

IMPAIRMENT OF SPATIO-SPATIAL ASSOCIATIVE SHORT-TERM MEMORY IN HUMANS WITH HIPPOCAMPAL DAMAGE Carsten Finke¹, Mischa Braun¹, Florian Ostendorf¹, Christoph J. Ploner¹; ¹*Charité - Universitätsmedizin Berlin* – Increasing evidence suggests an involvement of the hippocampal formation in short-term memory. We recently demonstrated that in patients with post-surgical lesions of the right hippocampus short-term memory of visuo-spatial associations is impaired, while short-term memory of non-associative spatial and visual information is normal. Here, we investigated whether this finding reflects a special role of the human hippocampus for processing of spatial associations in general or its specialization for processing of between-domain associations involving spatial information. Patients with post-surgical lesions of the right hippocampal formation performed memory-guided saccade paradigms (5-s delay) where the memory-cue was presented simultaneously with a spatial reference with unpredictable spatial relationship to the cue. Three variants were tested, requiring either (1) non-associative memory only, (2) non-associative or associative memory, or (3) associative memory only. In contrast to previous ("allocentric") memory tasks, all tasks were purely spatial and did not require the integration of visual and spatial information into a map-like representation of the stimuli. Compared to controls, patients showed a selective impairment in task (3), while performance in tasks (1) and (2) was intact. These results suggest that the right hippocampal formation is particularly involved in spatial associative memory at short delays, even for simple and purely spatial associations. Furthermore, the data provide evidence that non-associative memory can sufficiently compensate for impaired associative memory in situations that allow for both memory strategies. We suggest that the observed deficits may significantly contribute to impaired short-term memory of more complex visuo-spatial material in humans with hippocampal damage.

E30

BEHAVIORAL EVIDENCE FOR COMPETITION BETWEEN PROCEDURAL-LEARNING AND EXPLICIT-RULE CATEGORY LEARNING SYSTEMS Matthew J. Crossley¹, Amy E. Hadden¹, F. Gregory Ashby¹; ¹*University of California, Santa Barbara* – There is now overwhelming evidence that human category learning is mediated by multiple systems. Much evidence suggests that one system relies on procedural-learning and one system learns to apply explicit rules. Although many studies have reported evidence for separate systems, almost no research has been directed at the question of how these differ-

ent systems interact. In fact, the only evidence on this issue appears to come from neuroimaging studies that have reported negative correlations between task-related activation in the striatum and medial temporal lobes. This result has been interpreted as support for inhibitory or competitive interaction between procedural-learning and explicit-rule systems. To our knowledge, however, no behavioral data address this question. Two experiments are reported that provide strong behavioral evidence for system competition. Both experiments used hybrid categories in which optimal responding required participants to use explicit rules for some stimuli and procedural learning for others. In Experiment 1, participants inappropriately used simple one-dimensional explicit rules on all stimuli. In Experiment 2, participants first trained on either the procedural-learning rule that they needed to use on some hybrid categorization trials or on the explicit rule they needed to apply on the other hybrid categorization trials. Following this training period, they then all transferred to the hybrid category structures. Despite this difference in initial training, both groups failed to use hybrid strategies on transfer. Thus, it appears that use of an explicit rule on some trials inhibits the use of procedural-learning strategies on other trials.

E31

PATTERNS OF REMOTE MEMORY IMPAIRMENT IN PATIENTS WITH FOCAL HIPPOCAMPAL AND MORE WIDESPREAD TEMPORAL LOBE DAMAGE Peter Bright¹, Michael Kopelman²; ¹*Anglia Ruskin University, Cambridge, UK*, ²*Kings College, London, UK* – Objectives and Methods: There is considerable controversy concerning the theoretical basis of retrograde amnesia. We compared medial temporal, medial plus lateral temporal, and frontal lesion patients on a new autobiographical memory task and measures of the more semantic aspects of memory. We also present a more detailed analysis comparing individual patients with quantified pathology restricted to specific critical brain structures. Additionally, we employed a range of methods for coding elicited memories to ensure that we successfully differentiated episodic from semantic detail. Results: Only those patients with damage extending beyond medial temporal cortex into lateral temporal regions showed severe impairment on free recall remote memory tasks, and this held for both the autobiographical and more semantic memory tests. We found no clear evidence for remote memory impairment in the frontal group on any test. These findings, in the context of our further detailed analysis of individual cases, raise the possibility that, although medial and temporal regions may form part of a distributed neural network subserving memory retrieval, damage needs to be quite extensive and exceed a certain critical volume before a significant remote memory impairment can be observed. Conclusions: Across all memory coding methods, our results were more consistent with consolidation theory than multiple trace theory. Nevertheless, the findings indicate a more complex characterization of long term consolidation in which a widely distributed network of regions underlies the retrieval of past memories, within which the extent of lateral temporal involvement is critical to the emergence of a severe remote memory impairment.

E32

A REDUCTION IN SUSTAINED HIPPOCAMPAL ACTIVITY UNDERLIES AGE-RELATED DEFICITS IN THE EPISODIC RICHNESS OF AUTOBIOGRAPHICAL MEMORIES Peggy L. St. Jacques^{1,2}, David C. Rubin², Philip Kragel², Roberto Cabeza^{1,2}; ¹*Center for Cognitive Neuroscience, Duke University*, ²*Psychology and Neuroscience, Duke University* – The retrieval of autobiographical memories (AM), memory for our personal past, is a protracted process that allows for the segregation of the spatiotemporal dynamics of retrieval using fMRI. Understanding the time-course of retrieval has important implications in aging, because older adults might be impaired on later elaboration processes rather than initial search processes. Older adults show a reduction in episodic richness in AMs, but the neural mechanisms underlying this deficit are largely unknown. Thus, the goal of the present fMRI study was to examine the neural bases of age-related reductions in the episodic rich-

ness of AMs. We used a self-paced design in which young and older adults searched for an AM elicited by a generic cue word, pressed a key when one was found, and finally elaborated on the memory until the end of the trial. After scanning, participants described the memories for subsequent objective coding of episodic richness. We predicted that episodic richness of AMs would be attenuated in older adults due to a reduction in hippocampal activity during the elaboration phase. Behavioral results indicated that older adults recalled less episodically rich AMs. Consistent with this, the fMRI results revealed a reduction in the sustained response of the hippocampus during elaboration. Furthermore, episodic richness modulated hippocampal activity during elaboration. In sum, these results suggest that the age-related reduction in the episodic richness of AMs is the result of a deficit during elaboration, when older adults fail to sustain hippocampal activity.

E33

ELECTROPHYSIOLOGICAL DISSOCIATION OF CATEGORY LEARNING MECHANISMS Robert Morrison¹, Paul Reber¹, Ken Paller¹; ¹Northwestern University, Psychology – Behavioral, neuropsychological, and neuroimaging evidence has suggested that categories can often be learned via either explicit mechanisms critically dependent on medial temporal and prefrontal brain regions, or implicit mechanisms relying on the basal ganglia and sensory cortex. In this study we used a visual category-learning paradigm (Maddox, Ashby, & Bohill, 2003) in which subjects learn to categorize Gabor patches based on their spatial frequency (i.e., how striped the patch is) and/or spatial orientation (i.e., the angle of the lines in the patch). These features are systematically combined with respect to decision thresholds to build category distributions that encourage participants to use either explicit rule-based or implicit information integration strategies to categorize stimuli. On each trial participants choose whether the Gabor patch is an "A" or "B" and then receive feedback as to whether they were correct or not; they receive no explicit instruction on how to categorize stimuli. We monitored brain activity with scalp encephalography while participants (1) passively observed Gabor patches, (2) categorized patches from one distribution, and, one week later, (3) categorized patches from another distribution. Behavioral observations of learning were similar across the two learning conditions. Analysis of EEG collected during both categorization and feedback using both event-related potentials and time-frequency methods provided evidence for distinct brain mechanisms supporting rule-based versus implicit information integration category learning. New insights into this distinction can thus be obtained by monitoring relevant neurocognitive processes in real time using these methods.

E34

CATEGORY LEARNING, BINDING, AND THE MEDIAL TEMPORAL LOBE: EVIDENCE FROM EARLY ALZHEIMER'S PATIENTS Jared X. Van Snellenberg¹, Janet Metcalfe¹, Murray Grossman², Edward E. Smith¹; ¹Columbia University, Psychology, ²University of Pennsylvania School of Medicine – Despite considerable impairments in explicit memory, patients with medial temporal lobe (MTL) lesions and patients with Alzheimer's Disease (AD) have been shown to have intact learning in a number of implicit learning paradigms, including category learning, suggesting that implicit learning does not depend on the integrity of the MTL. Recent evidence, however, suggests that the implicitness or explicitness of a learning paradigm may not be the critical determinant of learning in individuals with a compromised MTL. One alternative is that a 'binding' process, in which distinct elements of a stimulus or event become associated in memory, is critically mediated by MTL. In a test of this hypothesis, we showed that AD patients are at chance performance, and significantly worse than control participants, on an implicit two-category learning task that requires binding for successful performance. These results indicate that some forms of implicit category learning are not intact in patients with MTL pathology, suggesting that the MTL subserves a binding process in learning and memory rather than explicit forms of learning per se.

E35**DETAILED DESCRIPTION OF ROUTES TRAVELLED, BUT NOT MAP-LIKE KNOWLEDGE, CORRELATES WITH TESTS OF HIPPOCAMPAL FUNCTION IN OLDER ADULTS** *Marnie*

Hirshhorn^{1,2}, Leorra Newman¹, Morris Moscovitch^{1,2}; ¹University of Toronto, Psychology, ²Rotman Research Institute – We examined hippocampal contribution to remote spatial memory in older adults by correlating their performance on tests sensitive to hippocampal damage with their description of routes they traversed many times or only once, and with their map-like knowledge of downtown Toronto. We found that performance on table-top tests of spatial location (Smith & Milner, 1984) and on paired-associate learning, and the number of Internal Details on the Autobiographical Interview (Levine et al, 2002) all correlated significantly with the number and type of perceptual details used in describing routes one has traversed, but not with map-like knowledge of Toronto. No significant correlations were found with performance on tests of frontal function (WCST, phonemic fluency, backward digit span). We conclude that the hippocampus is implicated in vivid re-experiencing of a familiar route, but not with map-like knowledge of a large-scale environment. These findings are interpreted as consistent with Multiple Trace Theory, but as problematic for Cognitive Map Theory.

E36**HIPPOCAMPAL, PARAHIPPOCAMPAL AND STRIATAL ACTIVITY PREDICTS OBJECT-LOCATION RECALL DURING ACTIVE NAVIGATION** *Oliver Baumann¹, Edgar Chan^{1,2}, Jason B. Mattingley^{1,2}*

¹Queensland Brain Institute, The University of Queensland, ²School of Psychology, The University of Queensland – In humans, hippocampal, parahippocampal and striatal circuits have been implicated in object-location memory and navigation, but it remains unclear how these areas contribute to the distinct processes of encoding and retrieval of object-locations in three-dimensional space. We used event-related fMRI to measure neural responses during active navigation within an immersive virtual environment. Healthy male volunteers were asked to encode the location of a single target object relative to three cylindrical landmarks and, following a delay period, to retrieve that location from memory by navigating back to the target's original position. The relative and absolute locations of landmarks and the target object were changed on every trial, and no feedback on accuracy was provided. Within subjects, activity in the right hippocampus, the parahippocampal gyrus bilaterally, and the striatum was strongly correlated with accuracy in navigating back to the original target location during retrieval. Between subjects, accuracy and consistency of responses during retrieval also correlated significantly with levels of activity in the parahippocampal gyrus and basal ganglia. These results provide the first evidence that purely landmark-related learning is mediated by hippocampal, parahippocampal and striatal systems, even within a single trial and without reinforcement. We suggest that activity in the hippocampus reflects an allocentric place computation, whereas activity in the parahippocampus reflects a perceptual representation of the landmarks. The concurrent activity in the striatum probably reflects a procedural component of the learning and retrieval process.

E37**CONTRIBUTIONS OF PARIETAL CORTEX TO ATTENTION AND MEMORY: DIVERGENT PROCESSES OF VISUAL ATTENTION AND EPISODIC RETRIEVAL** *J. Benjamin Hutchinson¹, Melina R. Uncapher¹, Anthony D. Wagner^{1,2}*

¹Stanford University, Psychology, ²Stanford University, Neuroscience Program – Functional neuroimaging studies of humans engaged in retrieval from episodic memory have revealed a surprisingly consistent pattern of retrieval-related activity in lateral posterior parietal cortex (PPC). Given the well-established role of lateral PPC in subserving goal-directed and reflexive attention, it has been hypothesized that PPC activation during retrieval reflects the recruitment of parietal attention mechanisms during remembering. Here, we evaluate this hypothesis by considering the anatomical overlap of

retrieval and attention effects in lateral PPC. Specifically, we briefly review the literature implicating dorsal PPC in goal-directed attention and ventral PPC in reflexive attention, as well as the pattern of dorsal and ventral PPC activation during episodic retrieval. This assessment revealed that apparently divergent subregions of lateral PPC are engaged during acts of episodic retrieval and during goal-directed and reflexive attention, suggesting that PPC retrieval effects reflect functionally distinct mechanisms from these forms of attention. Consistent with this conclusion, we then discuss the findings from a recent fMRI study of episodic retrieval and goal-directed attention that revealed within-subject divergence between parietal retrieval and attention effects. Although attention must play a role in aspects of retrieval, the data reviewed here suggest that further investigation into the relationship between processes of attention and memory, as well as alternative accounts of PPC contributions to retrieval, is warranted.

E38**NEURAL CORRELATES OF FACE MEMORY AS A FUNCTION OF RACE-BASED ATTENTION AND CATEGORIZATION**

Heather Lucas¹, Joan Chiao^{1,2}, Ken Paller^{2,1}; ¹Northwestern University, Psychology, ²Northwestern University, Interdepartmental Neuroscience Program – Memory for faces from one's own racial group is typically more accurate than memory for faces from another racial group. Recent social-cognitive models suggest an instrumental role of social categorization in this phenomenon. Indeed, neural correlates of attention to social category membership have been identified previously, but the relationship of such measures to recognition memory is unknown. In the present study, event-related potentials were recorded during face encoding and retrieval to examine neural correlates of memory for same-race (SR) and cross-race (CR) faces. CR faces were presented in two conditions that differentially emphasized social-categorical encoding. Faces in the CR1 condition were racially uniform, whereas faces from five racial groups were shown in the CR5 condition such that each face differed in race from the majority of others within the same block. Recognition memory was impaired for both CR conditions compared to the SR condition. Event-related potentials differed between CR faces presented within a homogeneous (CR1) and heterogeneous (CR5) context beginning around 150 ms after face onset, reflecting early attentional biases. Subsequent-memory analyses suggest that these race-sensitive potentials index processing that is particularly relevant for later recognition memory for CR faces. Thus, results provide neural evidence linking markers of social-categorical attention at encoding with memory for cross-race faces. Furthermore, FN400-like potentials at retrieval in the CR5 condition suggest that categorical encoding of faces engenders distinct retrieval-related processing. Results are discussed in terms of social-cognitive influences on face memory and the cognitive and mnemonic processes reflected in race-sensitive brain potentials.

E39**DOES LONG-TERM SEMANTIC PRIMING ACTUALLY REFLECT ANTI-PRIMING?**

Katrina Schleisman¹, Matthew Olson², Kim Ahneman¹, Rachel Ryan¹, Nicole Landi¹, Chad Marsolek¹; ¹University of Minnesota, Minneapolis, MN, ²Macalester College, St. Paul, MN – Our previous work indicates that the visual representation of an object is strengthened via small representational changes after the object is identified. These changes are responsible for both facilitating subsequent identification of that object (repetition priming) and impairing subsequent identification of other objects whose representations are superimposed with the representation of the primed object (antipriming). In this study, we investigate whether antipriming extends beyond visual object processing and can also be observed in semantic processing. We measured both priming and antipriming relative to a baseline condition in a long-term semantic priming paradigm. First, we obtained measures of visual word naming performance that were unaffected by repetition priming or antipriming (baseline word naming). Next, participants heard a new set of words and made like/dislike judgments to them. Finally, participants performed

another visual word naming task in which half of the words were repeated from the preceding phase (to measure repetition priming) and the other half were new words that were unrelated to any words presented previously (to measure antipriming). As expected, repeated words were named faster than new words, but this difference was due to antipriming and not to priming. That is, the antiprimed words were named slower than baseline, while the primed words did not differ from baseline. This suggests that the same principles responsible for visual object antipriming extend to the processing of semantic concepts. Ongoing event-related potential (ERP) investigations will help to clarify the underpinnings of these effects.

E40**CORTICAL REINSTATEMENT DURING RECOLLECTION- AND FAMILIARITY-BASED MEMORY: A MULTI-VOXEL PATTERN ANALYSIS STUDY**

Jeffrey D. Johnson¹, Susan G. Robison McDuff², Michael D. Rugg¹, Kenneth A. Norman²; ¹Neurobiology and Behavior and Center for the Neurobiology of Learning and Memory, University of California, Irvine, ²Psychology and Princeton Neuroscience Institute, Princeton University – Episodic memory retrieval is hypothesized to involve the reactivation (reinstatement) of processing engaged during encoding. Recent fMRI studies have supported the reinstatement hypothesis by demonstrating that the neural correlates of retrieval (recollection) differ according to episodic content, and that content-specific retrieval effects overlap with analogous effects observed during encoding. It remains unclear, however, whether cortical reinstatement is restricted to instances where subjects report recollection of episodic details, or if it also occurs when responses are reportedly based on familiarity. The present study (N=16) used fMRI and multi-voxel pattern analysis (MVPA) to investigate the relationship between reinstatement, recollection, and familiarity. Subjects studied words in one of three encoding tasks and then undertook a recognition memory test. The test employed a modified remember/know procedure, in which subjects designated items as either recollected, or if not recollected, rated the confidence that words were old vs. new using a 4-point scale. fMRI data from the study phase were used to train a pattern classifier to discriminate between patterns of brain activity associated with the three encoding tasks. The classifier was then tested on fMRI data from the test phase to determine the degree to which the encoding-related activity patterns were reinstated. Reinstatement was evident for words that were given remember responses and, in addition, for words judged to be highly familiar, with stronger reinstatement effects observed in the former case. The findings indicate that although reinstatement of encoding-related activity may be necessary for the subjective experience of recollection, it is not sufficient.

E41**FUNCTIONAL MR ACTIVATION DURING ENCODING FOR SUBSEQUENTLY PRIMED CONCEPTUAL AND PERCEPTUAL ITEMS**

Wei-chun Wang¹, Charan Ranganath¹, Andrew P. Yonelinas¹; ¹University of California, Davis – Does conceptual implicit memory rely on regions within the medial temporal lobe? Although previous research has indicated that encoding related activity in the perirhinal cortex is predictive of subsequent familiarity-based recognition, few studies have specifically explored whether this region contributes to implicit memory at encoding. Neuroimaging and behavioral evidence indicates that familiarity-based explicit memory and perceptually-driven implicit memory may be dissociable, but familiarity and conceptual implicit memory are sensitive to the same kinds of manipulations. Mildly hypoxic amnesic patients that are expected to have relatively restricted hippocampal damage exhibit normal levels of familiarity and conceptual priming, while patients with extensive left hemisphere medial temporal lobe damage including the hippocampus as well as the surrounding perirhinal and parahippocampal cortex show significant deficits in both familiarity and conceptual priming. Moreover, to date no study has specifically examined the neural substrates of conceptual implicit memory at encoding. In the current study, we conducted an event-related functional magnetic

resonance imaging study to examine the neural correlates of conceptual and perceptual priming, in order to test the hypothesis that the perirhinal cortex plays a critical role in conceptual implicit memory. Healthy young adult participants were scanned as they completed a pleasantness rating task. After scanning, they completed conceptual (i.e., category exemplar generation) and perceptual (i.e., word fragment completion) implicit memory tasks. Preliminary analyses revealed medial temporal lobe recruitment during the rating task, and that encoding activity leading to successful conceptual priming could be dissociated from encoding activity leading to perceptual priming.

E42

THE HIGH QUALITY OF VISUAL MEMORY Ilja G. Sligte¹, H. Steven Scholte¹, Victor A.F. Lamme^{1,2}; ¹Cognitive Neuroscience Group, Psychology, University of Amsterdam, ²Netherlands Institute for Neuroscience, part of the Royal Netherlands Academy of Arts and Sciences (KNAW) – While we experience a rich and detailed world, we can only represent a few objects in visual short-term memory (VSTM). Based on these observations, many authors have suggested that our mental representations of the world are sparse and lack quality. Here, we test this claim by inspecting the representational quality of iconic memory, VSTM and a recently discovered form of visual memory that lies intermediate of iconic memory and VSTM both in terms of life-time (up to four seconds) and capacity (up to 16 objects). We used a variant of the delayed matching-to-sample paradigm that can measure these three forms of visual memory (Sligte et al., 2008). In the basic design, subjects have to detect changes between sample and match displays across a brief retention interval and changes occur in 50 percent of the trials. After each change trial, we presented an identification display that contained the object present in the sample display, but not in the match display (so-called pre-change item) among three distracter items. On the assumption that high-quality representations support both change detection and identification of the pre-change item, we found that people could represent six high-quality representations in iconic memory, three and a half high-quality representations in the intermediate store and only one high-quality representation in VSTM. This clearly suggests that people build up a much richer internal picture than is evident from VSTM alone and people can access these additional rich mental representations when they direct attention to them.

E43

THE DEVELOPMENT OF NEW CONCEPTS IN THE ADULT BRAIN Rasha Abdel Rahman¹, Kerstin Unger¹; ¹Humboldt-University Berlin, Psychology – The formation of conceptual representations in the adult brain was tracked with event-related brain potentials in a multi-step learning procedure, in analogy to the incremental enrichment of the semantic system in children. Adult participants were confronted with pictures of initially unfamiliar objects and received gradually increasing functional information about the objects in consecutive sessions. Each session was followed by a test block in which the newly learned objects were presented randomly alternating with well-known objects. Gradual concept development was investigated with different semantic and non-semantic tasks. Initially, electrophysiological parameters associated with newly learned and well-known objects were markedly different in amplitude and distribution across tasks. The cumulative enrichment of object concepts was associated with gradually decreasing differences between newly learned and well-known objects until, in the last session, they were indistinguishable. These effects related to the development of new concepts were highly stable over time, as suggested by a follow-up test session six months after learning.

E44

INTENTIONAL FORGETTING AND REMEMBERING OF ANGRY AND NEUTRAL FACES - AN ERP STUDY Johanna Kissler¹, Bastian Zwissler¹, Anne Hauswald¹; ¹University of Konstanz, Psychology – The present study investigated behavioral and electrophysiological mechanisms of intentional forgetting and remembering of faces with angry and neutral expressions using item method directed forgetting. Event-related

potentials (ERPs) were recorded as participants viewed random sequences of angry and neutral faces, each face followed by a cue designating the previous face as 'to-be-remembered' or 'to-be-forgotten'. Results from a subsequent forced choice recognition memory task revealed overall superior recognition memory for angry faces. However, the 'forget' instruction reduced memory for both angry and neutral faces. ERPs revealed the following effects: First, during face presentation a parietal positivity between 450 and 700 ms after picture on-set was more pronounced for angry than for neutral faces. Second, an enhanced frontal positivity between 500 and 700 ms after cue on-set appeared selectively for 'forget' cues following angry faces. Third, a parietal positivity between 400 and 550 ms after cue onset was largest for 'remember' cues following neutral pictures. The results suggest two different processes contributing to the behavioral directed forgetting effects for neutral and angry faces: For angry faces, initial superior encoding during face viewing as evidenced by an enhanced parietal positivity may be attenuated by frontally mediated active suppression during presentation of 'forget' cues. By contrast, for neutral faces primarily selective rehearsal during presentation of remember cues, reflected in an enhanced parietal positivity, appears to contribute to the effect.

E45

BLACK AND WHITE ISSUES: COLOR PERCEPTION AND OBJECT COLOR KNOWLEDGE Nina S. Hsu^{1,2}, Steven M. Frankland^{1,2}, Sharon L. Thompson-Schill^{1,2}; ¹University of Pennsylvania, ²Center for Cognitive Neuroscience, University of Pennsylvania – Various theories of semantic memory suggest that our knowledge about objects is grounded in the same neural substrates responsible for perceiving and acting on those objects. In accordance with this view, color knowledge retrieval has been shown to activate some of the same cortical regions involved in color perception, which are defined as those responding more to chromatic than grayscale stimuli (Simmons et al., 2007). It is unclear, however, whether these regions are also differentially engaged by the retrieval of color knowledge about chromatic and achromatic objects. To address this issue, subjects performed two tasks while undergoing fMRI. First, subjects made lighter/darker judgments on pairs of words that named either chromatic (e.g., BASKETBALL - LEMON) or achromatic objects (e.g., COAL - SNOW). To localize color perceptual regions, subjects saw blocks of the Farnsworth-Munsell 100 hue stimuli in which they judged whether color and grayscale wedges were sequentially ordered. Within those regions responding more to color than to grayscale perceptual stimuli, we compared activation during lighter/darker chromatic judgments to that during achromatic judgments. We report co-localization of chromatic perceptual and chromatic object knowledge retrieval processes in the lingual gyrus. Taken in conjunction with Simmons et al.'s report of co-localization in the anterior fusiform gyrus, our results may help to distinguish between brain regions involved across perceptual and conceptual tasks in hue representation, and those involved in higher-level categorical color processing. This is consistent with a general posterior to anterior, perceptual to categorical, transformation in information representation in ventral occipito-temporal cortices.

E46

ANXIETY MODULATES HIPPOCAMPAL INVOLVEMENT IN CLASSIFICATION LEARNING AND EXPLICIT MEMORY Ajay Satpute^{1,2}, Russell Poldrack¹, Bruce Naliboff¹; ¹University of California, Los Angeles, ²Columbia University – BACKGROUND: Memory is characterized by multiple systems with distinct processing capabilities and neural substrates, broadly characterized into declarative and non-declarative systems. Under some circumstances, these systems have been shown to compete with each other in learning and expressing new skills, and this competition can be modulated by factor such as distraction. AIMS: The present study examined whether anxiety may also modulate the relative engagement of these memory systems. METHODS: Participants engaged in two identical, interleaved probabilistic classification learning tasks

either behaviorally or while undergoing fMRI. One task was completed while under a high state of anticipatory anxiety as induced by threat of shock, and the other was completed under no threat ('safe'). A test probe was administered after learning to index memory-related neural activity, since neural activity in the learning portion is confounded with the anxiety manipulation. RESULTS: Behavioral measures, consisting of performance (percent correct) and explicit awareness- a verbal report measure indicating the extent to which participants had awareness of associations obtained while learning, were correlated with neural activity in hippocampus, but only for the task learned under threat of shock. CONCLUSIONS: These results suggest that anticipatory anxiety may modulate hippocampal memory processes, but that it does not increase the reliance upon nondeclarative memory as suggested by some rodent studies.

E47**A COMBINED DTI AND FMRI ANALYSIS OF THE NEURAL CORRELATES OF IMPLICIT PROBABILISTIC SEQUENCE LEARNING**

Ilana J. Bennett¹, Jessica R. Simon¹, David J. Madden², Chandan J. Vaidya¹, James H. Howard Jr.^{1,3,4}, Darlene V. Howard¹; ¹Georgetown University, Psychology, ²Center for the Study of Aging and Human Development, Duke University Medical Center, ³The Catholic University of America, Psychology, ⁴Georgetown University Medical Center, Neurology – Implicit probabilistic sequence learning involves distributed neural substrates, including fronto-striatal and possibly medial temporal lobe (MTL) networks. Integrity of white matter connecting these networks may mediate relationships between functional activation and learning. To test this hypothesis, 10 younger adults underwent diffusion tensor imaging (DTI) and three runs of functional magnetic resonance imaging (fMRI) while performing the Triplets Learning Task (TLT). In this task, participants respond to the location of the last stimulus (target) in a series of three stimuli, without knowing that the location of the first stimulus predicts one target location on most trials (High Probability) and another location on remaining trials (Low Probability). Correlations were conducted among TLT learning (regression of triplet probability and reaction time), learning-related fMRI activity (regions more active in High minus Low Probability contrast), and white matter tract fractional anisotropy (FA, degree of directionally restricted water diffusivity). Results revealed that early learning (run 1) was negatively correlated with fMRI activity in the hippocampus and later learning (run 3) was positively correlated with caudate and dorsolateral prefrontal cortical (DLPFC) activity. However, there was no evidence that FA mediated the learning-activation relationships. For example, caudate-DLPFC tract FA was marginally negatively correlated with later DLPFC activity, but it was not correlated with later learning. Instead, caudate-DLPFC tract FA was negatively correlated with learning in run 1, possibly indicating that fronto-striatal integrity interferes with early learning, which was functionally correlated with MTL activity. In general, findings revealed complex interactions between the structure and function of these distinct networks.

Memory: Working memory**E48****RELATIONSHIP BETWEEN INDIVIDUAL DIFFERENCES IN SPATIAL AND WORKING MEMORY AND CORTICAL ACTIVATION DURING A DECEPTIVE TASK: AN FMRI STUDY**

Scott W. Meek¹, Michelle C. Phillips¹, Laura Bradshaw-Baucom¹, Jennifer M. C. Vendemia¹; ¹University of South Carolina – Individual differences in working memory performance on prefrontal cortical activation during a deception task was studied in 21 participants (M=20.7). Reaction time studies have shown that working memory capacity has a significant effect on deceptive response times (Vendemia, Buzan, & Simon-Dack, 2005). Working memory has been associated with prefrontal cortical activation in the literature (Rypma, Berger, & D'Esposito, 2002). Baddeley's

model of working memory includes a central executive, a phonological loop, and a visual spatial sketchpad (Baddeley & Hitch, 1974). We hypothesize that deception is associated with the phonological loop in order to maintain relevant deceptive information in memory. Participants viewed questions in which they were randomly prompted to respond truthfully (20%) or deceptively (80%). Data were collected from two tests of working memory, the verbal recognition memory (VRM) and spatial span (SSP) tasks, found in the CANTAB neuropsychological test battery. Activation scores across deception were analyzed for all participants and then correlated against VRM (M=8.587, SE=0.189) and SSP (M=7.065, SE=0.132) scores. Analysis indicates that participants who deceived to a higher number of trials showed stronger frontal lobe activation when lying than when telling the truth, specifically in the right and left superior and middle frontal gyrus (BA 8 and 46). The data show that greater activation for lying than truth telling when repeatedly deceiving can be explained by individual variations in verbal working memory (p=.007), supporting our hypothesis that the phonological loop is more heavily involved in deception than in truth telling.

E49**NEURAL CORRELATES OF WORKING MEMORY TRAINING IN OLD AGE**

Yvonne Brehmer¹, Helena Westerberg¹, Anna Rieckmann¹, Lars Bäckman¹; ¹Aging Research Center, Karolinska Institute, Stockholm, Sweden – Working memory (WM) is essential for many higher-order cognitive functions and is anatomically related to a widespread fronto-parietal network. WM declines in old age. These WM deficits underlie decline in other cognitive domains (e.g., episodic memory, reasoning) seen in old age. Prior research demonstrates that WM can be improved by intense training in children as well as in younger adults. The aim of the current project is to investigate whether older adults can benefit from intensive WM training, and how the related brain-activity patterns change following training. Twenty-four older adults (M = 63.7) participated in a five-week computerized training study. To test the effectiveness of the WM training program, half of the sample received adaptive training (i.e., individually adjusted task difficulty to bring individuals to their performance maximum), whereas the other half served as active controls (i.e., fixed low-level practice). Individuals' brain activity was measured before and after training with functional magnetic resonance imaging (fMRI), while performing a WM task under two task-difficulty levels. Results indicate that (a) individuals improve their WM performance through training, (b) adaptive training as well as low-level practice result in decreased brain activity in task-relevant regions (frontal, parietal, and temporal), and (c) under the high task-difficulty condition, adaptive training results in larger decreases in right frontal areas compared to the active control group. To conclude, intensive WM training improves older adults' functioning and neural efficiency. However, the advantage of adaptive training is most apparent under high task difficulty conditions.

E50**TEMPORAL DYNAMICS OF RESOURCE ALLOCATION IN VISUAL WORKING MEMORY**

Paul Bays^{1,2}, Nikos Gorgoraptis^{1,2}, Raquel Catalao^{1,2}, Masud Husain^{1,2}; ¹Institute of Cognitive Neuroscience, University College London, UK, ²Institute of Neurology, University College London, UK – Our ability to remember what we have seen is remarkably limited.

A longstanding model of visual working memory states that storage is limited to a fixed number of memory 'slots' - usually four - each holding one visual item. However there has been little investigation of the resolution with which visual information is maintained. Using a discrimination task, we recently probed the precision of subjects' memory for object locations and orientations (Bays & Husain, Science, 2008). We found that precision declines rapidly with increasing number of items, even when this number is well below the proposed limit. Rather than being stored in separate slots, these results suggest there is a common memory resource which must be distributed between visual objects. Allocation of this resource is flexible, so that salient items are stored with enhanced preci-

sion. Here, we probe the temporal dynamics of visual working memory by varying the presentation time of multi-item displays, followed by pattern masks. For very brief exposures (<100ms), we find that recall is limited by incomplete encoding; but at the longest exposures, recall becomes limited by the working memory resources available for each item. Intermediate presentation times reveal the dynamic allocation of visual resources to items in the scene. Accurate recall of an item depends not only on maintaining precise representations of its individual features, but also correctly storing features that belong to the same object together. Further analysis of our data demonstrates that precision and binding independently influence our ability to remember objects in the visual scene.

E51

AGE EFFECTS ON EVENT-RELATED POTENTIAL AND CARDIOVASCULAR PARAMETERS IN A WORKING MEMORY TASK

Sergei A. Schapkin¹, Gabriele Freude¹; ¹Federal Institute for Occupational Safety and Health, Berlin, Germany – Working memory (WM) is considered to be quite susceptible to age (e.g. West, 1996) that may cause problems in older employees who are occupied with complex work requiring WM. Under WM load older employees were hypothesized to involve controlled processing sub-served by frontal lobes to prevent performance decline and that enhanced frontal activity can provoke maladaptive cardiovascular reactions to changing task demands. 21 younger (28±3 years) and 21 older (54±3 years) employees had to perform a visual oddball and n-back tasks. In the 2-back task older employees responded slower and less accurately than younger, while no age effects in oddball task were found. In younger employees the target P3 of the event-related potential was progressively reduced from parietal to frontal sites, while more evenly distributed P3 upon the scalp in older employees was found. P3 latency was shorter in younger than in older employees. Heart rate (HR) was higher, both heart rate variability (HRV) and baroreflex sensitivity (BRS) were lower in older than in younger employees. Older employees showed lower responsivity of BRS, HRV and HR to task demands and delayed cardiovascular recovery as compared to younger employees. The results suggest that WM load in older employees can impair target categorization and lead to compensatory involvement of frontal lobes to enhance controlled processing and mental effort. In turn, the increase in frontal activity can induce maladaptive functioning of cardiovascular system in terms of a reduced responsivity to alternating task demands and a delayed recovery in healthy older employees.

E52

VERBAL WORKING MEMORY MAINTENANCE DEPENDS ON LANGUAGE PRODUCTION SYSTEMS: A FUNCTIONALLY-GUIDED TMS INVESTIGATION

Daniel Acheson¹, Bradley Postle¹; ¹University of Wisconsin - Madison – The emergent-property perspective of working memory (WM) states that the same brain regions involved in long-term processing of different types of information also subserve WM maintenance. Consistent with this view, several recent studies have demonstrated a critical role for the posterior superior temporal gyrus (pSTG), a region that has also been implicated in phonological ordering processes in language production, in verbal WM maintenance. We explored the functional relationship between language production and verbal WM by targeting language production regions with functionally guided repetitive transcranial magnetic stimulation (rTMS). First, functional magnetic resonance imaging (fMRI) was used to elicit activity in pSTG and middle temporal gyrus (MTG), respectively, during two stages of production: phonological ordering and lexical-semantic retrieval. Next, these regions were targeted with rTMS during three tasks: rapid paced reading; picture naming; and delayed serial recall (i.e., verbal WM). We hypothesized that rTMS of pSTG would alter phonological ordering processes, and would thus disrupt both rapid reading and serial recall of nonwords, but would only minimally impact lexical-semantic processes (picture naming); rTMS to the MTG would produce the opposite pattern. The results confirmed the theoretically critical prediction that rTMS applied to the pSTG

increases errors in rapid reading and in delayed serial recall, whereas rTMS to the MTG has no effect on these tasks. Picture naming (the control task) was sensitive to rTMS to both brain regions. Verbal WM maintenance may thus be nothing more than speech production processes (specifically, phonological ordering) "looping" for the duration of the delay period.

E53

PRECISION OF VISUAL WORKING MEMORY FOR SEQUENTIALLY PRESENTED STIMULI

Nikos Gorgoraptis^{1,2}, Paul M Bays^{1,2}, Masud Husain^{1,2}; ¹Institute of Cognitive Neuroscience, ²Institute of Neurology, University College London, UK – Recent work has shown that visual working memory capacity is not fixed by number of items, but rather is a limited resource, flexibly allocated across space (Bays & Husain, Science, 2008). Importantly, these findings emerged when investigators probed the precision with which visual information is maintained, rather than using change detection as an index of memory capacity. Here we investigate the allocation of visual working memory resources across time, using a discrimination rather than change detection task. We assess the precision of subjects' memory for the orientation of sequentially-presented visual stimuli (coloured bars) all displayed at central fixation. Precision is very high for a single item, but decreases as increasing numbers of stimuli are presented after that item. Memory for the intervening items falls with increasing sequence length but importantly delay length itself is not able to account for these effects. When a predictive cue is given for one of the stimuli (62.5% validity), recall for this item is considerably enhanced. Precision for non-cued items shows a corresponding reduction compared to trials where no cue is present. The findings support the concept of a limited resource that can be allocated to maintaining items in working memory. The allocation of this resource is flexible, not only across space but also over time, and can be modulated according to the relevance of stimuli to task goals.

E54

POSTERIOR PARIETAL CORTEX MEDIATES ENCODING PROCESSES IN CHANGE BLINDNESS

Philip Tseng¹, Tzu-Yu Hsu^{2,3,4}, Neil Muggleton⁵, Ovid Tzeng^{2,3,4,6}, Daisy Hung^{2,3,4}, Chi-Hung Juan^{2,3}; ¹University of California, Psychology, Santa Cruz, CA, ²Institute of Cognitive Neuroscience, National Central University, Jhongli, Taiwan, ³Laboratories for Cognitive Neuroscience, National Yang-Ming University, Taipei, Taiwan, ⁴Institute of Neuroscience, National Yang-Ming University, Taipei, Taiwan, ⁵Institute of Cognitive Neuroscience & Psychology, University College London, London, United Kingdom, ⁶Institute of Linguistics, Academia Sinica, Taipei, Taiwan – It is commonly accepted that right posterior parietal cortex (PPC) plays an important role in updating spatial representation, directing visuospatial attention, and planning actions. Recent change blindness studies in combination with functional magnetic resonance imaging (fMRI) and transcranial magnetic stimulation (TMS) techniques from Beck and colleagues (2001 & 2006), however, suggest that right PPC is also a critical component of processes that are "more conscious", such as detecting a change between two pictures (picture A and A') in a change blindness paradigm. The present study seeks to apply TMS in briefer and different time intervals to investigate the process of which the right PPC is involved. Since change detection requires proper encoding of visual features during viewing of picture A and successful comparison between the features during viewing of picture A', we applied TMS pulses either during the presentation of picture A (early TMS) or A' (late TMS) in a one-shot change blindness paradigm in order to selectively disrupt the encoding or comparison processes, respectively. Our results show that right PPC TMS was most effective during the encoding phase, thus suggesting that the right PPC is responsible for encoding visual features into our visual short-term memory. In addition, our change blindness paradigm did not alter any spatial components of the stimuli. Therefore, contrary to the belief that the right PPC is only responsible for the spatial aspect of a stimulus, our results imply that it is also involved in encoding certain identity-based information.

E55**WHEN 'WHAT' IS NEGLECTED BASED ON 'WHERE' IN NEGLECT PATIENTS**

Arnaud Saj^{1,2,3}, Patrik Vuilleumier^{1,2,3},
¹Neuroscience, University of Geneva, ²Center for Neuroscience, University of Geneva, ³University Hospital, Neurology, Geneva – Recent findings in healthy subjects indicate that memory capacity for spatial locations but not colors may increase when the items are separated between the two visual fields, rather than presented within the same hemi-field. This observation suggests some independence between the two hemi-fields for encoding spatial locations. We used a similar task to test patients with right hemispheric brain lesion with or without neglect syndrome. To examine whether a complete independence of the two visual fields can be observed, the squares could appear in two frames from the same hemi-field; or in two frames from different hemi-fields. In the two first experiments, participants indicated whether colors or locations of the squares in the test display were the same as, or different from, the ones in the sample display. In a last experiment, the task was similar to exp 1 but the squares also changed locations (but locations were always task irrelevant). Altogether, our results demonstrate that patients with spatial neglect have impaired spatial working memory capacity for location, whatever the visual field. However, no deficit was found for color capacity unless there was a concomitant change of location in left space. In conclusion, an independence between the two hemi-fields was not present in neglect patients, and their working memory showed selective impairment for location but not color in both fields. The deficits found in exp 3 suggest an inability to code for object properties across different spatial locations which may contribute to exploratory deficits spatial, typically observed in right-brain-damaged patients with spatial neglect.

E56**WORKING MEMORY CAPACITY AND INHIBITION IN AX-CPT**

Yukio Tsuchida¹, Harumitsu Murohashi²; ¹Graduate School of Education, Hokkaido University, ²Faculty of Education, Hokkaido University – Individual differences in working memory capacity (WMC) reflect the ability to control attention. This ability is related to response inhibition as a Stroop task, meanwhile is not related to simple response inhibition as a stop-signal task. We examined the relationship between two types of response inhibition and individual differences in WMC by ERPs. Participants were low- and high-WMC group assessed in a reading span test. We used an AX-CPT paradigm that consisted of cue and probe pairs. The probability of A-X trial was 70%, other trials (A-nonX, nonA-X, and nonA-nonX) was 10%, respectively. In the no-go condition (simple response inhibition), participant was asked to press a button when X followed A. In the 2-choice condition (response inhibition and selection), participant was asked to press one button when X followed A, and another button for all other letters. P300 amplitude for the cue in both conditions was larger for the high-WMC group than for the low-WMC group. However, there was no difference in P300 amplitude for all probes. N200 amplitude for the A-nonX probe in the 2-choice condition was larger in the low-WMC group than in the high-WMC group. There was no difference in N200 amplitude for other probes. These results suggest that response inhibition per se was not related to WMC. Rather, WMC is related to the ability to maintain an appropriate state of readiness based on the processing of cue information. Therefore, the enhanced N200 amplitude in the low-WMC group may suggest a deficiency of appropriate readiness.

E57**SEARCHING FOR TARGETS WITHIN VISUAL SHORT-TERM MEMORY**

Bo-Cheng Kuo^{1,2}, Anling Rao¹, Jöran Lepsien³, Anna Christina Nobre¹; ¹Experimental Psychology, University of Oxford, UK, ²National Taiwan University, Psychology, Taipei, Taiwan, ³Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany – Recent studies have revealed that the internal representations that we construct from the environment and maintain in visual short-term memory (VSTM) to guide behavior are highly flexible, and can be selectively modulated and accessed by attentional mechanisms according to our task goals and

expectations. However, how these attentional mechanisms operate upon VSTM representations is largely unknown. In the current experiment, we investigated whether VSTM representations contain an intrinsic spatial layout that is related to that in the perceptual array from which it is constructed; and tested whether searching for relevant target items from within VSTM representations involves spatially specific, retinotopic biasing of neural activity in a manner analogous to that which occurs during visual search for target items in perceptual arrays. Two ERP experiments revealed that selection of a target object within a search array maintained in VSTM proceeds through similar mechanism as that in the perceptual domain. In line with previous results, an N2pc potential was obtained when targets were identified within a perceptual visual-search array. Interestingly, a similar N2pc was also elicited when target items were identified within a VSTM representation. The N2pc in the visual and VSTM domains had equivalent time-courses and topographies, suggesting a large degree of overlap in the spatially specific neural mechanisms of target selection in the two cases.

E58**ANXIETY MODULATES NEURAL EFFICIENCY OF PROCESSING IN WORKING MEMORY**

Ulrike Basten^{1,2,3}, Christine Stelzel^{1,2,3}, Christian J. Fiebach^{1,2,3}; ¹University of Heidelberg, Psychology, Germany, ²University of Heidelberg, Neuroradiology, Germany, ³University of Heidelberg, Neurology, Germany – It has been postulated that anxiety impairs the efficiency of performance in cognitive tasks, specifically in tasks requiring the processing of information in working memory (WM) as opposed to pure WM maintenance. In comparison to non-anxious individuals, it is assumed that anxious individuals reach a given level of performance only by the investment of additional effort, which makes processing less efficient. In the present study, we used functional magnetic resonance imaging (fMRI) to explore how state anxiety is associated with neural efficiency, measuring BOLD activation in tasks addressing different processing functions of WM, i.e. monitoring, updating, and manipulation of information. We hypothesized that activation in dorsolateral prefrontal cortex (DLPFC) - a brain region critically involved in the processing of WM contents and executive functioning - shows a positive correlation with state anxiety (measured using Spielberger's state-trait anxiety inventory, STAI). During the task phase of a delayed response task, N = 48 subjects either monitored, updated, or manipulated a memory set of four letters. A conjunction of task-related BOLD activation revealed that bilateral DLPFC was commonly activated by the different conditions. In right DLPFC, activation was modulated by anxiety. Specifically, in all three conditions individuals scoring higher on state anxiety showed stronger DLPFC activation, independent of their performance. We interpret this result as evidence for a lower degree of neural efficiency in anxious individuals. The finding suggests that anxiety affects neural processes common to different component processes of WM that require the handling and processing of contents in WM.

E59**GENE-GENE-INTERACTION OF COMT VAL158MET AND DRD2 POLYMORPHISMS ON UPDATING BUT NOT MAINTENANCE**

Christian Fiebach¹, Ulrike Basten¹, Christine Stelzel¹, Christian Montag², Martin Reuter²; ¹University of Heidelberg, Psychology, Neuroradiology, and Neurology, Germany, ²University of Bonn, Psychology, Germany – Imaging genetics recently investigated how dopamine gene polymorphisms, particularly the Catechol-O-Methyltransferase Val158Met polymorphism, influence working memory (WM) performance, mostly relying on one behavioral paradigm, the n-back task. Dopaminergic influences on cognition, however, are multigenetic in nature, and WM involves different component processes not separable in the n-back task, such as maintenance of information in WM, and updating of WM contents. We explored how two polymorphisms related to dopaminergic activity, Val158Met and the DRD2/ANKK1-TaqIa receptor gene polymorphism, modulate maintenance vs. updating. 12 participants were randomly drawn for each of four genotype groups, Val+/A1-, Val+/A1+, Val-/A1-, Val-/A1+.

While genotype group had no influence on performance, fMRI responses revealed task specific genotype effects in prefrontal cortex (PFC). When maintaining four letters, no gene-gene interactions were observed in PFC. Maintenance of six letters, as well as updating, elicited a COMT/DRD2 interaction of activity in left DLPFC. Updating of WM contents additionally showed a COMT/DRD2-modulation of activity in the right inferior frontal junction area, known to be involved in the prefrontal control of executive task demands. Both gene-gene interactions showed increased activation for a genetic equilibrium, i.e., when high levels of dopamine concentration meet an increased receptor density, or when lower dopamine levels coincide with reduced receptor densities. These results suggest that dopamine system activity influences the efficiency of prefrontal cognitive processing, that these effects depend on multiple genetic factors related to dopamine, and that distinct prefrontal component processes such as maintenance and updating are differentially modulated by the activity of the dopamine system.

E60

IT'S NOT WHAT THEY DO BUT THE WAY THAT THEY DO IT: EXPLORING DIFFERENCES IN VERBAL WORKING MEMORY IN PARENTS OF CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

Johanna Barry¹, Beate Sabisch¹, Jens Brauer¹, Angela Friederici¹; ¹Max Planck Institute for Human Cognition and Brain Sciences – Children affected by Specific Language Impairment (SLI) typically demonstrate deficits in verbal working memory (VWM). SLI is highly heritable and, since parents of these children have a higher prevalence of poor VWM than parents of typically developing children, it has been suggested that this serves as heritable risk factor for the disorder. In this study, we used fMRI to tease apart factors contributing to the poorer VWM in parents of children with SLI. We included 32 parents; 16 parents of affected children and 16 of typically-developing children. We simultaneously presented verbal stimuli in both the auditory and visual modalities (encoding phase) and participants were required to subvocally rehearse either the seen or the heard stimuli for an extended period of time before performing a recognition task. We predicted similar cortical responses in both groups during the encoding phase of the task, with differences in activations emerging later, during the rehearsal and recognition phases and being localised to the inferior frontal gyrus, and the Sylvian-parieto-temporal and supramarginal areas. Preliminary results largely confirm these predictions. Notably, however, little evidence was found for deviant information-processing in the parents of children with SLI, instead group differences reflect considerably reduced levels of activation particularly across the frontal lobes in these adults.

E61

THE EFFECT OF RETRO-CUEING ON AN ERP MARKER OF VSTM MAINTENANCE

Alexandra Murray¹, Bo-Cheng Kuo¹, Mark Stokes¹, Anna Christina Nobre¹; ¹University of Oxford, Experimental Psychology – Previous research has found that Contralateral Delay Activity (CDA) is correlated with the number of items maintained in Visual Short Term Memory (VSTM) from one visual field (VF) (Vogel & Machizawa, 2004). CDA is usually elicited by a to-be-remembered array after a prospective cue (pro-cue) signalling the relevant side of the visual display, and is interpreted as a putative electrophysiological signature of WM maintenance. Attention can also be directed to the contents of VSTM, after the presentation of a visual array, using a retroactive cue (retro-cue) (Nobre, Griffin, & Rao, 2008). Because retro-cueing directs attention within a memory trace, potentially reducing the load of items to be maintained, we hypothesised that this would significantly attenuate the CDA. Participants were initially presented with a spatial pro-cue which reduced the number of to-be-remembered items to one side. After a delay, a memory array of either four (low load) or eight (high load) items was displayed. A retro-cue then cued participants to one location within the relevant VF, further reducing the load of to-be-remembered items; or provided no information, requiring participants to hold all items in the relevant VF. At the end of the trial, participants performed a same/different judge-

ment on a test stimulus. Retro-cues significantly improved VSTM performance. Unexpectedly, the CDA was abolished by the presentation of both spatially predictive and neutral cues, independently of the VSTM load participants had to maintain.

E62

CATEGORICAL AND COORDINATE SPATIAL RELATION PROCESSING IN WORKING MEMORY, AN FMRI STUDY

Ineke van der Ham¹, Mathijs Raemaekers², Richard van Wezel², Anna Oleksiak², Albert Postma¹; ¹Helmholtz Institute, Experimental Psychology, Utrecht University, ²Helmholtz Institute, Functional Neurobiology, Utrecht University – Spatial relations can be subdivided into two main types; categorical relations concern the more abstract, qualitative relations like "left of", while coordinate relations entail more metric relations such as "two meters away". Previous theoretical and experimental claims have been made about hemispheric lateralization dissociating the two types: categorical processing is suggested to show a left hemispheric advantage, while coordinate processing is proposed to show a right hemispheric advantage. Furthermore the brain areas suggested to be involved in this type of processing mainly lie within the parietal cortex. To expand the limited imagery data on this topic we have attempted to address this issue with an fMRI study using a new experimental paradigm. The design involves a match-to-sample working memory setup to assess activity during categorical and coordinate processing at different retention intervals (500 ms and 2000 ms). Behavioural data indicate the hypothesized double dissociation of hemisphere and task. Imaging data reveal a clear involvement of parietal regions, mainly during categorical processing, while some frontal activity is also found, related more to coordinate processing. One effect of laterality has also been found, limited to the superior parietal cortex and the 2000 ms retention interval. We therefore conclude that lateralization is not as strong as some previous studies have suggested. However, there is evidence that in certain circumstances categorical processing has a left hemispheric advantage, while coordinate processing shows a right hemispheric advantage.

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THE ROLE OF HIPPOCAMPAL THETA OSCILLATIONS IN WORKING MEMORY

Nathan Cashdollar^{1,2}, Ulrike Malecki³, Fergus J. Rugg-Gunn⁴, John S. Duncan^{1,4}, Emrah Duzel^{2,3}; ¹Institute of Neurology, UCL, London, UK, ²Institute for Cognitive Neuroscience, UCL, London, UK, ³Institute of Cognitive Neurology and Dementia Research, O.v.G University, Magdeburg, Germany, ⁴National Hospital for Neurology & Neurosurgery, UCL, London, UK – The relative contribution of the hippocampal formation to short-term working memory is currently under debate. In a series of working memory experiments using Magnetoencephalography (MEG) we investigated cortical synchronization within the theta band during the active maintenance of configural or non-configural visual stimuli in delayed-match-to-sample tasks (DMS) in healthy adults and patients with bilateral hippocampal lesions. Object-based maintenance of non-configural information enhanced theta coupling along fronto-parietal sensors. However, the active retention of spatial configurations engaged a characteristically alternative network of occipito-temporal and fronto-temporal theta synchrony. This pattern was abolished in patients with bilateral hippocampal injury who displayed selective impairments in configural DMS tasks, but intact visual discrimination of complex scenes. Additional behavioral testing after configural and non-configural DMS tasks revealed increased long-term recognition memory performance for configural stimuli compared to non-configural in healthy controls. Enhanced recognition memory performance for configural stimuli was evident in epilepsy patients with structurally intact hippocampi where no differences were found in patients with bilateral hippocampal atrophy. These results conclude that hippocampal integrity is critical to the process of actively maintaining spatial configurations over a delay and in turn results in more successful long-term memory. Overall, this suggests that occipito-temporal/fronto-temporal theta synchrony reflects recruitment of regions conventionally thought of as a long-term working mem-

ory system, and is necessary to support this form of working memory maintenance by orchestrating a qualitatively different neural network than fronto-parietal object maintenance.

E64**COMBINING ELECTROENCEPHALOGRAPHY AND NEAR-INFRARED SPECTROSCOPY TO EXPLORE INSTANTANEOUS AND CONTINUOUS MENTAL WORKLOAD STATES** *Krysta*

Chauncey¹, Leanne Hirshfield², Erin Solovey², Audrey Girouard², Robert Jacob², Angelo Sassaroli³, Sergio Fantini³; ¹Neurocognition Laboratory, Tufts University, ²Human-Computer Interaction Laboratory, Tufts University, ³Biomedical Engineering, Tufts University – Electroencephalography (EEG) and functional near-infrared spectroscopy (fNIRS) are complementary to each other in both temporal and spatial resolution, and both have been used to classify participants' working memory load; however, they have yet to be integrated in a way that takes advantage of the millisecond-by-millisecond temporal resolution of EEG and the millimeter-fine spatial resolution of fNIRS. This work explores ways that these two methods can be combined by creating a subsegmentable task, which can be informative when examined using either the timeframe of EEG or that of fNIRS. Participants viewed trials of rows of red and blue airplanes (only one row was visible at a time), and were asked to keep track of the total number of each color for blocks of 60 seconds. Working memory load was manipulated by the number of planes per row (two, eight, or variable). EEG analysis was done on a trial-by-trial basis, and fNIRS analysis was done by blocks of 60 seconds. EEG data showed increased event-related synchronization (ERS) to increasing memory load at the single-trial level, while fNIRS data showed increased blood oxygenation to increasing memory load in continuous load conditions, but could not differentiate between the variable-load blocks and the high-load blocks. These findings will be discussed in the context of current models of working memory and task management.

E65**MDMA AND POLYDRUG USE ERP EFFECTS IN MEMORY SCANNING** *Brian Lopez¹, John Polich¹; ¹The Scripps Research Institute* –

Short-term memory processing was assessed with a memory scanning paradigm in substance-using college students. Substance use was categorized into two groups: (1) MDMA users who primarily have used ecstasy with no or very little other substance use, and (2) polydrug users who have used many substances in addition to ecstasy. A third group consisting of non-using controls was also assessed. A total of 12 females and 12 males comprised each drug use-group. Participants were instructed to memorize a list of two, four, or six digits and were subsequently presented with single probe digits that were either present or absent in the preceding memory set. Participants responded to the probes while event-related brain potentials (ERPs) were recorded in the three memory-load conditions. Consistent with classic memory scanning findings, response time to positive and negative probes increased with memory set size and were shorter for positive probes versus negative probes. However, no performance differences were observed among drug-use groups. P300 amplitude decreased and latency increased as set size increased. Within each condition, positive probes yielded larger P300 component size and shorter peak latency than negative probes. No reliable differences in P300 amplitude or latency were observed among the three drug-use groups. MDMA and polydrug use does not appear to affect behavioral performance or neuroelectric assessment of short-term memory scanning.

E66**BACK TO THE FUTURE: DISTRACTION REVEALS PREEMINENCE OF PROSPECTIVE VS. RETROSPECTIVE REPRESENTATIONS IN VISUAL WORKING MEMORY** *Jarrold*

Lewis-Peacock¹, Bradley Postle¹; ¹University of Wisconsin-Madison – Delay-period activity in inferior temporal (IT) cortex of the monkey can represent both retrospective and prospective information, and by one account only the latter is robust to interference (Takeda et al., 2005). We explored

the effects of visual distraction on the short-term retention of information in humans. First, subjects performed delayed recognition in the fMRI scanner and a pattern classifier learned to identify delay-period activity associated with the retention of faces, scenes, and objects. Second, subjects learned (offline) arbitrary cross-category pairings of stimuli from the original set. Third, subjects returned to the scanner to perform delayed paired-associate recognition with distraction from irrelevant stimuli, and the pattern classifier was used to decode delay-period activity. Half of the subjects were instructed to concentrate on the initial target stimulus during the delay period (and thus engage a retrospective code), and half to concentrate on the anticipated memory probe (a prospective code). Performance was near ceiling. Delay-period classification results from the "prospective" group indicated that prospective representations in IT cortex (and other posterior brain regions) were eclipsed while distractors were on the screen, but re-emerged following the offset of distraction. In "retrospective" subjects, however, these regions were seemingly unable to sustain a retrospective representation across distracted delay periods, instead switching over to a prospective code with the onset of distraction. Thus, the pattern of robust prospective coding vs. mutable retrospective coding extends to humans. More generally, it is consistent with the view that the brain prioritizes preparing for the future over remembering the past.

E67**VISUO-MOTOR REPRESENTATIONS VARY AS A FUNCTION OF ONLINE FEEDBACK: VISUALLY-GUIDED VERSUS MEMORY-GUIDED TRACKING** *Joseph Geeseman¹, Matthew Schlesinger¹;*

¹Southern Illinois University, Carbondale – Visual information is typically available both prior to and during visually-guided behaviors such as reaching and pointing (i.e., offline and online, respectively). The current study investigated the conditions under which subjects exploit offline information that is available before movement begins. Accordingly, neural activity was measured with functional MRI as subjects tracked and "intercepted" a moving target. Prior to each trial, the path of the target was cued by briefly presenting four points along the target's trajectory. Online feedback was manipulated by occluding the center portion of the target's trajectory on half of the trials (i.e., Occluded vs. Visible). As expected, availability of online feedback influenced the observed pattern of neural activation. In particular, a comparison of Occluded and Visible trials revealed higher activity during the Occluded trials in parietal and frontal regions versus higher activity in occipital areas during Visible trials. This pattern suggests that subjects may rely less on offline or pre-movement information when visual feedback is available during the movement.

E68**INFLUENCE OF SPEED OF PROCESSING TRAINING ON WORKING MEMORY IN OLDER ADULTS** *Anne S. Berry¹, Theodore*

P. Zanto¹, Aaron M. Rutman¹, Wesley C. Clapp¹, Joseph L. Hardy², Adam Gazzaley¹; ¹University of California, San Francisco, Neurology and Physiology, ²Posit Science Corporation, San Francisco – Computer-based training programs designed to improve cognition have been utilized with apparent success in the auditory modality for children with autism and for older adults. These results have inspired interest in plasticity-based training approaches targeted at other modalities, such as vision to improve perception, attention, and working memory (WM). The burden of such studies is in demonstrating that training-related gains transfer to independent tasks and that these improvements are associated with neural change. The goal of this electroencephalography (EEG) study was to assess whether older adults receiving extensive training on a basic motion perception discrimination task (a module in Posit's InSight™ visual training package) show improved perceptual discrimination and WM performance on an independent visual motion task. To evaluate improvement associated with training, behavioral performance and neural recordings were collected at two time points for training (before and after training) and no-contact control groups. WM improvement was

tested using a delayed match to sample task with and without distractors. So that differences in motion direction discrimination between individuals was not a factor in WM task performance, perceptual discrimination was tested using a perceptual thresholding procedure prior to the WM experiment. Preliminary results reveal training improves perceptual discrimination and WM memory performance compared to controls. Interestingly, WM enhancement may only be present when post-training participants are tested at their pre-training threshold. These results suggest improved perceptual processing drives WM improvement. Spectral and event-related potential results for the cue period suggest more efficient visual processing after training.

E69**VISUAL WORKING MEMORY AND CONSCIOUS AWARENESS**

Weiwei Zhang¹, Steve Luck^{1,2}; ¹University of California, Center for Mind & Brain, Davis, CA ²University of California, Psychology, Davis – Researchers have proposed working memory representations are tightly tied to awareness. To explore this hypothesis, we combined a color recall paradigm with a confidence rating procedure. Participants viewed briefly presented arrays of colored items and recalled one of the colors after a 900-ms delay. They then used a 7-point scale to indicate their confidence. We found that observers tended to have high confidence levels when they were holding the tested item in working memory. When observers were not holding the tested item in working memory, they exhibited a reduced likelihood of indicating the highest level of confidence (level 7). These results indicate that the presence of a representation in working memory is associated with awareness of a representation. In addition, when the item was present in working memory, observers were able to use the whole confidence scale in a meaningful way, providing further evidence of a close tie between the presence of a representation and awareness of the representation. However, when the item was not present in working memory, observers could not use levels 1-6 of the scale in a meaningful way, suggesting that the absence of a representation does not provide any details that can be represented in awareness. Finally, although observers were aware of the presence of working memory representations, they did not have meaningful information about the accuracy of the representations that were in memory. Thus, awareness is linked to the presence but not the accuracy of working memory representations.

E70**THE EFFECTS OF MEDIAL TEMPORAL LOBE DAMAGE ON PROACTIVE INTERFERENCE**

Craig Brozinsky¹, David Badre², Mark DeSposito; ¹University of California Berkeley, ²Brown University – Recent findings demonstrate that patients with medial temporal lobe damage have subtle deficits on short-term item recognition tasks. Their deficits could reflect dysfunctional maintenance and storage processes, or they could reflect a reduced ability to resist interference that has built up across a test session. We tested this latter hypothesis by using a variant of Monsell's recent probes task, which has previously been related to prefrontally mediated processes such as inhibitory control and episodic retrieval. On this task, normal subjects perform more slowly and less accurately on trials where a memory probe was not a member of the current rehearsal set, but was a member of the previous trial's rehearsal set. We hypothesized that, under normal circumstances, recollection helps to reject these familiar lures. Accordingly, we predicted that patients with focal hippocampal damage, who tend to have impaired recollection and relatively normal familiarity, would be heavily susceptible to interference from previous trials. In patients with more extensive medial temporal lobe damage (unilateral hippocampus, perirhinal, and entorhinal cortices), who tend to have both familiarity and recollection deficits, we predicted that familiarity would minimally be generated, and thus protect against interference effects. The two patient groups were compared to controls on a letter and a shape version of the recent probes task. Despite having lower baseline recognition accuracy and slower reaction times, the focal hippocampal patients did not have magnified interference

effects. These results suggest that cross-trial interference does not mediate short-term recognition deficits in focal hippocampal patients.

E71**RETRIEVING INFORMATION FROM A NEW EVENT SELECTIVELY ACTIVATES THE MEDIAL TEMPORAL LOBES**

Jeffrey M. Zacks¹, Khen M. Swallow¹, Deanna M. Barch¹, Denise Head¹, Corey J. Maley¹, Derek Holder¹; ¹Washington University in Saint Louis – When watching others' activities, observers segment it into meaningful events. For example, when watching another person make tea, an observer might segment the activity into filling a mug with water, heating the water, and putting a tea bag in the mug. Event Segmentation Theory (EST, Zacks et al., 2007, Psychological Bulletin) proposes that retrieving information across an event boundary should rely more on episodic retrieval systems and medial temporal lobe structures than retrieving information within an event. Using functional MRI, we measured participants' brain activity while they watched movie clips in which a variety of objects appeared. Five seconds after an object left the screen the movie paused for a recognition test and participants distinguished between the object that was in the clip and a new object that had not appeared in the clip. An independent group of observers identified event boundaries by watching the clips in their entirety and dividing them into discrete units of activity. Brain activity during the recognition test was analyzed based on whether an event boundary occurred during the 5-s delay between object presentation and test. Thus, information was either retrieved across an event boundary or from within the current event. As predicted, the medial temporal lobe showed greater activity when participants retrieved information across an event boundary than when they retrieved information from within the current event. These differences were observed despite the equivalent delay across conditions. These data provide compelling evidence that event boundaries act as a form of control over some memory processes.

E72**NEUROPLASTICITY-BASED COGNITIVE TRAINING IMPROVES WORKING MEMORY IN SCHIZOPHRENIA PATIENTS: BEHAVIORAL AND FMRI ASSESSMENTS**

Sophia Vinogradov¹, Karuna Subramaniam¹, Tracy Luks¹, Stephanie Aldebot¹, Adelaide Hearst¹, Arul Thangavel¹, Melissa Fisher¹, Gregory V. Simpson¹, Srikantan Nagarajan¹; ¹UCSF – Previous research has demonstrated that schizophrenia patients show impairments in attention, working-memory (WM) and cognitive control functions, and show decreased activation in DLPFC when performing these tasks compared to healthy controls (HCs). Here, we investigated whether neuroplasticity-based cognitive training would improve working memory functions in schizophrenia patients. We used fMRI to measure brain activity in 24 patients and 12HCs while they performed three N-Back tasks, of increasing levels of WM load (0,1, and 2-Back tasks). Twelve patients were then randomly assigned to 16 weeks of computerized targeted cognitive training (TCT) focusing on auditory and visual processing, affect recognition, and mentalizing tasks, while the remaining 12 control patients played computer games (CGs). All subjects repeated the fMRI task after 16 weeks. BOLD fMRI activity was measured on a 3T-GE scanner before and after intervention. Whole-brain analyses of the N-back task focused on regions showing greater activation on the 2-back compared to the 0-back task. At baseline, HCs demonstrated greatest activation in the right middle/inferior frontal gyrus (M/IFG). After 16 weeks of training compared to baseline, the TCTs had increased activation in the right M/IFG, while CGs did not show any change. These fMRI results indicate a possible "restorative" effect of training in schizophrenia subjects, not observed in control patients, where behavioral performance improved and fMRI activity increased in the right M/IFG during a WM task. These findings suggest that training generalizes to improve working memory functions in schizophrenia patients.

E73

NEURAL MEASURES OF AGE DIFFERENCES IN VISUAL WORKING MEMORY: THE ROLE OF FILTERING EFFICIENCY

Kerstin Jost¹, Rick Bryck², Edward K. Vogel², Ulrich Mayr²; ¹Philipps-University Marburg, ²University of Oregon – It is well-known that working memory (WM) functions decline with age. The reasons for this decline, however, are not completely understood. Here we tested whether the ability to prevent irrelevant information from being stored is a critical factor for age differences in WM. In order to address this question we compared younger (18-30 years) and older (65-80 years) adults' performance in a visual WM task. In each trial participants were presented with an array of colored rectangles and had to remember only the red ones. During the retention interval the so-called contralateral delay activity (CDA) of the EEG was recorded. The CDA allows an online measurement of the number of active representations, because its amplitude increases with the number of stored items. Participants who are good in filtering should show CDA amplitude increases for red items only, whereas the amplitude for participants who are not good in filtering should depend on the numbers of both relevant and irrelevant items [see Vogel, E.K. et al. (2005). *Nature* 438, 500-503]. In both groups filtering efficiency, quantified by CDA amplitudes, substantially varied across individuals and was correlated with WM capacity: individuals with low capacity were less efficient in filtering out irrelevant information than high-capacity individuals. Although filtering efficiency seems to be responsible for interindividual differences, it did not explain the obtained age effects in WM capacity. This suggests that a filter deficit is not responsible for the age-related WM decline.

E74

REPRESENTATION OF KEY IN NONVERBAL WORKING MEMORY: AN EVENT-RELATED POTENTIAL STUDY Laura

Manning¹, Edward Golob²; ¹Tulane University, Psychology, ²Tulane University, Program in Neuroscience – Long-term memory (LTM) can influence verbal working memory via knowledge of language. Similarly, LTM may influence nonverbal working memory via knowledge of musical key. Here we tested the hypothesis that key repetitions across trials facilitates encoding of musical chords in a working memory task. Event-related potentials (ERPs) were measured at encoding to determine if key repetition affected sensory processing (early auditory ERPs) and/or top-down processing (late slow waves: 400-600 ms). Participants (N=15; ages 19-25; 6M/9F) heard trials consisting of 3 different chords followed by a maintenance period (2 sec) and a probe chord. Participants pressed buttons to indicate whether the probe was a match or nonmatch to any member of the initial 3 chord set. Chords within a trial were in the same key, but key either changed each trial (random) or remained the same for 3 consecutive trials (consistent). Accuracy was comparable among conditions (~77%). Auditory ERP measures (P50, N100, P200) did not differ between consistent and random conditions. However, in the consistent condition late frontal slow wave amplitudes were more negative for consistent trials 2 and 3 vs. the first trial ($p < .05$). Late slow wave amplitudes in the random condition and consistent trial 1 were comparable. Results suggest the influence of key develops over trials, and is most evident in longer-latency, possibly top-down activity rather than early sensory processing.

E75

DRIVEN FROM DISTRACTION: IMPROVING VISUAL SHORT-TERM MEMORY IN OLDER ADULTS WITH ATTENTIONAL SELECTION Maha Adamo¹, Carson Pun¹, Susanne Ferber¹; ¹University of

Toronto, Psychology – One cognitive faculty that declines with age is visual short-term memory (VSTM), or the ability to hold visual information in mind after it is no longer physically present. Specifically, older adults typically show lower VSTM capacity estimates than do young adults. This age-related decline, however, may be a derivative of increased distractibility: Older adults' memory performance may be impaired not because of reduced storage capacity per se, but due to interference from additional items within VSTM. We used a "retro-cue" para-

digim to test whether attentional enhancement of information held in VSTM reduces interference, manifesting as improved capacity estimates. We presented a memory array of 1-6 colored circles for 1000ms, followed by a blank period of 1000ms. Then, on "retro-cue" trials, we presented a central arrow for 100ms pointing to the to-be-remembered location, followed by another blank display for 400ms. Finally, we presented a probe display containing only the cued item, and participants indicated with a button press whether the probe was the same color as the item presented at that location previously. The comparison condition also included a cue, which was presented simultaneously with the probe display after the first blank period ("simu-cue"). Both young and older adults showed improved estimates for retro-cue trials relative to simu-cue trials; critically, older adults' performance improved to the level of young adults. Thus, providing a cue for attentional selection of an item already held in VSTM reduces the typically observed age-related decline, suggesting that reducing distraction improves older adults' memory.

E76

EARLY VISUAL COMPONENT DURING MENTAL IMAGERY GENERATION WAS AFFECTED BY MEMORY ORDER Keiko

Yamazaki¹, Junichi Katayama¹; ¹Graduate School of Education, Hokkaido University – ERP P2 reflected visual process of mental imagery generation in our previous study. In this study, we examined whether the P2 amplitude was affected by memory order of shape or not. There were four kinds of shape to be memorized, two of which were SIMPLE shape composed of three segments, and the others were COMPLEX shape of five segments. 16 Participants memorized SIMPLE shape as "a" and "b" at first, and COMPLEX shape as "c" and "d" next (SIMPLE first group). Another 16 participants memorized COMPLEX shape as "a" and "b", SIMPLE shape as "c" and "d" (COMPLEX first group). They memorized these shapes with sequence of the segments to be drawn. In the experiment, 5 x 5 grids with the name of shape in the central cell, and with an "X" probe mark in another cell, were presented. Participants decided whether or not the probe mark fell on the visualized shapes. Half of the trials were ON trials where the mark fell on the shape. The significant P2 effect was observed in the SIMPLE first group, which was consistent with our previous study, but not in the COMPLEX first group. They showed significant P1 effect, which was larger for the SIMPLE trials than in the COMPLEX trials. These results indicated that early visual components were affected by both complexity of shape and memory order, and that these components might be first signal to the visual areas from memory.

E77

INDIVIDUAL DIFFERENCES IN WORKING MEMORY CAPACITY: AN FMRI STUDY Vivek Prabhakaran¹, Veena Nair¹; ¹University of

Wisconsin School of Medicine and Public Health, Radiology – Working memory capacity is defined as the extent of resources available to perform on-line cognitive processing involving both working memory storage and working memory rehearsal. Lesion studies have posited that posterior brain regions are involved in working memory storage while prefrontal brain regions are involved in working memory rehearsal (D'Esposito and Postle, *Neuropsychologia* 1999). To identify whether individual differences in working memory capacity is secondary to increased working memory rehearsal or increased working memory storage, we conducted a fMRI study of working memory known to invoke working memory capacity in which subjects (n = 12) perform an item recognition paradigm where subjects maintain six letters over a delay period versus a no-delay period. Working memory capacity is measured in each of these subjects using a Digit span task. To isolate areas involved working memory capacity, we correlate individual differences in working memory capacity with activity in brain regions involved in the maintenance of working memory. Overall, maintenance of working memory information involved a prefrontal-posterior network. Prefrontal brain regions showed greater activity with greater working memory capacity across individuals. This suggests that individual differences in working memory capacity is secondary to increased working memory rehearsal.

E78

WORKING MEMORY AND SEMANTIC COMPETENCE IN OLDER ADULTS' COMPLEX LANGUAGE COMPREHENSION *Claire*

Simpson¹, Fan-Pei Gloria Yang¹, Carlos Marquez de la Plata^{1,2}, Kourosh Zakeri³, Daniel Krawczyk^{1,2}; ¹Center for Brain Health, University of Texas at Dallas, ²University of Texas Southwestern Medical Center at Dallas, Texas, ³The University of Texas at Dallas – Previous aging studies suggest that declining working memory is the primary cognitive factor that contributes to impaired comprehension of complex linguistic sentences. This is based on the reported correlation between working memory and several types of figurative language that use conventional neuropsychological batteries. These studies have not considered other cognitive confounds such as familiarity of the stimuli and semantic competence which we observed to have an impact on neural activations in our previous imaging study. The goal of the proposed study is to investigate the correlation between these cognitive factors and complex language processing. Sentences were presented on a computer screen and older adults were asked to judge the valence of sentences by pressing buttons on the keyboard. Some of the sentences were conventional and only assessed subjects' verbal competence whereas novel metaphors tested their reasoning ability. We also conducted several neuropsychological measures for working memory (e.g., Trails and Digit Span) and for semantic competence (e.g., Nelson-Denny). Subjects' reaction times demonstrate that novel sentences were most difficult to process compared with conventional expressions. This indicated that familiarity was a crucial factor for aging population's language processing. We also found that, with verbal ability controlled, subjects with declining working memory performed worse on novel expressions but not on conventional metaphors. This suggests that familiarity instead of figurative language (e.g., metaphor) has an impact on working memory. We suggest that a combination of computerized tasks and neuropsychological measures can give a more accurate assessment of older adults' language performance and cognitive functions.

Perceptual processes: Auditory processing

E79

HARMONY WANTS TO SIT IN THE FRONT *Eduardo A. Garza Villarreal^{1,2}, Elvira Brattico³, Sakari Leino³, Leif Ostergaard^{1,4}, Peter Vuust^{1,2}*; ¹Aarhus University, Center for Functionally Integrative Neuroscience, ²Royal Academy of Music, Aarhus, Denmark, ³University of Helsinki and Helsinki Brain Research Center, Cognitive Brain Research Unit, Psychology, Finland, ⁴University Hospital of Aarhus, Neuroradiology – Deviations from auditory regularities elicit early negative electric potentials distributed over the frontal regions of the scalp. The mismatch negativity (MMN) is elicited when local regularities of the auditory stimulation are violated and is also affected by the familiarity with the stimuli, whereas the early right anterior negativity (ERAN) appears when sounds diverge from a hierarchically organized musical regularity. In this study we wished to further disentangle the functional roles of these two brain processes associated with the detection of local vs. hierarchical musical violations by studying the localization of the underlying generators. To this aim, fifteen subjects listened to musical sequences constituted by seven chords. Each sequence contained harmonically congruous chords, harmonically incongruous chords, or harmonically congruous but mistuned chords. Simultaneously, an electroencephalography (EEG) was recorded and afterwards brain electric source analysis (BESA) was performed. Incongruous chords violating the rules of harmony elicited a bilateral early anterior negativity (ERAN), the amplitude of which depended on the degree of the harmony violation as expected, while mistuned chords violating the local rules of relations between the sounds, elicited a bilateral mismatch negativity (MMN) within chord sequences. We found that the dominant transcerebral sources for the ERAN were localized in Broca's area and its right

homologue. The MMN signal was instead localized on the bilateral auditory cortex. These findings demonstrate the predominant role of the auditory cortices in detecting local auditory regularities and of the prefrontal cortex in parsing hierarchical regularities in music.

E80

WHEN SOUNDS BECOME OBJECTS *Lisa D. Sanders¹, Rachel E. Keen², Richard L. Freyman³*; ¹University of Massachusetts, Psychology and Neuroscience and Behavior Program, Amherst, ²University of Virginia, Psychology, ³University of Massachusetts, Communication Disorders, Amherst – The ability to isolate a single sound source among concurrent sources and reverberant energy is crucial for understanding the auditory world. Our ability to localize sounds despite these echoes has been explored with the precedence effect: identical sounds presented from two locations with a short stimulus onset asynchrony are perceived as a single source with a location dominated by the lead sound. We recently found that event-related potentials (ERPs) elicited by click pairs near echo threshold differ when listeners do and do not report hearing the lag sound as a separate source. Specifically, when participants report hearing two sounds, we observe a negativity 100-250 ms, previously termed the object-related negativity (ORN). From previous research it is not possible to determine if the early neurosensory processing differences indexed by the ORN reflect variability in subcortical representations that result in a one- or two-sound interpretation or top-down influences. We measured ERPs elicited by physically identical sounds in contexts that resulted in listeners reporting either one or two sources. Repeating a lead-lag sound pair several times made participants less likely to report hearing the lag sound as a separate source. Presenting several lead-only sounds before the pairs resulted in behavioral responses similar to those for pairs presented in isolation. Sounds perceived as two auditory objects elicited an ORN and a posterior positivity 250-500 ms. These results indicate that recent experience with the spatiotemporal properties of sound allows listeners to form complex models of room acoustics that affect early auditory object processing.

E81

DISCRIMINATION OF NATIVE AND NON-NATIVE VOWEL CONTRASTS IN TURKISH-GERMAN AND GERMAN CHILDREN: INSIGHT FROM MISMATCH NEGATIVITY *Tanja Rinker^{1,2,3}, Paavo*

Alku⁴, Sibylle Brosch², Markus Kiefer¹; ¹Section for Cognitive Electrophysiology, Psychiatry, University of Ulm, Germany, ²Section for Phoniatrics and Pedaudiology, ENT, University of Ulm, Germany, ³Transfercenter for Neuroscience and Learning, University of Ulm, Germany, ⁴Laboratory of Acoustics and Auditory Signal Processing, Helsinki University of Technology, Finland – The development of native-like memory traces for foreign phonemes can be measured by using the Mismatch Negativity (MMN), a negative deflection of the auditory event-related potential. Previous studies have shown that the MMN is sensitive to changes in neural organization depending on language experience. In this study we measured the MMN-response in five year-old monolingual German children and in bilingual Turkish-German children growing up in Germany. MMN was investigated to a German vowel contrast and to a Turkish vowel contrast. The results show that while an MMN is elicited in German children to the German vowel contrast, there is no MMN present in Turkish-German children. Moreover, the early MMN-response to the Turkish contrast is more prominent in monolingual German children. Only in a later time window, Turkish-German children show a more prominent response to the Turkish contrast. The temporal onset of the MMN is delayed in the Turkish-German children for both vowel contrasts. Overall, the results suggest that the Turkish-German children have not yet fully acquired the German phonetic inventory despite being immersed in a German environment and that their phonetic inventory in Turkish is affected by their bilingualism as well. Furthermore, the delay in the MMN-response may reflect a slight general slowing due to the cognitive demands of processing two languages.

E82

NEURAL CODING OF FRICATIVE SPEECH SOUNDS WITH AND WITHOUT HEARING AIDS

Sharon Müller¹, Yang Zhang^{1,2}; ¹Speech-Language-Hearing Sciences, University of Minnesota, Minneapolis, MN, ²Center for Neurobehavioral Development, University of Minnesota, Minneapolis, MN – The present study used auditory event-related potential (ERP) measures to investigate how the adult brain differentially processes fricative speech sounds with and without the use of a hearing aid. Three questions were addressed: (1) whether wearing a hearing aid makes a significant difference in the ERP components, (2) whether the ERP responses to fricatives consistently differ in both aided and unaided conditions, and (3) whether phonological context significantly affects the ERP responses. Eleven right-handed adult listeners with normal hearing participated in the study. ERP responses were recorded in an electrically shielded sound booth for digitally-edited /sa/, /sha/, /as/, and /ash/ stimuli in unaided and aided conditions using a randomized block design. At least 160 trials per stimulus were averaged for each subject. The results showed that (1) the basic ERP responses significantly differed between the unaided and aided conditions, (2) the N1 amplitudes and latencies to /s/ and /sh/ significantly differed in both unaided and aided conditions as well as in syllable-initial and syllable-final positions, and (3) phonological context significantly affected the N1 responses. These results confirm that hearing aids alter neural coding of speech. Unlike previous findings, however, there is strong evidence that the basic information for fricative contrast perception through a hearing aid is not entirely lost at the cortical level.

E83

MAPPING HUMAN AUDITORY CORTEX ACCORDING TO BOLD fMRI RESPONSE TO CLICK-TRAIN STIMULI VARYING IN PRESENTATION RATE AND BINAURAL-LEVEL CONFIGURATION

Susan A. McLaughlin¹, G. Christopher Stecker¹; ¹Speech and Hearing Sciences, University of Washington – Due to the highly distributed nature of mammalian auditory cortex (AC) processing, no single stimulus characteristic has proven sufficient to completely differentiate AC fields on a physiological basis. Mapping human AC with non-invasive methods remains a particular challenge. The goal of our study was to discriminate and identify human AC fields using a "multiple functional marker approach," mapping regional variation in BOLD fMRI response along multiple dimensions. Human AC responses to variation in stimulus level, presentation rate, and interaural level difference were measured using a sparse imaging paradigm (TR = 12 s, 32 slices, 3.0 x 3.0 x 4.5 mm, 3 T). Narrowband click-train stimuli were delivered in 12-second blocks, and varied pseudorandomly by 1) binaural-level configuration (sound or silence in one or both ears [sound levels at each ear varied independently over a 30-dB range across blocks]) and 2) presentation rate (fast or slow: 40 brief trains or 5 longer trains per second, respectively). Listeners monitored stimuli for rare changes in inter-click interval. Consistent with previous reports, overall activations (sound minus silence) of the superior temporal plane were greatest for slow (vs fast) presentation, contralateral to the stimulated ear. Additional focal activations exhibited regional and subject-to-subject variation in parametric sensitivity to overall level, binaural interaction, and presentation rate. The results are consistent with the view that neural populations vary along multiple dimensions of stimulus sensitivity, and that these parameters can be used to define a set of functional markers useful for mapping AC field structure. Supported by NSF IOB-0630338.

E84

LISTENING STRATEGY MODULATES NEURAL CORRELATES OF AUDITORY RHYTHM PERCEPTION

Amanda Pasinski¹, Devin McAuley², Joel Snyder¹; ¹University of Nevada, Psychology, Las Vegas, ²Bowling Green State University, Psychology – Two fundamentally different mechanisms have been hypothesized to underlie listeners' perception of rhythm: 1) A beat-based mechanism synchronizes with the rhythm, similar to the beat people tap while listening to music, and listeners use

this synchronized pattern to generate expectations for the onset times of new events; and 2) An interval-based mechanism calculates time intervals between consecutive events and listeners use the calculated time intervals to compare with time intervals formed by new events. Recent psychophysical evidence using a novel tempo discrimination paradigm has shown that some individuals use a beat-based mechanism while others use an interval-based mechanism, even for the same rhythmic pattern and set of instructions. This paradigm therefore presents a unique opportunity to identify brain processes underlying the two strategies. We used this paradigm while measuring event-related potentials (ERPs) in 38 participants. Strongly beat-based and weakly beat-based listeners showed no difference in sensory-evoked ERPs (N1, P2, N2). In contrast, the two groups showed a marginal difference in the contingent negative variation elicited by expectation of the final tone in the pattern and a significant difference in the late positive component after the end of the pattern, with larger responses in the more strongly beat-based listeners. These results demonstrate that stronger beat-based listening is accompanied by enhanced neural processing of tempo changes at the end of a rhythmic pattern.

E85

SENSITIVITY TO WITHIN-GROUP AND BETWEEN-GROUP SPEECH CATEGORIES IN EARLY, INTERMEDIATE, AND LATE SPANISH-ENGLISH BILINGUALS WITH VARYING PROFICIENCY LEVELS

Pilar Archila¹, Arturo Hernandez¹, Jason Zevin²; ¹University of Houston, ²Weill-Cornell Medical College – The purpose of this study was to examine differences in the categorization of speech in bilinguals who varied in age of acquisition and proficiency level in the second language. Spanish-English bilinguals (n=100) were classified as early (<5 years), intermediate (6-9 years), or late (>10 years) for a syllable discrimination task. Monolingual controls were used. Participants were asked to rate, on a 4-point scale, the level of dissimilarity between two pairs of naturally produced English syllables /saf, sef, sof, suf/ consecutively presented. The perceptual responses to these syllables were analyzed using multidimensional scaling (MDS). Consequently, the perceptual distances within and between clusters of stimuli indicated that early and high-proficient bilinguals more closely resemble monolinguals, whereas late and low-proficient bilinguals show dissimilar patterns of perception. Separate regression analysis demonstrated that proficiency is a significant predictor for the accurate categorization of between-group stimuli, while age of acquisition is a better predictor for within-group stimulus distances. Altogether, the results suggest that early learners of a second language are particularly adept at attending to the phonemic boundaries between vowel speech sounds and ignoring the minute variations within a vowel sound. Yet, high proficiency, in intermediate and late bilinguals, can favorably increase differentiation between vowel sounds, thus resulting in better categorization. In the near future, we plan to investigate how age of acquisition and proficiency affect the neural specialization of bilingual adults.

E86

PURE WORD DEAFNESS A NEUROLINGUISTIC STUDY

Ravi Nehru¹, Amit Batla², Farah Kanam³; ¹DM Neurology DNB Psychiatry Professor and Incharge Neurobehaviour Clinic and Neurolinguistics lab, Neurology GB Pant Hospital, New Delhi, India, ²MD (Medicine) Senior Resident Neurology G B Pant Hospital, New Delhi, India, ³MA Psychology and PhD student, Neurology G B Pant Hospital, New Delhi, India – Background: Pure word deafness is caused by superior temporal gyrus lesions in the dominant hemisphere that isolate Wernicke's area from incoming auditory information. Most cases are reportedly caused by stroke. Aims and Objects: To describe a 16 year old boy who developed pure word deafness and study the case as an example of representation of speech in human brain. Methods: The patient developed bilateral temporal lobe infarction. With recovery, a speech comprehension defect became evident by the 6th month. He was completely deaf for spoken speech, but could identify and localize all environmental sounds and recognize voices. His

speech was normal and he could read and write correctly. Audiometry revealed high frequency deafness. His BAER was normal. He had particular difficulty perceiving initial consonants, but did extremely well with vowels. He used his ability to recognize vowels in listening to letters and numbers. Reading aloud and reading for comprehension, writing spontaneously and naming to confrontation were normal. Conclusions: Pure word deafness serves as a model to understand localization of speech in the temporal cortices. It appears that a selective phonemic perceptual deficit results in pure word deafness. This case serves to prove that there is a fine grained highly selective representation of phonemes at cortical level.

E87

EARLY AUTOMATIC CATEGORIZATION OF SPEECH SOUNDS IS NOT MISLED BY CHANGES IN THE SURFACE FORM Heidrun Bien¹, Lothar Lagemann², Christian Dobel^{2,3}, Pienie Zwitserlood^{1,3}; ¹Institute for Psychology II, University of Muenster, Germany, ²Institute for Biomagnetism and Biosignalanalysis, University of Muenster, Germany, ³Otto-Creutzfeldt Center for Cognitive and Behavioral Neuroscience, University of Muenster, Germany – During speech perception, sound is mapped onto abstract phonological categories. Assimilation of place or manner of articulation, which is quite common in connected speech, challenges this categorization. Does assimilation result in categorizations which need to be corrected later on, or does the system get it right in the first place? We presented participants with isolated nasals, extracted from naturally produced German sentences. The nasals differed in their place of articulation (/m/ labial, /n/ alveolar, and /n'/ regressively assimilated towards labial). Behavioural two-alternative forced-choice tasks showed that participants were able to correctly categorize the isolated /n/s and /m/s. The assimilated nasals were predominantly categorized as /m/, suggesting a changed place of articulation in the surface form. The categorizations were also linearly influenced by a pitch variation. In a MEG experiment, we analyzed the N100m component elicited by the same stimuli, with no categorization task on the nasals. In sharp contrast to the behavioural data, this early, automatic brain response ignored the assimilation in the surface form and reflected the underlying category (/m/ elicited a smaller amplitude than /n/, independent of the presence or absence of assimilation). These phonemic differences were processed exclusively left-laterally (both in temporal and in parietal areas), while the pitch variation was processed in temporal regions bilaterally. In conclusion, explicit categorization draws attention to the surface form - to the changed place and acoustic information such as pitch. The N100 reflects automatic categorization, which exploits any hint of an underlying feature.

E88

EMOTIONAL SPEECH INTELLIGIBILITY: NOT JUST A MATTER OF THE RIGHT HEMISPHERE Sonja A. Kotz¹, Friedemann Szymanowski¹, Jonas Obleser¹, Stuart Rosen², Sophie K. Scott³; ¹MPI for Human Cognitive and Brain Sciences, Leipzig, Germany, ²UCL, Division of Psychology and Language Sciences, London, UK, ³UCL, Institute of Cognitive Neuroscience, London, UK – Speech perception is tightly linked to activation of auditory association areas in the temporal lobes with a particular role of the left anterior superior temporal sulcus (STS) in the perception of intelligible speech (Scott et al., 2000; 2006). In the current study we extended this approach to investigate emotional speech intelligibility with noise-vocoded speech as previous evidence with filtered emotional speech (Kotz et al., 2003; 2006) and non-speech vocal sounds (Belin et al., 2004) suggest a role of the right anterior STS in processing paralinguistic aspects of vocal expression (i.e., age, gender, emotional state; see also Schirmer & Kotz, 2006). We confirm a speech intelligibility network consisting of the IFG (BA 45) and the anterior STS/MTG bilaterally, the left STG (BA 41), and the left inferior parietal lobe (BA7). Emotional speech intelligibility involved the anterior STS/MTG bilaterally, the left STG (BA 41), and the right posterior STG (BA 22). The data suggest that speech intelligibility - whether neutral or emotional - relies on the bilateral anterior temporal STS/MTG, while emotional speech additionally recruits the

posterior STG. The data will be discussed in relation to models of vocal and non-vocal expression in neutral and emotional speech.

E89

IT'S ONLY IN YOUR HEAD: HOW EXPECTANCY OF AVERSIVE AUDITORY STIMULATION MODULATES AUDITORY CORTICAL ALPHA ACTIVITY Thomas Hartmann¹, Winfried Schlee¹, Nathan Weisz¹; ¹University Konstanz – INTRODUCTION: Recent publications have shown that modulations of alpha oscillations play an essential role in information processing. E.g. anticipation of target stimuli lead to a desynchronization of alpha oscillations in the respective sensory modalities. These top-down effects are usually induced using differing stimuli or instructions. METHODS: In the current study we set up a fake auditory frequency discrimination task, in which always the same sound was presented to the left ear. Participants were instructed that one sound (the high-pitch sound) would be followed by an aversive noise. Over the experiment the expectancy which sound subjects perceived fluctuated systematically. Oscillatory brain activity was acquired using a 64 channel EEG system. RESULTS: 12 out of 16 subjects were included in the analysis (4 men; mean age 22.25; all right handed). We found a significant relationship between the number of previous equal feedback and expectancy thus confirming the validity of the task. Time-frequency analysis using a multitaper FFT approach revealed an overall 20% stronger alpha-desynchronization during sounds for which an aversive noise was expected. Statistical analysis using a nonparametric permutation test revealed one significant cluster over right-temporal regions. Source-localization using a beamformer-approach localized the difference at right auditory cortical regions. CONCLUSION: Extending previous research, we were able to show that alpha-oscillations originating from auditory areas can be "purely" modulated by top-down influences.

E90

A REVERSE STROOP EFFECT IN ABSOLUTE PITCH POSSESSORS Lilach Akiva-Kabiri^{1,2}, Avishai Henik^{1,2}; ¹Ben-Gurion University of the Negev, Psychology, Beer-Sheva, Israel, ²Zlotowski Center for Neuroscience, Beer Sheva, Israel – Absolute pitch (AP) is the ability to identify and produce musical pitch tones without using an external reference tone. The present study examined how automatic such identification is. Eight participants with AP and eight musically trained controls participated in two auditory-visual Stroop-like tasks. In a given trial, participants were presented with an auditory tone and a tone name (e.g., do, re) or a note. In separate blocks, they were asked to respond to the note or the word and ignore the auditory tone or to respond to the auditory tone and ignore the visual display. The irrelevant dimension could be congruent, neutral or incongruent with the relevant dimension. In the pitch-tone naming task, only controls showed a significant congruity effect and were slower in identifying tones in the incongruent conditions. In contrast, in the note reading task, only those with AP showed a significant congruity effect. These results are in contrast with those of the original reverse Stroop task (Stroop, 1935) where no effect was found when participants were asked to read the color name and ignore the ink color. These findings demonstrate that pitch tones are processed automatically in those with AP. Moreover, the AP participants showed a unique asymmetrical congruity effect, with a greater influence of the auditory dimension on the visual dimension.

E91

FUNCTIONAL COUPLING BETWEEN AUDITORY AND MOTOR REGIONS IS MODULATED BY THE PERCEPTUAL DIFFICULTY OF SPEECH Conor Wild¹, Matt Davis³, Alexis Hervais-Adelman^{3,4}, Ingrid Johnsrude^{1,2}; ¹Centre for Neuroscience Studies, Queen's University, Kingston, ON, Canada, ²Queen's University, Psychology, Kingston, ON, Canada, ³MRC Cognition and Brain Sciences Unit, Cambridge, UK, ⁴Cambridge University, Physiology, UK – A number of recent neuroimaging studies have suggested that cortical motor activity is essential for successful speech perception (for reviews see Davis and Johnsrude 2007, Poeppel et al., 2008). We suggest that this may be particularly true for degraded or masked

speech. In this study, we used functional magnetic resonance imaging (fMRI) to examine whether interactions between auditory and somato-motor brain regions are stronger during the perception of degraded, relative to clear, speech. We presented subjects with English sentences that were processed as clear speech, 3-band noise-vocoded speech (NVS), or rotated 3-band noise-vocoded speech (rNVS). Whereas NVS is somewhat intelligible to naïve listeners, rNVS is unintelligible. Whole brain fMRI data were gathered from 19 subjects with a sparse-imaging paradigm and analyzed using a beta-series functional connectivity method (Rissman et al., 2004). We observed an increase in the functional coupling between motor cortex and peri-auditory regions during presentation of NVS speech, compared to either clear speech or rNVS; in other words, these areas demonstrate significantly increased correlation of activity when speech is hard to understand, compared to when it is unintelligible, or when it is clear and easily understood. The modulated auditory response was localized to belt and/or parabelt regions of auditory cortex immediately surrounding Heschl's gyrus. These results suggest that auditory cortex may recruit motor cortex in situations of high auditory perceptual uncertainty; or, alternatively, that motor cortex modulates lower-level auditory processes under these conditions.

E92

BILINGUAL AND MONOLINGUAL VOWEL PERCEPTION: AN ERP STUDY *Monika Molnar^{1,2}, Shari Baum^{1,2}, Linda Polka^{1,2}, Lucie Ménard^{2,3}, Karsten Steinhauer^{1,2}; ¹School of Communication Sciences & Disorders, McGill University, Canada, ²Centre for Research on Language, Mind, & Brain, McGill University, Canada, ³Université du Québec à Montréal, Canada* – In the present study, we addressed the question of whether being a native speaker of one or two languages affects automatic speech sound processing. Specifically, we investigated vowel perception patterns of monolingual (English, French) and simultaneous bilingual (English/French) speakers using an auditory oddball paradigm. The auditory discrimination abilities of each language group were measured in response to four vowels: English /u/, French /u/, French /y/, and a control /y/. The vowels were created using the Variable Linear Articulatory Model (VLAM) (cf. Boë & Maeda, 1998) which simulates realistic vowels in terms of articulatory-to-acoustic relationships. In line with previous behavioral and electrophysiological findings, monolingual speakers exhibited increased sensitivity to the phonemic status of the vowels than to the acoustic properties differentiating the sounds. For instance, monolingual French speakers showed an early and robust mismatch negativity (MMN) effect when discriminating between two native vowels; however, monolingual English speakers responded with a later and smaller MMN to the same vowel contrast. Also, monolingual speakers were able to detect subtle within-phonetic-category differences (i.e., English /u/ vs. French /u/) which elicited relatively late MMN components. Bilingual speakers, on the other hand, revealed a different type of processing pattern. They demonstrated overall slower discrimination responses to all sounds, but showed almost equal sensitivity to phonemic and acoustic differences. Compared to the performance of the monolingual speakers, the overall results suggest that bilingual speakers exhibit a more flexible but less uniquely-specified perceptual pattern.

E93

PHONEMIC PERCEPTION IN ENGLISH AS A FIRST AND SECOND LANGUAGE: EVIDENCE FROM EVENT RELATED POTENTIALS *Pauline Peri¹, Cheryl Frenck-Mestre¹, Christine Meunier¹; ¹Université de Provence* – The present study investigated phonemic perception of American-English vowel categories by French-English advanced learners, French monolinguals and native English speakers. Specifically, we examined the discrimination of different vowel categories specific to English and the amount of attentional resources allocated to these contrasts. A three stimulus oddball paradigm was used: /E/ as standard; /ae/ as target and /I/ as deviant in the first experiment; /ae/ as deviant and /I/ as target in the second experiment. In both experiments, early ERP responses (N100) showed discrimination of the three vowels for all

groups, based on acoustic differences. In contrast, ERP responses associated to attentional and categorization updating processes (N200-P300) showed differences between vowel categories across groups. In the first experiment, all the participants showed a categorization response for the vowel /ae/ against /E/. An "N2-P3" complex was also elicited for native English speakers and advanced learners in response to the deviant /I/ but not for French monolinguals. In the second experiment, native English speakers showed a larger N2-P3 response for the /I/ vowel. Advanced learners showed a larger N2-P3 response when focusing their attention on /I/ and a smaller response to the deviant /ae/. These results suggest a difficulty for advanced learners to deal with the three categories at the same time. Finally, French monolinguals show a small response to the /I/ vowel when it acts as a target. Results are further discussed in terms of attentional demands and the influence of the mother tongue when processing American-English vowel categories.

E94

MEANINGFUL NOVELTY PROCESSING DURING SLEEP IN HUMANS *Perrine Ruby¹, Jean-Baptiste Eichenlaub¹, Dominique Morlet¹; ¹INSERM U821, Lyon, France* – Up to which extent does the sleeping brain process modifications in its sensory environment? To address this issue, we investigated brain reactivity to meaningful sounds during sleep in healthy subjects. EEG, EOG and EMG were recorded during wakefulness and all-night sleep, while a passive oddball paradigm (standards, deviants and rare novels) was applied. Novel sounds were first-names uttered by a neutral voice: the subject's own name OWN and an unfamiliar first-name OTHER. During wakefulness recordings, subjects watched a silent movie with subtitles. During sleep recordings, stimuli were presented continuously. During wakefulness, OWN and OTHER evoked N1 and P3a components. The P3a component peaked significantly earlier (15 ms) for OWN. OWN only, evoked a large parietal positivity peaking at 550 msec. An enhanced response to OWN was also detected during sleep (stages 2, 4 and REM sleep), at late latencies, with a similar topography as the one observed during wakefulness. These results demonstrate that, during wakefulness, OWN induces an earlier reorientation of attention than OTHER, possibly due to its greater familiarity or to its meaning. OWN subsequently evoked a late positivity which may be interpreted as a complex cognitive processing e.g. recall of memory associated to the own name. Only late positivities were found in sleep stages 2, 4 and REM for OWN, suggesting that only the latter effect is preserved during sleep. In conclusion this study demonstrates verbal discrimination for the first time in all sleep stages and suggests a possible preservation of stimulus-driven recollection during sleep.

E95

PURE WORD DEAFNESS FOLLOWING LEFT HEMISPHERE STROKE WITH PRESERVED INTERHEMISPHERIC CONNECTIVITY *L. Robert Slevoc¹, Philip C. Burton², A. Cris Hamilton¹, Randi C. Martin¹; ¹Rice University, ²University of Minnesota* – Pure word deafness (PWD) is characterized by severely impaired speech perception despite good hearing ability and preserved functioning in other language domains (e.g., reading, writing and speaking). Despite its rarity, PWD has attracted considerable attention because of its specificity to speech sounds. 'Pure' cases of PWD show dissociations not only between speech perception and other types of linguistic processing but also between perception of speech stimuli and other complex auditory stimuli. The case reported here shows exactly this pattern: severely impaired speech perception despite relatively preserved reading, writing and speaking ability, as well as preserved perception of complex environmental sounds (Saygin, Dick, & Bates, 2005) and musical pitch. The patient has particular difficulty with stimuli characterized by rapid temporal transitions (i.e., consonants), supporting accounts of PWD resulting from an underlying deficit in rapid spectrotemporal processing (cf. Stefanatos, Gershkoff, & Madigan, 2005). Although PWD typically results from bilateral damage to the posterior superior temporal lobes, or more rarely from damage to the left superior temporal lobe combined with damage to

inter-hemispheric connections, this patient has only unilateral left temporal and parietal lobe damage, including superior temporal gyrus, supra-marginal gyrus, and angular gyrus. Not only does he have an intact right hemisphere, but he also has preserved white matter tracts connecting the two hemispheres as shown by diffusion tensor imaging. These data thus imply a crucial role played by the left superior temporal regions in the processing of rapid temporal aspects of the speech signal and constrain bilateral accounts of speech perception.

E96**LATE PARIETAL POSITIVE WAVES TO A SUBJECT'S OWN NAME IN NON-COMMUNICATIVE PATIENTS** *Dominique*

Morlet^{1,4}, Irena Holeckova^{2,3,1}, Perrine Ruby^{1,4}, Jean-Baptiste Eichenlaub^{1,4}, Catherine Fischer^{3,1}; ¹INSERM U821, Lyon, France, ²Medical Faculty Plzen, Charles IV University Prague, Czech Republic, ³Neurological Hospital, Clinical Neurophysiology, Lyon, France, ⁴Université Lyon 1, Lyon, France – We report a series of findings from passive oddball paradigms including the subject's own name (SON) presented as a novel ($p < 0.03$) in healthy awake subjects and in comatose patients. In a first experiment (15 subjects), the SON was randomly uttered either by an unknown or by a familiar voice in the same stimulation block. A late parietal positive wave (LPP) appeared after the novelty P3 (nP3) in response to the familiar voice. In a second experiment (10 subjects), the unknown voice and the familiar voice were presented in separate blocks. No LPP could be observed in either condition. In a third experiment (11 subjects), the SON and another proper name were randomly presented in the same block. A large LPP followed nP3 only in response to the SON. In 50 severe comatose patients (on average 20 days after coma onset), an oddball paradigm including the SON uttered by an unknown voice was applied. The SON elicited a central-parietal P3 response in 21 patients, of whom 17 awoke within the next 3 months. In 12 patients (of whom 11 woke up), we observed an additional component with more pronounced parietal predominance, significantly prolonging the duration of the P3 response. In healthy subjects, the presence of LPPs in response to SON depends highly on the stimulation context. This result questions about the cognitive counterpart of these components. Moreover, LPPs could also be observed in supposedly unconscious patients in whom they could highlight some residual cognitive functions.

E97**MENTAL ABILITY AND THE EFFECT OF PATTERN CHANGE ON P300 AND MISMATCH NEGATIVITY** *Lauren Sculthorpe¹, Robert*

Stelmack¹, Kenneth Campbell¹; ¹University of Ottawa – In previous research using event-related potential (ERP) recording procedures, compelling evidence of a relation between intelligence and speed of auditory discrimination was presented. During an auditory oddball task with backward masking, higher ability participants (HA) displayed more accurate discriminations, faster response time, larger P300 amplitude, and shorter P300 and mismatch negativity (MMN) latency than lower ability participants (LA). The temporal effects suggested that the speed of accessing short-term memory is faster for HA than LA. Since the MMN occurs without focused attention, these effects were interpreted to reflect differences in preattentive processing. We attempted to extend previous sensory discrimination effects to higher-order cognitive mechanisms by examining mental ability and variation in pattern change discrimination as indexed by P300 and MMN. HA and LA participants were presented with a two-tone alternating pattern (ABABAB...) with occasional deviant repetitions (ABABBBAB...). The two tones of the pattern were separated by 1 or 6 semitones in different blocks, under both 'ignore' (reading) and active response conditions. HA achieved better performance than LA, particularly in the more difficult 1 semitone condition. This was mirrored by a larger P300 and shorter P300 latency for HA than LA in the 1 semitone condition. MMN amplitude was larger for HA than LA across both semitone conditions. These results suggest that mental ability is related not only to sensory discrimination, but also to higher-order cognitive processes of rule extraction that operate even at a preattentive level.

E98**THE INFLUENCE OF COMPETING STIMULI ON AUDITORY SELECTIVE ATTENTION: A BEHAVIORAL AND ELECTROPHYSIOLOGICAL STUDY** *Aparna Rao¹, Yang Zhang¹, Sharon*

Miller¹; ¹Speech-Language-Hearing Sciences, University of Minnesota – This research work investigates the neurophysiologic mechanisms involved in selective listening. Behavioral and electrophysiological data were obtained from 12 subjects with normal hearing in a selective attention task (Garner filtering condition). In this paradigm, subjects were required to identify signals that co-occurred with competing stimuli. Pure tones mixed with filtered noise at a signal-to-noise ratio of +15 dB were used as stimuli. In separate blocks, subjects judged the pitch of tones while ignoring the random variation in filtered noise and vice versa. Results were compared for the two conditions, i.e., when subjects classified the pitch of tones and when subjects classified the pitch of filtered noise. Behavioral results indicated higher response accuracy and shorter reaction times when subjects attended to tones ($p < 0.01$). Electrophysiologic findings revealed greater amplitudes for P1, N1 and P2 when subjects identified the pitch of tones ($p < 0.01$). N2 was larger when subjects attended to the pitch of filtered noise ($p < 0.01$). More importantly, significant interactions ($p < 0.05$) were obtained between tone classification, noise classification and attention condition for all behavioral and electrophysiological measures, except the amplitude of N2. The effects of auditory interference were asymmetric. Results suggest that behavioral and electrophysiological responses to signals are altered by the presence of competing stimuli.

E99**AREA SPT IN THE HUMAN PLANUM TEMPORALE SUPPORT SENSORY-MOTOR INTEGRATION FOR SPEECH PROCESSING** *Gregory Hickok¹, Kayoko Okada¹, John Serences²; ¹Center for Cognitive*

Neuroscience, University of California, Irvine, ²University of California, Psychology, San Diego – Processing incoming sensory information and transforming this input into appropriate motor responses is a critical and ongoing aspect of our moment-to-moment interaction with the environment. While the neural mechanisms in the posterior parietal cortex (PPC) that support the transformation of sensory inputs into simple eye or limb movements has received a great deal of empirical attention - in part because these processes are accessible to study in non-human primates - little work has been done on sensory-motor transformations in the domain of speech. Here, we used fMRI and multivariate pattern classification analysis techniques to demonstrate that a region of the planum temporale (Spt) shows distinct spatial activation patterns during sensory and motor aspects of a speech task. Our results demonstrate that just as the PPC supports sensorimotor integration for eye and limb movements, Spt is part of a sensory-motor integration circuit for the vocal tract.

E100**ELECTROPHYSIOLOGICAL CORRELATES OF ECHO SUPPRESSION IN HUMANS** *Kristina C. Backer¹, Kevin T. Hill^{1,2}, Lee*

M. Miller^{1,2,3}; ¹Center for Mind and Brain, University of California, Davis, ²Neuroscience Graduate Group, University of California, Davis, ³Neurobiology, Physiology, and Behavior, University of California, Davis – In everyday reverberant environments, the auditory system encounters an acoustically complex scene, consisting of primary sounds and their spatially-scattered echoes. In order to localize an auditory object, the brain suppresses directional information from echoes occurring within a short delay of the primary sound—a phenomenon known as the precedence effect. In this study, we aimed to characterize the temporal evolution of neural processes mediating the precedence effect. In a behavioral calibration session, we presented subjects with clicks from two locations in virtual acoustic space (+/- 45°) with varying delays between them: a primary (left) and an echo (right) click. On each trial, subjects reported whether or not they heard a click on the echo side. This allowed us to determine each subject's echo-suppression threshold. In a follow-up EEG session, subjects ($n = 9$, 4 males) were presented with either a single click

in the primary click location, an obvious double-click pair (delay of 35 milliseconds), or a near-threshold click pair (delay based on the calibration, appx. 5ms). For near-threshold click trials, the right-lateralized N1c ERP component was larger in amplitude when the echo was suppressed compared to when the echo was audible. This suggests that enhanced processing in lateral auditory cortex within 150ms of sound onset may underlie the perceptual suppression of echoes.

E101

PERCEPTION OF PITCH DIRECTION IN NATIVE SPEAKERS OF TONE AND NON-TONE LANGUAGES

Edith Kaan¹, Bethany Rowlings¹, Ratree Wayland¹; ¹University of Florida – Tone languages such as Thai and Mandarin Chinese use pitch differences to distinguish lexical meaning. The aim of the present study was to investigate the effects of language background on both involuntary and attentive perception of linearly rising and falling syllables, abstracting over differences in average pitch. Native speakers of American English (a non-tone language) and of Mandarin Chinese (a tone language) participated in a passive EEG oddball paradigm, and behavioral discrimination and oddball detection tasks. Seventeen rising and seventeen falling tokens of the syllable [ba:] were generated, differing in overall pitch to mimic different speakers. The critical stimuli, to which ERPs were recorded, were always in the mid range of the pitch frequencies used. The English group (n=14) was better at actively discriminating falling tokens from rising tokens than vice versa. Preliminary data from the native Chinese speakers (n=4) showed no differences. Both groups were faster at detecting falling oddball tokens among rising standards than vice versa. Both groups showed a later negativity (600-800ms) for deviants versus standards in both rising and falling conditions. However, ERPs for the deviant versus standard stimuli showed a mismatch negativity (MMN) for the rising deviants in the English group only. This confirms the view that different experiences with pitch contours through language affects both involuntary and conscious perception of pitch direction.

E102

NEURAL ACTIVITY UNDERLYING PASSIVE PERCEPTION OF NATIVE VS. NON-NATIVE PHONETIC CONTRASTS

Ran Liu^{1,2}, Jeremy Skipper¹, Bruce McCandliss^{1,2}, Jason Zevin^{1,2}; ¹Sackler Institute for Developmental Psychobiology, ²Weill Cornell Medical College – Early language experience shapes neural processing of phonetic contrasts in a manner that promotes distinction between contrasts that are meaningful in one's native language and generalization across those that are not. As a result, second language learners often have difficulties learning, or even perceiving, differences between phonemes that are non-contrastive in their native language. To investigate the neural basis of this phenomenon, we used fMRI to scan 28 native Japanese speakers (all with extensive naturalistic exposure to English) while they passively listened to two English phonetic contrasts: one that is contrastive in Japanese (/d/ vs. /g/) and one that is not (/r/ vs. /l/). Subjects heard trials of these speech sounds in succession, each trial consisting of either four repetitions of the same standard stimulus or three repetitions of the standard followed by one deviant stimulus. The deviant > standard comparison reflects neural processing of the phonetic contrast present in the deviant trials. Results reveal activity in left posterior superior temporal gyrus and anterior supramarginal gyrus responding specifically to change across the /d/-/g/ contrast (native-language relevant) but not to the /r/-/l/ contrast (native-language irrelevant). This suggests that neural responses to speech contrasts may be susceptible to a sensitive period such that, even after extensive naturalistic exposure, adult second language learners do not activate regions typical of native speakers' during passive listening to non-native contrasts.

E103

AUDITORY CORTEX SENSITIVE TO F1-F2 INTERACTION: EVIDENCE FROM MEG

Pedro M. Alcocer¹, Brian Dillon¹, William Idsardi^{1,2}; ¹Linguistics, University of Maryland, ²Neuroscience and Cognitive Science Program, University of Maryland – We report magnetoencephalographic (MEG) evidence that the M100 response is sensitive to interactions between first and second vowel formant (F1, F2) frequencies. Two F1 (500Hz, 700Hz) and two F2 values (1100Hz, 1900Hz) were chosen and crossed to give four different American English vowel categories: /[^]/ (500Hz/1100Hz), /E/ (500Hz/1900Hz), /a/ (700Hz/1100Hz), and /ae/ (700Hz/1900Hz). Four synthetic tokens were generated from these crossings. Comparison of subjects' M100 responses to these stimuli revealed a significant effect of F2 and a significant interaction of F1 and F2 values. Subsequent pair-wise comparisons revealed the source of the effects: /ae/ was significantly delayed relative to /a/, and there were additional marginally significant delays of /E/ and /[^]/ relative to /a/. The pattern of results suggests that neither F1 nor F2 is the primary factor modulating M100 latency. Rather /a/ tentatively appears to have a privileged status with respect to the other vowels in the study. If the view that the tonochronic properties of the M100 are largely predicated on formant structure is to be maintained, then the current set of results suggests a hypothesis that is grossly consistent with the view outlined by Ohl and Scheich (1997) and Diesch and Luce (2000), where it is claimed that the auditory cortex does not specifically resolve different formant peaks, but rather that the auditory cortex tracks a single value that represents a transform of the F1 and F2 values.

E104

AUTOMATIC VERSUS CONTROLLED PROCESSING OF TEMPORAL STRUCTURE

Michael Schwartz¹, Maren Schmidt-Kassow¹, Sonja A. Kotz¹; ¹MPI CBS, Leipzig, Germany – Recent years have seen substantial progress in the specification of the functional and the neural bases of temporal processing. It has been suggested to dissociate between two timing systems. An automatic one, involved in short range, discontinuous timing, and a controlled one, dependent on attention, and involved in longer range, continuous timing (Buhusi & Meck 2005). To investigate this position, the Electroencephalogram (EEG) of 24 subjects was recorded in a first session (MMN), in which attention was directed away from tonal stimuli towards a muted video, and in a second (P300) session, in which attention was directed towards the tonal stimuli. Subjects listened to pseudo-randomized non-chunked as well as binary chunked (CH) auditory oddball sequences consisting of 512 standard (600 Hz) and 128 deviant (660 Hz) equidurational (300 ms) sinusoidal tones that were presented with either isochronous (ISO) or random (RAN) pause durations. For the P300 session, results show a significantly reduced event-related response (ERP) to deviant tones in the RAN as opposed to the ISO condition, whereas no such difference occurs when attention is distracted in the MMN session. Chunking produces comparable results, but also reveals different ERP patterns as a function of deviant position. Thus, the temporal structure of a stimulus sequence has direct influence on ERPs evoked in auditory oddball paradigms. The results support a separation of automatic and controlled timing systems. Furthermore, the facilitating effect of temporal predictability can be interpreted in favour of models that assume dynamic, stimulus-driven allocation of attention (Barnes & Jones 2000).

E105

MODELING VOCAL PITCH PRODUCTION WITH PERTURBED AUDITORY FEEDBACK

Anja Hohmann¹, Psyche Loui^{1,2}, Gottfried Schlaug^{1,2}; ¹Beth Israel Deaconess Medical Center, ²Harvard Medical School – Tone-deafness is a disorder whose phenotypical expression is characterized by an inability to sing in tune. Recent data suggests an underlying auditory-motor disconnection, resulting in an inability to benefit from or adjust to altered auditory perceptual feedback. Analogous studies in perceptuomotor feedback in vision have used the technique of altered feedback as in studies investigating prismatic adaptation. Using transposed

auditory feedback, we tested the hypothesis that normal-hearing individuals may be sensitive to feedback perturbation. We presented subjects with pure tones within their vocal range and asked them to reproduce these pitches by humming. Fundamental frequency of subjects' produced pitch was extracted and played back in real time via headphones. In 50% of trials, the feedback was transposed (perturbed) in frequency. The level of perturbation was adapted to each participant's individual, psychophysically-defined pitch-discrimination threshold. We recorded subjects' vocal production and applied pitch-extraction offline. Similar to EEG/ERP methods, data was artefact-rejected, baseline-corrected, and averaged across trials and subjects. Results were plotted as percent deviation from a preperturbation baseline. Results demonstrated frequency-shifted vocal production in the opposite direction of the applied perturbation for the duration of altered feedback. This opposing response shows that persons with intact pitch perception are sensitive to perturbed auditory feedback and compensate if given the impression of being out of tune. Pilot data from tonedeaf subjects suggest a lack of feedback-sensitivity. The perturbed auditory feedback paradigm can be adopted to further investigate behavioral markers of tone-deafness and also the general development of auditory-motor connectivity.

E106

ABNORMAL RESPONSE DYNAMICS DURING COGNITION-RELEVANT AUDITORY INFORMATION PROCESSING IN SCHIZOPHRENIA Corby L. Dale^{1,2}, R. Alison Adcock³, Anne M. Findlay¹, Alex Genevsky², Mary Vertinski², Tracy L. Luks¹, Gregory V. Simpson¹, Srikanth S. Nagarajan¹, Sophia Vinogradov^{2,4,5}; ¹University of California, Radiology, San Francisco, ²NCIRE, San Francisco VA Medical Center, ³Duke University Medical Center, Psychiatry, ⁴San Francisco VA Medical Center, Psychiatry Service, ⁵University of California, Psychiatry, San Francisco – Accumulating evidence suggests that schizophrenia is associated with neurocognitive impairments in both higher order cognitive functions and fundamental properties of sensory representations. Following on the premise that disorganized sensory representations are more vulnerable to interference and perceptual errors, we investigated the effect of speech-spectrum noise on the perception and representation of successively-occurring speech sounds by characterizing magnetoencephalographic (MEG) responses to syllable pairs. Patients diagnosed with schizophrenia and healthy comparison subjects performed a syllable discrimination task in both the presence and absence of noise. Statistical analyses of the M100 response over Superior Temporal cortex indicate that schizophrenia subjects, relative to healthy comparison subjects, show smaller amplitudes during the auditory M100 response to the first syllable and larger amplitudes to the second syllable in the presence of noise. In contrast, syllable discrimination without noise produces relatively equal responses in patients and comparison subjects during the first syllable, and a reduced response to the second syllable in patients. Taken together, these data suggest that perceptual interference leads to a less well-integrated response to the first syllable in schizophrenia patients, with a subsequent lack of attenuation in the response to the second syllable. Findings are consistent with "noisier" cortical-based representations of sensory information and their interactions with higher order cortex in schizophrenia patients, leading to faulty predictive processes and cognitive deficits. Results will be discussed with respect to the application of cognitive training to improve auditory information processing and its potential effects on physiological markers of sensory processing dysfunction in schizophrenia.

E107

AN EVENT-RELATED POTENTIAL INVESTIGATION OF THE PHONEMIC RESTORATION EFFECT David Groppé¹, Marvin Choi¹, Ben Topkins¹, Marta Kutas^{1,2}; ¹University of California, Cognitive Science, San Diego, ²University of California, Neuroscience, San Diego – The phonemic restoration effect (Warren, 1970) refers to the tendency for people to hallucinate a phoneme within a word replaced by a non-speech sound (e.g., tone). The level of processing at which this illusion occurs is unknown.

One event-related brain potential (ERP) study (Sivonen et al., 2006) suggests that it begins within 120-180 ms of the onset of the non-speech sound, but the result was confounded by physical stimulus differences. In our study, absent this confound, participants read a word and then heard a word; the two were identical on half the trials. Additionally, for half the trials a tone replaced a non-initial phoneme in the spoken word; for the other half, the spoken word and tone were coincident (overlapped). Participants indicated if the written and spoken words were identical and whether or not the tone replaced part of the spoken word. When the written and spoken words were identical (versus non-identical), participants more frequently reported that the tone did not replace part of the word, whether or not it did. When the spoken and written words were identical, a large late positivity beginning before tone offset obscured other possible effects of the prior written word. High-pass filtering, however, dampened this positivity and revealed that the N1 to the replacement tone is enhanced when the written and spoken words are identical (vs not). This suggests that phonemic restoration begins early in auditory processing and that linguistic context can affect early phases of speech processing.

E108

FUNCTIONAL SIGNIFICANCE OF P50 AND N100 SENSORY GATING NEUROPHYSIOLOGY Carly A. Yadon¹, Aubrey J. Anthony¹, Julie M. Bugg², Marlisa Ison²; ¹Colorado State University, ²Washington University in St. Louis – The P50 auditory event-related potential is used to measure sensory gating. This is typically in a paired-click paradigm in which amplitude to the second click (test (T) click) is "gated" or suppressed compared to the first click (conditioning (C) click) when measured by a T/C ratio. Sensory gating is dramatically reduced in individuals with schizophrenia and is highly variable among neurologically typical adults. For healthy adult participants, there is some evidence to suggest that P50 suppression varies with personality characteristics (schizotypy) and endorsement of sensory disturbances. However, the functional significance of poor P50 sensory gating is not well understood for either group. The goal of the present study was to better understand the functional implications of poor gating in a healthy adult sample. Toward this end, we examined the relationships between participants' (N = 30) scores on the Schizotypal Personality Questionnaire-Brief version, self-reported sensory processing as measured by the Sensory Gating Inventory, and neurophysiological measures of sensory processing (e.g. P50 and N100 amplitude, latency and suppression). Interestingly, for the P50 wave, latency but not suppression related to most of the subscales of the Schizotypal Personality Questionnaire and the Sensory Gating Inventory whereas suppression but not latency related to most of the subscales for the N100 wave (all data from electrode Cz). We consider several explanations for the differential patterns we observed for the P50 and N100 measures.

Poster Session F

Attentional processes: Visual

F1

ATTENTION AND REWARD: INDEPENDENT OR INTEGRATIVE MECHANISMS?

Stephanie Baines¹, Anling Rao¹, Anna C. Nobre¹; ¹*University of Oxford* – Attention has been widely demonstrated to modulate perceptual processing. Advance information as to the location of a target stimulus provides benefits to accuracy and reaction times. Event-related potentials (ERPs) have shown neural responses to be facilitated from early perceptual responses (e.g., visual P1 and N1). Reward has been shown to influence decision-making and motor processing, but there has been little investigation with regards to its possible effects upon perceptual processing. We investigated whether reward was able to influence information processing at the perceptual stage, and asked whether reward utilised the attentional system or an independent mechanism to influence behaviour and perception. We manipulated the probability of target location and reward availability to investigate how changing spatial and motivational expectations influence perceptual judgments. The task required speeded orientation discriminations of peripheral Gabor stimuli, presented to the left or right of fixation. Spatial and reward expectations modulated behavioural performance in different and non-interactive ways. Spatial attention shortened response times and improved performance accuracy. Reward expectations also shortened response times, in an additive fashion, but had no effect upon accuracy. ERP recordings charted the relative time-courses for the modulation of neural processing by spatial and reward expectations, and determined the stages at which the two sources of top-down biases interacted.

F2

ORIENTING ATTENTION BASED ON LONG-TERM MEMORY IMPROVES PERCEPTUAL DISCRIMINATIONS

E. Zita Patai¹, Anling Rao¹, Jennifer Summerfield¹, Anna Christina Nobre¹; ¹*The University of Oxford* – The role of attentional orienting in daily life is to selectively deploy both behavioural and neural resources towards events, based on continually changing task goals and expectations, in order to optimize performance. In the following experiment, we show that attentional orienting is influenced by long-term memories in a perceptual discrimination task. In the learning phase, participants were trained on 120 ecologically valid natural scenes, of which 80 contained a target. Their task was to locate the target (a small key) on the screen by clicking on it with the mouse. One or two days later, participants completed a cued perceptual discrimination task. The same scenes that were studied before, but without any targets, were presented as cues (50 ms duration), followed, after a delay (450ms), by the scene again with or without the target (200ms). Participants discriminated covertly whether the key was present or absent from the second scene. There were three conditions: valid (key in learning and discrimination task was in same location), invalid (key in learning and discrimination task were in different location) and neutral (there was no key in learning phase). Behavioural results indicated that memory-guided attention benefits both the sensitivity (d') and speed of target identification within natural scenes. A replication of the study is being carried out with event-related potentials to chart the neural modulations that accompany the perceptual enhancements observed behaviourally.

F3

AN ERP EXAMINATION OF THE DIFFERENTIAL EFFECTS OF SLEEP DEPRIVATION ON ENDOGENOUSLY CUED AND EXOGENOUSLY CUED ATTENTION

Logan T. Trujillo¹, Caitlin S. Tenison¹, Natalie S. Dailey¹, David M. Schnyer¹; ¹*University of Texas, Psychology, Austin* – Moderate sleep deprivation (SD) is generally thought to have the greatest impact on high-level cognitive functioning. Here we show that SD can also affect relatively early-stage selective attention. Twenty three human subjects performed modified Attentional Network Tasks (ANTs) that used exogenously and endogenously cued letter target stimuli to index brain networks underlying orienting attentional functions. Event related potentials (ERPs) were recorded as subjects performed the ANTs on 2 days separated by 24 - 36 hours of total sleeplessness. Typical orienting effects were found on each day for both endogenous and exogenous tasks. Reaction times (RTs) to correctly categorize targets were significantly shorter for Spatial Cue trials (targets preceded by a 100% predictive cue) vs. Neutral Cue trials (targets preceded by a non-predictive cue) and Spatial Cue vs. No Cue trials. Additionally, the posterior N1 component of the ERP was enhanced, and the P3 component diminished, for Spatial vs. Neutral/No Cue trials. Sleep deprivation led to slowed RTs in both tasks. Nevertheless, this RT slowing was greater for the endogenous ANT, which exhibited faster RTs than the exogenous ANT during the fresh condition, but not during the fatigued condition. Furthermore, SD affected ERPs in the endogenous ANT only. The N1 was diminished and P3 enhanced in response to endogenously cued targets during fatigued vs. fresh conditions. Additionally, the N1 response to endogenous cue stimuli was also diminished with SD. These findings suggest that endogenously directed attention is differentially affected by as little as 24 hours of SD.

F5

IMPAIRED EARLY VISUAL PROCESSING IS ASSOCIATED WITH HIGH DISTRACTIBILITY IN CHILDREN WITH ADHD

Risa Sawaki^{1,2,3}, Sharon Coffey-Corina¹, Junichi Katayama², Blythe Corbett¹, George Mangun¹; ¹*University of California, Davis*, ²*Hokkaido University*, ³*Japan Society for the Promotion of Science* – Attention-deficit/hyperactivity disorder (ADHD) is thought to involve high distractibility. However, it is still unclear whether high distractibility in children with ADHD is due to impaired cognitive control at late stages of processing, or rather it stems from impaired early sensory processing. We recorded event-related brain potentials from ADHD and typically developing children while they performed a simple visual discrimination task in which target or non-target stimuli were serially presented at a central location. Participants were asked to respond to target stimuli and ignore infrequent deviation. In the change condition, task-irrelevant features of central stimuli were infrequently changed. In the appearance condition, distractors infrequently appeared around central stimuli. Compared to typically developing children, ADHD children showed a smaller P1 for all stimuli in both conditions. Furthermore, although typically developing children did not show significant differences in P3 between change and appearance deviations, ADHD children showed a larger P3 for appearance deviation than for change deviation. The P1 response reflects an early stage of visual processing in visual cortex and its amplitude can be affected by spatial attention, while the P3 response reflects a later stage of attentional allocation. These findings suggest that children with ADHD have reductions (perhaps perceptual or attentional) in early visual processing, which are associated with high distractibility by salient deviations. One interpretation could be that the reduced P1 reflects their difficulty in focusing spatial attention on

the to-be-attended zone of visual space, which then permits irrelevant stimuli to induce greater distraction.

F6

CONTROL OF A SMART HOME WITH A BRAIN-COMPUTER INTERFACE Christoph Guger¹, Clemens Holzner¹, Günter Edlinger¹, Chris Groenegrass², Mel Slater²; ¹g.tec medical engineering GmbH/Guger Technologies OEG, Austria, ²Centre de Realitat Virtual, Universitat Politècnica de Catalunya, Spain – An EEG based Brain-Computer Interface (BCI) measures and analyzes the electrical brain activity (EEG) in order to control external devices. Such a BCI system can be controlled e.g. by the P300 EEG response. Therefore different characters are arranged on a computer screen and are highlighted in a random order. If the subject is focused on one specific character that is flashing up the P300 response is induced and the BCI system is able to recognize this response and therefore the character. The P300 based BCI system was connected to a Virtual Reality system and three subjects participated in the experiment. The virtual 3D representation of the smart home had different control elements (TV, music, windows, heating system, phone,...) and allowed the subjects to move through the apartment. Therefore special control masks (arrangement of specific icons on the screen) for the BCI system were developed containing all the different commands. The experiment for the P300 smart home control was divided into 3 parts with 15, 11 and 16 decisions respectively. One task was e.g. to go to the living room, to switch on the TV and to select a specific channel, ... The three subjects achieved an accuracy between 83 and 100 % depending on the control mask. The experiment yielded 2 important new facts: (i) instead of displaying characters and numbers to the subject also different icons can be used, (ii) the BCI system must not be trained on each individual character. Funded by EU project PRESENCCIA.

F7

SUPPRESSION OF TASK IRRELEVANT INFORMATION AS MECHANISM OF TASK SET INDUCED ATTENTIONAL CONTROL IN THE STROOP TASK Sascha Purmann^{1,2}, Christian J. Fiebach^{1,2}, Mark D. Esposito¹; ¹Helen Wills Neuroscience Institute and Psychology, University of California, Berkeley, ²University of Heidelberg, Psychology, Neurology, and Neuroradiology – Using fMRI, we examined the neural mechanisms of goal-directed, task-set induced top-down control of information processing. We had participants perform a color-word Stroop task under two task sets, i.e., color naming in some task blocks vs. word naming in others, using identical stimuli in both tasks. Consistent with the literature, we found increased activity in a fronto-parietal network comprising the anterior cingulate cortex (ACC), dorso-lateral prefrontal cortex (DLPFC), inferior frontal gyrus (IFG), and parietal cortex, when contrasting color naming with the less demanding word naming blocks. Most importantly with respect to task-set induced top-down control, we found decreased activity for word relative to color naming in color area V4, and decreased activity for color relative to word naming in the visual word form area (VWFA), suggesting that implementation of task sets involves the sustained suppression of task-irrelevant sensory representations. Additionally, in a connectivity analysis the right IFG, left DLPFC, and left superior lateral occipital cortex (LOC) showed a negative correlation with VWFA. In contrast, the right supramarginal gyrus and left inferior LOC showed such a relationship with V4.

F8

THE ELECTROPHYSIOLOGICAL SIGNATURE OF PHOSPHENE PERCEPTION: COMBINED ONLINE TRANSCRANIAL MAGNETIC STIMULATION AND EVENT RELATED POTENTIAL EVIDENCE Paul Taylor^{1,2}, Vincent Walsh², Martin Eimer¹; ¹School of Psychology, Birkbeck College, ²Institute of Cognitive Neuroscience and Psychology, University College London – We present electrophysiological evidence of trial-by-trial changes in the sensitivity of human primary visual cortex and of its causal role in visual perception. Transcranial magnetic stimulation (TMS) was applied to the right primary visual cortex of 12 participants so that they perceived phosphenes (brief flashes of light). Participants reported

whether phosphenes were present or absent with a manual button press. By stimulating at the phosphene threshold intensity, phosphenes were reported as present or absent on approximately equal numbers of trials. We simultaneously recorded the event related potentials (ERPs) evoked by each TMS pulse. Comparing the ERPs on trials where participants did or did not see phosphenes ('phosphene-present' or 'phosphene-absent' trials) revealed statistically significant differences reflecting changes in underlying visual cortical activity. The ERP elicited by the phosphene - the 'phosphene-related potential' - showed positive deflections on phosphene-present compared to phosphene-absent trials starting from 160ms after the TMS pulse. This positive shift was present earlier or more strongly in parieto-occipital cortex in the stimulated hemisphere than in the left hemisphere or in frontal cortex. The position of the TMS coil was confirmed using stereotactic registration to each participant's magnetic resonance imaging structural scan. The phosphene-related potential was also clearly distinguishable from the ERP produced after TMS to a control site in more dorsal parietal cortex when phosphenes were not perceived, and to that on trials without any TMS. This phosphene-related potential offers an index of visual cortical sensitivity that can be used as a tool in future studies of cortical interactions and attention.

F9

SPATIAL SELECTION OF VISUAL REPRESENTATIONS IN PERCEPTION AND WORKING MEMORY: EVIDENCE FROM LATERALISED POSTERIOR EVENT RELATED POTENTIALS COMPONENTS Silvia Dalvit¹, Martin Eimer¹; ¹School of Psychology, Birkbeck College, University of London – Selective attention can be allocated to sensory representation of currently present visual stimuli, and to representations of previously seen stimuli in visual working memory (Awh et al, 2006). Event Related Potentials (ERPs) were used to contrast the attentional selection of representations in perception and in working memory. The N2pc and SPCN components were measured as indicators of allocating attention to perceptual and working memory representations, respectively. In a temporal integration task, participants were asked to combine information from temporally separated visual displays. In both displays, two semicircles, whose orientation was randomly selected, were presented in the left and right visual hemifield. The interval separating both displays varied between 0 ms and 900 ms. The task was to detect the location where the combination of the two successive semicircles resulted in a complete circle. We observed the expected U-shaped pattern with high accuracy in the shortest and longest intervals and low accuracy with intermediate intervals. The N2pc was most prominent for the shortest interval, and the SPCN was present for longer intervals. Lateralised posterior ERP components were smallest for intermediate intervals where performance was poor. These results suggest that the allocation of attention to perceptual representations and to visual working memory representation can be dissociated with ERP measures.

F10

A HIGH-LOADED HEMISPHERE SUCCESSIVELY IGNORES DISTRACTORS Ritsuko Nishimura¹, Kei Kuratomi², Kazuhito Yoshizaki²; ¹Japan Society for the Promotion of Science / Aichi Shukutoku University, ²Aichi Shukutoku University – We investigated whether a distractor that is presented to high-loaded visual-field/hemisphere (high-loaded hemisphere condition) is rejected more effectively, using a response competition paradigm. This question is motivated by both the findings derived from the studies on interhemispheric interaction which suggested two hemispheres have a separate resource and works in parallel (e.g., Banich, 1998; Friedman & Polson, 1981) and load theory of selective attention (Lavie, 2005). Our previous study (Nishimura et al., 2008, CNS) demonstrated that a distractor under high-loaded hemisphere condition is rejected more effectively. However, there was a procedural shortcoming which allows for an alternative explanation of the finding. The present study retested this finding with an improved paradigm. We asked right-handed participants to identify a target among a briefly presented set of

five task-relevant letters and three noises (non alphabets), while ignoring a peripheral distractor. We presented one task-relevant stimulus and three noises in one visual-field (low-loaded visual-field), and the remaining four task-relevant letters in the opposite visual-field (high-loaded visual-field). We manipulated the visual-field where a distractor was presented (low-loaded versus high-loaded visual-field), as well as compatibility of target and distractor. In the low-loaded visual-field condition, a distractor was presented in the low-loaded visual-field, whereas the high-loaded visual-field condition, it was presented in the high-loaded visual-field. We found a compatibility effect in the low-loaded visual-field condition, but not in the high-loaded visual-field condition. These results supported our previous findings, suggesting that the distractor is processed in the low-loaded hemisphere, in which more processing resources are typically available.

F11

EFFECTS OF EXOGENOUS ATTENTION ON CONSCIOUS DETECTION AND PERCEPTUAL DISCRIMINATION

Ana Chica^{1,2}, Juan Lupianez³, Stefano Lasaponara⁴, Fabrizio Doricchi⁴, Paolo Bartolomeo^{1,2}; ¹INSERM-UPMC UMR, Paris, France, ²Hopital de la Salpetriere, Paris, France, ³University of Granada, Spain, ⁴Università degli Studi di Roma – Introspection suggests that when we attend to an object we become conscious of it. However, recent evidence suggests that at least endogenous attention is independent of conscious perception (Koch & Tsuchiya, 2007). Nevertheless, neuropsychological evidence suggests that exogenous attention might instead be crucial for conscious perception. Neglect patients do not consciously perceive information contralateral to their lesion; exogenous attention is biased in these patients, with a relative sparing of endogenous attention (Bartolomeo & Chokron, 2002). In the present research we explored the relationship between exogenous attention and conscious perception in neurologically intact observers. A non-informative peripheral cue precedes a target (a gabor stimulus oriented to either the left or right) that was not consciously perceived in a proportion of trials. Participants were asked to first discriminate the orientation of the gabor, or to give their best guess if they did not see it (discrimination response); and then to indicate whether they saw or not the gabor (awareness response). Discrimination accuracy and conscious detections were greater for cued than for uncued targets. Thus, exogenous attention enhanced perceptual discrimination and also increased the probability of consciously detecting the stimulus. However, there was no interaction between the two effects, suggesting that exogenous attention improved discrimination responses and consciousness independently: More targets were correctly discriminated when exogenously attended, no matter whether they were consciously detected or not. Our data support the role of exogenous attention in perceptual discrimination and demonstrate that unlike endogenous orienting, exogenous attention might be crucial for conscious perception.

F12

ATTENTION SHIFT TO A TASK-IRRELEVANT FACE IS INHIBITED BY PRESENTING AN ADDITIONAL FACE: AN ERP STUDY

Kanghee Lee¹, Yang Seok Cho¹, Hyun Taek Kim¹; ¹Korea University, Psychology, Seoul, Korea – The interference effect caused by a task-irrelevant face distractor is decreased simply by adding a face, but not an object. To see the role of attention shift in this dilution effect, we used event-related potentials (ERPs). Subjects were asked to categorize the occupation of a presented famous name (target) while ignoring a distractor, which was a face of an individual person from the same occupational category of the target (congruent) or another occupational category (incongruent). A face distractor was presented alone, or it was presented with an anonymous face in Experiment 1 or a scene of house in Experiment 2. N2pc, the component that is related to attention shift, was measured at contralateral electrode site (T5 or T6) to a distractor face. The behavioral data showed a decreased interference effect, which was not significant, when the anonymous face was presented with the name and the face distractor. For the ERP data, when the famous face and the name

were presented without an anonymous face or a house scene, N2pc appeared with a more positive peak followed by a sharp negative peak. The change of N2pc indicated that the distractor captured attention. When a house scene appeared with them, a delayed positive change with no negative rebound was observed. When an anonymous face appeared, however, N2pc was not observed. These results imply that the presence of the anonymous face inhibits attention shift to the distractor face indicated by a diminished N2pc, causing a decreased interference effect.

F13

ERP CORRELATES OF ENHANCED VISUO-SPATIAL ATTENTION ALLOCATION UNDER DIFFICULT TASK DEMANDS

Stefanie Kehler^{1,2}, Stefan P. Koch¹, Antje Kraft¹, Kerstin Irlbacher¹, Herbert Hagenдорf², Norbert Kathmann², Stephan A. Brandt¹; ¹Charité, Neurology, Berlin, ²Humboldt University, Institute of Psychology, Berlin – Recent studies provide evidence that more difficult target selection lead to stronger attentional top-down control thereby reducing arising conflicts (Lavie & Fox, 2000; Kehler et al., in press). In order to test this assumption we combined the location negative-priming (NP) paradigm with a probe-technique (Kim & Cave 1999). Selection difficulty was manipulated by comparing an easy and a difficult discrimination task. The probe stimulus appeared in one of four possible stimulus locations in half of the trials. It was equally distributed on a previous distractor (DT), target (TT) or blank (BT) prime location. Subjects (N=52) had to detect the probe stimulus by pressing a foot-pedal. Event-related potentials (ERP) were recorded from 64 electrodes. A significantly delayed reaction time (RT) for NP- as compared to control-trials, i.e. NP-effect, was only evident in the easy task. Further, we found generally faster detection rates for probe stimuli in the difficult than in the easy task, indicating stronger attention allocation. For probe locations RTs were faster in TT followed by BT and DT in both tasks. ERP-analysis revealed a reduced frontal P2-component for the difficult compared to the easy task. The N2pc, an index for attentional allocation, was differentially modulated by probe conditions with reduced amplitudes for DT compared to TT and BT. In sum, these findings are consistent with our theory that increasing task demands lead to stronger top-down control, thus reducing conflicts in visuo-spatial attention.

F14

ATTENTION ENHANCES THE NEURAL PROCESSING OF RELEVANT FEATURES AND SUPPRESSES THE PROCESSING OF IRRELEVANT FEATURES IN HUMANS: AN FMRI STUDY OF THE STROOP TASK

Thad Polk^{1,2}, Robert Drake², John Jonides^{1,2}, Mason Smith¹, Edward Smith³; ¹University of Michigan, Psychology, ²University of Michigan, Neuroscience Program, ³Columbia University, Psychology – We present a functional MRI experiment investigating the neural basis of feature-based attention in humans using the Stroop task. Cortical areas specifically involved in color processing and word reading were first identified in individual participants using independent tests. These areas were then probed during the Stroop task (in which participants must selectively attend to the font color of a word while ignoring the word itself). We found that activation in functionally-defined color areas increased during the task relative to a neutral color-naming task while activation in functionally-defined word areas decreased. These results are consistent with a biased competition model of feature-based attention in which the processing of attended features is enhanced and the processing of ignored features is suppressed. (This work was supported by NIH Grant R01-MH60655-01A1 and by the National Science Foundation.)

F15

SENSORY CONSEQUENCES OF DIRECTING ATTENTION AND ACTION TO OPPOSITE LOCATIONS

Elena Gherri¹, Martin Eimer¹; ¹School of Psychology, Birkbeck College, University of London – Previous event-related-potential studies have demonstrated that preparing an action at a specific location selectively enhances the processing of visual stimuli at that location, as demonstrated by enhanced N1 components to visual probes presented close to the hand involved in a currently pre-

pared response. These effects were similar to those previously found observed as a result of covert spatial attention, suggesting that attention and action both result in spatially selective modulations of visual processing. If this is the case, the attentional processing of visual stimuli on one side should be less efficient when participants simultaneously prepare an action directed to the opposite side. To test this prediction, we cued participants to shift their attention to the left or right side, and to simultaneously prepare to lift the index finger of their left or right hand. Imperative stimuli were either a central Go signal, requiring execution of the prepared manual response, or a peripheral visual stimulus, which required a visual target-nontarget discrimination only when presented on the cued side. An enhanced N1 was elicited by visual non-target stimuli on the task-relevant attended side only when attention and action were directed to the same side. In contrast, no such attentional N1 modulation emerged when they were directed to opposite locations. These results demonstrate that selecting a visual stimulus on one side is less efficient when simultaneously preparing an action on the opposite side, and thus supports the hypothesis that shared mechanisms are involved in the control of attention and action.

F16

GENDER DIFFERENCES IN ATTENTION TO SOCIAL AND NON-SOCIAL STIMULI: AN ERP STUDY Anna Kresse¹, Yenchen Chang¹, Heather Ford¹, Nga Nguyen¹, Kelly Snyder¹; ¹University of Denver, Psychology, – Young infants exhibit gender differences in attention to social and non-social stimuli (e.g., faces vs. mechanical mobiles). Specifically, females attend more to social than non-social stimuli, whereas males show the opposite effect (Luchmaya & Baron-Cohen, 2002; Connelan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000). Previous work in our lab found that 6-month-old females, but not males, showed better long-term memory for social stimuli (i.e., objects with faces such as people, pets, stuffed animals, etc.) compared to non-social stimuli (e.g., objects without faces such as furniture, toy cars, etc.). One possible explanation for these gender differences in memory is that they result from differences in attention at encoding, where greater attention toward one class of stimuli (e.g., people) results in deeper encoding and thus better memory for those stimuli. In the present study, we used high-density electrophysiology to examine gender differences in attention to, and memory for, social and non-social stimuli. Six-month old infants viewed 25 pictures of unfamiliar people and 25 pictures of unfamiliar cars, each presented twice in immediate succession, while event-related potentials (ERP) were collected. Preliminary analyses indicate that females exhibit larger (i.e., more negative) amplitudes of a mid-latency negative component (Nc) thought to index attention in response to people ($M = -18.8$ uV) compared to cars ($M = -11.5$ uV), whereas males show no difference in Nc amplitude to people and cars. This pattern of findings suggests that females direct more attention toward social than non-social stimuli, consistent with the findings from previous behavioral work.

F17

VERTICAL AND HORIZONTAL LINE LENGTH COMPARISON IN LEFT NEGLECT Pom Charras^{1,2}, Paolo Bartolomeo², Juan Lupiáñez¹; ¹University of Granada, ²INSERM 610 - Hôpital Pitié Salpêtrière – Patients with left unilateral neglect usually show a rightward bias when bisecting horizontal lines. This effect has been accounted for by postulating a distortion of spatial coordinates with a progressive enlargement from the right to the left (Bisiach et al, 1996). However, Urbanski et al (2008) have demonstrated that the rightward bias was decreased or even nullified by having patients explore lines from the left endpoint. Their results support a biased competition account, according to which an attentional orienting dysfunction due to a lesion of a right parietal-frontal network emphasizes the right part of the horizontal line, so that it would be overestimated in comparison to its left counterpart. In this study, we explored another aspect of left-right competition, involving horizontal and vertical lines. We asked patients with left neglect to draw a horizontal segment having the same length of a vertical segment. Horizontal lines had to be drawn

either on the left or right of the sample vertical line. Results showed that horizontal lines were drawn as longer when on the left side (as in a reversed L), as compared to when they had to be drawn on the right side of the sample (as in a canonical L). This result suggests that the sample line was overestimated when presented on the right and underestimated when presented on the left, and thus extends the findings by Urbanski et al, by showing that even vertical lines may participate to the left-right competition resulting in biased line estimation in neglect.

F18

THE RELATIONSHIP BETWEEN FRONTAL EYE FIELD SELECTIVITY AND REACTION TIME IN CORRECT AND ERRANT BEHAVIOR Richard Heitz^{1,2,3}, Jeremiah Cohen^{1,2,3}, Geoff Woodman^{1,2,3}, Jeffrey Schall^{1,2,3}; ¹School of Psychology, ²Vanderbilt Vision Research Center, ³Center for Integrative and Cognitive Neuroscience – Research suggests that neurons in the frontal eye field (FEF) are part of a frontal network that integrates sensory evidence and discriminates contextually relevant targets. Using a neuron-antineuron approach, we have studied this using Target Discrimination Time (TDT): the moment target-related neural activity becomes significantly larger than distractor-related neural activity. Recent work shows that variance in TDT is related to task difficulty, providing a mechanism for related delays in behavioral reaction times. The current work extends these findings in two routes. First, we examined how TDT relates to set size in a T/L visual search task. Second, we looked at TDT during error trials. Our results provide contrasting support for current theory regarding the nature of FEF. On the one hand, neuron TDT is delayed as set size increases; in accord with current thinking and extant data, this supports the viewpoint that FEF is directly involved in target selection and decision processing. Likewise, TDT on error trials is earlier than TDT on correct trials, mimicking the behavioral effects. In opposition to this, neural activity for most neurons on error trials tended to select the saccade endpoint rather than the target itself (Thompson et al., 2005). Evidence for two other neuron types were also observed: a small proportion of cells continued to select the target on error trials, and another small proportion initially selected the target, only to represent the saccade endpoint a short while later.

F19

A SINGLE CLASSIFIER PREDICTS THE DIRECTION OF SPATIAL ATTENTION, WORKING MEMORY, AND MOTOR INTENTIONS Clayton Curtis¹, Adam Riggall¹; ¹New York University, Psychology & Neural Science – We recently demonstrated that neural activity in the same frontal and parietal cortical areas persists when humans 1) maintain a location in working memory, 2) covertly maintain attention peripherally, and 3) maintain a spatially directed motor intention. We concluded that spatial working memory, attention, and intentions share a common neural mechanism that is implemented in these areas. To further test these conclusions, here, we use multivoxel pattern classification of fMRI data to test two hypotheses. First, we can predict the location of a working memory representation, the direction of covert attention, and the target of a motor intention based on the multivariate pattern of delay period activity. Indeed, we find that frontal and parietal cortex activity can correctly classify whether subjects are remembering, attending, and planning a movement to the right or left hemifields. Second, we show that the classifiers generalize across tasks. We trained classifiers on one task (e.g., working memory) and tested its predictive validity on the other tasks (e.g., spatial attention and motor intention). Remarkably, despite that subjects were performing a different task, we observe robust cross-task classification. A classifier trained to discriminate the position of a working memory representation can predict the direction of one's attention and the goal of one's motor intentions. These results suggest that the information contained within these areas during delay periods is not dependent on working memory, attention, or intentions. Instead, it argues that these areas implement a common mechanism that supports a variety of spatial cognitions.

F20**SELECTION IN ENUMERATION: NEURAL EVIDENCE OF INDIVIDUAL DIFFERENCES IN THE SELECTION OF MULTIPLE ITEMS**

Trafton Drew¹, Jason Fair¹, Edward K. Vogel¹; ¹University of Oregon – How many objects can be simultaneously selected at once? While there is an enormous literature devoted to understanding search for one target amongst distractors, there is a relative paucity of research on selecting multiple targets. Certainly, there must be an upper limit on the number of objects than can be simultaneously selected, but it is not currently clear what this limit is. When asked to judge the number of items, there is behavioral evidence that people can select between 3 and 4 items in parallel and generally have to count additional items in serial. Our lab has developed a procedure that allows us generate an electrophysiological index of the number of items that a subject selects. Previously, this index has indicated that individual differences in the initial selection phase of the multiple object tracking task strongly predict tracking ability (Drew & Vogel, *Journal of Neuroscience* 2008). In the current set of studies, we extended this finding by showing that when subjects are simply asked to count the number of targets, this electrophysiological index of selection (the N2pc) once again reflects individual differences in the ability to select multiple items. Furthermore when subjects are asked to count the number of targets, this index increases from one to three targets and asymptotes between three to five items.

F21**EVIDENCE FOR A HIGH-THRESHOLD CAPACITY LIMIT IN VISUAL PERCEPTION**

Edward Ester¹, Keisuke Fukuda¹, Edward Awh¹; ¹University of Oregon, Psychology – Recent research has suggested that capacity in working memory (WM) is best described by a high threshold model, in which some information is available for a discrete number of items, while zero information is retained regarding items that exceed this "slot limit" (e.g., Rouder et al., 2008; Zhang and Luck, 2008). Alternatively, signal detection models suggest that WM is supported by a pool of resources that can be flexibly allocated across much larger numbers of items, with declining resolution as the number of stored items increases. The goal of the present research was to examine which of these models best describes performance in an encoding-limited procedure that required memory for only a single item. Subjects in our study were required to monitor multiple locations in a masked visual display with the goal of discriminating the orientation of a lone target amongst distractors. Performance in this task was well described by a high-threshold model, suggesting that subjects could simultaneously monitor a small number of locations, while encoding no information from others. Moreover, individual capacity estimates from this task were strongly correlated with a separate measure of working memory capacity for the same kinds of stimuli. These data suggest that both perceptual encoding and storage in working memory depend upon a common high-threshold system that allows monitoring or storage of a highly-limited, discrete set of positions or items.

F22**AN EVENT-RELATED POTENTIAL STUDY OF THE EFFECT OF INVOLUNTARY SPATIAL ATTENTION ON RESPONSE-SELECTION RELATED PROCESSES**

David Prime¹, Pierre Jolicoeur¹; ¹University of Montreal – There has recently been renewed interest and controversy regarding the effect of involuntary attention on target processing. In the present study we utilized event-related potentials (ERPs) to investigate the effect of involuntary attention on response-selection related processes. In a visual cue-target experiment with a short cue-target stimulus-onset asynchrony (SOA) participants were required to make speeded responses to frequent Go-targets and to withhold responses from infrequent NoGo-targets. In addition to the typical effect of involuntary attention on response time, we found that cue validity affected the latency of the fronto-central ERP peaks related to response-selection and executive control. The peak latencies of the fronto-central P2, N2, and P3 peaks elicited on NoGo trials were delayed when the target was pre-

sented at an uncued location relative to when the target was presented at a cued location. However, cue-validity did not effect the amplitude of either the P2 or N2 component. In contrast, Prime and Jolicoeur (in press) found that the inhibition of return (IOR) effect found at long cue-target SOAs was associated with a large increase in N2 amplitude for targets presented at uncued locations relative to targets presented at a cued locations. The present results indicate that involuntary attention can facilitate the speed of post perceptual processing starting at a latency of approximately 200 ms. Furthermore, these results combined with the results of Prime & Jolicoeur (in press) indicate that involuntary attention and IOR have different effects on post perceptual processes.

F23**NEUROPHYSIOLOGICAL SHIFTS IN ATTENTION USING VALID AND INVALID PERIPHERAL CUES**

Nikki Pratt^{1,2}, Dennis Molfese³; ¹Psychological & Brain Sciences, University of Louisville, ²VA Northern California Health Care System, Martinez, CA, ³Birth Defects Center, University of Louisville – Electrophysiological responses (P1, N1) were analyzed to track the neural underpinnings associated with voluntary and involuntary attention. The task consisted of a modified Posner attention paradigm that used valid and invalid cues to elicit effortful or automatic orientation. The P1 (80 to 120 ms) and N1 (120 to 170 ms) were analyzed with respect to valid and invalid cues in the two attention orientation conditions. The results indicated that the P1 response was associated with activity in the lingual gyrus and was greater to targets that appeared in the voluntary attention compared to targets in the involuntary attention condition. This finding extends previous research by Doallo et al. (2004) that reported peripheral cues in a voluntary attention task decreases the amplitude of the P1 when valid targets are presented. On the other hand, the N1 response, located within the inferior parietal and medial temporal gyrus, was larger to invalid targets compared to valid targets. This suggests that the N1 reflects attention shifts from the incorrect cue location to a location where the target is presented. Both electrophysiological findings indicate that early attention processes are sensitive to effortful and automatic shifts in attention orientation using only peripheral cues.

F24**VISUAL VIGILANCE TRAINING ENHANCES HEMISPHERIC ASYMMETRIES IN GLOBAL AND LOCAL PROCESSING**

Albert K. Hoang Duc¹, Thomas Van Vleet^{1,2}; ¹University of California, Berkeley, ²Veterans Affairs, Martinez – Studies of neurologically impaired patients have shown right hemisphere (RH) dominance for global processing and left hemisphere (LH) dominance for local processing. Likewise, studies of event-related potentials in healthy subjects have revealed right parietal and left temporal activity with attention shifts to global and local forms, respectively. In addition to global processing specialization, neuroimaging studies point to the crucial role of RH in vigilance and sustained attention. Here we show that a short visual vigilance training (VVT) task significantly enhances hemispheric asymmetry in global/local processing. Healthy subjects are asked to identify the global and local aspects of compound stimuli, pre- and post-VVT. Training consists of performing a discrimination task in which subjects withhold response to an infrequent target, but respond to all non-target scene pictures. In a control experiment, the VVT task is substituted with a change blindness task containing similar scene pictures. Following VVT, subjects demonstrate dramatic reduction of local and an increase of global interferences while attending to global and local forms, respectively. On the other hand, change blindness task does not produce any similar effects. Given evidence supporting hemispheric asymmetries in vigilance, targeting this attention domain exclusively may have provided more focused activation of the RH. Indeed, the detection of low frequency events has been proven to modulate right neuronal network. Since restoring the balance between RH and LH is critical to cognitive recovery, our findings pave the way for developing novel rehabilitation protocols to reduce cognitive disorders associated with RH lesions, such as unilateral spatial neglect.

F25

AN EVENT RELATED POTENTIAL STUDY OF INHIBITION OF RETURN IN YOUNGER AND OLDER ADULTS Nora Gayzur^{1,2}, Stephanie Simon-Dack^{1,2}, Alyson Saville^{1,2}, Linda Langley^{1,2}, Wolfgang Teder-Salejari^{1,2}; ¹North Dakota State University, ²Center for Visual Neuroscience, Psychology – The purpose of this study was to examine age differences in inhibition of return (IOR) using event related potentials (ERPs). IOR has been defined as a delayed return of attention to a previously searched location and is indexed by a slowed response on Posner's spatial cuing paradigm to a valid location compared to an invalid location. The time course of IOR is altered with age, with IOR developing at longer cue-target intervals for older adults as compared to younger adults. In this experiment, younger (18-35 years) and older adults (55 years and older) were tested using a single-cue paradigm (cue-target interval: 425ms-625ms). Reaction time (RT) analysis revealed that younger adults showed IOR response patterns, but older adults did not. Consistent with previous research, younger adults showed a P2 reduction for valid trials, thought to reflect an inhibition of attention to the searched location. Younger adults showed a P2 for invalid trials, but older adults did not. P3 differences were found, with older adults having larger P3 amplitudes to invalid trials, and younger adults having larger P3 amplitudes to the valid trials. The P3 patterns may reflect age differences in expectations for valid and invalid targets. Validity differences in the P2 and P3 effects may reflect attentional processing in two populations showing different IOR response patterns.

Higher level cognition: Disorders

F26

MINDBLINDNESS IN RELATION TO ONESELF: NEURAL RESPONSE TO SELF-REFLECTIVE MENTALIZING IN AUTISM AND NEUROTYPICAL ADULTS Michael Lombardo¹, Bhismadeo Chakrabarti¹, Ed Bullmore², Susan Sadek¹, Greg Pasco¹, Sally Wheelwright¹, John Suckling², Simon Baron-Cohen¹, MRC AIMS Consortium³; ¹Autism Research Centre, University of Cambridge, ²Brain Mapping Unit, University of Cambridge, ³Institute of Psychiatry, Kings College London; University of Cambridge; University of Oxford – "Mindblindness" is a term used to characterize the impairments in understanding mental states by individuals with autism spectrum conditions (ASC). Most research however, has tested mindblindness in relation to other's minds. More recently, work has begun to focus on the self-referential cognitive difficulties in ASC. With fMRI, we assessed adults with and without a diagnosis of ASC for differences in the neural systems engaged during reflective mentalizing or physical representations about the self or others. Reflective mentalizing deficits were apparent in mentalizing/simulation circuits consisting of posterior superior temporal sulcus (pSTS) and secondary somatosensory cortex (SII). Ventromedial prefrontal cortex (vmPFC) was less active in ASC during self-reflection. Specific deficits for self-mentalizing were observed in middle cingulate cortex (MCC). Variability in dorsomedial prefrontal cortex (dMPFC) differentially predicted the degree of alexithymia and autistic traits depending on diagnostic status. Neurotypical individuals activated dMPFC more with increasing alexithymia and autistic traits while individuals with ASC activated dMPFC less with increasing alexithymia and autistic traits. Thus, mindblindness in ASC occurs across a distributed neural network implicated across various circuits for social cognition. Understanding the abnormal organization or interactions between this distributed neural system may shed light on the mechanisms underlying the social impairments in ASC.

F27

NON-VERBAL AUDITORY COGNITION IN PATIENTS WITH EPILEPSY BEFORE AND AFTER UNILATERAL ANTERIOR TEMPORAL LOBECTOMY Aurelie Bidet-Caulet¹, Xiaoli Ye², Patrick Bouchet¹, Marc Guénot³, Catherine Fischer^{1,2}, Olivier Bertrand¹; ¹INSERM,

U821, Lyon, France; University Lyon 1, Lyon, France, ²Neurological Hospital, Functional Neurology and Epileptology, Lyon, France, ³Neurological Hospital, Neurosurgery, Lyon, France – For patients with pharmaco-resistant temporal epilepsy, unilateral anterior temporal lobectomy (ATL) - i.e. the surgical resection of the hippocampus, the amygdala, the temporal pole and the anterior part of the temporal gyri - is an efficient treatment. There are growing evidence that anterior regions of the temporal lobe are involved in the integration and short-term memorization of object-related sound properties. However, non-verbal auditory processing in patients with temporal epilepsy has raised little attention. To assess non-verbal auditory cognition in patients with temporal epilepsy both before and after unilateral ATL, we developed a set of non-verbal auditory tests, including environmental sounds. Auditory semantic identification, acoustic and object-related memory, and sound extraction from a sound mixture were evaluated. We compared the performances of 26 patients with temporal epilepsy before and/or after ATL to those of 18 healthy subjects. Epileptic patients before or after ATL showed similar deficits in pitch retention, and in identification and memorisation of environmental sounds, whereas not being impaired in basic acoustic processing. Furthermore, the more the resection was encompassing the superior temporal gyrus, the more patients were impaired in pitch retention of pure tones. It is most likely that the deficits we observed after ATL reflect removal of already dysfunctioning tissue in the anterior temporal regions because of the epileptic neuropathological manifestations (epileptic spikes and/or atrophy). Therefore, in patients with drug-resistant temporal epilepsy, ATL significantly improves seizure control without producing additional auditory deficits.

F28

BRAIN ACTIVITY PRECEDING INHIBITORY ERRORS IN CHILDREN WITH AND WITHOUT ATTENTION DEFICIT/HYPERACTIVITY DISORDER Tess Nelson¹, Roma Vasa^{1,2}, Eunice Awuah¹, Stewart Mostofsky^{1,2}; ¹Kennedy Krieger Institute, Baltimore, MD, ²Johns Hopkins University School of Medicine – Attention Deficit/Hyperactivity Disorder (ADHD) is characterized by deficits in response inhibition, increased reaction time variability, and decreased neural activity during response inhibition tasks such as the Go/No-go task. No studies, however, have examined whether a specific pattern of brain activity precedes inhibitory errors in children with ADHD. Evidence in healthy adults indicates that increased default mode network activity predicts errors, which suggests that momentary lapses of attention are related to subsequent error commission. In this study, event-related fMRI and a Go/No-go paradigm were used to explore whether this same neural circuit precedes error trials in children with and without ADHD. We examined group differences in brain activity during trials prior to commission errors compared with trials preceding correct inhibition of response in 13 children with ADHD and 17 typically developing (TD) controls. On trials prior to errors, TD children demonstrated relatively greater activity in the precuneus, a central region in the default mode network, compared to children with ADHD. Children with ADHD, however, demonstrated no such predictive activity in the precuneus or other regions of the default mode network. These data suggest that brain activation patterns immediately preceding inhibitory errors in children with ADHD differ from those in TD children. While TD children activate the precuneus, suggesting that momentary lapses of attention precede errors, the errors in children with ADHD may be mediated by different circuits, such as those involved in motor response control.

F29

FIRST-EPIISODE SCHIZOPHRENIA PATIENTS EXHIBIT PREFRONTAL GAMMA BAND DEFICITS DURING COGNITIVE CONTROL Alana Firl¹, Michael Minzenberg¹, Andrew Watrous², Jong Yoon¹, Daniel Ragland¹, Cameron Carter¹; ¹University of California-Davis, Psychiatry, Davis California, ²University of California-Davis Neuroscience Graduate Group – Schizophrenia is characterized by deficits in cognitive control. Schizophrenia patients have shown impairment in the gamma

band (30-80Hz) during cognitive control and perceptual processing tasks. This study examined differences between a patient group and a control group in a cognitive control paradigm. The POP task was used to compare a high control condition with a low control condition. Data was recorded in a shielded room using 128 channel, NSL layout Neuroscan Quik-caps, at a 1000 Hz sampling rate. Electrode impedances were maintained below 5 kOhms. Data was later imported into EEGLAB, average referenced, downsampled to 250 Hz, high-pass filtered at 0.5 Hz, epoched -400 to 1700 ms with 0 ms being cue onset, and artifact rejected. ICA was used to isolate and remove ocular artifacts, primarily blinks. After removal of the ocular component, data was again artifact rejected at a threshold of +/- 50 microvolts. To examine the gamma band from 30-80 Hz, data was analyzed in the time-frequency domain using a complex Morlet wavelet with a c-value of 6. Results included main effect of group when comparing differences between the high control condition and the low control condition, as well as group-by-region-by-condition effects when electrodes were parsed into clusters according to scalp topography. Cognitive control related gamma band activity was specifically reduced across prefrontal sites. These findings suggest that induced gamma band deficits are present in schizophrenia patients at the first episode and point to a possible neural mechanism underlying impaired cognitive control in the illness.

F30

PREVAILED COGNITIVE IMPAIRMENT PLAYS A SIGNIFICANT ROLE FOR MENTAL HEALTH FUNCTIONING IN MAJOR DEPRESSIVE DISORDER - RESULTS FROM A FOLLOW UP STUDY Guro Årdal¹, Åsa Hammar^{1,2}; ¹Biological and Medical Psychology, University of Bergen, Norway, ²Division of Psychiatry, Haukeland University Hospital, University of Bergen, Norway – Significant evidence suggests that depression is characterized by cognitive impairment in the acute phase of illness, and some studies indicate that this impairment persists despite symptom reduction. Disability in mental health functioning is another serious feature concerning the disease, and a number of studies suggests that Major Depressive Disorder (MDD) is associated with significant disability and poorer quality of life. However, the knowledge about the relationship between cognitive impairment and mental health functioning in MDD patients is scant. The aim of this study was to examine the degree to which cognitive functioning, independent of mood symptoms, is related to mental health functioning in a 6 months follow up. 20 patients diagnosed with recurrent MDD and 20 healthy individually matched controls were tested at two occasions, at inclusion and after six months. Inclusion criteria were a Hamilton depression rating scale score at > 18, and a history of more than 2 episodes of MDD. The test battery consisted of experimental tests measuring attention in a visual search paradigm. Mental health functioning was measured using the SF-36 health survey. The results show that prolonged cognitive impairment, independent of mood symptoms, is related to poor mental health functioning in MDD in a six months follow up. In conclusion, these data indicate that prolonged cognitive impairment plays an important role for mental health functioning in MDD.

F31

DOPAMINE, DECISION MAKING AND RISK IN PARKINSON'S DISEASE Victoria Singh-Curry¹, Nico Bunzeck¹, Richard Perry², Peter Bain², Emrah Duzel¹, Masud Husain^{1,2}; ¹Institute of Cognitive Neuroscience and Institute of Neurology, University College London, ²Imperial College London – The role of dopamine in modulating decision making and risky behaviour was investigated in patients with Parkinson's disease (PD). Recent studies implicate dopaminergic medication in pathological risk-taking in PD, yet most patients do not develop such symptoms. We investigated how 28 PD patients responded to novelty and their willingness to take risks, compared to healthy controls. Participants were assessed on two versions of an oddball task, each containing 3 types of infrequently occurring stimulus: targets, perceptually salient standards and novels. In one version of the experiment (task N) subjects were

instructed to respond only to targets and novels; while in another version (task P) responses to targets and perceptually salient standards were required. Akinetic-rigid PD patients were significantly quicker to respond on task N compared to task P. By contrast tremor dominant PD patients and controls performed equally across the two tasks. Faster responses on task N correlated with greater risk-taking behaviour on the Iowa Gambling Task for akinetic-rigid patients only. Importantly, there was an interaction between dose of dopaminergic medication and subgroup of PD. In tremor dominant patients higher L-dopa equivalent doses were associated with quicker responses on task P - to perceptually salient, non-novel stimuli. But dopaminergic dose did not correlate with either performance measure in the akinetic-rigid group. Both patient groups were matched in terms of motor impairment and cognitive performance. These results suggest dopaminergic modulation might have differential effects in the two subgroups of PD patients. Moreover, novelty-seeking correlates with risk-taking behaviour but only in akinetic-rigid PD.

F32

AUTISM SPECTRUM TRAITS IN HEALTHY ADULTS PREDICT CHANGES IN STRUCTURE AND BOLD RESPONSE IN SUPERIOR TEMPORAL SULCUS Elisabeth von dem Hagen¹, Lauri Nummenmaa^{1,2}, Rongjun Yu¹, Michael Ewbank¹, Andrew Calder¹; ¹MRC Cognition & Brain Sciences Unit, Cambridge, UK, ²University of Tampere, Psychology, Finland – Autism Spectrum Disorders (ASD) are neurodevelopmental disorders characterized by deficits in social interactions and communication, repetitive behaviours, and restricted interests. It has been suggested that autism spectrum traits form a continuum which extends across typically developing individuals and individuals with ASD. Baron-Cohen et al (2001) developed the Autism Quotient (AQ) scale as a measure of the severity of autism spectrum traits in adults with normal intelligence. Using the AQ scale, we wanted to determine whether these traits could predict structural and functional differences in the typical population. Based on Kennedy et al's (2006) finding of abnormal deactivation patterns in resting state network regions in ASD during cognitively demanding tasks, we scanned 19 healthy volunteers using a counting stroop task to determine the effect of autism spectrum traits on resting state deactivation in these individuals. In addition, we performed a VBM analysis of 92 healthy adults to determine whether structural differences were also predicted by individual differences in AQ. Using Kennedy et al's (2006) task, we found significant modulation of deactivation as a function of AQ in posterior STS during task conditions. For the VBM analysis, individuals with higher AQ showed a significant reduction in white matter volume in pSTS. These results suggest that autism spectrum characteristics within the typical population predict differences in structure and BOLD response. Our findings have important implications for group-based analyses of typical and ASD populations. References: Baron-Cohen S., et al. J Aut Dev Dis 2001;31:5-17. Kennedy DP, et al. Proc Natl Acad Sci 2006;103:8275-80.

F33

FUNCTIONAL NEUROIMAGING OF AUDITORY LANGUAGE PROCESSING IN CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT Jens Brauer¹, Beate Sabisch¹, Angela D. Friederici¹; ¹Max Planck Institute for Human Cognitive and Brain Sciences – Children affected by specific language impairment (SLI) show problems with language processing in language tasks involving phonological, syntactic, and/or semantic information. Though, they have normal nonverbal intelligence and don't show overt neurological, physical, or emotional deficit. We conducted a functional magnetic resonance imaging (fMRI) experiment on auditory sentence comprehension in children with SLI at the age of 6. Additionally, a group of children, matched for gender, nonverbal IQ, and handedness, served as controls. Short sentences were presented auditorily to the children. These sentences were either correct or carried obvious syntactic or semantic violations. While listening to the material, children were required to evaluate the correctness of the sentences. First

analyses yielded the following results: Even though both groups demonstrate equivalent behavioral results in response correctness and reaction times for the acceptability judgment task, functional activation is deviant in the SLI group in perisylvian language areas. This group shows less activation in inferior frontal and superior temporal cortices. While in control children functional activation of language processing is left-lateralized according to cluster size of activated regions, there is no hemispheric language lateralization in SLI children. These preliminary results indicate a pattern of unusual functional processing of auditory language information at the sentential level in 6-year-old children with SLI. The observed activation pattern in SLI children converges with data reported for adults with SLI. They are also compatible with previous data on structural abnormalities in SLI in perisylvian brain regions.

F34

PATTERNS OF NEURAL ACTIVATION IN SOCIAL ANXIETY DISORDER Emily Dennis¹, Paul Hamilton¹, Jutta Joormann², Michael Chen¹, Ian Gotlib¹; ¹Stanford University, Mood and Anxiety Disorders Laboratory, Psychology, ²University of Miami, Psychology – Social Anxiety Disorder (SAD) is marked by a debilitating fear of social situations that is thought to be subserved, in part, by cognitive biases toward affectively negative information. The neural bases of these cognitive biases in SAD have yet to be systematically explored. Participants in this functional magnetic resonance imaging (fMRI) study were women diagnosed with SAD who had no comorbid Axis-I disorders, and women with no current or past Axis-I disorders. As they were scanned, participants listened to self- or other-directed statements that included positive ("you are attractive"), negative ("she is downcast"), and socially-relevant negative ("he is embarrassed") adjectives. Preliminary results indicate that, in contrast to the never-disordered participants, SAD participants activate the frontoparietal attention network and the anterior insula in response to negative self-directed statements. Importantly, healthy participants activated this same network in response to positive self- and other-directed statements, whereas SAD individuals showed deactivation in these areas. These results implicate a distributed neural network in affectively biased information processing in SAD and suggest that attentional biases play a key role in the maintenance of SAD.

F35

ELUCIDATION OF SLOWED PROCESSING SPEED IN ADHD Joshua Ewen¹, Priya Xavier², Balaji Lakshmanan¹, Jeffrey Moher³, Howard Egeth³, Martha Denckla², Mark Mahone²; ¹Kennedy Krieger Institute, Neurology and Developmental Medicine, ²Kennedy Krieger Institute, Developmental Cognitive Neuroscience, ³Johns Hopkins University, Psychological and Brain Sciences – Children with ADHD have slowed response latency on most timed tasks, suggesting reduced "processing" speed. Clinical measures of processing speed, however, do not reveal which cognitive sub-process(es) (stimulus perception/evaluation vs. response selection/preparation [RS/P] vs. motor execution) are slowed in ADHD. The psychological refractory period (PRP) is an effect seen in dual task interference paradigms. It depends on a cognitive bottleneck in RS/P and can be used to study slowing specifically in RS/P. The paradigm consists of 2 forced-choice reaction time (RT) tasks presented in quick succession with variable stimulus-onset asynchrony (SOA) (50, 150, and 750msec). Elongation of RT to the second task (T2) with shorter SOAs is thought to represent interference during RS/P. To address our hypothesis that children with ADHD have slowing in RS, we tested 10 children (6 ADHD, 4 controls) ages 9 to 13. Children with ADHD had slower T2 RT at all 3 SOA levels. All conditions had a large effect size ($d > 0.95$), but the effects were not statistically significant, given small N. ADHD participants showed a greater PRP effect (i.e., difference in T2 RT between short and long SOA) ($d = 0.99$). The increased PRP effect in ADHD subjects suggests a delay in RS/P in children with ADHD. This is consistent with neuroimaging evidence of anomalous development of the supplementary motor cortex, thought to be responsible for response control. These data do not exclude additional slowing in other sub-processes.

Future research will use event-related potentials in this same paradigm to address the latter question.

F36

NEURAL CORRELATES OF VOLITIONAL SACCADÉ INITIATION IN SCHIZOPHRENIA Julia Bender¹, Christian Kaufmann¹, Benedikt Reuter¹, Norbert Kathmann¹; ¹Humboldt Universität zu Berlin, Psychology, Clinical Psychology – Action control is known to be impaired in Schizophrenia patients. This is reflected in profound deficits in various volitional saccade tasks, but not in visually-guided saccades. Recent models therefore suggest a deficit in the volitional initiation of action. The present study aimed to identify the neural correlates of a putative saccade initiation deficit by functional magnetic resonance imaging of volitional and visually-guided saccades in 18 Schizophrenia patients and 18 healthy control subjects. The experimental design allowed the isolation of saccadic response selection and wilful saccade initiation. Schizophrenia patients showed altered initiation activity in the frontal eye field, the supplementary eye field and in the intraparietal sulcus, which varied with the type of saccade initiation (volitional vs. visually-guided). The results are discussed in the context of theories of a deficit in willed action in Schizophrenia.

F37

DISSOCIATION OF ERROR MONITORING AND RESPONSE INHIBITION IN COLLEGE STUDENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER Wen-Pin Chang¹, William Gavin², Patricia Davies²; ¹University of Indianapolis, ²Colorado State University – Attention-deficit/hyperactivity disorder (ADHD) has been recognized as a lifelong disorder. Recent studies focused their attention to examine neurological underpinnings in adults with ADHD and found that poor cognitive control in ADHD is associated with deficient error monitoring and response inhibition. However, there remains a paucity of information regarding both error monitoring and response inhibition in college students with ADHD. Therefore, the purpose of this study was to investigate electrophysiological indices of error monitoring and response inhibition in college students with and without ADHD. We examined 17 control (10 males, 7 females; age = 24.02 ± 3.68; IQ = 117.41 ± 6.35) and 17 ADHD (10 males, 7 females; age = 23.88 ± 3.48; IQ = 116.76 ± 7.22) students using a visual flanker task and a simple go/no-go task. The results for the visual flanker task revealed that the ADHD group exhibited a smaller mean error-related negativity (ERN) amplitude as compared to the control group, $t(32) = 2.020$, $p = .027$, but no group difference in the error positivity (Pe) amplitude. Thus, in contrast to control students, ADHD students displayed less error detection (ERN amplitude) but comparable response to evaluating errors (Pe). In the go/no-go task, there were no significant differences between the two groups in the NoGo-N2 and NoGo-P3 amplitudes. Thus, related to inhibitory control, ADHD students displayed brain responses to inhibition of prepotent responses similar to control students even though college students with ADHD displayed deficits in error monitoring. Thus, brain responses in error monitoring and response inhibition were dissociated in college students with ADHD.

F38

DEGREE OF LIMB APRAXIA RECOVERY VARIES IN ACUTE AND CHRONIC STROKE PATIENTS WITHIN PRODUCTION AND CONCEPTUAL DOMAINS Vessela Stamenova^{1,2}, Eric A. Roy^{3,4,2,1}, Debbie Hebert⁵, William McIlroy^{3,2,1}, Sandra E. Black^{6,2,1}; ¹Graduate Department of Rehabilitation Science, University of Toronto, ²Heart and Stroke Foundation of Ontario Centre for Stroke Recovery, ³University of Waterloo, Kinesiology, ⁴University of Waterloo, Psychology, ⁵University of Toronto, Occupational Science and Occupational Therapy, ⁶University of Toronto, Medicine (Neurology) – Limb apraxia is a disorder affecting performance of gestures on verbal command (pantomime), on imitation, and/or in tool and action recognition. We aimed to examine recovery on tasks assessing both conceptual and production aspects of limb praxis in left ($n = 19$), right ($n = 9$) and bilateral ($n = 1$) stroke patients. Patients were assessed longitudinally (average 3 times) on 3 conceptual (Action identi-

fication, Action naming and Tool Naming) and 5 production tasks (Pantomime, Pantomime by Picture, Concurrent Imitation, Delayed Imitation and Object Use). They were grouped as presenting with apraxia (Score < 2 SDs of the controls' mean (n=27)) or not, and as acute (1st assessment within 3 months post stroke) or chronic (over 3 months post stroke). Hierarchical linear modeling was used to analyze the data because patients were assessed at different intervals and had variable numbers of follow-ups. Average performance of chronic apraxic patients was higher than acute apraxic patients on pantomime, pantomime by picture and concurrent imitation. While all tasks, except Action Identification, showed evidence of recovery in both acute and chronic apraxia patients, a faster rate of recovery among acute patients was observed only in the two pantomime and two imitation tasks. Chronic apraxia patients did not have lower gains in performance than the acute apraxia patients on Object Use and the two naming tasks; tasks that are continuously practiced in everyday life. Thus, patients may continue to improve in these tasks even at chronic stages through the practice they engage in by performing everyday activities.

F39

NORADRENERGIC EFFECTS ON FUNCTIONAL CONNECTIVITY IN AUTISM Ananth Narayanan^{1,2}, Catherine White¹, Sanjida Saklayen^{1,2}, Mary Scatudo¹, Amir Abduljalil¹, Petra Schmalbrock¹, David Beversdorf^{1,2}; ¹The Ohio State University, ²University of Missouri – Previous experiments have demonstrated decreased functional connectivity in subjects diagnosed with ASD when compared to controls, during language tasks. Therefore, drugs that affect functional connectivity may be beneficial in ASD. The noradrenergic system is upregulated in stress, which causes a decrease in the flexibility of access to semantic networks. This impairment in the network flexibility due to stress is reversed by administration of centrally acting β -adrenergic antagonists. Propranolol (a central and peripheral β -blocker) has also shown benefit for language and social behavior in ASD. We hypothesized that administration of propranolol would increase functional connectivity observed during language tasks in ASD as compared to nadolol (peripheral β -blocker), administered to control for effects on peripheral blood flow. Subjects with ASD and age and IQ-matched controls without neurodevelopmental diagnoses were scanned using a Philips 3T scanner, while instructed to respond to the pronunciation (phonological) of a word related to a cue word in a block-design task. Data was preprocessed and analyzed using SPM5 and the correlation of time series was calculated and compared between drug conditions. Administration of propranolol revealed a significant increase in the functional connectivity between activated brain regions as compared to nadolol. Effects on heart rate and blood pressure were identical between the two drugs. These results reveal an increase in functional connectivity upon administration of propranolol in ASD that is not due to peripheral blood flow effects. This may suggest an anatomical substrate for the effects of noradrenergic agents on tasks involving a network search within the brain.

F40

IMPROVING PREFRONTAL CORTEX FUNCTION IN SCHIZOPHRENIA THROUGH FOCUSED TRAINING OF COGNITIVE CONTROL Bethany Edwards¹, Deanna Barch^{1,2,3,4}, Todd Braver^{1,2,3,4}; ¹Washington University, Psychology, St. Louis, ²Washington University, Radiology, St. Louis, ³Washington University, Neuroscience, St. Louis, ⁴Washington University, Philosophy, St. Louis – Previous research has shown that patients with schizophrenia show deficits in cognitive control functions thought to depend on the lateral prefrontal cortex (IPFC), as well as interactions with other regions such as anterior cingulate cortex (ACC), and posterior parietal cortex (PPC). The current study explored the effects of instructed strategy training in improving cognitive control functioning in patients with schizophrenia. Event-related fMRI was used to test whether effects of such training were associated with changes in brain activity dynamics during task performance. Patients with schizophrenia performed the AX-CPT cognitive control task in two-

sessions, with the first session occurring pre-training and second immediately following strategy training. The training protocol emphasized direct encoding of contextual cues and updating response selection goals in accordance with cue information. A matched group of healthy controls underwent the same protocol but were only scanned in the pre-training session. Compared to controls, patients exhibited the typical pattern of impaired utilization of contextual information in the pre-training session. However, following training their performance selectively improved in terms of the use of context. Analyses of brain activity indicated changes in dynamics of trial-related activation within IPFC, ACC and PPC. Specifically, the strategy training session appeared to have a "normalizing" effect on patient's brain activity dynamics to bring them in closer alignment to the pattern observed in controls. These results suggest that focused strategy training may facilitate cognitive task performance in patients with schizophrenia by changing the dynamics of activity within critical control-related brain regions.

F41

MODELING LATERALIZATION OF SEMANTIC KNOWLEDGE IN THE ANTERIOR TEMPORAL LOBES Anna Schapiro¹, James McClelland¹, Stephen Welbourne², Matthew Lambon Ralph²; ¹Stanford University, ²University of Manchester – A connectionist model of semantic knowledge is presented that accounts for the performance on semantic tasks of patients with varying degrees of unilateral damage (due to, for example, tumor resection or stroke) and bilateral damage (due to semantic dementia) to the anterior temporal lobes. Patients with unilateral damage are able to perform at or close to normal levels on naming and word-to-picture matching tests, whereas patients with bilateral damage show a steep decline in accuracy with increasing damage. In addition, patients with bilateral but asymmetrically left-sided damage have more difficulty with verbal tasks, and patients with bilateral but asymmetrically right-sided damage have more difficulty with visual tasks. The model has sparse connectivity between the units representing right and left anterior temporal lobes to encourage independence in the function of the two sides and uses noise and weight decay in training to induce robust and distributed representations. Like the patients, the model performs significantly better with unilateral than bilateral damage, providing a possible explanation for the trends in patient behavior. The model also incorporates decreased connectivity from the left semantic representations to visual output and from the right semantic representations to verbal output, allowing it to exhibit the dissociation seen in patients with asymmetrically right-sided or left-sided damage. The close fit of the model's behavior to the patient data suggests that the representation and processing of semantic information in the brain may be similar to that in the model.

F42

ABSENCE OF CUE INDUCED CROSS-FREQUENCY INTERACTIONS IN CHILDREN DIAGNOSED ATTENTION-DEFICIT/HYPERACTIVITY DISORDER Ali Mazaheri^{1,4}, Sharon Coffey-Corina^{1,4}, Evelijne Hart de Ruijter, Anne Berry, George R. Mangun^{1,4}, Blythe A. Corbett^{1,2,3,4}; ¹Center for Mind and Brain, ²M.I.N.D. Institute, ³Psychiatry, ⁴University of California (Davis) – Attention Deficit Hyperactivity Disorder (ADHD) is characterized by symptoms of inattention, impulsivity, and hyperactivity. The current pathophysiologic models of ADHD suggest that symptoms may be related to impaired functional connectivity within brain networks. In this electroencephalogram (EEG) study we analyzed cross-frequency amplitude anti-correlations between distant regions to investigate differences in cue induced functional connectivity in typically developing and ADHD children. EEG was recorded in 19 children (11 ADHD) while they performed a cross-modal attention task in which visual cues signaled the modality of an upcoming target. The power spectra of theta (3-4 Hz) and alpha (7-11 Hz) activity were calculated for the 1 second interval after the cue. Behaviorally, the visual cue appeared to facilitate stimulus processing for both typically developing and children with ADHD ($p=0.018$), although the reaction times were

slower in the latter ($p=0.03$). The EEG analysis revealed that a visual cue induced a decrease in occipital alpha activity for typically developing children but not children with ADHD ($p<0.01$). This decrease in posterior-alpha activity was anti-correlated with midline theta activity on a trial-by-trial basis ($p<0.028$). This anti-correlation was absent in children with ADHD. We speculate that the presence of this functional connectivity could indicate top-down drive (midline theta) to perceptual areas (occipital alpha) providing a preparatory state for oncoming stimuli. The cue induced theta-alpha connectivity could be necessary for efficient regulation of attentional resources. The lack of connectivity indexed through cross-frequency interactions has the potential to be used as a new locus in studying ADHD.

F43

THE EFFECTS OF NEUROPLASTICITY-BASED COGNITIVE TRAINING IN ULTRA-HIGH RISK, RECENT-ONSET, AND ADULT CHRONIC SCHIZOPHRENIA Liza Reese³, Melissa Fisher², Rachel Loewy¹, Ashley Lee¹, Sophia Vinogradov², ¹The Wright Institute, San Francisco VA Medical Center, University of California San Francisco, ²San Francisco VA Medical Center, University of California San Francisco, ³University of California San Francisco – We examined the effects of a novel neuroplasticity-based cognitive training program that targets the cognitive deficits in schizophrenia. We compared the response to training, using MATRICS-recommended cognitive measures, of three subject groups (ultra-high risk for psychosis, recent onset of schizophrenia, and adult chronic schizophrenia), to a chronic schizophrenia control group who completed the same number of hours of computer games. The active training condition consists of computerized exercises (developed by Positscience, Inc.) that drive the user to make progressively more accurate distinctions about the spectro-temporal fine-structure of auditory stimuli and speech under conditions of increasing working memory load, and to incorporate and generalize those improvements in auditory signal salience into real-world language comprehension and working memory rehearsal. After 40 hours of this training, and relative to the computer games control group (N=26), ultra-high risk subjects (N=10), recent-onset subjects (N=10), and chronic schizophrenia subjects (N=29), show significant cognitive improvement, as measured by the Global Cognition composite score ($p=.003$), with gains on measures of Working Memory, Verbal Learning and Memory, and Problem Solving. A larger response to training is observed in younger subjects (age<22) compared to adults with chronic schizophrenia (age>23) ($p=.01$). These findings suggest that intervening with a restorative cognitive training program at a younger age provides greater benefit to patients and may be a means of preventing the cognitive decline associated with chronic schizophrenia.

F44

NEURAL CIRCUITRY OF SPEECH PERCEPTION AND PRODUCTION: A COMPARISON BETWEEN STUTTERING AND FLUENT SPEAKERS Helen Chen¹, Einar Mencl¹, Steven Frost¹, Vincent Gracco^{1,2}, ¹Haskins Laboratories, ²McGill University – The purpose of this study was to investigate the similarities and differences in neural circuitry between stuttering and fluent speakers in visual and auditory perception versus production tasks. A total of 20 subjects, in which 10 were stuttering speakers and 10 were fluent speakers, participated in the study. Words were presented auditorally and visually to examine how presentation modality modulated group differences. In the production trials, participants were requested to say the word that was presented. In-scanner speech responses were recorded. Using functional and diffusion imaging, we examined brain structure and function in language and auditory processing areas. Initial comparison between the two groups revealed fluency-related differences in regions including inferior frontal gyrus (IFG), occipital temporal gyrus, superior temporal gyrus (STG), Angular gyrus (AG) and supramarginal gyrus (SMG) in both perception and production tasks. Further comparisons showed effects of presentation modality on these regions that differed across speaker groups. These

results suggest that the two groups differentially activate various language-related processing regions.

F45

ECONOMIC GAMES QUANTIFY DIMINISHED SENSE OF GUILT IN PATIENTS WITH DAMAGE TO THE PREFRONTAL CORTEX Ian Krajbich¹, Ralph Adolphs^{1,2}, Daniel Tranel², Natalie Denburg², Colin Camerer¹, ¹Division of the Humanities and Social Sciences, California Institute of Technology, ²Neurology, The University of Iowa – Damage to the ventromedial prefrontal cortex (VMPFC) impairs concern for other people, as reflected in the dysfunctional real-life social behavior of patients with such damage, as well as their abnormal performances on tasks ranging from moral judgment to economic games. Despite these convergent data, we lack a formal model of how, and to what degree, VMPFC lesions affect an individual's social decision-making. Here we provide a quantification of these effects using a formal economic model of choice that incorporates terms for the disutility of unequal payoffs, with parameters that index behaviors normally evoked by guilt and envy. Six patients with focal VMPFC lesions participated in a battery of economic games that measured concern about payoffs to themselves and to others: dictator, ultimatum, and trust games. We analyzed each task individually, but also derived estimates of the guilt and envy parameters from aggregate behavior across all of the tasks. Compared to control subjects, the patients donated significantly less and were less trustworthy, and overall our model found a significant insensitivity to guilt. Despite these abnormalities, the patients had normal expectations about what other people would do, and they also did not simply generate behavior that was more noisy. Instead, the findings argue for a specific insensitivity to guilt, an abnormality that we suggest characterizes a key contribution made by the VMPFC to social behavior.

F46

THE SAME KIND OF SPATIAL DISTORTION EXPLAINS APPARENTLY DIFFERENT NEGLECT ERRORS IN READING AND BISECTING WORDS Silvia Savazzi¹, Francesca Mancini¹, ¹University of Verona – Neglect patients show rightward errors in bisecting horizontal lines and make errors on the initial letters in reading words. Both these disorders have been found to be ameliorated by the Ooppel-Kundt illusion, thought to simulate the way space is represented in neglect1,2,3. However, these two studies found an amelioration of neglect with opposite illusory conditions. Here, we investigate the hypothesis that this difference is due to the specific task used (line bisection and word reading). Four patients with spatial neglect and neglect dyslexia without hemianopia were asked to read words and to bisect words both with letters evenly and unevenly spaced following the Ooppel-Kundt illusion. All the neglect patients replicated the results by Ricci et al.1 in bisecting words and the results by Savazzi et al.2,3 in reading words; that is opposite modulations of neglect errors with the same patients. These data indicate that opposite results previously found can be reconciled by taking into account the particular requests of the tasks patients are confronted with: a single object to bisect versus a series of ordered letters within a word. In addition, these results show that even if the behavioural results are different, the theoretical framework is the same, the space anisometry hypothesis3. References 1. Ricci R, Pia L, Gindri P. *Exp. Brain Res.* 2004; 154: 226-237. 2. Savazzi S, Frigo C, Minuto D. *Cogn Brain Res* 2004; 19: 209-218. 3. Savazzi S, Posteraro L, Veronesi G, Mancini F. *Brain* 2007; 130: 2070-2084.

F47

THE SAME KIND OF SPATIAL DISTORTION EXPLAINS APPARENTLY DIFFERENT NEGLECT ERRORS IN BISECTING REAL AND NUMERICAL INTERVALS Francesca Mancini¹, Silvia Savazzi¹, ¹University of Verona – Neglect patients show rightward errors in bisecting lines and numerical intervals (mental number line). For both real and numerical intervals, the bisection error increases as a function of the size of the interval: long lines and large numerical intervals produce large rightward errors, short lines and numerical intervals produce medium rightward errors and very short lines and numerical intervals

produce the crossover effect. The rightward bisection error in bisecting real lines has been found to be ameliorated by the Oppel-Kundt illusion, thought to simulate the way space is represented in neglect^{1,2,3}. Here we tested the hypothesis that physical lines and numerical intervals can be modulated by the same visual illusion. Neglect patients were requested to both physically and numerically bisect intervals of different sizes within evenly or unevenly backgrounds inducing the Oppel-Kundt illusion. We found opposite effects on the real and numerical intervals in terms of both bisection errors and illusory effects. This in line with what found for word reading³ and can be explained by taking into account the particular requests of the tasks: a single object to bisect (a word or a physical interval) versus a series of ordered objects (letters or numbers). These results can be explained within the same theoretical framework, the space anisometry hypothesis². References 1. Ricci R, Pia L, Gindri P. *Exp. Brain Res.* 2004; 154: 226-237. 2. Savazzi S, Posteraro L, Veronesi G, Mancini F. *Brain* 2007; 130: 2070-2084. 3. Savazzi S, Frigo C, Minuto D. *Cogn Brain Res* 2004; 19: 209-218.

F48

MEMORY MONITORING FAILURES IN CONFABULATION: EVIDENCE FROM THE SEMANTIC ILLUSION PARADIGM Irene

P. Kan^{1,2}, Karen Fossum², Mieke Verfaellie²; ¹Psychology, Villanova University, ²Memory Disorders Research Center, VA Boston Healthcare System, Boston University School of Medicine – Confabulation is the tendency to make statements or perform actions that are based on apparent distortions of memory. It is a common symptom in patients with ruptured anterior communicating artery (ACoA) aneurysm. Confabulators are typically unaware of the falseness of these memories and often uphold their memories with the greatest conviction. One prominent model characterizes confabulation as a failure in cognitive control and monitoring. In this study, we used the semantic illusion paradigm to evaluate memory monitoring and to examine whether confabulators are particularly impaired at suppressing semantically-related, yet incorrect, memory traces. The semantic illusion paradigm elicits erroneous endorsement of misleading statements (e.g., "Two animals of each kind were brought onto the Ark by Moses before the great flood") in neurologically intact individuals, even though participants are fully aware of the correct answer (Noah, in the example above). We hypothesized that if confabulators are differentially impaired at suppressing incorrect, but semantically-related, memory traces, they will have particular difficulty in overcoming semantic illusions, even at lower levels of semantic confusability. Confusability was manipulated by using difficult, easy, or extremely easy foils (e.g., Moses, Adam, Malcolm X, respectively). Consistent with our hypothesis, we found that confabulators are more susceptible to semantic illusions than both non-confabulating ACoA patients and healthy controls, but endorsed true statements as often as the other two groups. Reducing semantic confusability had less impact on confabulators than on the other groups, consistent with the notion that confabulators are impaired at evaluating and monitoring the veracity of retrieved memory traces.

F49

SELF-PACED TIMING TASK SHOWS SENSITIVITY TO SUBTLE DYSFUNCTION IN PRE-DIAGNOSED HUNTINGTON'S DISEASE Kelly

Rowe^{1,2}, David Moser^{1,2}, Douglas Langbehn^{1,2}, Chiachi Wang^{1,2}, Kevin Duff^{1,2}, Leigh Beglinger^{1,2}, Sarah Queller^{1,5}, Julie Stout^{1,4}, Steven Rao^{1,3}, Jane S. Paulsen^{1,2}; ¹University of Iowa, ²University of Iowa Roy and Lucille Carver College of Medicine, ³Medical College of Wisconsin, ⁴Monash University, Victoria, Australia, ⁵Indiana University – Cognitive outcome measures remain unknown for pre-diagnosed Huntington's disease (pre-HD), though efforts are underway to conduct clinical trials in these participants. Timing tasks have demonstrated impairment in pre-HD, even before characteristically disease-affected brain regions show volume loss. This study compared performance on self-paced finger-tapping between pre-HD and healthy normal participants. Further, the study evaluated the relationship of task performance with proximity to

diagnosis, quantified as the probability of receiving HD diagnosis in the next five years based on trinucleotide expansion in the HD gene and age. Participants in two groups (747 preHD : 188 healthy) listened to tones presented at 550ms intervals, matched that pace by tapping response keys, and continued tapping at that pace for 31 taps after the tone had stopped. There were two conditions: dominant hand index finger tapping and alternating-thumbs tapping. Standardized cross-sectional linear modeling examined the relationships between self-paced tapping precision and age, gender, education, musical experience, typing experience, and proximity to diagnosis. Proximity to diagnosis was related to self-paced tapping precision in both conditions ($t=-11.14, df=920, p<.0001$; $t=-11.32, df=918, p<.0001$), even considering demographic and experience variables. It was possible to identify weaknesses on the alternating thumbs condition in individuals far from HD onset (as low as 4.35% probability of diagnosis over the next five years). In conclusion, the self-paced tapping paradigm has potential for use as a screening tool or outcome measure in preHD trials because it detects impairment in participants with low probabilities of onset, suggesting it could be used to gauge therapeutically-mediated improvement or maintenance in function.

F50

RELATIONSHIP BETWEEN AUDITORY HALLUCINATIONS AND ABNORMAL FMRI ACTIVITY DURING PERFORMANCE OF A WORKING MEMORY TASK: DATA FROM THE fBIRN CONSORTIUM STUDY Cynthia Wible¹, Kang Uk Lee², Israel Molina¹, Brian Roach³, Judy Ford³, Daniel Mathalon³, Jessica Turner⁴, Steven Potkin⁴, Daniel O'Leary⁵, Greg Brown⁶; ¹Harvard Medical School and Brockton VAMC, Psychiatry, Boston, MA, ²Kangwon National University School of Medicine, Psychiatry, ³University of California, San Francisco (UCSF), ⁴University of California, Psychiatry and Human Behavior, Irvine, CA, ⁵University of Iowa, Psychiatry, Iowa City, IA, ⁶University of California, Psychiatry, San Diego, CA – Auditory hallucinations of voices are a frequent and prominent symptom of schizophrenia. The fBIRN consortium study tested schizophrenic and control subjects in similar fMRI procedures at sites around the country. We analyzed the relationship between levels of fMRI activity and levels of auditory hallucinations during performance of a Sternberg Item Recognition Working Memory Paradigm (SIRP). We hypothesized that measures of auditory hallucinations would be correlated with abnormal activity in the temporal and inferior parietal lobe voice/speech perception and production regions. Subjects were 96 chronic schizophrenics. The functional scans were gradient echo EPI, TR = 2, TE = 30 ms, 90 deg, 64x64, 22 cm FOV, 27 slices, 4 mm thick/1 mm gap, oblique axial. The SIRP task was presented using a block design with four six second runs and subjects encoded numbers and were then tested in a probe phase. Two different analyses were performed (hallucinators vs. non-hallucinators and a correlation analysis between activation and symptom levels). Results of both analyses implicated superior temporal and inferior parietal regions. These regions are part of speech and voice perception and production networks. Voice perception/conversation can also involve the activation of aspects of social cognition and self/other representation. Over-activation of this social communication system could also contribute to other symptoms of schizophrenia. We will present the results in the context of a framework implicating these regions in the generation of most of the symptoms of schizophrenia. Supported by NCR 1 U24 RR021992.

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F51

INVESTIGATING NEUROMYTHS OF SOCIAL BRAIN PATHOLOGIES AND CREATIVITY Rachael Grazioplene¹, Judith Segall¹, Robert Chavez¹, Rane Flores¹, Shirley Smith^{1,3}, Alison Marshall¹, Rex Jung^{1,2,3,4}, ¹Mind Research Network, University of New Mexico, ²University of New Mexico, Neurosurgery, ³University of New Mexico, Psychology, ⁴University of New Mexico, Neurology – Controversy surrounding the supposed link between creative ability and the abstract cognitive style is often seen in psychotic-spectrum disorders, whereas high mathematical

"creative" ability has been linked to the compartmentalized cognitive style seen in autistic-spectrum disorders. The literature has spoken both for (Dinn et al. 2002; Nettle & Clegg 2006) and against (Tal & Miller 2007) a correlation between positive schizotypal symptoms and measures of creativity; the link between autism and physical/mathematical thinking has been shown more firmly (e.g. Wheelwright & Baron-Cohen 2001, Baron-Cohen 2002), with Rawlings & Locarnini going so far as to find support not only for schizotypy-creativity correlation, but also the connection of autism-spectrum traits to scientific creativity (2008). We hypothesize that two general types of creativity, wherein abstract creative thinking reflects more global brain connectivity (schizotypal) while a more mathematical creative ability exists by way of enhanced local network (autism-type) connectivity. Gathering data from a nonclinical sample population of visual artists and high math (>95th %ile on SAT/GRE) engineers, we predict that visual artists will perform better on divergent task measures of creativity, whereas engineers will perform better on convergent reasoning measures. Preliminary data supports a trend towards increased performance of visual artists on divergent reasoning tasks compared to age, gender, and FSIQ matched normal controls (Artists = 105.1; Controls = 97.2, $p = .07$). Collection of high math Engineering subjects is ongoing. Differences in brain structure (cortical thickness, diffusion tensor imaging) between visual artists and high math engineers will also be presented.

F52

THE EFFECTS OF SMOKING ON NOVELTY PROCESSING: AN ERP STUDY Sandra Wiebe¹, Dennis McChargue¹, Leigh Blobaum¹, Stephanie Wulff¹, Alex Knezevic¹; ¹University of Nebraska-Lincoln – Nicotine addiction is associated with novelty-seeking and impulsivity. We examined smoking-related differences in ERPs to novel stimuli, to shed light on novelty-related neural processes. A sample of 63 participants (38 smokers, 25 non-smokers) completed a visual oddball task that included 20% targets, 70% standards, and 10% novel trials (non-repeating photographs; Suwazano et al., 2000). EEG was recorded from 128 channels, averaged by trial type, and then reduced using spatiotemporal PCA (Spencer et al., 1999). The first spatial component, accounting for 50.8% of variability in the ERP data, primarily reflected central and right leads. In the virtual epoch corresponding in time to a medial frontal negativity, there was a significant main effect of Smoking Status ($p < .02$) and Trial Condition ($p < .0001$) qualified by an interaction between the two ($p < .005$). Overall, this component was maximal to novel trials. A larger negative amplitude was observed in non-smokers than smokers for both novel ($p < .02$) and standard trials ($p < .03$), but not for target trials, when a response was required ($p = .13$). The third spatial component (8.25% of variance) reflected activity at parietal leads. In the virtual epoch corresponding to the P300, there was again an interaction between Smoking Status and Trial Condition ($p < .01$). P300 amplitude was reduced in smokers for the novel condition ($p < .005$) but not other conditions ($p > .65$). Blunted novelty-related responses may reflect specific effects of nicotine or relate to personality differences underlying predisposition to addition.

F53

INCREASED SERUM LEVELS OF THE NMDA RECEPTOR CO-AGONIST D-SERINE CORRELATE WITH COGNITIVE GAINS INDUCED BY NEUROPLASTICITY-BASED AUDITORY TRAINING IN SCHIZOPHRENIA Rogerio Panizzutti^{1,2}, Melissa Fisher^{3,4}, Christine Holland^{3,4}, Sophia Vinogradov^{3,4}; ¹W.M. Keck Foundation Center for Integrative Neurosciences, University of California, San Francisco, CA, ²Biomedical Sciences Institute, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, ³School of Medicine, Psychiatry, University of California, San Francisco, CA., ⁴Veterans Affairs Medical Center, San Francisco, CA – The cognitive deficits that characterize schizophrenia may be in part related to hypofunction of glutamate-NMDA receptors due to reduced levels of the receptor co-agonist D-serine. Serum D-serine levels are decreased in patients with schizophrenia and increase as their clinical status improves,

while administration of oral D-serine appears to ameliorate cognitive symptoms in patients. We previously performed a randomized controlled trial of neuroplasticity-based cognitive training exercises of auditory perceptual and working memory functions in schizophrenia and showed significant improvement in MATRICS-based cognitive outcome measures in active training subjects vs. computer games control subjects. In the present study, we investigated whether the gain in cognitive outcome measures was associated with changes in serum D-serine levels. We measured D-serine and other amino acids in serum from schizophrenia subjects before and after they performed either 50 hours of computerized cognitive training (N= 21) or 50 hours of computer games (N= 20). The active training subjects, but not the control subjects, showed significant positive correlations between changes in D-serine levels and gains in working memory ($r = 0.5$, $p = 0.04$), verbal learning ($r = 0.6$, $p = 0.00$), and global cognition ($r = 0.5$, $p = 0.01$). The ratio D-serine / L-serine also showed highly significant associations with these same measures. No such associations were observed with glutamate or L-serine levels. Our data suggest that D-serine may serve as a biomarker for a successful response to neuroplasticity-based cognitive training in schizophrenia. These findings may provide some clues as to potential mechanisms of action for this form of cognitive enhancement.

F54

OBSERVATIONAL LEARNING IN THE REMEDIATION OF AN ASSOCIATIVE LEARNING DEFICIT SECONDARY TO PARKINSON'S DISEASE Winifred Limmer¹, Francesco Fera², Antonio Daniele³, Pietro Spinelli³, Ahmed Moustafa¹, Catherine Myers⁴, Mark Gluck¹; ¹Center for Molecular and Behavioral Neuroscience, Rutgers University, Newark, NJ, ²Neuroradiology Unit, University Magna Græcia, Catanzaro, Italy, ³Institute of Neurology, Catholic University, Rome, Italy, ⁴Rutgers University, Psychology, Newark, NJ – Parkinson's disease (PD) is associated with dopamine depletion in the basal ganglia. Research suggests that disruption of the dopamine signal impairs associative learning via error-correcting feedback. In the present study, a computerized concurrent object discrimination task was administered to PD patients and elderly controls. Pairs of objects, which differed in either color or shape, were presented. Some subjects learned by trial-and-error to find a hidden smiley face beneath one of the two objects; other subjects learned by observation. During a test phase, subjects were tested on the trained pairs, and, during a generalization phase, on novel object pairs that had the same relevant - but different irrelevant - features as the trained pairs. Previously, Shohamy et al. (2006) observed that medicated, but not withdrawn PD patients, were impaired relative to controls during the feedback-based learning phase. In the present study, both medicated and withdrawn PD patients were impaired relative to controls during the feedback-based training phase and the test phase, the medicated patients being more impaired than the withdrawn. Medicated and withdrawn PD patients who learned the discriminations via an observational procedure, however, exhibited no learning deficit, making the same number of errors as controls during the test phase. Interpreted in light of functional neuroimaging studies that suggest that feedback-based and observational learning rely on the integrity of different neural structures, the present results suggest that the learning deficit observed in PD patients may be remediated by training via an observational procedure, which recruits different, putatively intact brain structures.

F55

MECHANISMS OF RECOVERY AFTER STROKE: REORGANIZATION OR REGAINING OF FUNCTION? Veena Nair¹, Kirk Brown², Gregory Kirk¹, Vivek Prabhakaran¹; ¹University of Wisconsin-Madison, School of Medicine and Public Health, Radiology, ²University of Wisconsin-Madison, School of Medicine and Public Health, Medical Physics, Medical Scientist Training Program – Neuroimaging studies of stroke have provided conflicting evidence in terms of mechanisms of recovery after stroke. Prabhakaran et al. (2007) examined the neural substrates underlying word generation in chronic stroke (at least 6

months post-stroke) patients. While normal subjects displayed activations in the left-lateralized fronto-temporo-parietal network, stroke patients showed decreased activation in the cortical regions that were hypoperfused and increased activation in the homologous regions of the normal hemisphere suggesting reorganization of structure-function relationship. Other studies of stroke patients with aphasia have observed reduced activation surrounding the infarct in the left hemisphere language areas at the acute time point (< 2 days post-stroke), and activity in the hypoperfused hemisphere returning back to normal at the chronic stage (Saur et al., 2006) suggesting regaining of function by the affected region. The objective of this study is to investigate mechanisms of recovery after stroke. We will map brain activations in stroke patients who are in the acute (less than 3 days post-stroke) or chronic stage (>4-6 months post stroke) using fMRI while patients perform the verbal fluency task in the scanner. Subjects with left and right strokes, along with normal controls, will be imaged while performing a verbal fluency task. Preliminary results from 2 acute left stroke patients show decreased activity in task-related areas in the affected region, 4 chronic left stroke patients show increased activity in the homologous contralateral hemisphere. These results suggest that reorganization is the mechanism that leads to recovery after stroke.

F56

DEVIATIONS IN ALPHA-BAND FUNCTIONAL CONNECTIVITY BETWEEN BRAIN REGIONS IN PATIENTS WITH SCHIZOPHRENIA DURING MAGNETOENCEPHALOGRAPHY (MEG) RECORDINGS AT REST

Srikantan Nagarajan¹, Leighton Hinkley¹, Adrian Guggisberg¹, Anne Findlay¹, Kasra Khatibi¹, Alison Adcock², Sophia Vinogradov^{3,4}; ¹University of California, San Francisco, Radiology, ²Duke University, Psychiatry and Behavioral Sciences, ³University of California, San Francisco, Psychiatry, ⁴Veterans Affairs Medical Center, San Francisco – Evidence from neuroanatomical and imaging studies suggests that schizophrenia is associated with impairments in anatomical cortical connectivity and/or aberrant functional coupling between brain regions. Limited evidence demonstrates aberrant functional connectivity between areas of the brain whose idling frequency exceeds what can be recorded by imaging methodologies such as fMRI. Using magnetoencephalography (MEG), we recorded spontaneous cortical activity during a resting state from 24 patients with schizophrenia and 15 healthy control subjects using a whole-head 275-channel biomagnetometer (CTF Systems, Vancouver BC) with a sampling rate of 600Hz. A single epoch (60s) of artifact-free data was selected and the sources of oscillating neural activity in the alpha range (~8-12Hz) were estimated using an adaptive spatial filtering technique (Vrba and Robinson, 2001). Resting-state functional connectivity in the alpha band between brain voxels was computed using imaginary coherence (IC), a metric that overcomes overestimation biases arising from volume conduction and crosstalk in MEG data (Guggisberg et al., 2007). Tomographic reconstructions of the data were spatially normalized to a canonical MNI template and the mean Z-transformed IC values of alpha activity at each voxel were compared between patients and controls using a non-parametric unpaired t-test. Patients with schizophrenia demonstrated increased alpha band connectivity in the inferior frontal gyrus (IFG) of the right hemisphere, and decreased alpha band connectivity in regions of the right superior temporal gyrus, precuneus and left anterior temporal lobe. These results expand upon the known patterns of aberrant functional connectivity that underlie schizophrenia.

F57

RECOGNITION OF FACIAL AND PROSODIC EMOTIONAL EXPRESSION IN PARKINSON'S DISEASE

Lynette Tippett¹, Sharon Buxton¹, Lorraine Macdonald²; ¹University of Auckland, Psychology, ²Auckland City Hospital, Neurology – Some research findings suggest Parkinson's disease (PD) affects recognition of emotional facial expressions (especially disgust and anger), and reduces sensitivity to prosodic expressions of anger, disgust and fear, but findings are inconsistent. We investigated recognition of facial and prosodic emotional expressions in

30 medicated-PD participants and 30 age, education and gender-matched controls. The 108 face stimuli were based on Ekman and Friesen (1976) faces. Six faces each displaying 6 emotions (happy, sad, angry, disgust, fear, surprise) were morphed between each emotion and neutral. Three levels of expression were selected: 100% emotion and morph levels with 70% and 40% identification accuracy by young controls. Participants identified each facial expression in a multiple-choice format with emotion labels presented simultaneously. Prosody stimuli comprised 8 trials each of happy, sad, angry, fear and neutral intonations (Ross, Thompson, & Yenkosky, 1997) presented simultaneously with 5 multi-choice labels. Participants listened to a neutral sentence read with different emotional intonations (20 trials) and monosyllabic repetitions with emotional inflections (20 trials). PD participants had no difficulty identifying expressions on 100% emotion faces, but were impaired with morphed emotional expressions with significantly lower scores recognising disgusted, happy, sad and surprised faces but not anger or fear. PD participants were also impaired overall on emotion identification by prosody. These data demonstrate that PD induces subtle dysfunction of emotional processing affecting both facial and prosodic stimuli. Dopaminergic depletion interrupting basal ganglia/frontal-striatal systems is likely to underlie these findings, with orbitofrontal cortex, sensitive to judging vocal and facial emotional expressions, also implicated.

F58

FUNCTIONAL-ANATOMIC ABNORMALITIES IN INHIBITION AND ERROR REGULATION AMONG YOUNG ADULTS WITH CHILDHOOD-ONSET ADHD: AN FMRI STUDY OF OCULOMOTOR CONTROL

Katerina Velanova¹, Beatriz Luna^{1,2}, Tracey Wilson¹, Kendal Kingsley¹, Elizabeth Gnagy³, William Pelham^{3,4,5}, Brooke Molina^{1,2}; ¹University of Pittsburgh, Psychiatry, ²University of Pittsburgh, Psychology, ³SUNY Buffalo, Psychology, ⁴SUNY Buffalo, Psychiatry, ⁵SUNY Buffalo, Pediatrics – Attention deficit hyperactivity disorder (ADHD) is the most common neurodevelopmental disorder of childhood, conservatively affecting 3-5% of school-aged children in the US. The disorder is thought to persist into adulthood in 30-70% of affected children. While extensive research has been conducted to describe the cognitive profile and neural correlates of childhood ADHD, relatively little work has been done with young adults. Here we present data from an ongoing pilot study of young men aged 18-25 years, 9 of whom, run to date, met DSM-III-R or DSM-IV diagnostic criteria for ADHD in childhood. All participants have been followed since childhood as part of the Pittsburgh ADHD Longitudinal Study (AA11873; DA12414). Comprehensive clinical data were available for each participant. For this research, event-related functional magnetic imaging (fMRI) was conducted as participants performed the antisaccade task, an oculomotor test of inhibitory control. Regions of interest were derived from an independent fMRI study of antisaccade performance in typical young adults. Timecourses of activity for correctly performed antisaccades, and for (corrected) errors were estimated within regions, and effects confirmed in whole-brain voxelwise analyses. Notable findings to date include attenuated activity in supplementary/pre-supplementary motor area and ventromedial prefrontal cortex during correct performance of antisaccades, and atypical signaling in anterior cingulate cortex during error commission. Voxelwise analyses indicate also that ADHD participants recruited additional regions in ventrolateral prefrontal cortex that were minimally active in typical adults. These data provide preliminary evidence of continued functional-anatomic anomalies, even among ADHD adults whose parent-reported daily functioning is relatively unimpaired.

F59

THE STRENGTH OF THE LINKS BETWEEN OBJECTS, ACTIONS, AND NAMES INFLUENCES ACTION PRODUCTION AND VISUAL OBJECT IDENTIFICATION IN PATIENTS WITH LEFT-HEMISPHERE STROKE Genevieve Desmarais¹, Laurel J. Buxbaum²; ¹Mount Allison University, Psychology, ²Moss Rehabilitation Research Institute – In healthy participants, similarity of novel objects impacts novel action production, and novel action similarity impacts novel object naming: actions are confused more often when associated with similar as compared to distinct objects, and object names are confused more often when associated with similar as compared to distinct actions. These relationships indicate that neighborhood "distance" may benefit both action and name retrieval. Left hemisphere stroke has been shown to disrupt links between actions, objects, and lexical-semantics (names). We therefore investigated this phenomenon using object identification and action production in 20 left hemisphere stroke patients. Participants were asked to learn the associations between novel objects, novel actions, and non-word names (for example, a curved object is pulled and is called 'FINT'). We manipulated the similarity relationships between objects and actions. On test trials, participants were asked to recall the nonword 'name' of each object, and then produce its associated action. Visually similar objects were mis-named more often than visually distinct objects, a normal pattern. Contrary to previous findings in healthy participants, however, action production did not benefit from object distinctiveness, suggesting that object-shape neighborhood distance may not facilitate action retrieval in these patients. Moreover, 62% of all action errors corresponded with the precise incorrect name given the object, suggesting an effort to rely on object name-action links (rather than on object shape-action links) to guide action. Results are discussed in terms of a cognitive-neuroanatomic model of object-related action production.

F60

SEMANTICS VERSUS GRAMMAR: EVENT-RELATED POTENTIALS DURING AUDITORY LANGUAGE PROCESSING IN WILLIAMS SYNDROME Inna Fishman¹, Anna Yam^{1,2}, Mark Grichanik¹, Ursula Bellugi¹, Debra Mills^{1,3}; ¹Salk Institute for Biological Studies, La Jolla, CA, ²University of Florida, Gainesville, FL, ³Bangor University, United Kingdom – The present study examined event-related potentials (ERP) patterns linked to the processing of semantic vs. grammatical aspects of language in individuals with Williams Syndrome (WS), autism (ASD) and typically developing controls (TD). ERPs were recorded as participants listened to a series of sentences, half of which ended with an anomalous last word (e.g. I have five fingers on my moon.) and half with a congruent last word (e.g., I have five fingers on my hand). ERPs were averaged according to semantic (i.e., congruous vs. incongruous ending) and grammatical (i.e., open- vs. closed-class first word) categories. Using temporal Principal Component Analysis (PCA), a centroparietal N400 and left anterior negativity (N280) were identified. A significant condition-by-group interaction was found for the N400, whereby WS group had the largest N400 effect in response to incongruent endings, while ASD group exhibited the smallest N400 effect. In contrast, analysis of variance of the N280 component yielded no significant difference between grammatical categories (i.e., open- vs. closed-class words) in the WS group, unlike the TD and ASD groups. These results suggest that while individuals with WS show a large ERP effect to semantic anomaly, their ERP patterns do not show differential processing of the main grammatical classes. These findings (a) support the largely behavioral data indicating atypical semantic organization of language in WS, (b) provide evidence that grammatical processing is also unusually organized in WS, and (c) illustrate qualitatively different processing of language in WS and ASD, potentially mirroring the fundamental differences between the two disorders.

F61

COMPUTERIZED NEUROPLASTICITY-BASED TRAINING OF COGNITIVE CONTROL PROCESSES IN CHRONIC SCHIZOPHRENIA Maryann Bens^{1,2,3}, Melissa Fisher^{1,2}, Alexander Genevsky^{1,2}, Sophia Vinogradov^{1,2}; ¹University of California, Psychiatry, San Francisco, ²San Francisco Veterans Affairs Medical Center, ³The Wright Institute – We previously reported on the effects of a novel neuroplasticity-based cognitive training program that targets auditory perceptual processes and working memory in schizophrenia. In this study we investigated the effects of an additional computerized training module that targets cognitive control processes in schizophrenia (developed by Posit-Science, Inc.). Exercises in the cognitive control module were designed to improve categorization, prediction, novelty detection and task switching. The exercises were continuously adaptive in that they first established the precise parameters within each stimulus set required for an individual subject to maintain 80% correct performance; once that threshold was determined, task difficulty increased systematically and parametrically as performance improved. Thirty adult chronic schizophrenia subjects were stratified by age, education, and symptom severity and randomly assigned to either 20 hours of the targeted cognitive training condition (TCT, N=15), or to 20 hours of a computer games control condition (CG, N=15). Subjects participated in either the TCT or CG condition for one hour per day, five days per week. Repeated Measures ANOVA reveal significant group differences on measures of Stroop Inhibition ($p = .01$), and visual working memory (WMS-III Spatial Span) at trend level significance ($p = .11$). These early findings provide evidence of the specificity of effects and cognitive benefits that individuals with schizophrenia can achieve through a training program that explicitly incorporates core principles of neuroplasticity-based learning.

F62

FRAGILE X MENTAL RETARDATION-1 GENE MRNA AS A PREDICTOR FOR AMYGDALA VOLUME IN FRAGILE X PREMUTATION MEN John Wang¹, Kami Koldewyn^{2,3}, David Hessl^{2,4}, Diana Selmecky¹, Randi Hagerman^{2,5}, Paul Hagerman^{2,6}, Chris Iwahashi⁶, Flora Tassone^{2,6}, Andrea Schneider², Susan Rivera^{1,2,3}; ¹University of California Davis, Center for Mind and Brain, ²University of California Davis Medical Center, M.I.N.D. Institute, ³University of California Davis, Psychology, ⁴University of California Davis Medical Center, Psychiatry and Behavioral Sciences, ⁵University of California Davis Medical Center, Pediatrics, ⁶University of California Davis School of Medicine, Biological Chemistry – Fragile X Mental Retardation-1 Gene (FMR1) premutation carriers (55-200 CGG repeats) have been shown to have psychological and possible late-life neurodegenerative problems. Evidence of volumetric decreases in limbic structures, increased anxiety, and social cognition deficits suggest possible amygdala dysfunction. Previous studies have shown premutation carriers to have elevated levels of FMR1 mRNA that correlate with CGG repeat size. Carriers with large repeat sizes may also exhibit decreased Fragile X Mental Retardation Protein (FMRP). A previously proposed RNA toxic gain of function model predicts increased cell death and diminished volume in affected brain regions. We investigated amygdala volumes in premutation men compared with well-matched controls and explored the possible molecular correlates of individual volumetric differences. Amygdala volumes were acquired by manual segmentation of participants' structural MRI images. CGG repeat number and mRNA levels were ascertained through standard analysis of peripheral blood. FMR1 mRNA levels were found to be negatively correlated with amygdala volumes in both controls and in premutation carriers with lower CGG repeat size (<120). CGG repeat number and amygdala volumes were also negatively correlated in this lower CGG group. So, mRNA levels may predict amygdala size in controls and premutation carriers with smaller repeat sizes. In premutation carriers with larger CGG repeat sizes (>120), we suspect that decrements in FMRP levels may counteract the effect of high FMR1 mRNA levels. Previous studies have shown full mutation fragile X participants, who lack FMRP, to have

larger amygdalae. We will present these results with hippocampal volumes, neuropsychiatric data, and protein measures.

F63

CONVERGENT EEG AND FMRI EVIDENCE OF REDUCED RESPONSE TO NEGATIVE FEEDBACK IN COCAINE-DEPENDENT INDIVIDUALS

Matthew Shane¹, Carla Harenski¹, Prashanth Nyalakanti¹, Kent Kiehl^{1,2}; ¹The Mind Research Network, ²The University of New Mexico – Our laboratory has become guided by a model of substance abuse that posits insufficient responsiveness to error-related information as underlying the abuser's chronic, perseverative drug-taking behavior. Indeed, a growing body of work has demonstrated that cocaine abusers show behavioral rigidity (Franken et al., 2007) and attenuated electrophysiology (Hester et al., 2007) after the commission of errors on a variety of laboratory tasks. The underlying nature of these abnormalities remains uncertain, however. One possibility suggests that cocaine abusers' reduced responsiveness underlies an initial failure to detect the commission of their errors; alternately, it may be that their error detection mechanisms remain intact, and that their attenuated response instead indicates a chronic insensitivity to error-related information. To test these alternate hypotheses, we evaluated the amplitude of the cocaine abuser's feedback error-related negativity (fERN) within a time-estimation task that presented participants with explicit positive ('+'), negative ('-') and uninformative ('?') feedback. Participants were simply required to estimate how long they believed a one-second duration took; the explicit performance feedback ensured that any deficit associated with error-detection could not influence participants' electrophysiology. Results indicated that both nonabusing groups evidenced a well-formed fERN on '-/-' trials, and that this waveform was absent in the cocaine abusing group. In contrast, the cocaine abusers showed the highest negative deflection on '?' trials. These results suggest that cocaine abusers display with an underlying insensitivity to error-related information that may contribute to their chronic and repetitive drug-taking behavior.

F64

CLINICAL EFFECTS IN FMRI ARE INFLUENCED BY ACTIVITY AND VARIANCE: AN EXAMPLE FROM AN ADHD STUDY

Gregory Burgess¹, Marie Banich¹, Erik Willcutt¹, Luka Ruzic¹; ¹University of Colorado, Psychology, Boulder – Studies using fMRI have become influential toward understanding the neural bases of clinical disorders. Typically, fMRI statistics are interpreted only with respect to group differences in the magnitude of activity. However, fMRI statistics are also influenced by unexplained variance in the data, and by spatial variability in the localization of activation. These sources of variability could affect fMRI statistics, leading researchers to misinterpret results and miss effects of theoretical interest. We developed simple procedures to identify brain regions where fMRI statistics are affected by spatial variability or unexplained variability. We applied those procedures to fMRI data comparing adults with ADHD to controls during the Color-Word Stroop task. This identified regions involved in executive control and word-reading where statistics were influenced by large amounts of unexplained variance. Importantly, unexplained variance was related to existing behavioral performance measures excluded from the initial model. Considering these correlations increased the significance of the group difference statistic, and also demonstrated group differences in the relationship between brain activity and behavior that would have been missed. Furthermore, our procedures identified brain regions where significant group differences resulted from greater spatial variability in the ADHD group rather than an actual difference in activity. In conclusion, we demonstrate the necessity for researchers to consider unexplained variance and spatial variability before interpreting clinical group differences, and provide simple procedures for accomplishing this.

Perceptual processes: High-level vision

F65

THE EFFECTS OF DISCRIMINABILITY AND SELECTIVE ATTENTION ON EVENT-RELATED POTENTIALS TO GAZING EXPRESSIVE FACES

Janessa Manning¹, Katie Sicking², Nicole Wicha^{1,3}, Reiko Graham²; ¹University of Texas Health Sciences Center, San Antonio, ²Texas State University, ³University of Texas at San Antonio – Although it is accepted that gaze and expression information is integrated at some level of visual processing, the exact nature of the interaction is unknown. Behavioral evidence suggests that gaze and expression interactions are maximized when facial expression is difficult to discriminate (Graham & LaBar, 2007). However, it is uncertain whether this occurs because decreasing the discriminability of expression slows down expression processing, allowing for gaze and expression interactions (a speed of processing account), or whether the extra information from gaze helps to resolve expression under conditions of uncertainty (an ambiguity account). Using a blocked design, the current study examined event-related potentials (ERPs) to faces with subtle or intense facial expressions (fear, anger) with direct and averted gaze while subjects (N = 18) made either gaze or expression judgments. Behavioral analyses revealed that subjects were more accurate when the expression discrimination was easy. Furthermore, reaction times were faster for emotion than gaze judgments, but only when emotion was easily discriminable. ERP analyses revealed that both selective attention and expression discriminability had widespread effects on both early and late ERP components. Notably, gaze and expression interactions were observed in components associated with early visual processing, but only when expression discriminations were difficult - e.g., P1 amplitudes were largest to 55% intensity angry faces with direct gaze and 55% intensity fearful faces with averted gaze. These results suggest that information about gaze and expression can be integrated relatively early in visual processing, supporting an ambiguity-based account of gaze and expression interactions.

F66

OBJECT CLASSIFICATION IN THE ABSENCE OF VISUAL AWARENESS AND FIGURE-GROUND SEGREGATION

Johannes J. Fahrenfort^{1,2}, Klaartje Heinen², Simon van Gaal¹, H. Steven Scholte¹, Victor A.F. Lamme^{1,3}; ¹University of Amsterdam, Cognitive Neuroscience Group, Psychology, Amsterdam, the Netherlands, ²Institute of Cognitive Neuroscience, London, UK, ³Netherlands Institute for Neuroscience, Amsterdam, the Netherlands, part of the Royal Academy of Arts and Sciences (KNAW) – It is well known that neurons in the temporal lobe classify objects, such as faces, and it is generally assumed that the activity of such neurons is necessary for conscious awareness of these objects. However, object categorization may also occur unconsciously, as has been shown by the selective activation of object selective neurons by masked objects. So what distinguishes conscious from unconscious object recognition? We constructed schematic images containing objects such as faces and houses while keeping local retinal stimulation between conditions identical. Using a dichoptic fusion paradigm, we manipulated stimulus visibility such that objects were either visible or not visible. Confirming earlier results, we found that both consciously perceived and non-perceived objects result in category specific BOLD activation, even if they are task irrelevant and non-attended. Critically however, we show that objects that are consciously seen show a distinct neural signature of figure-ground segregation in early and midlevel visual areas, which is completely absent when objects are not seen. Although counterintuitive, this implies that consciousness is more intimately related to processes of figure-ground segregation and perceptual organization than to object categorization. We propose that figure-ground segregation is a prerequisite for visual awareness, and that both phenomena share part of their neural correlate, which is recurrent processing within visual cortex.

F67

DISTINCT BRAIN ACTIVITY ELICITED BY COLOR MODULATED 'UNNATURAL' VISUAL SCENES

N. Eiji Nawa^{1,2}, Hiroshi Ando^{1,2}; ¹Multimodal Communication Group, NICT Universal Media Research Center, ²Perceptual and Cognitive Dynamics, ATR Cognitive Information Science Labs., Kyoto, Japan – Several studies have investigated the brain areas involved in the processing of physical attributes of visual stimuli such as color, luminance and contrast, but relatively little is known about how such attributes affect the perception of complex scenes as 'natural' looking, as opposed to 'unnatural' or 'artificial'. In a previous study, contrast curves were manipulated to generate unnatural stimuli that looked like negative images. BOLD contrasts revealed enhanced activity when viewing contrast modulated unnatural stimuli in a large network encompassing regions in the fusiform gyri, left middle occipital cortex, right inferior temporal cortex, and the inferior frontal cortex (right inferior frontal operculum). In this study, using a block-design fMRI paradigm, we examined whether distinct activity patterns are elicited by natural and unnatural visual stimuli resulting from the manipulation of colors. Stimuli were pictures portraying various natural sceneries, e.g., country fields, beaches, and mountains. Colors in the natural looking stimuli were not altered; however, the stimuli in the unnatural looking set had their colors "reversed", by inverting the parameters in a color-opponent space ($L^*a^*b^*$). During scanning, participants performed a discrimination task in which they had to judge whether the picture depicted an animal or not. When viewing color modulated unnatural stimuli, BOLD contrasts revealed that activity was greater in the right inferior temporal cortex and the left inferior frontal operculum. The existence of overlapping regions suggests the involvement of a common network in the high-level perception of visual stimuli as natural or unnatural.

F68

FACIAL CONFIGURATIONS AND FEATURES INVOLVE DIFFERENT HEMISPHERES

Dario Bombari¹, Fred W. Mast¹; ¹Institute of Psychology, University of Bern – A wealth of knowledge shows that faces can be recognized on the basis of configural or featural information (Leder & Bruce, 1998; Cabeza & Kato, 2000; Lobmaier & Mast, 2007). Features are referred to as detailed information contained in individual facial parts (e.g., the shape of the mouth or the color of the eyes) whereas configurations concern spatial interrelationships between facial parts (e.g., the metric distance between the eyes and the mouth). In the present study, we analyzed whether featural and configural processing involves different hemispheres using a divided visual field methodology. In a same-different matching task, 18 right-handed participants had to match the identity of a cue face containing either featural (scrambled faces) or configural (blurred faces) information with an intact test face presented subsequently in either the left or right visual fields. Unilateral presentation was controlled by monitoring central gaze direction. D prime analysis revealed that the visual field of test face presentation interacted with the information provided by the cue image ($F(1, 17) = 7.43; p < .05$), thus suggesting that featural and configural information is differently processed by the two hemispheres. Specifically, our findings show a left hemispheric superiority for featural processing and a right hemispheric superiority for configural processing (Rossion et al., 2000; Maurer et al., 2007). Our findings contribute to the growing body of evidence showing that the two hemispheres differ in the way they process global and local information. This project was funded by the Swiss NSF.

F69

TRAINING FACILITATES OBJECT PERCEPTION IN CUBIST PAINTINGS

Alumit Ishai¹, Martin Wiesmann¹, Robert Pepperell²; ¹Institute of Neuroradiology, University of Zurich, Switzerland, ²Cardiff School of Art and Design, University of Wales Institute Cardiff, UK – To the naïve observer, cubist paintings contain "cubes" or "boxes" and in the absence of a meaningful title, familiar objects are hardly recognizable. We tested the extent to which a short training session about cubism would facilitate object perception and subsequent memory of cubist paintings by Picasso,

Braque and Gris. Subjects, who had no formal art education and were unfamiliar with cubist paintings, performed an object recognition task followed by an aesthetic judgment task. Each painting was preceded by a meaningful title, a false title, or the word "untitled". Three days later, subjects returned for a surprise recognition memory test, in which paintings from the study phase were mixed with new paintings. Half the subjects received a short lecture about cubism and learned how to identify familiar objects in the paintings. Relative to the control group, the trained subjects reported seeing significantly more objects in the paintings, especially in paintings that were preceded by correct titles, and their response latencies were significantly shorter. No differences were found between trained and control subjects in terms of aesthetic rating and memory performance. Our data suggest that meaningful titles are necessary for understanding the content of artwork, and provide empirical evidence for learning-dependent top-down effects on object recognition.

F70

HOW GENDER AND BODY-MASS-INDEX SHAPE FOOD DISCRIMINATION

Ulrike Toepel^{1,2}, Jean-François Knebel¹, Julie Hudry³, Johannes Le Coutre³, Micah M. Murray^{1,2,4}; ¹The Functional Electrical Neuroimaging Laboratory, Neuropsychology and Neurorehabilitation Service, Centre Hospitalier Universitaire Vaudois and University of Lausanne, Switzerland, ²Radiology Service, Centre Hospitalier Universitaire Vaudois and University of Lausanne, Switzerland, ³Nestle Research Center, Vers-chez-les-Blanc, Lausanne, Switzerland, ⁴EEG Brain Mapping Core, Center for Biomedical Imaging of Lausanne and Geneva, Switzerland – Men and women differ in their susceptibility to eating disorders. Whether perceptual differences in food discrimination are a contributing factor remains unknown. Here, we investigated the spatiotemporal brain mechanisms by which normal-weighted men and women discriminate images of foods from non-foods. Electrical neuroimaging analyses of 160-channel visual evoked potentials (VEPs) independently tested for topographic and strength modulations between object categories for each gender. In women, between-category VEP topographic modulations were observed within the initial 100ms post-stimulus onset, while in men they first occurred at 200ms post-stimulus onset. By contrast, between-category modulations in VEP response strength occurred at ~220ms irrespective of gender. Further, source estimations significantly correlated with Body-Mass-Indices (BMIs) of the participants of either gender. In women, a higher BMI was found to be predictive of increased activations to food images in distributed occipito-temporal cortices during two time periods, i.e. ~100ms and ~220ms. Further, a lower BMI in women was correlated with stronger responses to food images in prefrontal areas over the earlier post-stimulus epoch only. In men, merely a lower BMI was predictive of higher neural source strengths over both the early (~100ms) and late (~220ms) post-stimulus intervals with correlations confined to parieto-occipital areas. Our results indicate that both the speed and locus of food vs. non-food object discrimination is impacted by the gender of the viewer. Moreover, even in normal-weighted populations, activity within neural networks for food perception varies as a function of BMI.

F71

PERCEPTUAL AND SPATIAL MECHANISMS IN NEGLECT DYSLEXIA

Lisa S. Arduino¹, Marialuisa Martelli², Roberta Daini³; ¹Istituto di Psicologia, Università di Urbino and ISTC-CNR Roma, ²Dipartimento di Psicologia, Sapienza Università di Roma and IRCCS Santa Lucia Roma, ³Dipartimento di Psicologia, Università degli studi Milano-Bicocca – Patients with neglect dyslexia (ND) tend to misread letters occupying the initial left-sided letters of single words and nonwords. The most common errors are substitutions and omissions. The relative proportion of these error types varies across patients and we hypothesized this is because they are due to different mechanisms. In particular, we propose that omissions depend on a spatial mechanism (as unilateral spatial neglect) while substitutions reflect a perceptual one (crowding). Method: Seven right-handed patients were recruited for the study on the basis of the presence of left unilateral spatial neglect and ND. All patients had suffered an

ischemic stroke to the right hemisphere. The severity of neglect was calculated for each patient on the basis of their performance on some visual-spatial tasks. The experimental task included two lists of written verbal stimuli, presented in two conditions: standard font spacing and spaced (center-to-center letter spacing proportional to each letter's eccentricity). Patients were requested to read aloud each stimulus and reading errors were recorded. Results and conclusions: Increasing the distance between letters increased the number of 'omission' errors. By contrast, in the patients who presented more 'substitution' errors an increase in letter separation did not worsen performance but rather improved it, as in the crowding phenomenon. A correlational analysis showed that the severity of unilateral spatial neglect was related to the presence of omissions but not substitutions. The results strongly support the view that these two kind of ND errors depend on different mechanisms, one spatial and the other perceptual.

F72

CONTEXTUAL PLASTICITY OF HUMAN JUDGMENTS: BEYOND STANDARD RANDOMIZATION OF TRIALS

Alexander N. Sokolov¹, Marina Pavlova^{2,3}; ¹Centre for Ophthalmology, Low Vision Clinic and Research Laboratory, University of Tuebingen Medical School, Tuebingen, Germany, ²Cognitive and Social Developmental Neuroscience Unit, Childrens Hospital, University of Tuebingen Medical School, Tuebingen, Germany, ³Institute of Medical Psychology and Behavioral Neurobiology, University of Tuebingen Medical School, Tuebingen, Germany – In cognitive neuroscience, studies of stimulus-driven attention, decision making, implicit learning and memory often vary statistical context for a task by employing different-frequent stimuli, such as in repetition-priming, mismatch and oddball paradigms. The overall frequency of occurrence of distinct stimuli is considered the primary modulatory variable for behavioral and brain responses. Using judgments of visual speed, we challenge this view showing that standard randomization of different-frequent stimuli for presentation confounds the effects of overall and outset frequencies of stimulus occurrence. Participants judged sets of visual speeds that comprised either frequent low or frequent high speeds. In four experiments, standard and biased randomization of stimuli for presentation made either frequent or infrequent speeds, respectively, to occur mainly at the series outset. With standard randomization, judgments of speed assumed their levels from the very beginning of the series and did not change across the experiment. By contrast, with biased randomization of stimuli (i.e., with the on-overall infrequent, either low or high speeds presented mainly at the series outset), the judgments exhibited a striking gradual change across the trials. We conclude that biasing the different-frequent stimuli for presentation reveals a novel kind of contextual plasticity of judgments that is contingent on the opposite relationship of the overall and outset frequency of distinct stimuli. The overall- and outset-frequency processing is likely to engage separate neural mechanisms. The findings have significant implications for neurophysiological, electrophysiological and neuroimaging studies that employ distinct stimuli blended in varying proportions.

F73

REGULARITY AND TASK EFFECTS IN THE LEFT FUSIFORM GYRUS DURING CHINESE CHARACTER READING

Yi Guo¹, E.Darcy Burgund¹; ¹Rice University – The left fusiform gyrus is hypothesized to be selectively involved in visual word processing. Nevertheless, the particular components of reading to which this area responds is the subject of much controversy. The purpose of Experiment 1 was to examine the role of the left fusiform gyrus in reading, in the context of a dual-route model. Accordingly, activity in the left fusiform gyrus was measured using functional magnetic resonance imaging (fMRI) while subjects performed a phonological task with regular and irregular Chinese characters. Regular characters were those containing elements that provide phonological information for the whole character, and irregular characters were those without such phonological elements. Results exhibited greater activity for irregular than regular characters in the left fusiform

gyrus, suggesting that this region is involved in the direct route of the dual-route model. The purpose of Experiment 2 was to determine whether the left fusiform gyrus responds preferentially to lexical phonological access, semantic access, or orthographic processing. Accordingly, activity in the left fusiform gyrus was measured using fMRI while subjects performed phonological, semantic, and orthographic tasks with irregular Chinese characters. A region in the left fusiform gyrus exhibited greater activity during the orthographic task than during the phonological and semantic tasks, which did not differ, suggesting that this region is involved in orthographic processing to a greater extent than phonological or semantic access. In addition, two regions in the right fusiform gyrus exhibited a similar effect. This right fusiform activity may relate to the use of pictorial Chinese characters.

F74

NEURAL CORRELATES OF PRIOR STIMULUS AND PRIOR PERCEPTION DURING VISUAL MOTION SEGREGATION

Joel Snyder¹, Olivia Carter², Amanda Pasinski¹; ¹University of Nevada, Psychology, Las Vegas, ²University of Melbourne, Psychology – Two gratings moving in different directions viewed through an aperture are perceived as a coherent plaid moving in one direction or two segregated gratings moving past each other. When the angle formed by the motion directions of the two gratings is larger, observers perceive more segregation. To examine effects of prior angle, we presented an adaptation plaid with a small, intermediate, or large angle, followed by a test plaid with an intermediate angle. Stimuli were flickered on every 200 ms to elicit event-related potentials (ERPs). When the adaptation plaid had a larger angle, the test plaid was more often perceived as coherent, similar to suppressive after-effects. During adaptation, large angle resulted in ERP modulations in occipital electrodes that peaked 150 ms post-flicker; during tests following large-angle adaptation, ERP modulations in occipital electrodes peaked at 100 and 230 ms post-flicker. To examine effects of perception during adaptation on perception during the subsequent test, we analyzed only those trials in which the adaptation (and test) had an intermediate alpha. Segregated percepts during adaptation were more likely than not to be continued during test, similar to perceptual stabilization. During adaptation, segregated percepts resulted in ERP modulations in occipital electrodes at 85 and 170 ms post-flicker; during tests that followed segregated percepts, ERP modulations occurred with similar timing as segregation-related modulations during adaptation. These results demonstrate that encoding the current and prior stimulus engages brain processes with distinct time courses, whereas encoding the current and prior perception engages brain processes with similar time courses.

F75

EFFECTS OF ORIENTATION AND EXEMPLAR ON OBJECT PRIMING IN THE FUSIFORM CORTEX

Denise Y. Harvey¹, E.Darcy Burgund¹; ¹Rice University – Behavioral experiments indicate the critical role of the right hemisphere in specific-orientation and exemplar visual form processing and the left hemisphere in abstract-orientation and exemplar visual form processing. However, findings from neuroimaging studies conflict in their support of these results. While researchers have found that the right fusiform gyrus (RFG) mediates specific-orientation and exemplar visual form processing, it remains unclear to what extent the left fusiform gyrus (LFG) mediates abstract visual form processing. That is, some neuroimaging studies demonstrate exemplar-abstract priming in the LFG, while another implicates orientation- but not exemplar-abstract priming in this region. We investigated this inconsistency by comparing priming in functional magnetic resonance imaging data across four different conditions: same-orientation, same-exemplar; different-orientation, same-exemplar; same-orientation, different-exemplar; and unprimed. In line with previous studies, priming was observed for same-orientation, same-exemplar objects, but not different-orientation, same-exemplar objects or same-orientation, different-exemplar objects, in the RFG. In contrast to some studies, priming was observed for same-orientation, same-exemplar objects and different-orientation, same-exem-

plar objects, but not same-orientation, different-exemplar objects, in the LFG. Thus, we conclude that the RFG stores objects in an orientation- and exemplar-specific manner, and the LFG stores objects in an orientation-abstract and exemplar-specific manner.

F76

RECURRENT ACTIVITY IN THE VENTRAL STREAM SUPPORTS RECOGNITION OF VISUAL OBJECTS Alexander Clarke¹, Kirsten Taylor^{1,2}, Lorraine K Tyler¹; ¹Centre for Speech, Language and the Brain, Experimental Psychology, University of Cambridge, UK, ²Memory Clinic - Neuropsychology Center, University Hospital Basel, Switzerland – Visual object recognition takes place within a hierarchically-organised processing stream in ventral temporal cortex, with feature complexity increasing from posterior to anterior regions. Activity along the stream is modulated as a function of the information required to complete different processing tasks, with anterior regions involved when more fine-grained analyses are required (Tyler et al, 2004). In the present study we asked how meaningful object representations evolve over time and how the time-course of activity along the ventral stream is modulated under different processing conditions, by comparing basic-level naming (e.g. tiger) which requires more detailed object information than domain-level naming (i.e. living). We included a baseline of meaningless objects. Visual object processing involves an initial feedforward sweep along the ventral stream within 100-150ms, which may be sufficient for broad categorical decisions, with subsequent recurrent processing necessary for finer-grained decisions. This predicts (a) increases in recurrent activity which (b) includes anterior regions for basic-level compared to domain-level naming or meaningless objects. We recorded MEG signals while subjects named objects at a basic or domain-level. Sources of cortical activation were estimated using MNE for a priori ROIs from posterior to anterior sites along the ventral stream. All conditions displayed early bilateral responses propagating from posterior to anterior sites within 150ms, consistent with rapid feedforward processing, followed by stronger recurrent activity between posterior and anterior ROIs during basic-level compared to domain-level naming. This dynamic pattern suggests that recurrent activity along the stream may be necessary to form detailed representations of meaningful objects.

F77

ACTION RECOGNITION FROM BODY FORM ANALYSIS Markus Lappe¹, Simone Kuhlmann¹, Marc de Lussanet¹; ¹Psychological Institute II and Otto Creutzfeldt Center for Cognitive and Behavioral Neuroscience, Westf. Wilhelms University, Münster, Germany – In point-light biological motion the combination of the form of the human body and its motion is easily perceived from very limited visual input. It is debated whether this percept results from the analysis of motion vectors via the dorsal pathway or from the analysis of the form of the body and its changing over time via the ventral pathway. We have proposed to use the method of lifetime limitation of the point-lights to eliminate local motion signals in the stimulus and prohibit the motion vector route. Good performance in walking discrimination tasks has supported a predominant role of form analysis. Walking discrimination is a standard procedure for biological motion studies but arguably limited in scope. In the current study we investigated the perception of limited lifetime point-light stimuli with a broader set of stimuli, and for the more natural task of action recognition. Participants viewed a set of 33 different action stimuli (e.g. dancing, hopping, jumping, etc.) that were recorded from human actors. The actions were presented as point-light stimuli in which each point was shown only for a single video frame, thereby eliminating local motion signals. Participants had to name or describe the actions. The results showed that participants were very good at recognizing these actions (about 90% correct) even though they could not use motion signals for the recognition. Our findings corroborate the view that action recognition is primarily based on the analysis of the changes of body form over time.

F78

INVESTIGATION OF BISTABLE BIOLOGICAL MOTION WITH "SILHOUETTE SPINNER": THE POWER OF HUMAN INTENTION AND THE BIOLOGICAL CONSTRAINT Chao-Hsuan Liu^{1,2}, Chi-Hung Juan^{1,3}, Daisy L. Hung^{1,3}, Ovid J.L. Tzeng^{1,3,4}; ¹Institute of Cognitive Neuroscience, College of Science, National Central University, Jhongli, Taiwan, ² College of Science, National Central University, Life Sciences, Jhongli, Taiwan, ³Laboratories for Cognitive Neuroscience, National Yang-Ming University, Taipei, Taiwan, ⁴Institute of Linguistics, Academia Sinica, Taipei, Taiwan – Visual competition has been investigated with binocular rivalry paradigm and other multistable phenomena such as ambiguous figure reversal and bistable apparent motion (BAM). In this study, we employed "silhouette spinner" as a biological BAM stimulus, which was first created by Nobuyuki Kayahara. The silhouette spinner can be perceived either as a clockwise or an anti-clockwise spinner in spite of the identical physical movement. We examined how subjects' intention can alternate their subjective percepts and how it interacts with bottom-up factors (e.g. fixation positions, frame durations). Our preliminary results showed that the changing rate of the percepts was lower in the passive viewing condition than in the active viewing condition (intentional effects). Furthermore, the intentional effects were significantly stronger when subjects fixated at the spinner's foot than at the body. This pattern of results indicates that human intention can effectively change their percepts of the bistable stimulus but this intentional effect is possibly constrained by the principle of the biological motion.

F79

TOP-DOWN ACTIVATION OF FUSIFORM CORTEX WITHOUT SEEING FACES Ruthger Righart^{1,2}, Frédéric Andersson¹, Sophie Schwartz^{1,3}, Eugène Mayer⁴, Patrik Vuilleumier^{1,2,3}; ¹Neurology and Imaging of Cognition Laboratory, University of Geneva, ²Swiss Center for Affective Sciences, University of Geneva, ³Geneva Neuroscience Center, University of Geneva, ⁴Neuropsychology Unit, Neurology, Geneva University Hospital – Face processing can be modified by bottom-up and top-down processes, but it is unknown how these processes interact in patients with prosopagnosia. We investigated a well-documented prosopagnosia patient (P.S.) who has lesions in the right occipital and left fusiform gyrus, whereas the right fusiform gyrus is intact and still activated during face processing. P.S. was instructed to detect the presence of faces or houses in pictures with different amounts of noise. P.S. showed a normal activation in the FFA (Fusiform Face Area) to faces with low-noise. However, her FFA activated to the same degree to images containing noise-only when she was instructed to detect faces (not when instructed to detect houses). These results reveal that the fusiform cortex is still sensitive to task-demands and selectively modulated by top-down processes, despite severe face recognition deficits.

F80

DOES MENTAL ROTATION RECRUIT HUMAN MOTION AREA MT? A MULTI-VOXEL PATTERN ANALYSIS Giorgio Ganis^{1,2,3}, Haline Schendan^{2,4}; ¹Harvard Medical School, Radiology, Boston, MA, ²MGH/ Athinoula Martinos Center, Charlestown, MA, ³Harvard University, Psychology, Cambridge, MA, ⁴Tufts University, Psychology, Medford, MA – Mental rotation is a process thought to take place when performing spatial transformation tasks that require bringing misoriented (static) visual images into spatial congruence with one another. The present fMRI study tested the hypothesis that mental rotation utilizes neural operations also recruited during motion perception. First, a localizer for human motion area MT was used in the same subjects performing a mental rotation task in order to determine whether mental rotation actually recruits human motion area MT. Second, a multi-voxel pattern analysis was conducted at the single subject level, in the common region activated by motion perception and by the mental rotation task, to determine whether the pattern of activation was the same for the two conditions. Mental rotation activated portions of area MT in common with motion perception, both at the group level and in the majority of individual subjects. However,

multi-voxel analyses showed distinct patterns of spatial activation in the two conditions in area MT. These results suggest that both mental rotation and motion perception recruit neural populations that carry out motion computations in area MT but that the specific operations differ in the two cases. To explain the different spatial pattern of activation, we hypothesize that area MT activation elicited by motion stimuli reflects predominantly bottom-up influences, whereas area MT activation elicited by mental rotation (when actual motion is not present but instead visualized) reflects primarily top-down influences.

F81

THE RADICAL IS A UNIT IN CHINESE CHARACTER PERCEPTION: EVIDENCE FROM BEHAVIORAL AND PSYCHOPHYSIOLOGICAL COSTS DUE TO STIMULUS INVERSION

Man-Ying Wang¹, Yi-Jhong Han¹, Bo-Chen Guo²; ¹Soochow University, Psychology, Taipei, Taiwan, ²National Taiwan University, Psychology, Taipei, Taiwan – The recognition of Chinese characters is considered to be a process mediated by radicals. Evidence is not as clear on whether the radical actually constitutes a unit in character perception. This study examines recognition costs for the inversion of a two-radical character versus a single-radical character, with faces and objects as control stimuli. The tasks are lexical, face and object decision. RT inversion cost for two-radical characters is about twice as much as single-radical characters and faces. Inversion costs are exhibited in the reduction of P3 positivity as in the study of mental rotation (Heil, 2002). The magnitude of P3 reduction over parietal/temporal electrodes parallels behavioral effects so that two-radical characters resulted in greater P3 reduction by inversion than single-radical characters and faces. These findings suggest that the radical serves as a unit in the perceptual processing of inverted and, most likely, upright Chinese characters.

F82

DIRECTION-SPECIFIC AFTEREFFECTS ARISE FROM CELLS TUNED TO DIFFERENT SOCIAL CUE TYPES

Rebecca P. Lawson¹, Andrew J. Calder¹; ¹MRC Cognition and Brain Sciences Unit, Cambridge, United Kingdom – Electrophysiological recording in the anterior superior temporal sulcus (aSTS) of macaques has demonstrated separate cell populations responsive to different gaze directions, head directions and body orientations (Perrett et al. 1992). A proportion of these cells responded to different cues (e.g. heads or bodies) oriented in the same direction (e.g. facing left). Recent psychophysical studies have found direction-specific aftereffects in humans following adaptation to a single gaze direction (Jenkins et al, 2006; Calder et al. 2008); similar effects have also been found for heads and bodies (Fang & He, 2007; Lawson et al, in press). However, it is unclear if these effects occur at the level of direction-selective cells tuned to specific classes of social cue (i.e., gaze, head, and body representations) or putative social attention cells tuned to the same direction irrespective of cue type. We address this by measuring participants' discrimination of head direction following adaptation to 20°; left and right oriented heads and bodies. A third "non-social" adaptor, directionally oriented chairs, was included to rule out the possibility that any aftereffects simply reflect recruitment of general 3D object representations. Aftereffects were found for the head adaptor condition only. These effects transferred across changes in the size and identity of the heads, indicating that these effects were not the result of adaptation to low-level properties. Our study provides the first evidence that direction-specific aftereffects in humans occur as a result of adapting direction-selective cells tuned to specific classes of social cue.

F84

IS 30 THE NEW 20? BEHAVIORAL EVIDENCE FOR PROTRACTED DEVELOPMENT OF FACE RECOGNITION

Laura Germine¹, Bradley Duchaine², Ken Nakayama¹; ¹Harvard University, ²University College London – Face perception and recognition is important over the entire life span, from early infancy to old age. There is an implicit assumption in the literature, however, that perceptual abilities reach their peak at or before the end of adolescence and so no study has investigated face learn-

ing competence beyond early adolescence. We investigated face recognition development using a variant of the Cambridge Face Memory Test (CFMT), where subjects learn six new faces, followed by stringent tests of recognition under conditions of varied lighting, pose and image degradation (Duchaine and Nakayama, 2006). From the results of over 47,000 subjects on the web, we found that performance rises steeply post-puberty, and does not peak until just after age 30. In a second experiment, we replicated this pattern of performance for recognition of unfamiliar adult and children's faces, but found no evidence of a late performance peak for inverted faces. This indicates that this peak is specific to recognition of upright faces. Finally, in a third experiment, we found a similar late performance peak for faces, but not for names, with an intermediate but somewhat late peak for recognition of eyeglasses. Our data provide the first behavioral evidence for late or delayed maturation of face processing, in particular the learning of new faces. This is consistent with recent studies showing slower maturation of face-specific areas in the brain (Golarai et al., 2007). It remains to be determined whether this late peak arises from increased experience with faces.

F85

SELECTIVITY OF VISUAL WORD FORM AREA IS DEPENDENT ON ATTENTION AND READING SKILL

Li-Wei King¹, Dafna Palti¹, Manuel Perea², Jessica Kim¹, Caroline Huang¹, John Gabrieli¹; ¹Massachusetts Institute of Technology, ²Universitat de València – An area of left fusiform cortex, commonly referred to as the visual word form area (VWFA), has consistently been shown to activate during the processing of written language. However, the question of whether the VWFA differentiates between strings of differing lexicality and legality is still open. In this study, we tested whether attention modulates the selectivity of the VWFA, and whether this selectivity could be influenced by reading skill. We localized the VWFA in a group of normal reading young adults by selecting left fusiform clusters for each individual that activated more for words than for photographs of faces and houses. We then extracted the activation of these ROIs while participants performed a spatial cueing task that directed their attention either towards or away from three different types of letter strings (words, pseudowords, and consonant strings). Participants were divided into two groups based on standardized reading measures. The lower-reading group showed no significant differences in VWFA response to different stimulus types, regardless of attentional manipulation. The higher-reading group showed an interaction between attention and string type. Specifically, the better readers showed higher VWFA activation for words than for consonants strings in the unattended condition, but not in the attended condition. Thus, selective response of the VWFA toward orthographic regularity is not uniform across contexts, but varies according to individual reading skill and attention.

F86

A DISTANCE PRINCIPLE OF ORGANIZATION OF THE VENTRAL VISUAL STREAM

Elinor Amit¹, Yaacov Trope¹, Galit Yovel²; ¹NYU, ²Tel-Aviv University – Perceiving the distance of an object from the self is a fundamental feature of the visual system. Here we used fMRI to test the hypothesis that the ventral visual stream represents distance-related information in discrete cortical regions. In particular, object-related regions (Lateral Occipital Complex - LOC) are biased towards proximal stimuli, whereas scene-related regions (Parahippocampal Place Area - PPA) are biased towards distant stimuli. Participants were presented with Ponzo lines, which create an illusion of depth. In one condition, the stimuli (pictures of objects or houses) appeared in the perceived proximal position. In the second condition, the stimuli appeared in the perceived distal position. In addition, we ran a localizer, which included scenes, objects and scrambled images of objects. We defined for each subject the PPA (Scenes > Objects, $p < 10^{-4}$, uncorrected) and the LOC (Objects > Scrambled Objects, $p < 10^{-4}$, uncorrected). Consistent with our hypothesis, we found a double dissociation such that object areas showed a higher response to perceived proximal stimuli than perceived distal stim-

uli, whereas scene-related regions showed a higher response to perceived distal objects than perceived proximal objects. Importantly, this effect was found for both objects and houses. This outcome suggests the plausibility of a distance principle of organization of the ventral visual stream.

F87

NEURAL RESPONSE TO PHYSICAL SIMILARITY TO THE SELF DIFFERS DEPENDING ON THE TRUSTWORTHINESS OF THE OTHER FACE Sara Verosky¹, Alexander Todoroo¹; ¹Princeton University – People have been found to self-enhance across a number of domains, including self-face recognition. In order to investigate how this positivity affects the processing of the self-face, we conducted a functional magnetic resonance imaging (fMRI) study examining whether neural response to physical similarity to the self would differ depending on the valence of the face the self was morphed with. We morphed models of participants' faces with novel faces that were either trustworthy or untrustworthy in appearance and we asked them to decide whether each morph looked more like them or more like the other person. Behaviorally, participants were more likely to say the trustworthy as compared to untrustworthy morphs looked like the self. Bilateral inferotemporal cortex, right middle temporal cortex, and right prefrontal cortex all showed an interaction between the linear effect of physical similarity to the self and trustworthiness, responding more strongly as the trustworthy morphs looked more like the self and less strongly as the untrustworthy morphs looked like the self. Increased behavioral discrimination between the trustworthy and untrustworthy morphs of the self was correlated with increased activity to the trustworthy as compared to untrustworthy morphs in the right inferior frontal gyrus (IFG). These findings indicate that trustworthy as compared to untrustworthy faces are seen as more similar to the self and they suggest that the IFG plays a special role in self-representation.

F88

YOU NEED BOTH SIDES OF THE BRAIN TO PROCESS MY BODY Boris Suchan¹, Denise Minnebusch¹, Martin Busch², Dietmar Schulte³, Dietrich Grönmeyer², Silja Vocks³; ¹Institute of Cognitive Neuroscience, Neuropsychology, Ruhr-University, Bochum, Germany, ²University of Witten-Herdecke, Radiology, Germany, ³Ruhr-University, Clinical Psychology and Psychotherapy, Bochum, Germany – The extrastriate body area (EBA), a specialised area for body processing is in the focus of research over the last years. By contrasting human bodies and objects, reliable activation can be elicited in a bilateral distributed network covering the lateral EBA and also the medial fusiform body areas (FBA). This organisation is similar to that involved in face processing. We used dynamic causal modelling to get further insight in the organisation and interaction of this network. Different models were estimated and compared using Bayesian statistics. The most likely model suggests bilateral effective connectivity of the EBAs but not FBAs. Detailed results yield evidence for a hemispheric balanced network without any hemispheric lateralisation. Each EBA is effectively connected to its associated FBA unidirectional. Both EBAs show strong effective connectivity with a more pronounced effect of the right onto the left EBA. These results yield strong evidence for balanced effective connectivity within the network involved in body processing. They further suggest parallel networks like used in face processing.

F89

A RUSH TO JUDGMENT Jonathan Page¹, Laura Aldrich¹, Brandy Baczowski¹, Laurie Colson¹, Kaley Radermacher¹; ¹Minnesota State University-Mankato – Discrimination under time constraints leads to errors in judgment. We looked at this using standard behavioral measures of correct/incorrect responses and reaction times, and using electrophysiological measures of P300 and late positive potential (LPP) waveform components of the event-related potential (ERP). Participants viewed a series of achromatic and colored circles with either vertical (target) or horizontal (standard) stripes in two timing conditions: fast (ITI 800 ms) and slow (ITI 1.6 s). We were specifically interested in error processing and focused

our analyses on misses and false alarms. Differences in behavioral responses (RTs) and cortical recordings (P300 and LPP) were found in these conditions and compared. Our results suggest that 'snap' judgments lead to more visual errors, with correlates in neural processing that are evident in both P300 and LPP components of ERP waveforms.

F90

PATTERN ANALYSIS OF CATEGORY-SELECTIVE EXTRASTRIATE CORTICAL ACTIVITY DURING PERCEPTION AND IMAGERY OF SCENES Matthew Johnson¹, Marcia Johnson^{1,2}; ¹Yale University, Interdepartmental Neuroscience Program, ²Yale University, Psychology – Reflective processes such as visual mental imagery and visual working memory maintenance can modulate activity in category-selective extrastriate areas of cortex such as the fusiform face area (FFA) and parahippocampal place area (PPA). While it is thought that this activity likely represents a re-instantiation of activity patterns experienced during perception and thus carries information relevant to the identity of the representation in question, relatively few studies have attempted to decode the information represented by reflectively induced activity in such areas. In the present study, participants either viewed (Perceive conditions) or were instructed to form vivid mental images (Image conditions) of four well-learned scene stimuli while being scanned with functional magnetic resonance imaging (fMRI) at a relatively high resolution (2mm x 2mm x 2.5mm voxels). Scene-selective areas of posterior visual association cortex were identified with a separate localizer task, and scene-selective voxels were subjected to several types of pattern analysis to determine whether the spatial pattern of activity in those areas conveyed information about the task being performed (perception versus imagery) and/or the identity of the specific stimulus being perceived or imagined. Preliminary analyses indicate that, even after accounting for overall differences in activation magnitude between the Perceive and Image conditions, activity patterns in PPA and other scene-selective regions still differ depending on the task being performed. Thus far, we have not found patterns that distinguish specific stimuli, but future work will continue to explore the possibility of stimulus-specific activity patterns in category-selective extrastriate cortex during reflective processing.

F91

REORGANIZATION OF ATTENTIONAL NETWORKS WITH CORTICAL DEAFFERENTATION Keith Main¹, Temilade Adelere¹, Erin Kinzel¹, Leanne Metcalfe¹, Kevin Moloney¹, Vijay Palvia¹, Zane Blanton¹, Susan Primo², Julie Jacko³, Eric Schumacher¹; ¹Georgia Institute of Technology, ²Emory University, ³University of Minnesota – The visual cortex of the mammalian brain has a topographic relationship with the retina. This relationship can be altered through changes in retinal input (i.e. cortical reorganization). Recent research shows that cortical reorganization occurs in adult humans with macular degeneration (MD), an eye disease that results in the loss of central vision. Baker et al. (2005) reported that activation in the lesion projection zone occurs for MD patients' when visual stimuli are presented to their preferred retinal locations (PRL) (i.e., the intact retinal area used to fixate in place of the diseased macula) (c.f., Schumacher et al., 2008). However, Masuda et al. (2008) showed this finding may be primarily due to attentional feedback, not feed-forward reorganization. Whatever the mechanism, if reorganization does occur, it may not only affect the primary visual cortex but also areas involved in the allocation of spatial attention. MD patients often dramatically alter their oculomotor behavior to accommodate the location of PRLs. Is this change accompanied by a concomitant alteration in attention networks? Using fMRI tasks that have reliably demonstrated activation of attentional networks (Corbetta & Shulman, 2002; Mangun et al. 1998), we show a MD patient with aberrant activity in areas involved in exogenous but not endogenous allocation of attention. This finding suggests a reorganization of attention networks in MD patients, a change that could in turn influence V1 through top-down feedback.

F92**PREDICTING DISTRIBUTED PATTERNS OF BRAIN ACTIVITY DURING COLOR PERCEPTION**

Steven M. Frankland¹, Sharon L. Thompson-Schill¹; ¹University of Pennsylvania, Center for Cognitive Neuroscience – Following recent advances in multi-voxel pattern analyses of fmri data (e.g., Mitchell et al. 2008; Kay et al. 2008), we attempted to develop a general predictive model of cortical activity during a color perception task. A computational model learned the relationship between stimulus variance along the axes of different three-dimensional color spaces and variance in BOLD signal in bi-lateral ventral temporal and occipital cortices. Once trained, the model successfully predicted a distributed pattern of activity for previously unseen color categories, not just unseen instances thereof. Moreover, using a spherical searchlight technique (Kriegeskorte et al. 2006), we were able to compare the predictive accuracies of multi-voxel models trained on different color spaces in local brain regions previously implicated in color perception. Along with other recent work, this constitutes an improvement in the attempt to leverage pattern classification analyses of fmri data to understand neural representation. For unlike previous approaches in which binary categories are associated with patterns of brain activity (e.g. Haxby et al., 2001), we can (1) predict a neural signature for entire color categories (e.g., red) that were not included in the training of the model and (2) compare the performance of models trained on different stimulus spaces to evaluate which space descriptions co-vary with neural activity across brain regions.

F93**VIEW INVARIANCE IN MASKED REPETITION PRIMING EFFECTS IS A FUNCTION OF PRIME EXPOSURE**

Marianna Eddy¹, Phillip Holcomb²; ¹Massachusetts Institute of Technology, ²Tufts University – How objects are represented in the brain has been debated for decades. The current experiment provides evidence that achieving viewpoint invariance in priming can depend on the amount of feed-forward processing of the prime. We previously examined event-related potential (ERP) effects of masked repetition priming when the prime object was rotated 30°, 60°, or 150° from the conventional target view. Early perceptual processing, as indicated by the N190/P190 effect, showed invariance to target objects regardless of how much the prime was rotated. However, invariance in a later, higher level component (N400) was only achieved for the 30° rotation condition. One explanation for the lack of invariance on the N400 is not enough time for feed-forward processing to activate a higher level, presumably viewpoint independent representation with a 50 ms prime exposure. The current experiment used the same masked priming paradigm as the previous study, but increased the prime duration to 90 ms. Intact perceptual priming effects (N190/P190) were found for all of the rotation conditions. In addition, N400 effects or trends towards effects were found for all degrees of rotation with increased prime exposure. These results suggest that perceptual information activated during brief (50 ms) prime exposure is not sufficient to produce higher level benefits in target processing when the prime is rotated in depth. However, with increased exposure to the prime, presumably a higher level representation of this object is activated that allows for a benefit in target processing even when the viewpoint of the prime and target differ.

F94**CATEGORIZATION OF ACCUMULATED SENSORY EVIDENCE: A FLEXIBLE LINK BETWEEN DECISION AND ACTION**

Marios Philiastrides¹, Paul Sajda², Hauke Heekeren¹; ¹Max Planck Institute for Human Development, Neurocognition of Decision Making Group, ²Columbia University, Biomedical Engineering – Animal models of perceptual decision-making often include three main processing stages: sensory evidence representation, temporal integration of sensory evidence and evidence categorization, which is often expressed through a motor response. Though this hierarchical model is appealing, the boundaries between the latter two stages, if in fact such discrete stages exist, remain

unclear. The problem arises because in monkeys the areas implicated in integrating the sensory evidence are also the ones that select, and execute motor responses. In contrast, recent human neuroimaging studies identified decision-related activity independent of the response modality used, suggesting that humans might have evolved an abstract decision-making network that allows a flexible link between decision and action. To test whether there is a separate categorization stage, we designed an object categorization task using a novel dynamic stimulus to provide accumulating evidence while simultaneously recording EEG data from thirteen subjects. Using single-trial analysis techniques we identified a late, response-locked component, which not only correlated with psychophysical performance but was also a good predictor of the content of a subject's choice. Time-course analysis of the period preceding this component revealed ramp-like activity consistent with evidence accumulation. Source localization places this component in left medial parietal cortex, a region that was shown to communicate with both areas exhibiting accumulator activity as well as premotor and motor cortices. Taken together these results suggest that human perceptual decision-making entails a separate categorization stage, which converts the accumulated evidence into a categorical decision and provides a flexible link between decision and action.

F95**SENSITIVITY TO EMOTIONAL VARIANCE IN A TEXTURE OF FACES**

Jason Haberman^{1,2}, Pegan Lee^{1,2}, David Whitney^{1,2}; ¹UC Davis Center for Mind and Brain, ²UC Davis, Psychology – Humans are sensitive to the statistical characteristics of a scene. The visual system efficiently derives a mean representation across multiple dimensions, including low-level features such as dot size (Ariely, 2001; Chong & Treisman, 2003), motion (Alvarez & Oliva, 2008), and oriented gratings (Parkes et al., 2001), as well as high-level features such as faces (Haberman & Whitney, 2007, 2008). We explored whether the visual system represents another kind of high-level summary statistic - variance. After viewing a set of 16 emotionally distinct faces for 2 seconds, observers adjusted a group of test faces to match the variance of the set just displayed. Observers were surprisingly precise in their ability to report emotional variance; they showed a nonlinear dependence on the degree of set variance that resembled a dipper function. Specifically, variance sensitivity improved slightly with increased set variance relative to a homogeneous set of faces, followed by parametrically decreasing sensitivity as variance continued to increase. Dipper functions have been described for many other visual domains, including blur (Watt & Morgan, 1983), contrast discrimination (Nachmias & Sansbury, 1974), and even orientation variance detection in textures (Morgan, Chubb, & Solomon, 2008). To our knowledge, this work is the first of its kind to demonstrate sensitivity to variance in complex objects, and it is interesting to note that the data resemble the dipper pattern found for low-level visual features. This supports the notion that a specialized mechanism for variance detection exists that is adapted to assess crowds of faces.

F96**THE PERCEPTION OF IMPOSSIBLE GESTURES: MEG EVIDENCE**

Diogo Almeida¹, David Corina², David Poeppel¹; ¹University of Maryland, College Park, ²University of California, Davis – Visual objects and scenes elicit a cascade of responses, the peaks of which have been argued to index different stages in visual processing and differing neuronal selectivity. Here we test, using MEG, the response properties of a novel stimulus crafted to test gesture and sign (possible versus anatomically impossible arm/hand configurations) and compare the evoked field to the well-known cortical signals driven by faces (e.g. M130, M170). American Sign Language signs were edited to become physically impossible gestures. Participants (n=17, ASL naïve) were asked to judge whether each stimulus (static presentation) was a physically possible gesture while undergoing MEG. Passive viewing of upright or inverted emotionally neutral faces was used as a control task. MEG data from the same posterior sources that best capture the M170 for faces show that no effect

of gesture anomaly was observed in the M170. However, anomalous gestures elicited higher amplitudes 600-1200ms post stimulus onset in the left hemisphere and 400-1000ms post stimulus onset in the right hemisphere. Compared to the control (faces), (i) at 130ms (M130), gestures elicited higher amplitudes (ii) at 190ms (M170), gestures elicited later and more attenuated amplitudes and (iii) from 250ms onwards, gestures elicited higher amplitudes (bilaterally, in all cases). We conclude that detection of specific kinds of visual information is structured in early perceptual processes, but detection of configural anomaly involves both early (more transient) and later (more extended) perceptual processes. We are currently collecting data from ASL users to investigate how lexical knowledge interacts with gesture anomaly detection.

F97

NEURAL CONNECTIVITY OF EXPERIENCED VISUAL INFORMATION Anthony Herdman¹, John Gaspar¹; ¹Simon Fraser University, Psychology – We will present our findings on the neural connectivity within a network used for orthographic perception. We applied phase-coherence analysis methods to magnetoencephalographic data collected during a letter/nonletter judgement task. Phase-locking values between source waveforms for predefined frequency bands identified the connectivity amongst brain regions responsible for detecting experienced (letters) from inexperienced (nonletters) stimuli. Significantly larger phase-locking to letter than nonletter stimuli occurred in the theta band (3-8 Hz) amongst visual areas at about 140 ms. However, there was a stronger theta phase-coherence between right occipital and left inferior frontal sources around this time for nonletter than letter stimuli. In the alpha band (8-13 Hz) larger phase coherences occurred in visual cortices similar to the theta band and likely reflect differences in synchronous activity of the evoked visual responses. There was generally a greater alpha desynchronization in visual cortices that occurred around 250 ms and persisted longer for nonletter than letter stimuli. These results might indicate that more processing is required for nonletter stimuli in order to rule out all possible perceptual hypotheses that the nonletter could be a letter. Our results will be presented in the context that functional connectivity of the visual network is altered by experience with visual stimuli in order to allow for rapid identification as compared to novel/inexperienced stimuli, such as nonletters.

F98

EVENT-RELATED fMRI OF INTEGRAL AND SEPARABLE DIMENSIONS IN SIMPLE VISUAL OBJECTS Anthony Cate¹, Xiaojiang Kang^{1,2}, Timothy Herron¹, David Woods^{1,2,3,4}. ¹Veterans Administration Northern California Health Care System, ²UC Davis, Neurology, ³UC Davis, Center for Neuroscience, ⁴UC Davis, Center for Mind and Brain – This study tested the hypothesis that different regions in both ventral and dorsal extrastriate visual cortex encode information about the size and shape of simple visual objects. Event-related fMRI responses were measured to pairs of briefly-presented shapes taken from a set of 5 simple rectangles that varied parametrically in width and height. Stimuli were presented in a counterbalanced sequence that included baseline fixation trials. Trials were binned according to the pattern of dimensional change in the stimulus pair. After participants' cerebral hemispheres were inflated and normalized to a cortical surface curvature template using FreeSurfer, analyses distinguished voxels sensitive to changes in the integral object dimensions of aspect ratio and surface area, as well as to changes in width and height. Contrasts were performed to identify visual regions that showed greater BOLD responses to changes in aspect ratio (shape) than to changes in area and vice versa, and regions were characterized in terms of the degree to which they responded to changes in width and height as integral or separable dimensions. Voxels sensitive to aspect ratio changes were identified in the medial fusiform gyrus, and voxels sensitive to surface area changes were found in the posterior parahippocampal gyrus. Subregions of the posterior parietal cortex were also found to be sensitive to both criteria as well. This study shows that the functional specificity of extrastri-

ate visual areas, including regions that are typically selective for images of complex objects, can be characterized in terms of basic modes information-processing using simple shapes.

F99

HIGHER-LEVEL VISUAL AREAS ENCODE PERCEIVED OBJECT POSITION Jason Fischer¹, David Whitney¹; ¹University of California, Davis; Center for Mind and Brain, Psychology – Beyond early retinotopic cortex, the human visual system contains a host of higher-level, specialized regions, selectively tuned to stimuli such as motion and optic flow (MT+), faces (FFA), objects (LOC), and scenes (PPA). While these areas can be reliably parceled on the basis of stimulus preference, their other functional properties such as the precision and nature of position coding are not well understood. Specifically, while retinotopy and center-periphery biases have been reported in some of these areas, it is possible that additional sources of information such as head and eye position also influence position coding at higher stages in the visual processing hierarchy. In the present study, we tested the degree to which activity in higher-level visual areas reflects perceived versus retinal stimulus position. In an fMRI experiment, subjects performed a 5AFC position discrimination task; we dissociated retinal and perceived stimulus position by analyzing the trials in which subjects misreported the positions of the stimuli. Using a multivariate pattern analysis to track the coupling of the BOLD response with parametric stimulus changes, we found that activity in areas MT+, FFA, PPA, LO, and pFs reflects perceived object position significantly more precisely than it reflects retinal position. Early visual areas, on the other hand, preferentially coded the physical positions of the stimuli. Our results demonstrate that position coding in higher-level visual areas incorporates extra-retinal information, and more closely reflects the position in which we perceive an object than the position in which it falls on the retina.

F100

TEMPORAL-NASAL ASYMMETRY OF THE N170 RESPONSES TO FACE-LIKE PATTERNS IN THE VISUAL PERIPHERY Przemyslaw Tomalski¹, Gergely Csibra^{1,2}, Mark H. Johnson¹; ¹Centre for Brain and Cognitive Development, Birkbeck, University of London, UK, ²Central European University, Philosophy, Budapest, Hungary – Newborns and adults alike show preferential orienting towards upright schematic face (Config stimulus - white oval with three black dots), an effect suggested to be mediated by the superior colliculus and the retinotectal visual pathway. We investigated whether the N170, a face-sensitive ERP component indexing face detection, is modulated by the contrast polarity and orientation of Config stimuli and whether it shows the temporal-nasal hemifield asymmetry. In two experiments participants passively observed upright or inverted Config stimuli with normal or reversed contrast polarity, while monitoring the central fixation stimulus. In Experiment 1, the contrast polarity and orientation of face-like patterns presented in the fovea were found to interact, modulating the N170 in a face-typical manner. It peaked earlier and was less negative to upright positive polarity than to inverted or/and negative polarity stimuli. In Experiment 2, the influences of the retinotectal pathway on this effect were tested by presenting the stimuli monocularly to either the temporal or the nasal visual field. The temporal/nasal hemifield factor influenced the modulation of the N170 amplitude by both contrast polarity and orientation. The N170 peaked earlier in response to stimuli presented in the temporal than in the nasal visual field. Our results are consistent with the existence of a low-level, subcortical, face-biasing mechanism that facilitates rapid detection of faces and face-like stimuli. The visual input to the superior colliculus appears to modulate the activity of cortical face processing areas, which generate the N170 component.

F101

RELATING NEURAL OBJECT REPRESENTATIONS TO PERCEPTUAL JUDGMENTS WITH REPRESENTATIONAL SIMILARITY ANALYSIS Marieke Mur^{1,2}, Mirjam Meys^{1,2}, Jerzy Bodurka^{1,3}, Peter Bandettini^{1,3}, Nikolaus Kriegeskorte¹; ¹Section on Functional

Imaging Methods, Laboratory of Brain and Cognition, National Institute of Mental Health, National Institutes of Health, Bethesda, MD, ²Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands, ³Functional Magnetic Resonance Imaging Facility, National Institute of Mental Health, National Institutes of Health, Bethesda, MD – Human inferior temporal cortex (hIT) has been shown to be involved in the representation of visual objects. Recent studies have begun to investigate the relationship between perceived object similarity and similarity of response patterns in hIT. These studies often used a small set of (novel) stimuli from a few a priori defined categories. Here, we use a stimulus set consisting of 96 object images from a wide range of object categories including faces, body parts, animals, places, and artificial objects. We compare the neural and perceptual similarity structure of these 96 object images using representational similarity analysis. We performed BOLD fMRI measurements at high resolution (voxel size 1.95x1.95x2 mm³). Activity in response to 96 different object photos was measured in four subjects. hIT was defined at a range of sizes by selecting the most visually responsive voxels, based on independent data. The neural similarity structure of hIT response patterns was constructed by computing the dissimilarity (1-correlation distance) between each pair of object activity patterns. Subjects were asked to arrange the 96 object images in 2D to report perceptual similarity. The neural and perceptual similarity structures were significantly correlated ($r = 0.46$, $p < 0.0001$). This indicates that objects that are perceived as similar tend to elicit similar response patterns in hIT. In addition, both structures showed a categorical organization, with the main clusters being animate and inanimate objects. These findings suggest that, for a wide range of real-world objects, similarity of neural object representations in hIT reflects perceived object similarity.

F102

VISUAL TRAFFIC JAMS: CROWDING OF TWO-TONE CARS

Amrita Puri¹, Faraz Farzin^{1,2}, David Whitney^{1,2}, ¹Center for Mind and Brain, University of California, Davis, ²University of California, Psychology, Davis – Crowding refers to the increased difficulty in perceiving non-foveal objects when they are flanked by other objects. This phenomenon is typically explored using stimuli that can be readily segmented into parts or features; it is thought that when too closely spaced, interference between these low-level features contributes to crowding. Recent work using Mooney faces, two-tone images lacking discernable features, demonstrates that crowding can also occur selectively between higher-level, holistic representations (Farzin et al., under review). Here, we tested whether crowding occurs for non-face objects containing little or no low-level information that would support part-based recognition. Participants fixated a small square while a two-tone, Mooney-like car photograph briefly flashed at varying eccentricities either with (crowded) or without (uncrowded) flanker cars, and reported whether the orientation of the target car was to the right or left. Discrimination accuracy decreased with increasing eccentricity and with flanker presence, but was unaffected by flankers at the fovea, consistent with a between-object crowding account. However, when participants were separately shown an uncrowded two-tone car of varying size, performance increased with image size at all non-foveal eccentricities, with the magnitude of the required scaling factors suggesting an additional contribution of within-object crowding. The results suggest that crowding occurs both within and between objects.

F103

VISUAL AGNOSIA, A DEFICIT IN TEMPORAL VISUAL INFORMATION PROCESSING?

Maarten van der Smagt¹, Susan te Pas¹, Tanja Nijboer¹, ¹Experimental Psychology, Helmholtz Institute & Utrecht University – Visual agnosia is generally defined as the loss of ability to identify, name and/or recognize objects, faces shapes, colors or even brightness (i.e. an impairment of detailed visual knowledge), despite intact (low-level) visual perception and memory functions. Here we tested two patients, one with color agnosia and one with brightness agnosia,

on a task that required the detection of gradual changes in color and brightness of a 5 degree disc, presented on a CRT. The colored disc changed every 33 ms in chromaticity along one of three different MacAdam ellipses in color space (200 equal steps per revolution), while keeping the luminance constant. The achromatic disc increased and decreased every 33 ms linearly in luminance between 10 and 55 cd/m² (in 100 steps). Results for these patients, who showed average or above average performance on several tasks designed to test low-level color and luminance (contrast) perception, yielded a double dissociation. The brightness agnostic patient was within normal range for the colored disc but much slower to detect brightness differences, whereas the color agnostic patient was within normal range for the achromatic disc, but much slower for the colored disc (often needing multiple revolutions around the ellipses before detecting a change). Interestingly, a control patient with achromatopsia was also within normal range on the colored disc. Despite the general agreement that low-level visual functions must be intact in agnosia, these results suggest that a modality specific impairment in the detection of gradual changes might underlie the phenomenon of visual agnosia.

Poster Session G

Emotion

G1

UNIVERSAL AND CULTURALLY-SPECIFIC NEURAL BASIS OF INGROUP BIAS IN EMPATHY Bobby K. Cheon¹, Dong-Mi Im², Tokiko Harada¹, Vani A. Mathur¹, Jason Scimeca¹, Hyun-Wook Park², Joan Y. Chiao^{1,3}; ¹Northwestern University, Psychology, ²Korea Advanced Institute of Science and Technology, ³Northwestern Interdepartmental Neuroscience Program – Empathy, the capacity to understand and share the emotional states of others, is associated with neural response primarily within bilateral insula and anterior cingulate cortex. Both individuals and culture groups vary in the degree to which they show greater empathy for the suffering of their own group members. Here we examined the universal and culturally-specific neural bases of ingroup biases in empathy. Using cross-cultural neuroimaging at 3T, we measured neural activity in native Korean and Caucasian-American participants while they viewed images of either ingroup or outgroup members in either painful or neutral situations. All participants showed greater neural activity in cortical midline structures, such as the medial prefrontal cortex (MPFC) and posterior cingulate cortex (PCC), to ingroup relative to outgroup pain. Additionally, Caucasian-American participants compared to native Korean participants showed greater right parahippocampal and bilateral fusiform activity in response to ingroup pain. By contrast, Korean participants relative to Caucasian-American participants showed greater MPFC, PCC and left insula response to ingroup pain relative to outgroup pain. Taken together, these findings indicate that ingroup biases in empathic reactions share similar neural substrates across cultures, yet the distress of ingroup members may elicit distinct cognitive and affective responses between cultures.

G2

NEURAL AND BEHAVIORAL CORRELATES UNDERLYING EMOTION REGULATION OF RISKY DECISION-MAKING Laura N. Martin¹, Mauricio R. Delgado¹; ¹Rutgers University – Decisions are often influenced by one's emotional state, at times leading to maladaptive behaviors. The positive emotional state induced by the expectation of winning the lottery, for example, may tempt an individual to spend excessively for a chance at the jackpot. Thus, it is important to understand how to better control emotional responses to affective stimuli present in society. It is plausible that effective cognitive control, achieved by antecedent focused emotion regulation strategies, can diminish the impact of positive emotions and promote goal-directed behavior. The current study tested whether the benefits of emotion regulation would extend beyond emotional experience to subsequent decision-making. Participants in the scanner were presented with a picture representing a choice between potential monetary rewards. While viewing the picture, participants were cued to respond naturally (Look condition), increase (Excite regulation condition) or decrease their excitement (Relax regulation condition). In the Excite and Relax regulation conditions, participants altered their emotions by imagining exciting (e.g., riding roller coasters) or relaxing (e.g., napping on the beach) scenes, respectively. After the picture presentation, participants faced a choice between a gamble (e.g., 50% chance of winning \$12) and a sure thing (e.g., 100% chance of winning \$6). Participants gambled less during the Relax condition (compared to Look or Excite) consistent with the hypothesis that decreases in positive emotion can promote better decision-making. Moreover, this effect was stronger in female subjects. Future analysis will focus on the neural basis underlying the successful regulation of positive emotions probing the role of cortico-basal ganglia circuits.

G4

NEURAL CORRELATES FOR PROCESSING BIOLOGICAL AND SOCIAL EMOTIONAL STIMULI Michiko Sakaki^{1,2,3}, Kazuhisa Niki¹; ¹National Institute of Advanced Industrial Science and Technology, ²Japan Society for the Promotion of Science, ³University of Southern California – Emotions often promote individual survival or reproduction by directing behaviors to biologically significant stimuli (e.g., food; dead animals), while they also contribute to social adaptation by directing behaviors to socially significant stimuli (e.g., emotional faces) (Britton, et al. 2006). The present study aimed to examine the neural substrates associated with processing biological and social emotional stimuli. By using photographs and words, we also addressed whether emotional pictorial materials and verbal materials recruit similar neural substrates or not. In the scanning session, sixteen participants were presented with either a photograph or a word, both of which were manipulated in terms of stimulus type (biological, social, neutral, and nonsense), and they rated each item for whether they liked it or not. The results revealed that social emotional pictures and social emotional words produced activity in similar brain regions, such as the posterior cingulate, the left superior frontal gyrus, and the bilateral occipitotemporal gyri. In contrast, biological emotional words produced activity in different brain regions from biological emotional pictures. In other words, biological emotional pictures induced activity in the bilateral thalamus, the midbrain, and the left amygdala, whereas biological emotional words did not produce activity in any of these regions. These results suggest (a) the involvement of the subcortical regions in processing biological emotional pictures, (b) the involvement of cortical regions in processing social emotional materials, and (c) the larger stimulus type effects (verbal vs. pictorial) for biological emotional stimuli than for social ones.

G5

ATTENTION ORIENTATION IN ADULTS AND CHILDREN EXPOSED TO TRAUMA Kara Lindstrom^{1,2,3}, Jennifer Britton¹, Karin Mogg⁴, Brendan Bradley⁴, Monique Ernst¹, Christina Hoven⁵, Yair Bar-Haim⁶, Daniel Pine¹; ¹SDAN/NIMH/NIH, ²Clinical Neuroscience/Karolinska Institutet, ³Stockholm Brain Institute, ⁴Southampton University, Psychology, ⁵Child Psychiatric Epidemiology Group, Columbia University, ⁶Tel Aviv University, Psychology – After witnessing a traumatic event, people may have a higher risk of developing an anxiety disorder. Some individuals with anxiety disorders show an abnormal attention orientation to threat; thus, attention biases towards threat may be present in individuals exposed to a traumatic event. The dot-probe task, an attention orientation paradigm, was administered to assess attention bias towards or away from an emotional cue (happy or angry face) in parents and children (age 9-15) exposed to the World Trade Center (WTC) attack on September 11th, 2001 and control subjects. Compared to parents with low exposure to events of September 11th, highly exposed parents show greater attention bias towards angry faces. When the parent was evacuated from WTC, the evacuated parents have an increased threat bias compared with non-evacuated parents. The children of evacuated parents show a lack of a happy bias when compared with children of non-evacuated parents. These findings explore the effect of witnessing a traumatic event on psychiatric assessment and attention orientation.

G6

AFFECTIVE CONSEQUENCES OF PRODUCING SEQUENCED MOTOR RESPONSES Amy Hayes¹, Ian Glasscock¹; ¹Bangor University, Wales, UK – Past research has shown that when items are more fluently perceived or acted upon, they are liked more (e.g. Hayes, Paul, Beuger &

Tipper, 2008; Reber, Winkielman & Schwarz, 1998). Winkielman & Cacioppo's (2001) hedonic fluency model proposes that sensitivity to processing fluency influences positive (but not negative) affect, and that the affect provides information about the environment and may serve as a reward mechanism for facilitating performance. Here we used a serial response time task to investigate whether producing sequenced motor responses evokes positive affect. In each trial a tone or visual target called for a speeded response from the subject (pressing a button to the tone; "tagging" the location of the visual target.) In some blocks of trials, the sequence of responses to the tones and visual targets followed a fixed sequence; in other blocks the sequence of responses was pseudorandom. Subjects were not informed about the sequence manipulation. After each block of trials, subjects rated on a visual scale their positive and negative affect, and their sense of how effortful the previous block had been. Sequenced blocks were rated as less effortful, and consistent with the hedonic fluency model positive affect was elevated following sequenced blocks but negative affect was not influenced by the sequence manipulation. These results did not interact with a grouping factor that classified subjects as aware or not aware of the sequence, based on post-experiment interview. However, additional research is needed to determine how awareness and affect interact when learning sequenced behaviour.

G7

MEG MEASUREMENT OF FACIAL EMOTION RECOGNITION ABILITIES IN TEMPORAL LOBE EPILEPSY Maria I. Ventura¹, Adeeti Ullal², Srikantan S. Nagarajan¹, Heidi E. Kirsch³; ¹University of California, San Francisco, Radiology, ²Harvard-MIT Health Sciences and Technology, ³University of California, San Francisco, Neurology – Because temporal lobe epilepsy (TLE) may affect the function of structures involved in social cognition, there is an increasing need to understand social cognitive deficits, such as impaired facial emotion recognition, in TLE. We investigated this phenomenon using magnetoencephalography (MEG). Subjects with TLE and controls performed a facial emotion discrimination task (happy vs. sad faces) and a non-emotional discrimination task (face vs. non-face). We examined the M170 response, suspected to be a face-selective component of the neural response. Root mean square (RMS) analysis of the M170 revealed significant intergroup differences: subjects with left TLE had smaller amplitudes and delayed latencies compared to those with right TLE and to controls in the emotional discrimination task. Subjects with TLE also performed poorly on a validated test of facial emotion recognition (CATS) compared to normal controls, with left TLE subjects performing worse than those with right TLE. Exploratory time frequency source localization of brain activity during both emotion and non-emotion face tasks reveals that the activation pattern extrastriate visual cortex, including the fusiform face area, does not differ from that of controls. Neurophysiological and behavioral data show deficits in facial emotion recognition in subjects with TLE which may depend on laterality of seizure focus. Exploratory analysis of cortical activation, as indexed by task-evoked frequency changes in MEG data, suggest that this deficit is not apparent at the level of extrastriate visual cortex and might instead be due to disruption of downstream processing, e.g. in temporal structures affected by the subjects' epilepsy.

G8

BEHAVIORALLY MODIFYING FEAR MEMORY: EXTINCTION LEARNING DURING RECONSOLIDATION BLOCKS RECOVERY OF FEAR IN HUMANS Candace M. Raio¹, David C. Johnson¹, Marie-H. Monfils², Daniela Schiller^{1,2}, Joseph E. LeDoux², Elizabeth A. Phelps^{1,2}; ¹New York University, Psychology, New York, NY, ²Center for Neural Science, New York University, New York, NY – Evidence suggests that consolidated memories, once retrieved, enter a time dependent lability period before re-stabilizing (i.e., reconsolidation). Although non-human animal studies have successfully altered memories by pharmacologically targeting the neurobiological mechanisms underlying reconsolidation, these results are problematic to replicate in humans, due to the invasive nature and side effects of drug manipulations. A novel drug-free behavioral protocol

in rats demonstrated that fear memories were attenuated when extinction training occurred during reconsolidation. Our aim was to extend these findings to humans and further examine the specificity of this effect. In Experiment 1, fear conditioned subjects underwent either standard extinction or extinction preceded by reactivation of the fear-eliciting cue 10 minutes or 6 hours beforehand. There was no spontaneous recovery when extinction training occurred within the reconsolidation window (10 minutes post-retrieval). However, extinction outside this window (6 hours post-retrieval), or extinction without retrieval, allowed for spontaneous recovery of fear. In Experiment 2, we aimed to selectively target one fear memory while leaving another intact. Subjects were fear conditioned to two cues and underwent extinction whereby only one cue was reminded 10 minutes before extinction. A day later, subjects showed reinstatement of fear only to the cue that was not reminded before extinction. These data suggest that specific fear memories can be persistently modified when extinction training occurs within the reconsolidation window of a retrieved fear memory. These findings have significant clinical implications for the treatment of anxiety disorders such as Post Traumatic Stress Disorder, by targeting the intrusive memories that afflict patients.

G9

EFFECT OF DOPAMINE REGULATING GENES (DAT1 & COMT) ON LOGICAL REASONING WITH EMOTIONAL CONTENT Melanie Stollstorff¹, Stephanie Bean¹, Lindsay Anderson¹, Chandan Vaidya^{1,2}; ¹Georgetown University, ²Children's National Medical Center – Variation in dopamine (DA) regulating genes influences performance on cognitive tasks, such as working memory, and have also been shown to influence affective processing. Both working memory and affective processing are important during logical reasoning in real life under emotionally charged circumstances. How variation in DA modulation influences logical reasoning with emotional and non-emotional content is unknown. We investigated the effect of the catechol-o-methyltransferase gene (COMT) and the dopamine transporter gene (DAT1) on emotional and non-emotional reasoning in healthy adults. Participants were grouped according to DAT1 (9/10 or 10/10) and COMT (Met/Met, Met/Val, Val/Val) genotypes. The reasoning task included syllogisms with emotional and non-emotional content. Results indicated that regardless of genotype, accuracy was lower on emotional than non-emotional syllogisms. A task by DAT1 interaction showed that accuracy was lower in DAT1 9/10 than 10/10 subjects on emotional reasoning but did not differ for non-emotional reasoning. A task by COMT interaction showed that accuracy was lower in the COMT Met/Met than Val subjects on emotional reasoning but did not differ for non-emotional reasoning. Thus, inheritance of DAT1 10-repeat allele and COMT Val allele was beneficial for emotional reasoning.

G10

ELECTROPHYSIOLOGICAL CORRELATES OF MORAL PROCESSING: AN EVENT RELATED POTENTIAL STUDY Carla L. Harenski¹, Alek G. Chakroff¹, Matthew S. Shane¹, Kent A. Kiehl^{1,2}; ¹MIND Research Network, Albuquerque, NM, ²University of New Mexico, Psychology and Neuroscience, Albuquerque, NM – Several theories regarding moral decision making have emphasized the role of fast, automatic responses to moral stimuli in the decision making process (e.g., Haidt, 2001; Pizarro & Bloom, 2003). Although most studies examining the neural mechanisms of moral processing to date have utilized functional magnetic resonance imaging (fMRI), the superior temporal resolution of other imaging techniques, such as event-related potentials (ERPs), may help identify neural markers underlying the early detection of morally salient information. The goal of the current study was to investigate whether neural responses to moral stimuli could be differentiated from those to non-moral stimuli within the first 1000 ms of processing. ERPs were recorded while fourteen healthy participants viewed 100 unpleasant social scenes, 50 of which contained moral violations (e.g. an abusive situation), and 50 which did not (e.g. an argument), and 50 neutral pictures (e.g. a conversation). The task was to identify whether each picture

occurred indoors or outdoors. Moral and non-moral pictures were matched on emotional arousal. ERPs elicited by moral pictures showed an increased frontal positivity relative to non-moral and neutral pictures, peaking within the 220-300 ms time window. The larger frontal positivity may reflect automatic selective attention to intrinsically-relevant objects within images (Schupp et al., 2004). This suggests that the differentiation between moral and non-moral conditions may represent the fast, automatic detection of morally salient information within a social context.

G11

MULTIMODAL INTEGRATION OF EMOTIONAL SIGNALS *Raliza Stoyanova¹, Anthony Cox¹, Andy Calder¹; ¹MRC Cognition and Brain Sciences Unit, Cambridge, UK* – Although multiple sensory inputs are involved in the assessment of emotional context, little is known about the nature of these multimodal interactions. Most research in this area has addressed the effect of congruency between concurrently presented faces and voices on emotional categorization of either of these channels. However, it remains unclear whether these congruency effects are confined to naturalistic pairings of human emotional signals (i.e., faces/voices, bodies/voices) or extend to other semantically related, emotional pairings. To address this question, in one experiment, we examined the effect of unattended fear, disgust and neutral vocalizations on the speeded categorization of simultaneously presented fear and disgust-evoking scenes. In another experiment, we examined the opposite effect. The data revealed that when participants had to categorize emotional voices, congruent images facilitated response latency while incongruent images led to response slowing and poorer accuracy, relative to neutral. By contrast, fear voices facilitated the speed of categorizing both types of negative emotional images, with a similar trend for disgust voices. Considered together, these data indicate that the interaction between semantically related emotional images and voices is consistent with a categorical account of emotion such that fear images specifically facilitate the recognition of fear voices and slow the recognition of disgust voices and vice-versa for disgust images. However, unlike with more naturalistic, spatially congruent pairs of stimuli such as faces and voices, this effect is not bi-directional.

G12

BEAUTY IS IN THE EAR OF THE REMEMBERER: THE EFFECTS OF MEMORY ON MUSIC PREFERENCES *Daniel Meegan¹, Christopher Warren²; ¹University of Guelph, ²University of Victoria* – As with many stimuli, melodies tend to be judged more favorably following previous exposure. Fluency explanations for this 'mere exposure effect' suggest that it occurs because 'old' (i.e., perceptually-identical or conceptually-similar to previous stimuli) stimuli are processed with more fluency, and the experience that accompanies this fluency leads to a positive bias on tasks requiring an affective judgment about the stimuli. Evidence supporting a causal relationship between fluency and judgment bias is indirect, however. We report an experiment designed to directly test this hypothesis by manipulating the degree to which previously exposed stimuli could be processed fluently. The high fluency condition presented melodies composed in a familiar key and the low fluency condition presented melodies composed in an unfamiliar key. As predicted by the fluency hypothesis, likability judgments were affected by previous exposure only for the high fluency condition. At CNS 2008, we reported a parallel finding in which attractiveness judgments of inverted faces (the low fluency condition) were not affected by exposure. That presentation was received with questions about whether sufficient experience processing such disfluent stimuli (e.g., inverted faces or unfamiliar key melodies) would enable fluent processing and hence normal exposure effects. To address this question, we provided preliminary listening experience with music composed in an unfamiliar key. Later, we found that melodies constructed in this no-longer-unfamiliar key were responded to more positively following exposure.

G13

NEURAL CORRELATES OF REAPPRAISAL SUCCESS DEPEND ON INTENSITY OF EMOTIONAL RESPONSE *Jennifer A. Silvers¹, Jochen Weber¹, Tor D. Wager¹, Brent L. Hughes¹, Matthew L. Davidson¹, Kevin N. Ochsner¹; ¹Columbia University* – The ability to regulate one's emotions is critical to physical and emotional well-being. One of the most effective strategies for modulating emotional responses is cognitive reappraisal. While some studies have examined what reappraisal-related neural activity predicts successful regulation of negative emotion, none have investigated whether this activity varies according to the intensity of one's emotional response. In the present study, we investigated how the intensity of emotional response may impact what brain regions are associated with reappraisal success. Twenty-six healthy adults participated in an event-related fMRI paradigm. On each trial, participants were presented with a negative or neutral picture and were instructed either to reappraise ("reappraise" trials) or respond naturally ("look" trials) to the stimulus. At the end of each trial, participants rated their current level of negative affect. These ratings were used to categorize negative pictures as eliciting responses with "high" or "low" affective intensity. Reappraise > look contrasts for high and low negative stimuli were created and correlated with their respective reappraisal success scores, calculated as the drop in negative affect due to reappraisal (i.e., look-reappraise affect rating difference). For both high and low negative stimuli, reappraisal success was positively correlated with enhanced activity during reappraisal in the ventromedial prefrontal cortex and the perigenual anterior cingulate cortex. However, successful reappraisal of highly negative stimuli was uniquely correlated with enhanced reappraisal-related activity in the ventrolateral prefrontal cortex. These findings suggest that reappraisal of high and low intensity negative stimuli may rely on both overlapping and distinct regions.

G14

EMOTIONAL PROCESSES IN BORDERLINE PERSONALITY TRAITS: AN FMRI STUDY *Chia-Hsin Chuang¹, June Hung¹, Rou-Shayn Chen¹, Ying-Zu Huang¹, Chin-Song Lu¹, Yau-Yau Wai², Jiun-Jie Wang²; ¹Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Neurology, Taiwan, ²Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Radiology, Taiwan* – Previous neuroimaging studies showed that the emotional gateway in the brain, the amygdala, is overly active in patients with BPD. However, it remains unclear whether such dysfunctional emotional processes in the brain occur exclusively in BPD or not. Specifically, if cerebral emotional processes foster the development of BPD, one may expect to see similar dysregulation in emotional processes even in individuals who have borderline personality traits (i.e. those meeting less than five out of nine diagnosis criteria of BPD). To test this hypothesis, we used fMRI to examine the neural correlates of emotional processes in 6 females with borderline personality traits and 6 controls. Participants were scanned while viewing the same set of emotional pictures from the International Affective Picture System (IAPS) and, in different blocks, making a forced-choice response regarding arousal (aroused or unaroused) or pleasure (pleasant or unpleasant). The responses were collected to create an individualized mixed blocked/event-related design. Our results showed that, for individual with borderline personality traits, appraisal on emotional arousal is associated with lateralized medial frontal activation, whereas appraisal on pleasure is associated with lateralized amygdala activation. Our study supports the idea that emotional dysregulation should be regarded as a fundamental cerebral process underlying both BPD and borderline personality traits.

G15

NEURAL CORRELATES OF MUSIC-EVOKED NOSTALGIA *Frederick Barrett², Petr Janata²; ¹University of California, Psychology, Davis, ²Center for Mind and Brain, University of California, Davis* – Nostalgia is an emotionally rich experience, characterized by experience of both positive and negative emotions, and socially-themed autobiographical memories.

Music is a common and powerful evocateur of both nostalgic and non-nostalgic autobiographical memories. Investigation of music-evoked nostalgia may provide unique insight into the neural basis of emotional experience during memory recall. In this study, we used popular music to evoke nostalgic and non-nostalgic autobiographical experiences, and differentiated activation related to increased nostalgia and activation related to more general autobiographical memory recall. Thirty 20s samples of popular music were randomly selected and presented to 12 participants (4 M), while blood oxygen level dependent (BOLD) signal was recorded. Orthogonal parametric regressors, constructed from nostalgia, happiness, sadness, arousal, song familiarity and autobiographical salience ratings obtained immediately after each song, were entered into a general linear model predicting BOLD signal. Individual and group-level T-contrasts were calculated for each parametric regressor. Contrasts at the individual level showed wide variation in the focus and extent of activations correlated with each parametric regressor. Group-level contrasts showed both increased activation of medial prefrontal cortex (MPFC) and increased activation of left-lateralized dorsolateral prefrontal cortex (LDLPFC) to be positively correlated with increased strength of nostalgia. Group-level contrasts also showed increased activation in LDLPFC to be positively correlated with increased autobiographical salience. These findings are consistent with literature showing LDLPFC activation during autobiographical memory recall, and suggest that MPFC activation is involved in the recall of emotionally rich nostalgic memories.

G16

EMOTIONAL RESPONSES TO MUSIC AND THE REWARD SYSTEM: AN INVESTIGATION WITH [¹¹C]RACLOPRIDE PET, FMRI, AND PSYCHOPHYSIOLOGICAL METHODS

Valorie N. Salimpoor^{1,2}, Mitchel Benovoy¹, Gregory Longo¹, Alain Dagher^{1,2}, Jeremy Cooperstock¹, Robert J. Zatorre^{1,2}; ¹McGill University, ²Montreal Neurological Institute – The ability of music to incite intensely positive affective states has led to the speculation that it may involve the dopamine reward system. Previous neuroimaging studies have been limited to showing only correlations in blood flow or oxygenation to striatal regions of the brain during music listening, but a direct connection has not been demonstrated. This study involved an innovative combination of techniques to assess the direct links between music and the dopamine reward system: (1) psychophysiological measurements of biosignals (including heart rate, respiration, skin conductance, blood volume, and body temperature) to characterize intense autonomic nervous system responses, (2) fMRI to assess blood oxygenation to striatal regions, and (3) PET scanning using [¹¹C]raclopride as a radioligand to measure dopamine binding activity in striatal regions. Self-selected music was used as stimuli to ensure subjectively pleasurable responses, and the chills phenomenon was used to characterize intense affective states. Baseline control stimuli were individually selected for each participant from other participants' musical selections based on low ratings on pleasure and intensity of affective states. Thus, each piece of music was used once as control and once as experimental stimuli. Results demonstrated both blood oxygenation and dopaminergic activity in the striatal regions (nucleus accumbens, caudate, and putamen) of the brain, allowing for conclusive evidence of dopamine reward system involvement. This study has important implications for understanding the role of the dopamine reward system as music is not a biological reward with survival value (c.f. food) nor does it have an exogenous basis (c.f. drugs).

G17

WHY REGULATION FAILS: ANTICIPATORY PREFRONTAL CORTEX ACTIVITY PREDICTS INCREASED AMYGDALA ACTIVITY AND REDUCED REAPPRAISAL SUCCESS

Bryan Denny¹, Kevin Ochsner¹, Jochen Weber¹, Matthew Davidson¹, Brent Hughes¹, Tor Wager¹; ¹Columbia University – We examined how one prepares to engage in reappraisal, which is an emotion regulation strategy that involves the cognitive reinterpretation of an emotion-inducing stimulus.

In this study, participants completed 3 within-subject conditions: Reappraise a negative image (Reapp Neg), respond naturally to a negative image (Look Neg), and respond naturally to a neutral image (Look Neutral). Each trial contained a cue period (signifying the condition), an anticipation period, a stimulus period, and a negative affect rating period. Participants reported significantly less negative affect in the Reapp Neg condition relative to the Look Neg condition, and the magnitude of this drop served as our measure of reappraisal success. Amygdala activity during a contrast of Reapp Neg-Look Neg trials during the stimulus period was shown to be negatively correlated with reappraisal success. We used novel mediation analyses to determine whether anticipatory activity predicted reappraisal success via changes in amygdala activity during stimulus presentation. We found that activity in the medial prefrontal cortex (MPFC) during cue and anticipation was positively correlated with amygdala activity during stimulus presentation. Further, amygdala activity during stimulus presentation mediated a negative correlation between anticipatory MPFC activity and reappraisal success. This positive relationship between anticipatory MPFC activity and stimulus-related amygdala activity was itself mediated by stimulus-related precuneus and brainstem activation. These results suggest that more MPFC activity during reappraisal anticipation is associated with less reappraisal success, in contrast to MPFC activity during reappraisal itself, which has been associated with greater reappraisal success.

G18

EFFECTS OF FOCAL BRAIN DAMAGE ON SEXUAL BEHAVIOR

Timothy Kosciak¹, Daniel Tranel¹; ¹University of Iowa – Sex is a fundamental aspect of real-world behavior. Sexual behavior can be disrupted by focal brain injury resulting in serious consequences (e.g., contracting STDs, unintended offspring). Cases of sexual dysfunction following damage to ventromedial prefrontal cortex (VMPC) or the insula have been reported (e.g. Anderson et al., 1999). The present study aims to extend these case reports by examining a broad range of sexual behaviors in a large sample of brain-damaged patients. In particular, awareness of sexual feelings and sex-related, physical violence were assessed. Participants consisted of men and women with lesions to either of two target regions (VMPC or insula), and brain-damaged comparisons (BDCs) with damage outside of these areas. Participants completed a self-report questionnaire designed to assess prevalence of risky sexual behaviors and sex-related cognition and attitudes. Questionnaire items included statements using 5-point Likert-scale format, and a series of standard questions developed by Reitmeijer, et al. (2001). The results so far indicate differential influence of VMPC or insula damage on sexual behavior and cognition. Participants with insula damage displayed decreased sexual awareness compared to BDCs ($p=0.01$). Compared to BDCs, participants with VMPC damage displayed a trend toward increased frequency of sex-related, physical violence, e.g., giving physical pain for pleasure ($p=0.05$). The present study, based on a lesion approach, suggests that the insula and ventromedial prefrontal cortex are important for normal sexual behavior and cognition.

G19

BELIEFS, GUILT, AND THE BRAIN: NEURAL MECHANISMS UNDERLYING SOCIAL COOPERATIVE BEHAVIOR

Luke Chang¹, Alec Smith², Martin Dufwenberg², Alan Sanfey¹; ¹University of Arizona, Psychology, ²University of Arizona, Economics – Researchers across many disciplines have been intrigued by why people cooperate with a partner when they can better serve their own interests by acting selfishly. One possible mechanism underlying this phenomenon may be the influence of guilt on decision-making. Guilt has been formally defined as the extent to which a person believes they have let a partner down, modulated by an individual sensitivity parameter. Understanding the neural systems underlying this phenomenon has important implications for elucidating the broader impact of the interaction between cognition and emotion on decision-making. We employed a model of guilt aversion

developed within the context of Psychological Game Theory to predict the amount of guilt experienced by the participants within a social interaction. Seventeen participants were scanned using fMRI while they played a modified single-shot Trust Game. Participants' decisions and beliefs were entered into the model to produce a quantitative measure of guilt on a trial-by-trial basis. These values were then used as parametric regressors in a full-brain-analysis to predict regions of the brain associated with the experience of guilt. Consistent with our predictions, we observed a network of regions associated with processing negative emotions that included the amygdala, insula, and hippocampus. These results suggest that belief dependent states are processed by neural regions that have been previously associated with more basic emotions. More importantly, this study demonstrates that high-level questions about the role of emotions in decision-making can be addressed using the interdisciplinary Neuroeconomic framework by integrating psychological game theory and model-based fMRI.

G20

MOOD-DRIVEN DECISION BIASES IN THE ULTIMATUM GAME

Katia Harle¹, Alan Sanfey¹; ¹University of Arizona, Psychology – This study investigated the neural processes associated with emotional biasing of economic decision-making, specifically the effect of induced negative emotions. We used fMRI to monitor brain function in people engaged in a classic social economic task, the Ultimatum Game, which involves accepting or rejecting monetary offers from human and non-human (computer) partners. This research expands on a previous behavioral study, which showed that priming participants with negative emotions with underlying withdrawal motivational tendencies (i.e. sadness and disgust) result in higher rejection rates. Thus, negative avoidant emotions may play a particularly important role in modulating economic decisions of a social nature. To explore the neural basis of decision biases following such mood induction, we first used short video clips to induce either sadness or a neutral emotional state. The impact of additional modulating factors such as the degree of unfairness of the offer and type of interaction (i.e. human vs. computer partner) was also analyzed. Behaviorally, participants who first experienced sadness rejected more unfair offers than those in the neutral condition, replicating our previous findings. Preliminary fMRI analyses revealed that receiving unfair offers while in a sad mood elicited activity in brain areas related to negative emotions (insula) and cognitive conflict (anterior cingulate cortex). In contrast, receiving unfair offers while in a neutral mood elicited activity in brain areas related to reward anticipation (nucleus accumbens). These findings suggest a potential priming of neural regions involved in decision-related affective processing (e.g. insula) by more complex and socially-relevant emotions, such as sadness.

G21

MEASURING SOCIAL COGNITION AND THEORY OF MIND ACROSS DISEASED POPULATIONS USING FMRI

Nyaz Didehbani¹, Tandra Toon¹, Michelle McClelland¹, Michelle Kandalafi^{1,2}, Cassandra Adams^{1,2}, Sandra Chapman¹, Daniel Krawczyk^{1,2}; ¹University of Texas at Dallas Center for BrainHealth, ²University of Texas Southwestern Medical Center – Social cognition is the ability to regulate your own emotions, recognize others' thoughts, and anticipate other's feelings. It also includes knowing social rules and responding appropriately. One key aspect of social cognition is theory of mind which includes a person's ability to associate mental states and feelings to oneself and others. Preliminary data suggests differing regions of brain activity among those with social deficits compared to healthy controls. Research has shown that participants with Schizophrenia and Asperger's syndrome are prone to difficulties with social cognition. In our study, we recruited healthy controls, participants with Schizophrenia, and Asperger's Syndrome. We used a theory of mind task in fMRI, whereby participants watched a series of short animations of moving shapes and were asked to make judgments about whether the shapes were friendly or not (theory of mind condition) or the same weight (control condition). The imaging results

showed three areas of activation particularly the superior medial prefrontal cortex. These areas of activation differed between our healthy controls and our participants with Schizophrenia and Asperger's Syndrome, suggesting differences in social processing. Neurocognitive tests in addition to behavioral intervention data will also be discussed in relation to the imaging results.

G22

DISCRIMINATING FLEETING FACIAL EXPRESSIONS USING FEATURAL AND CONFIGURAL INFORMATION

Timothy Sweeney¹, Marcia Grabowecky^{1,2}, Ken A. Paller^{1,2}, Satoru Suzuki^{1,2}; ¹Northwestern University, Psychology, ²Interdepartmental Neuroscience Program – Humans are impressively adept at discriminating fleeting emotional expressions. We investigated how the type and duration of expression influenced discrimination accuracy. Observers viewed two facial expressions, one neutral and the other emotional (fearful, angry, or happy), in a two-interval forced-choice task with stimulus duration varied across trials (10, 20, 30, 40, or 50 ms). All faces were masked by a face with a surprised expression. On each trial, observers attempted to select the face with the emotional expression, and to report the expression. Discrimination against neutral was above chance at all durations, and more accurate for happy than for angry or fearful expressions. Emotional expressions that displayed teeth yielded the highest accuracy. To evaluate discrimination among emotional expressions, we calculated d' using 'hits' and 'false alarms' specific to each expression pair. Discrimination between angry and happy expressions was better than discrimination between fearful and happy expressions, and both pairs were discriminated well above chance even when presented for only 20 ms. In contrast, discrimination between fearful and angry expressions was near chance at all durations. With inverted faces, only discrimination between angry and happy expressions was impaired, which suggests a contribution of configural processing in this discrimination. Together, these results demonstrate that surprisingly brief presentations are sufficient for discriminating emotional expressions from neutral expressions. However, discriminating emotional expressions is difficult and depends on information from individual features and from their configurations.

G23

MENTALIZING OR MAXIMIZING: AN FMRI STUDY ON PROPOSER BEHAVIOR IN THE ULTIMATUM AND DICTATOR GAMES

Mascha van 't Wout¹, Alan Sanfey¹; ¹Neural Decision Sciences Laboratory, Psychology, University of Arizona, Tucson AZ – Examining behavior in interactive scenarios such as the Ultimatum Game (UG) and Dictator Game (DG) can provide useful insights into the nature of social decision-making. In this study, we examined brain activity in proposers as they made offers to both non-anonymous and anonymous partners in both of these games. In the UG, generous proposer decisions can be based on either social utility motives (wanting fairness) or from the anticipation that low offers could be rejected, leaving both players with nothing. In contrast, generous decisions made in the DG are usually thought to reflect only social utility motives. Using fMRI we tested whether generous UG proposers who exhibit brain activity patterns related to reward maximization, as opposed to social motivations, would in turn be less generous in the DG. Sixteen participants played the UG and DG while dividing either \$10 or \$40 with both non-anonymous and anonymous partners. Behaviorally, participants gave more money to partners in a UG as compared to a DG and more money to non-anonymous rather than anonymous partners. fMRI analyses showed activation of social network areas (amygdala, orbitofrontal and medioprefrontal cortex) in response to non-anonymous partners as compared to anonymous ones. We further observed activity in the rostral cingulate and dorsomedial prefrontal cortex (BA 8/9) for the interaction between task (UG/DG) and amount of money offered. This confirms our hypothesis that participants in the UG with brain activity patterns indicating "mentalizing" (medial prefrontal cortex) are also more generous in the DG.

G24

TEMPORAL UNPREDICTABILITY INCREASES AMYGDALA ACTIVATION AND DECREASES TRUST Andrew S Fox^{1,2}, Romana Snozzi⁴, Frédéric Schneider^{4,5}, Richard J Davidson^{1,2,3}, Tania Singer⁴, Ernst Fehr^{4,5}; ¹University of Wisconsin-Madison, Psychology, ²University of Wisconsin-Madison - Waisman Laboratory for Brain Imaging and Behavior, ³University of Wisconsin-Madison, Psychiatry, ⁴University of Zürich, Center for the Study of Social and Neural Systems, ⁵University of Zürich, Institute for Empirical Research in Economics – Trust is ubiquitous in human society and is critical for interpersonal interaction. Recent work investigating the biological bases of trust has implicated evolutionarily old brain structures, such as the amygdala, in judgments of trustworthiness and the decision to trust an anonymous individual. In our study we examined the effect of experimentally induced amygdala activation on trust behavior in a simple economic game, called the Trust Game. In the Trust Game, we gave participants 10 Monetary Units (MU's; paid in Swiss Franc's) and offered them the opportunity to invest any number of MU's in an anonymous individual designated as the trustee. For each MU invested by the participant, the trustee received 3 MU's that they could distribute between themselves and the participant as they saw fit. If the participant believes the trustee to be trustworthy they will maximize their gains by investing all of their MU's, whereas if the participant believes the trustee to be untrustworthy they retain the most MU's by investing nothing. In our experiment, while participants (n=55) were making this decision we exposed them to unpredictably spaced auditory stimuli, which are known to activate the amygdala. Additionally, approximately half the subjects (n=28) underwent fMRI while making these decisions. Results demonstrated that altering the temporal predictability of an auditory stimulus both increased amygdala activation and decreased investment amounts in the Trust Game, as predicted. These data suggest that task-irrelevant manipulation of amygdala activity influences the decision to trust.

G25

LETTING GO OF SADNESS: MINDFUL DETACHMENT IN EMOTION REGULATION Norman Farb¹, Adam Anderson¹, Zindel Segal²; ¹University of Toronto, Psychology, ²Centre for Addiction and Mental Health, Psychiatry, University of Toronto – Effectively regulating negative emotion is important for mental health. Indeed, extant research suggests that emotional reactivity to stressors predicts negative health outcomes. Mindfulness training (MT) has been shown to reduce the risk of depressive relapse and improve chronic mood, but little is known about its mechanisms of action. Using fMRI, the authors have developed a model of mindful emotion regulation linking: i) neural and subjective changes in emotional reactivity associated with MT, ii) neural evidence of attentional processes subserving MT-related changes in reactivity, and iii) how such changes promote positive mental health outcomes. Evidence from three fMRI studies will be presented to support a model of MT promoting reduced emotional reactivity to dysphoric challenge. Study 1 presents the association between mindfulness training (MT) and neural markers of emotion reactivity, in which MT was not associated with altered subjective experience of sadness following dysphoric challenge, but was associated with reduced neural reactivity. Study 2 links MT-related changes in interoceptive processing with altered neural recruitment in attentional suppression and maintenance tasks, implicating enhanced connectivity of suppression networks with interoceptive cortical networks following MT. The idea of reduced reactivity will be further explored in Study 3, which investigates neural indices of emotional reactivity that predict relapse into depression. Taken together, the studies suggest that neural changes associated with mindfulness training may facilitate a reduction in emotional reactivity through enhanced attentional control. A comparison of the neural signatures predicting depressive relapse and areas associated with mindfulness training will be discussed.

G26

DIFFERENTIAL EFFECTS OF FEARFUL AND ANGRY FACIAL EXPRESSIONS ON LEARNING F. Caroline Davis¹, Leah Somerville¹, Lisa Shin², Paul Whalen¹; ¹Dartmouth College, ²Tufts University – Research suggests that the amygdala is sensitive to both the valence and information value conveyed by facial expressions. For example, the human amygdala is more responsive to facial expressions of fear than anger, even though both expressions communicate negative valence. In non-human animals, amygdala responses to stimuli predicting negative events are enhanced when those stimuli have uncertain predictive value. We have proposed that the human amygdala is more responsive to fearful faces because of their inherently uncertain nature: angry faces embody a direct threat and call for focused attention, whereas fearful faces offer less information about the source of threat and therefore call for diffuse attention. This hypothesis predicts that angry faces should lead the viewer to learn more about the faces themselves, while fearful faces should lead the viewer to learn more about the context. We tested this hypothesis by measuring the effects of fearful and angry facial expressions on memory. In study 1, participants viewed fearful, angry, or neutral faces alternating with neutral words. Results show that when compared to neutral face blocks, fearful faces augmented memory for words, whereas angry faces impaired memory for words. In study 2, participants viewed blocks of fearful or angry faces alternating with neutral words. Results show that subjects remembered more words from the fearful face condition and more faces from the angry face condition. These data support the idea that although they communicate a similar message in terms of negativity, fearful and angry facial expressions call for different kinds of learning.

G27

AMYGDALA-CINGULATE CONNECTIVITY DURING REGULATION OF EMOTION PREDICT TREATMENT RESPONSE IN MAJOR DEPRESSIVE DISORDER Aaron S. Heller¹, Tom Johnstone², Ned H. Kalin¹, Richard J. Davidson¹; ¹University of Wisconsin, Madison, ²University of Reading – Theoretical work in Major Depressive Disorder (MDD) suggests that the inability to adaptively regulate negative emotion is a core etiological process underlying the development of MDD. However, few studies to date have investigated the neural substrates of emotion regulation (ER) in depression, and none to our knowledge have assessed group differences in within-subject connectivity. Studies investigating the neural substrates of ER in healthy control participants implicate the amygdala and pre-frontal cortex (PFC) as nodes in a healthy ER network, and this network has been shown to be abnormal when depressed patients attempt to regulate emotion. Other neuroimaging studies comparing controls to depressed patients at rest have further suggested abnormalities in the Anterior Cingulate Cortex (ACC) in depression, with pretreatment activity in this region predicting improvement in depressive symptoms when given antidepressant medication. Accordingly, we performed a functional connectivity analysis of Functional Magnetic Resonance Imaging (fMRI) data when subjects performed an ER task to investigate whether amygdala-PFC interaction is abnormal in depression and whether those regions showing abnormal functional connectivity are also predictive of antidepressant treatment response. Indeed, when reappraising negative affect elicited by emotional slides, depressed patients showed a decrease in amygdala-perigenual ACC (periACC) connectivity. Within the depressed group, degree of amygdala-periACC connectivity during reappraisal further predicted treatment response to Venlafaxine eight weeks post-scan as assessed by the Hamilton-Depression Inventory. These results point to a disordered amygdala-periACC network underlying the ER deficits in depression, and further suggest that the integrity of this network is critical to support symptom remission.

G28

THE AFTERMATH OF AFFECTIVE STIMULI: EVIDENCE FROM FMRI RECORDED INSULA AND AMYGDALA ACTIVITY IN GENERALIZED ANXIETY DISORDER Desmond J. Oathes¹, Daniel M. McFarlin¹, Tammi R.A. Kral¹, Michael J. Jenson¹, Issidoros Sarinopoulos², Jack B. Nitschke¹; ¹Waisman Laboratory for Brain Imaging and Research, University of Wisconsin-Madison, Psychiatry and Psychology, ²Michigan State University, Psychology – Problematic cognitions in affective disorders are thought to result from the combination of aversive events and an internal focus of attention. Behavioral evidence and a prominent theoretical model of generalized anxiety disorder (GAD; Borkovec et al., 2004) suggest that individuals with GAD engage in avoidance strategies to mitigate the emotional impact of aversive events. In the present study, we examined blood oxygen level dependent signal changes in an event-related functional MRI paradigm during which participants viewed emotional pictures and provided affective ratings after each picture. Half of the ratings required participants to rate the emotional impact of the pictures on themselves (self-ratings). The other half asked participants to rate the valence (pleasantness or unpleasantness) of the picture (picture-ratings). GAD subjects showed less amygdala and insula activity than controls while rating their emotional responses to affective pictures. Self-ratings and negative ratings were especially likely to evince a pattern of hypoactivity in the amygdala and insula for GAD subjects. These data support Borkovec's avoidance model of GAD. Implications for understanding the neurobiology, environmental triggers, and subjective experience of emotional distress in clinical anxiety will be discussed.

G29

INDIVIDUAL DIFFERENCES IN EMOTIONAL AWARENESS MODERATE THE EFFECTS OF AFFECTIVE STIMULI ON WORKING MEMORY PERFORMANCE Joseph U. Kim¹, Michael S. Cohen¹, Colin G. DeYoung², Adam E. Green¹, Todd S. Braver³, Jeremy R. Gray¹; ¹Yale University, ²University of Minnesota, ³Washington University – Previous work has shown that inducing particular emotional states can facilitate performance on verbal and visuospatial working memory tasks by selectively influencing lateral PFC activity (Gray, Braver, and Raichle, 2002). We examined whether individual differences in trait emotional awareness moderate these emotion-cognition interactions. The 20-item Toronto Alexithymia scale (TAS-20; Bagby et al., 1994), designed to measure difficulty identifying and describing one's own emotional states, was administered to college students and community members. 99 participants were scanned while performing a 3-back task using blocks of words and faces; prior to each 3-back run, subjects watched short videos intended to induce mild emotional states (pleasant/approach related, unpleasant/withdrawal related, or neutral). Those who scored high on facets of alexithymia (low emotional awareness) showed emotion-related enhancement of working memory (WM) performance, such that approach states led to improved verbal WM performance and withdrawal states led to improved face WM performance. This was not observed in subjects with lower alexithymia scores. In addition, lower levels of emotional awareness (higher alexithymia scores) correlated with lower brain volume in the right temporoparietal junction/superior temporal sulcus (TPJ/STS) region (uncorrected $p < .0005$) when controlling for gender, age, and gender by alexithymia interaction. Activity in TPJ has been associated with identifying emotional states in oneself and others, among other functions. This region may be involved in emotion-cognition interactions.

G30

RECALL OF EMOTIONAL STIMULI IS PRECEDED BY NEURAL REACTIVATION OF EMOTIONAL CONTEXT: AN FMRI STUDY Katherine Vytal¹, Jennifer Wilson¹, Stephen LaConte², Stephan Hamann¹; ¹Emory University, Psychology, ²Baylor College of Medicine – Tulving and other theorists have proposed that recalling events critically involves reactivating neural representations that were originally active during the event. Recent FMRI and human single-unit electrode recording studies

have supported this view, demonstrating medial temporal activity that precedes individual freely recalled items and reinstates neural patterns characteristic of recalled stimulus categories such as face, object, or location. Because emotion is a highly salient stimulus attribute, we reasoned that reinstatement of emotional activity would immediately precede spontaneous free recall of emotional stimuli, reflecting reinstatement of emotional attributes and context, and further, that this activity would predict whether the subsequently recalled item would be emotionally arousing or neutral. Eleven subjects were scanned at 3 Tesla, first while they encoded negative emotional (phone-KILLER), positive emotional (trumpet-ECSTASY) and neutral paired associates (table-ACTOR), and later while they freely recalled items by speaking into a pneumatic microphone. Analysis of the two-TR period before the onset of each recalled item indicated significantly increased memory and emotion-related medial temporal activity, including the hippocampus and amygdala, prior to recall of positive and negative emotional words, compared to neutral words. Activity in another emotion-related region, the insula, also preceded emotional but not neutral recall. These results are consistent with reactivation views of free recall, suggesting that emotion-related brain activity is reinstated prior to spontaneous free recall of emotional but not neutral stimuli. This reinstated information likely guides further retrieval processes as a specific item is ultimately selected for recall. Further multivariate analyses will examine reinstatement of distributed patterns of emotion-related activity and activity during overt cued-recall.

G31

COMPASSION FOR PHYSICAL AND SOCIAL PAIN ARE ASSOCIATED WITH OPPOSITE HEART RATE RESPONSES

Xiao-Fei Yang^{1,2}, Mary Helen Immordino-Yang^{1,3}, Savio W. H. Wong¹; ¹Brain and Creativity Institute, University of Southern California, ²Neuroscience Graduate Program, University of Southern California, ³Rossier School of Education, University of Southern California – Do compassion for physical and social pain share similar physiological response patterns? Here, we report the results of heart rate analyses from a psychophysiological study. Eight Chinese participants were exposed to a series of narratives based on episodes from real people's lives, designed to induce either compassion for physical pain (CPP), compassion for social/psychological pain (CSP), or engagement without strong emotion (Control). Participants learned the content of the narratives and discussed their feelings about each stimulus individually with an experimenter before psychophysiological recording, to ensure that each participant's response to each stimulus corresponded to the established emotional category. During psychophysiological recording, participants saw 5-second reminder videos about each narrative, followed by 13 seconds of dark screen and 2 seconds of fixation. Participants were asked to become as emotional as possible about each narrative, and to rate the intensity of their emotion on a scale from 1 to 4. Instantaneous heart rate was derived from ECG recording; heart rate during fixation served as baseline. CPP elicited acceleration in heart rate, while CSP elicited deceleration in heart rate relative to baseline. Heart rate during control stories stayed constant. Further, degree of acceleration/ deceleration correlated positively with participants' subjective rating of emotion intensity. Overall, our results show opposite heart rate responses to compassion for physical and social pain, suggesting differential modulation of the autonomic system for these social emotions.

G32

EMOTIONS COME AND GO: NEURAL ACTIVITY TO ONSETS AND OFFSETS OF HAPPY AND ANGRY FACIAL EXPRESSIONS

Andreas Mühlberger¹, Matthias Wieser¹, Monika Frey¹, Antje Gerdes¹, Paul Pauli¹, Felix Breuer², Peter Weyers¹; ¹University of Würzburg, Psychology, ²Magnetic Resonance Bavaria (MRB) – Pictures of facial expressions of emotion have been shown to elicit emotional reactions and neural activation in different neural structures related to emotional processing (e.g., amygdala). However, in daily live emotional expressions are in constant

dynamical change, and first results show enhanced processing of dynamically presented emotional expressions. Additionally, the development of a facial emotional expression (onset) might be processed differentially from the offset of the same expression. For example, an offset of a happy expression might be a sign of danger, while an offset of an anger expression might be a sign to relax. Therefore, we presented short video clips of the onset or offset of happy and angry facial expressions while measuring brain activity by fMRI in a block design. Emotional facial expressions were generated using Poser 5 software. Twenty-two participants (12 men and 10 women) were investigated. In line with our assumptions first analyses indicated enhanced neural activity in the Amygdala during the presentation of angry onset as well as happy offset, whereas other structures like hippocampus and fusiform face area were more sensitive to angry offset and happy onset. These results show that the emotional significance of dynamical changes is analyzed in its temporal context. Further research is necessary to elude the emotional processing of dynamical facial expressions in detail.

G33

EMPATHY AND SIMULATION OF THE PHYSIOLOGICAL RESPONSE TO PLEASANT AND UNPLEASANT THERMAL SENSATIONS Adrienne Moore¹, Mary Wright², Megan Luetje¹, Martin Paulus³; ¹U C San Diego, Cognitive Science, ²U C San Diego, Division of Biological Sciences, ³U C San Diego, Psychiatry – The goal of this study was to test the hypothesis that empathy for the physical discomfort of others involves a simulation of the other's autonomic response to the discomfort. Pairs of female participants were recruited to observe one another inserting the left hand into ice water (a cold pressor task), tepid water, and warm water for short intervals. VAS ratings of pleasantness, unpleasantness and pain resulting from the hand immersion were collected from all participants, with reference to their own sensations, and with reference to how they imagine the other person to feel. Heart rates were collected from one participant per pair, both during experience of and observation of the hand immersion in water baths of comfortable and uncomfortable temperatures. We found that trait empathy measured by the Interpersonal Reactivity Index (IRI) was significantly correlated with VAS rating of the unpleasantness of the other's ice water immersion ($r=.45$, $p < .05$). Further, the IRI subscale Empathic Concern was significantly correlated with a bradycardic heart rate response to observing another's cold discomfort ($r=.766$, $p < .01$), while a bradycardic response to observing both pleasant and unpleasant temperature sensations was significantly correlated with the Perspective Taking subscale of the IRI ($r=.623$, $p=.03$). This study links specific ANS mediated physiological changes in response to observed pleasant and unpleasant sensation with aspects of empathy, and motivates future work to identify the neural substrates involved.

G34

MINDFULNESS-INDUCED CHANGES IN THE EXPERIENCES OF PAIN AND NEGATIVE EMOTION: AN FMRI STUDY Peter Mende-Siedlecki¹, Hedy Kober¹, Jason Buhle¹, Brent Hughes², Ethan Kross³, Tor Wager¹, Kevin Ochsner¹; ¹Columbia University, ²University of Texas, Austin, ³University of Michigan, Ann Arbor – In recent years, emotion regulation has become a burgeoning area of research. Concurrently, acceptance-based meditation practices have sparked both lay and scientific interest. Though the two disciplines may share functional goals, understanding of the behavioral efficacy and neural substrates of acceptance as an emotion-regulation strategy is lacking. This study used fMRI to examine the use of acceptance-based mindfulness strategies to regulate responses to both physically and emotionally aversive stimuli. Sixteen healthy subjects were scanned while viewing neutral and aversive images and while experiencing warm or painful heat. While experiencing these stimuli, participants were instructed to either (a) react emotionally to the stimuli and to allow themselves to feel angry or hurt (react) or (b) accept the sensations they experienced and to recognize that these feelings would pass (accept). Subjective ratings indicated that participants displayed statisti-

cally significant drops in negative affect when maintaining an accepting mindset rather than a reactive mindset. Compared to warm heat, painful heat activated a widespread network known as the pain matrix (encompassing the insula, the anterior cingulate cortex, the thalamus, and the brainstem), while aversive images (compared to neutral images) activated the dorsal amygdala, the anterior cingulate, and regions within the brainstem. Critically, the cognitive strategy of acceptance modulated activations in the insula and dorsal amygdala during the presentation of aversive heat and aversive images, respectively.

G35

AN EEG STUDY OF REAPPRAISAL AND SUPPRESSION STRATEGIES FOR EMOTION REGULATION Aliya Tolegenova¹, Gerald Matthews², Satybaldy M. Jakupov¹, Almira Kustubayeva¹; ¹Kazakh National University, Almaty, Kazakhstan, ²University of Cincinnati, Cincinnati – Objective: Gross (1998) has developed experimental techniques for investigating different emotion regulation strategies. However, the neuropsychological bases for regulation remain unclear. In addition, there may be gender differences in emotion regulation. Hence, the aim of the present study was to investigate EEG rhythm differences during emotion regulation tasks in males and females. Subjects and methods: Subjects were 150 students (75 female, 75 male). Subjects were randomly allocated to one of three groups: control (C: no instructions), reappraisal instruction (R) or suppression instruction (S). A film was used to induce fear according to instructions of Gross and Levenson (1995). EEG was recorded by using an electroencephalograph "Neuron-Spectrum-1" monopolarly from symmetrical frontal, central, parietal, and occipital lobes with the indifferent joint ears electrodes. Spectral Power Density of EEG rhythms in 10 bands (2-45 Hz) was analyzed. Results: Gender differences were found in several bands, including alpha-4 (females showed higher power), theta-2 (males showed higher power) and gamma (females showed higher power in F2 and F4). The strongest effect of emotion regulation was found in the theta-1 band. At the majority of sites, reappraisal increased theta-1 power. In addition, effects of emotion regulation on alpha-1 and alpha-2 differed in males and females. Conclusion: Data add to understanding of emotion-regulation by demonstrating that experimental manipulations of regulation strategy influence EEG. However, there were gender differences in EEG during viewing of the fear-inducing film, and some evidence was found for differential effects of emotion regulation on alpha in males and females.

Linguistic processes: Other

G36

THE UNDERLYING NEURAL SUBSTRATES OF PROSODY COMPREHENSION: EVIDENCE FROM A FUNCTIONAL MAGNETIC RESONANCE IMAGING STUDY Isabelle Deschamps^{1,2}, Inbal Itzhak^{1,2}, Shari Baum^{1,2}, Vincent Gracco^{1,2,3}; ¹McGill University, Faculty of Medicine, School of Communication Sciences and Disorders, Montreal, Canada, ²Centre for Research on Language, Mind and Brain, McGill University, Montreal, Canada, ³Haskins Laboratories, New Haven, CT – The present study examined the cortical networks involved in the comprehension of prosody using functional magnetic resonance imaging. Judgments about the illocutionary force (intent) of a sentence were dissociated from purely acoustic judgments associated with the changes in fundamental frequency (Fo) distinguishing a statement from a question. The same sentence with different word-final intonation contours was used in two different judgment tasks. Two endpoint stimuli and two ambiguous stimuli were presented in a slow event-related paradigm. Twelve subjects identified either the direction of the contour (rising/falling) or made a declarative/interrogative (question/statement) judgment. The results from the whole brain analyses as well as the ROI analyses demonstrate that while similar networks were engaged in both tasks, greater activation accompanied question/statement judgements compared to rising/

falling judgments. The common cortical areas of activation for the two tasks included the medial frontal gyrus, the middle frontal gyrus on the right hemisphere, bilateral regions on the superior temporal and anterior cingulate gyri, the superior parietal lobe on the right hemisphere, and a bilateral area on the anterior insula. Common subcortical activation included the bilateral thalamus, putamen, and the cerebellum. A number of right hemisphere cortical and left hemisphere subcortical areas differentiated the two conditions. In general, ambiguous stimuli yielded increased activation mainly in frontal regions. The results address current theories of the neural bases of prosodic processing, and suggest that the attribution of illocutionary force invokes a broader, but largely overlapping, network relative to F0 contour judgments.

G37

THE INTERACTION BETWEEN PROSODY AND SYNTAX IN THE PROCESSING OF SUBJECT- AND OBJECT-CONTROL VERBS

Sara Bögels¹, Herbert Schriefers¹, Wietske Vonk^{2,3}, Dorothee J. Chwilla¹, Roel Kerkhofs³; ¹Radboud University Nijmegen, Donders Institute for Brain, Cognition and Behaviour, ²Max Planck Institute for Psycholinguistics, Nijmegen, ³Center for Language Studies, Radboud University Nijmegen – We investigated processing differences between subject- and object-control verbs in locally ambiguous Dutch sentences, which are disambiguated by an intransitive or transitive verb, e.g., The man promised(subject-control) / advised(object-control) the woman to sleep(intransitive) / support(transitive) (Dutch word-order). Linguistic literature shows that control verbs determine the understood subject of the later infinitive verb in the sentence, but their processing has not been studied before. We investigated whether a prosodic break (PB) after the control-verb leads to a preference for a transitive disambiguation. An off-line auditory fragment-completion experiment revealed predominantly intransitive completions after object-control verbs, but more transitive completions after subject-control verbs. A PB indeed shifted the preference to more transitive completions in both cases. An on-line ERP-study showed that after subject-control verbs, the intransitive as compared to the transitive disambiguating verb elicited an N400 effect, both with and without a PB. This result suggests, as the off-line results, that the default preference for subject-control verbs goes in the same direction as the effect of the PB. After object-control verbs, however, this 'intransitive N400 effect' only appeared when a PB was present. This shows that no clear default syntactic analysis of the sentence exists for object-control verbs, in contrast with the off-line results. Moreover, a PB can affect and change the syntactic analysis listeners pursue. Thus, this study reveals a dissociation between processing of subject- and object-control verbs. Furthermore, a different pattern of results was found for on- and off-line experiments: care is warranted in generalizing from off-line to on-line results.

G38

ARE TABOO ERRORS DETECTED BEFORE THEY ARE PRONOUNCED? AN ERP STUDY

Els Severens¹, Ine Janssens¹, Robert Hartsuiker¹; ¹Ghent University, Experimental Psychology – It has been thought that we monitor speech internally for errors and filter errors out before they are pronounced. There is only one study that provides direct evidence for covertly correcting speech errors. Motley, Camden, and Baars (1982) used the SLIP-task to elicit speech errors that differed in social acceptability. In this task some target word pairs are overtly named (e.g., tool kits), while the phonological make up of preceding bias word pairs (e.g., could tin) promotes speech errors. Either taboo errors (e.g., cool tits) or neutral errors (e.g., cool tarts) were elicited. There were fewer taboo than neutral errors. Additionally, the Galvanic Skin Response (GSR) was measured. The GSR was larger in the taboo condition; this was interpreted as demonstrating that taboo words were generated but corrected internally. However, the GSR is not a reliable measure of cognitive processes. In the present study we therefore wanted to replicate these results with a more reliable measure. The electro-encephalogram was measured while participants carried out a SLIP-task, which elicited taboo or neutral errors in Dutch. In the taboo condition there was a more negative going wave around 600 ms after the target word pairs. Previously, a

similar negativity has been described to conflict. We suggest that in our study, this conflict results from the taboo error that is detected and corrected internally. In the control condition this conflict is smaller because the error is socially acceptable. These findings provide support for an internal monitor that checks internal speech for errors.

G39

HOW CHILDREN HANDLE DIALOG INFORMATION: AN ERP INVESTIGATION OF FOCUS PROCESSING

Ann Pannekamp¹, Ulrike Toepel², Elke van der Meer¹; ¹Humboldt University of Berlin, Cognitive Psychology, Germany, ²Neuropsychology and Neurorehabilitation Service, University Hospital and University of Lausanne, Switzerland – Language acquisition is a complex task that involves not only the comprehension of single words and sentences but also the identification and integration of context information. An important step during this process is learning to interpret pragmatic information foci and their prosodic realization in discourse. So far, little is known about the time course in which children acquire these abilities. However, previous studies report that the development continues into adolescence. Using event related potentials (ERPs) we investigated the perception of spoken dialogs in the presence vs. absence of adequate prosodic cues for focus identification in three age groups (5, 8 and 12 years) and an adult control group. In adults, the processing of information foci was accompanied by focus-related positive-going shifts (FPS) irrespective of prosodic adequacy. However, missing prosodic markings on information foci additionally elicited N400 patterns. In the 12-year-olds, brain responses appeared to be similar as in adults. The 8-year-olds revealed an FPS only when the information focus was adequately prosodically realized. When the accent was missing the 8-year-olds simply showed an N400-like mismatch reaction. In the 5-year-olds, no FPS responses due to focus perception were evoked. Yet, the missing accentuation resulted in a mismatch reaction at single electrodes. The findings indicate late developmental changes in dialog interpretation, that is, the abilities to identify and understand relevant discourse information increase with age and become more and more independent of prosodic accentuation.

G40

BEFORE AND AFTER: AN ERP STUDY OF THE NEURO-COGNITIVE CHANGES ASSOCIATED WITH LATE SECOND LANGUAGE LEARNING

Erin White^{1,2}, Fred Genesee^{1,2}, Karsten Steinhauer^{2,3}; ¹McGill University, Psychology, ²Centre for Research on Language, Mind, and Brain, ³School of Communication Sciences & Disorders, McGill University – Currently, very little is known about the neuro-cognitive changes that accompany second language (L2) learning. Longitudinal work with English-speaking adults learning French suggests that foreign language learning can lead to functional changes in brain activity even in late L2 learners who have received limited classroom-based instruction (Osterhout et al., 2006). However, it is unclear whether such changes are possible for all aspects of learning, such as L2 morphology that cannot be directly transferred from one's first language. We present pre-post ERP data of Korean- and Chinese-speaking adults both at the beginning and end of a 9-week intensive intermediate level English course. Participants read correct sentences and those containing a violation of English grammar (i.e. verb-subject agreement or tense). Learning led to changes in the ERP signal at both orthographic and morpho-syntactic levels of sentence processing. By the end of the course the students exhibited a P600 effect that was not present in the first testing session, suggesting they were beginning to develop morpho-syntactic processing resembling that of native-speakers. Moreover, this P600 development reflected changes in participants' accuracy during the experiment across the two testing sessions. Additionally, in the Korean speakers, the P200 amplitude elicited in response to content words decreased, suggesting that for these participants orthographic processing had become less effortful. These results suggest that L2 learning at the behavioural level is associated with processing changes at the neuro-cognitive level and that even among late L2 learners, as proficiency improves brain processing begins to resemble that of native speakers.

G41

ADAPTATION TO PHONOLOGICALLY SIMILAR WORDS IN BILATERAL SUPERIOR TEMPORAL SULCI

Kenneth Vaden¹, Gregory Hickok¹; ¹University of California at Irvine, Cognitive Sciences – The goal of the present study was to functionally identify cortical regions supporting phonological-level processes in speech recognition. Most neuroimaging speech experiments use subtraction methodologies, often contrasting speech listening against non-speech baselines. Such contrasts may weaken activity in regions that respond non-selectively to speech, and typically ignore significant linguistic distinctions, making it unclear how to linguistically characterize observed activity. A better alternative is to manipulate specific linguistic representations to highlight specific speech processes. We used an fMRI-adaptation experiment to detect repetition-inhibition of response to repetitive phonological content in spoken wordlists, measured by phonological similarity among words. Speech performance is degraded in perception, production, and memory when words share phonemes with other words in close temporal proximity. A related phenomenon is neural adaptation, which occurs when a neural substrate is inhibited by repeated exposure to stimulus dimensions that it processes. Seventeen participants listened to recordings of CVC wordlists: phonologically dissimilar words, phonologically similar words, or a single word repeating. Short lag priming between list items was sufficient to reveal activity differences consistent with our prediction of repetition-inhibition. Words sharing greater numbers of phonemes had significantly reduced activity relative to words with no phonemes in common, bilaterally in middle Superior Temporal Sulci (STS). The activity pattern observed in STS demonstrated sensitivity to phonemic content in speech, further neuroimaging evidence for STS in phonological processing that corroborates observations of pure word deafness resulting in cases of bilateral STS damage.

G42

SIGN MEMORY AND LEXICAL ACCESS: EVIDENCE FROM AMERICAN SIGN LANGUAGE

Michael Groszald^{1,2}, Christian Lachaud¹, David Corina^{1,2,3}; ¹Center for Mind and Brain, University of California at Davis, ²University of California, Linguistics, Davis, ³University of California, Psychology, Davis – In our efforts to develop a theory of sign language recognition, we explore how the processing of sign language forms diverges from that of non-linguistic actions. This study used a 1-back paradigm to investigate memory and lexical access in 31 deaf signers and 18 hearing non-signers. Participants watched a series of video clips, each showing an American Sign Language sign or a non-linguistic grooming gesture, and needed to decide during each clip whether the action shown was the same action seen in the preceding clip. We manipulated sequential co-occurrences of particular image pairs to examine effects of prior exposure on memory judgments across stimulus class (signs versus gestures) and viewpoint (Upright, Side, or Inverted). We hypothesized that memory would be aided, and response times shortened, in contexts where lexical representations of the shown actions were available to subjects (i.e. for signers responding to signs). As expected, deaf subjects were faster and more accurate than hearing subjects. However, a surprising group difference emerged when comparing response times to Upright-view signs and gestures preceded by the same actions in various orientations: deaf subjects' responses to Upright-view actions were significantly slower when preceded by Side-views than by Upright-views; hearing subjects showed no such effect. These effects were more pronounced for gestures than signs. Our interpretation of this outcome is that lexical access was performed automatically by deaf subjects although not required for this task. We explore the implications of these findings in relation to theories of expertise in visual perceptual processing and memory.

G43

ERP EVIDENCE FOR 'STRESS DEAFNESS' IN LATE PROFICIENT FRENCH-GERMAN BILINGUALS

Maren Schmidt-Kassow¹, Sonja A. Kotz¹; ¹MPI CBS, Leipzig, Germany – French and German ERP data have shown that metric violations (i.e., incorrectly stressed words) in a sentence elicit a P600 component that is comparable to the P600 evoked by syntactic violations (Magne et al., 2007; Schmidt-Kassow & Kotz, in press). There is also recent evidence that French speakers are impaired in discriminating between two stimuli that vary in stress position (Dupoux et al., 2008). Therefore, French speakers have been labelled as 'stress deaf'. In the current study, we investigated whether late proficient French-German bilinguals can perceive metric violations in metrically regular German sentences. All of the participants were highly proficient learners of German, i.e., they were able to stress all words in sentence on the intended syllable in a production task. In contrast to German native speakers, French-German bilinguals failed to show a P600 component in response to the metric violations although attention had been directed to the metric pattern of the sentences. Thus, the current data corroborate the hypothesis that French speakers are stress deaf even if they reached a highly proficient level of German.

G44

NEURAL SUBSTRATES OF IRONY COMPREHENSION: A FUNCTIONAL MRI STUDY

Midori Shibata¹, Akira Toyomura¹, Hiroaki Itoh¹, Jun-ichi Abe¹; ¹Hokkaido University, Psychology – Irony is one of the pragmatic statements that conveys the opposite meaning to its literal meaning. Comprehension of irony may be required to infer the intentions, beliefs, and feelings of the speaker who expresses the opposite meaning. In this study, we investigated the neural substrate involved in the comprehension of irony using event-related functional magnetic resonance imaging (fMRI). Twelve participants read the short scenario which consisted of five sentences. The first four sentences explained the situation of protagonists. The fifth one had a connotation of either ironical, literal, or unconnected meanings. The participants had to press a button for "yes" or "no" regarding to whether the final sentence expressed the ironical meanings or not. In the ironical sentence condition, the bilateral inferior frontal gyrus (IFG), inferior parietal lobule (IPL), superior frontal gyrus (SFG), medial prefrontal cortex (MPFC), the left superior temporal gyrus (STG) and parahippocampal gyrus were activated. In the literal sentence condition, the bilateral IFG, SFG, MPFC, middle frontal gyrus, IPL, and the left STG were activated. We analyzed differential contrast in the ironical sentence condition versus the literal sentence condition. This contrast revealed higher activation in the MPFC, the left STG, and the left parahippocampal gyrus. The involvement of MPFC in mentalizing processes has been reported (Frith and Frith, 2003). Our results suggest that the comprehension of irony is strongly related to mentalizing processes.

G45

LEXICAL PROCESSING IN DIGLOSSIC CODE SWITCHING BETWEEN MODERN STANDARD ARABIC AND PALESTINIAN COLLOQUIAL ARABIC: AN EVENT-RELATED BRAIN POTENTIAL STUDY OF ARABIC NATIVE SPEAKERS

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Diglossia is a phenomenon whereby social functions are distributed between formal and colloquial language varieties. We used EEG to investigate MMN responses of native speakers of colloquial and standard Arabic (a diglossic language) to switching between language varieties, while controlling for semantic, acoustic-phonetic, and phonological variables. 16 participants were presented with four real-word conditions: 1) PCA words with different meanings (PCA ?a? (right) - ?ad (border)); 2) PCA and MSA words with the same meanings (PCA ?a?, MSA ?aq (right)); 3) switching between dialects and between meanings (PCA ?a?-MSA ?a? (prompt)); and 4) switching across languages (PCA fi:l (elephant): English feel). Real-word conditions were matched by pseudoword conditions utilizing identical phonetic contrasts. High-den-

sity EEG recordings were simultaneously acquired. MMN was derived from EEG recordings by averaging and montaging to a subset of fronto-central sensors, and subtracting averaged responses to standard stimuli from averaged deviant responses within each condition. MMN amplitude revealed a lexicality effect. Increased MMN amplitude was associated with colloquial-standard switches, compared to within-dialect conditions, even when the lexical semantics were held constant. This result indicates that the switch between dialects has neurophysiological consequences over and above those related to a simple phonemic category change. Our results show that appropriately constrained use of single words in pre-attentional auditory processing paradigms can provide evidence of graded neurophysiological responses reflecting linguistic distinctions between diglossic language varieties. Such studies can elucidate questions about the neural representation of diglossia.

G46

CONTRIBUTIONS OF LEFT INFERIOR FRONTAL GYRUS SUB-REGIONS IN READING DIFFERENTIATED BY REGION-OF-INTEREST ANALYSIS Priya Kalra¹, Taeko Wydel²; ¹Harvard Graduate School of Education, ²Brunel University – The Dual-Route Cascade model of reading (Coltheart et al. 2001) postulates a grapheme-phoneme conversion route for pseudowords and infrequent words of regular orthography, and a lexical search route for frequent and irregular words. Two areas within the left inferior frontal gyrus (LIFG-pars opercularis and LIFG-pars triangularis) analogous to Brodmann's areas 44 and 45 respectively have been put forward as candidates for the neural correlates of each route. However, whole-brain analyses have not demonstrated reliable double dissociations in activation between the two areas, in contrast to the predictions of the DRC model. Although both areas are predicted to be recruited in a variety of reading conditions, their contributions are predicted to differ. Our aim was to demonstrate this difference using region-of-interest (rather than whole-brain) analysis. Six healthy right-handed native English speaking volunteers aged 21-28 (3 female, 3 male) were scanned in a Siemens 3T scanner while performing a Homophone Decision Task (judging whether two stimuli would be pronounced the same way) across four conditions (regular word, irregular word, pseudoword and pseudohomophone). Data was analysed using SPM5 and MARSBAR. Although both regions-of-interest were recruited in all conditions, their percent BOLD signal change across conditions suggested complementary contributions within the DRC model. We interpret these results as support for the DRC model and as support for construing Brodmann's areas 44 and 45 as possible neural correlates of different routes within the model.

G47

READING THE MINDS OF OTHERS: DISENTANGLING THE GENDER-SPECIFIC MECHANISMS Heather J. Ferguson¹, Richard Breheny¹, Anthony J. Sanford², Christoph Scheepers²; ¹Research Department of Linguistics, University College London, UK, ²University of Glasgow, Psychology and CCNi, UK – The ability to understand and predict other peoples' behaviour by attributing independent mental states to them is commonly referred to as theory of mind (ToM). Over the past 50 years a great deal of work has investigated ToM, focusing largely on developmental issues, impairments of this ability (e.g. autism and schizophrenia) and also on locating a neurological basis for ToM reasoning. However, this research has traditionally relied on response-based measures and thus very little is known about the on-line processes that are activated when comprehenders use ToM. Moreover, investigations using ToM tasks have initiated theories of a gender bias in cognition, based on evidence that females are superior to males on off-line tests of social judgment and measures of empathy, while males excel in practical 'systemising' skills, such as mathematical reasoning and spatial tasks. In three experiments, we used the visual-world paradigm to disentangle the on-line predictions that males and females generate during false belief (Exp. 1) and deception (Exps. 2 & 3) story comprehension tasks. Overall, our results demonstrate that comprehenders can immediately modify

expectations based on their own knowledge about reality to direct their visual attention to appropriate referents according that character's perspective. However, the direct comparison of males and females suggests the existence of gender-specific cognitive strategies, where females consistently make 'person-relevant' predictions from the earliest opportunity, but males show delayed or no equivalent anticipation. We compare these findings across the specific language tasks involved and initiate discussions of possible explanations for the processing bias.

G48**THE EFFECT OF MOOD ON ANTICIPATION IN LANGUAGE**

COMPREHENSION: AN ERP STUDY Dieuwke de Goede¹, Petra van Alphen¹, Emma Mulder², Yvonne Blokland³, José Kerstholt⁴, Jos van Berkum^{1,5}; ¹Max Planck Institute for Psycholinguistics, ²University of Amsterdam, ³Utrecht University, ⁴TNO Soesterberg, ⁵Donders Institute, Centre for Cognitive Neuroimaging – Several aspects of cognition, such as memory retrieval, problem-solving and decision-making, have been found to be sensitive to a person's mood. The evidence suggests that people in a happy mood are more inclined to use heuristic, top-down processing strategies than people in a sad mood. Here we investigate whether mood also affects the use of heuristics to anticipate upcoming language. In constructions like David praised Linda because..., verbs like praise bias readers to expect more information about the person who is praised (in this case, Linda). The bias is so strong that pronouns disconfirming the expectation (he in David praised Linda because he...), actually elicit a morpho-syntactic P600 effect, indicating that such pronouns are briefly taken to be structurally problematic. We reasoned that if people process information more heuristically when being in a happy mood than when being in a sad mood, this should modulate the size of this expectation-based P600 effect. In a two-session EEG experiment, we used short film clips to manipulate the mood of participants who read short stories in which verb-based expectations were confirmed or disconfirmed with a gender-marked pronoun. When readers were in a happy mood, bias-inconsistent pronouns elicited a clear P600 effect, but when the same readers were in a sad mood, no such effect was observed. This supports the idea that a happy mood increases the use of heuristics. Moreover, it reveals that language-relevant ERP effects can come and go as a function of general mood state.

G49**EXPLORING LANGUAGE SWITCHING WITH LEXICAL DECISION AND EVENT RELATED POTENTIALS**

Kaitlyn Litcofsky¹, Katherine J. Midgley^{1,2}, Phillip J. Holcomb¹, Jonathan Grainger²; ¹Tufts University, Medford, MA, ²LPC-CNRS, Université de Provence, Marseille, France – Whether in production or comprehension, bilinguals can freely switch between their two languages. What are the underlying neural mechanisms and processing costs associated with these language switches? We investigated this by presenting common, single-word non-cognates in English and French to 26 native English speakers proficient in French in a lexical decision task. Items were either "switch" items, for which the language differed from the previously presented language (POMME - BEACH) or they were "non-switch" items, in which case the language remained the same (FIGHT - DRINK). Event-related potentials were recorded from 32 scalp electrodes to each item. Our most salient result was a clear, widespread language effect showing larger negativities in L1 relative to L2 in the N400 epoch, an effect previously reported by this lab. Additionally, the N400 component showed a tendency to index language switching in both L1 and L2, each having a different scalp distribution. Interestingly, we found effects on the late positive component reflecting switch effects that were robust in L1, but nonexistent in L2. Finally, the RT data showed an asymmetric switch effect such that L1 items incurred greater switch costs than did L2 items, replicating the findings found in the literature and prior work from this lab. 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. Our findings will be discussed within the framework of current models of bilingual language control.

G50

THE ROLE OF PHONOLOGICAL COMPLEXITY IN THE PAST TENSE DEBATE Tomasina Oh¹, Keith Tan¹, Philina Ng¹, Berne Yeh², Steven Graham³; ¹National University of Singapore, English Language & Literature, ²National University Hospital, Singapore, ³National University of Singapore, Psychology – For decades the English past tense has been the battleground for proponents of a dual (rules-and-memory) system versus those of a single (associative) system. For the former, the regular-irregular verb distinction reflects the rule-based nature of language (walk-walked) and its memorized aspects (run-ran) respectively. Previous imaging studies show differential activation for each type of verb, taken by some as further evidence for a dual model. Others believe that activation associated with regular past tense is actually due to higher phonological processing rather than rule application. Indeed, by matching regular and irregular verbs for phonological complexity, Desai et al. (2006) showed activation related to regular verbs (specifically left superior temporal gyrus/STG) disappeared. The current study extended this idea by also manipulating levels of complexity. Using a 2x3 design (regular vs. irregular x high, mid, low phonological complexity) twenty participants generated past tense verbs during fMRI. Two main findings emerged: (i) matching for phonological complexity did not remove all activation for regular verbs, suggesting a genuine difference between regular and irregular verbs over and above differences in complexity. Areas associated with irregular generation were similar to those found by Desai et al. We propose that our areas (including left middle frontal gyrus, right caudate, left thalamus and right cingulate) reflected a greater effort to suppress the automatic "-ed" rule. (ii) Relative to low complexity, high complexity verbs did not activate left STG, nor any traditional phonological processing areas. Together these results suggest that evidence is insufficient to reject a dual model.

G51

ELECTROPHYSIOLOGICAL INVESTIGATION OF INTERACTIONS OF PROSODY AND SEMANTICS IN CROSS-MODAL PHRASAL INTERPRETATIONS Shani H. Abada^{1,2}, Shari R. Baum^{1,2}, John E. Drury^{1,2}, Karsten Steinhauer^{1,2}; ¹School of Communication Sciences & Disorders, McGill University, ²Centre for Research on Language, Mind and Brain, McGill University – Previous electrophysiological research shows that the processing of prosodic boundaries in sentences elicits a Closure Positive Shift (CPS) in young adults. It is unclear whether boundaries in simple phrases elicit this component, and to what extent prosodic processing is influenced by concurrent visual input. To probe the interactions of the brain systems subserving the processing of prosodic and semantic information in simple phrases, subjects performed a cross-modal picture/phrase matching task while listening to phrases of conjoined nouns, (e.g., "[bike and dog] and [cup]", "[bike] and [dog and cup]") whose groupings were signaled by prosodic breaks. These spoken phrases either did or did not match concurrently presented pictures of three objects, presented in a horizontal row with a vertical bar marking the relevant (mis)matching groupings. Two further conditions included pure semantic word/picture mismatches (always on the 2nd word/object pair), and a double violation involving both a semantic and a prosodic mismatch. Behavioral and ERP results revealed that incongruous visual contexts modified responses, supporting an influence of visual context on prosodic processing not previously known. A positive component is elicited time-locked to pauses. Its amplitude is larger in prosodic mismatches and its morphology is modulated by the boundary location. Behavioral data revealed increased accuracy in semantic compared to prosodic mismatches, although ERP data revealed that both aspects are crucial, as evidenced by an N400 sensitive to prosody as well as semantics. Results address the electrophysiological correlates of prosody, as well as the interaction between, and relative weighting of, semantic and prosodic information.

G52

TITRATION OF STIMULUS DURATION: A METHOD FOR ACQUIRING DYNAMIC INFORMATION WITH FMRI W. Einar Mencl¹, Stephen Frost¹, Shin-Yi Fang², Nicole Landi³, Helen Chen¹, Kenneth Pugh^{1,2,4}, Jay Rueckl^{1,2}; ¹Haskins Laboratories, ²University of Connecticut, ³University of Minnesota, ⁴Yale University – While fMRI is renowned for its spatial precision, interpreting temporal differences in activation is problematic due to the nature and variability of the hemodynamic response. We have explored an experimental technique for inferring the temporal sequence of activations along the cortical pathway for printed single-word identification. In Experiment 1 (N = 15), we presented word and nonword stimuli for varied durations prior to backward masking (33, 66, or 200 msec). Under the simplest assumptions, brief stimuli should only activate early nonlinguistic visual areas, whereas stimuli available for longer durations should be able to progress into successive stages of the reading network. Results were relatively consistent with this assumption: for words, 33 msec presentations produced restricted activations primarily in left striate/extrastriate areas; 66 msec durations elicited activation in these areas, plus the superior parietal cortex and BA 44/45; 200 msec durations produced activations at these areas, and enhanced activations in the posterior extrastriate and occipitotemporal zones. In Experiment 2 (N = 16), we presented words only, but at a more thorough set of presentation durations (17 to 200 msec). Initial analyses suggest that the response in many areas is not strictly linear across presentation duration. Ongoing analyses are targeted to clarify the nature of these nonlinear responses. We accept that the direct interpretation of these results as indicating simple stage-by-stage processing depends upon the unrealistic assumption that the reading network is a sequential, non-reentrant system. However, the technique and these data provide a starting point for investigating its nonlinear properties.

G53

THE ROLE OF THE DORSAL PATHWAY IN CHINESE WORD READING Danling Peng¹, Ruifang Guo¹, Yuan Deng², Yanhui Yang³, Guosheng Ding¹; ¹State Key Lab of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China, ²Institute of Psychology, Chinese Academy of Science, Beijing, China, ³MRI Center of Xuan Wu Hospital, Beijing, China – Previous studies on word reading demonstrate that word reading is related to two systems: the anterior reading system and the posterior reading system. The latter include the ventral pathway and the dorsal pathway. Many studies have proved that the ventral stream is responsible for visual word recognition, while for the dorsal pathway, some researchers consider that it is involved in the analysis of the phonology or the integration of morpheme and phoneme. However, there are less known about the relationship between the dorsal pathway and orthography. In our study, we investigated the role of the dorsal pathway in orthographic processing of Chinese characters. We presented to undergraduate students two types of characters with normal characters and shifted characters (i.e. positions of radicals in character were counter-changed). Participants were asked to judge whether stimulus presented was a real Chinese character regardless of position of radicals. We found that both of these two types of characters activated the dorsal pathway. ROI analysis indicated that there was significant main effect of type in the precuneus gyrus (BA7) of the left hemisphere. The shifted characters had stronger activation than the normal characters. According to these results, we propose that the dorsal pathway maybe involved in radical position encoding in orthographic processing of Chinese characters.

G54

PATHWAY FOR SCRIPTS SPATIAL ANALYSIS-THE COMPARISON OF DIFFERENT SCRIPTS Yafeng Sun¹, Danling Peng¹, Guosheng Ding¹, Yuan Deng², Yanhui Yang³; ¹State Key Lab of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China, ²Institute of Psychology, Chinese Academy of Science, Beijing, China, ³MRI Center of Xuan Wu Hospital, Beijing, China – Nowadays researchers have paid more attention to how the dorsal pathway functions while peo-

ple read scripts. They have found that role of the Parietal Lobe (PL) or the Superior Temporal Gyrus (STG) differs for different scripts. However, most previous studies only focused on one script but did not make a direct comparison between different scripts. The aim of this research was to compare the role of the dorsal pathway in processing very different scripts such as Chinese and English. Fourteen undergraduate students participated in this study and all of them have passed the CET-6. We presented to participants both Chinese characters and polysyllabic English words with three formats. One was normal and the other two were degraded (i.e., the number of blank spaces between radicals or syllables was changed: 0, 0.75 & 1.5 spaces). It was found that the STG was activated by only English while the PL activated by both. The activation patterns were also inferenced by the formats of the scripts. The results demonstrate that the activations of the dorsal pathway are modulated by both the characteristics of scripts and the requirement of space analyses.

G55

OLDER ADULTS' PROCESSING OF PROSODY IN SPOKEN ENGLISH GARDEN-PATH SENTENCES: A DISSOCIATION BETWEEN ONLINE ERP DATA AND OFFLINE BEHAVIORAL DATA *Efrat Pauker^{1,2}, Shani Abada^{1,2}, Inbal Itzhak^{1,2}, Shari Baum^{1,2}, Karsten Steinhauer^{1,2}*; ¹School of Communication Sciences and Disorders, McGill University, Montreal, Canada, ²Centre for Research on Language, Mind and Brain, Montreal, Canada – Previous ERP investigations provided evidence for the immediate use of prosodic information in the comprehension of temporary syntactic ambiguities in garden path sentences (Pauker et al., 2006; Steinhauer et al., 1999). However, few ERP studies to date have examined the ability of older adults to process syntax-related prosody online. The present auditory study used ERPs to determine whether older adults (65-80 years) make use of prosody in resolving early and late closure (EC/LC) ambiguities, and directly compares the data to those of young adults (18-30 years). Participants made offline acceptability judgments on two types of sentences (EC/LC) which were either well-formed or contained prosody-syntax mismatches that varied in severity. Behaviorally, both groups identified prosody-syntax mismatches to some extent, but older subjects accepted mismatches significantly more often (70%) than younger participants (40%). Older adults also failed to discriminate between the two types of prosodic mismatches, while younger adults showed significantly lower acceptance of the more severe mismatch. ERP results demonstrate CPS components and garden-path effects (P600 and N400/P600) in both groups; however, older adults displayed a more posteriorly distributed CPS and more anterior P600 components than young subjects. The ERP data suggest that older adults processed and integrated prosodic information in real-time. However, behavioral offline data did not capture these online effects. Age-related differences (a) in neurocognitive processing mechanisms as reflected by distinct ERP scalp distributions, and/or (b) in the subsequent offline evaluation of initial processing difficulties, may contribute to this dissociation between online and offline data.

G56

THE EFFECT OF WORD REGULARITY AND FREQUENCY ON NAMING BEHAVIOUR AND FMRI BOLD ACTIVATION *Jacqueline Cummine¹, Carrie Esopenko¹, Gordon Sarty¹, Ron Borowsky¹*; ¹University of Saskatchewan, Psychology – Background: It has been suggested that the Frequency (high frequency, HF and low frequency, LF) X Regularity (regular words, REGs and exception words, EXCs) interaction on naming RT occurs because the whole-word and sub-word reading systems produce a competing phonological code for LF-EXCs (i.e., increased phonemic processing and preparation of motor response). It has also been shown that tasks involving phonemic processing activate regions in the right middle temporal gyri (rMTG; Glasser & Rilling, 2008), and tasks involving preparation of motor responses activate regions in the supplementary motor association cortex (SMA; Richter et al., 1997). Purpose: We explored the effect of regularity and frequency, both behaviourally (i.e., naming RT), and functionally (i.e., fMRI) and the extent to which activation is found in

these regions. Method: Participants (N=63 in the behavioural experiment and N=10 in the functional experiment) named words blocked by regularity and frequency. Naming RTs were collected and fMRI activation maps that separate unique versus shared regions of activation were created. Results: Behaviourally, the standard regularity x frequency interaction was significant. That is, EXCs were named significantly slower than REGs, and LF-EXCs were named significantly slower than all other stimuli. Functionally, we found more activation for EXCs in the SMA (i.e., increased preparatory response), and exclusive activation for LF-EXCs in the rMTG (i.e., increased phonemic processing). Conclusion: Using a blocked design, we replicate the standard Regularity X Frequency interaction in naming, and provide evidence for the role of rMTG in phonemic processing and SMA in preparing a motor response.

G57

THE INITIAL LANGUAGE EXPERIENCE SHAPES BOTH HUMAN BRAIN FUNCTION AND ANATOMY: EVIDENCES FROM THE CONGENITALLY PROFOUNDLY DEAF *Yanyan Li¹, Guosheng Ding¹, Danling Peng¹, Liping Wu², Ping Hu², Yating Lv¹, Yufeng Zang¹, Chunyun Guo³*; ¹State Key Lab of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, P. R. China, ²Special Education College of Beijing Union University, Beijing, P. R. China, ³Special Education School of Dagang District, Tianjin, P. R. China – Language experience plays an important role in shaping both the function and the anatomy of human brain. The current study explored how the initial language experience impacts the development of brain function and anatomy with comparing two groups of congenitally profoundly deaf and one group of hearing people. One deaf group born of deaf parents (deaf native signers) acquired language experience (Chinese sign language) earlier than the other deaf group born of hearing parents (deaf nonnative signers). The BOLD fMRI activation were examined when the participants tried to understand Chinese Sign Language or spoken language in 3T-fMRI scanner. The effect of the initial language experience was revealed by the comparison between two deaf groups, while the effect of language modality revealed by the deaf group (sign language) and hear group (spoken language). The results showed that the left classical language areas were active in both sign language and spoken language comprehension. The recruitment of different parts of this network is modulated by both the age of acquisition and language modality. In addition, we also found that the gray matter density is modulated by age of first language acquisition. These essential findings provide strong evidence that the initial language experience contributes to the development of both brain function and anatomy.

G58

EARLY AUDITORY CORTICAL REGIONS DISCRIMINATE INTELLIGIBLE FROM UNINTELLIGIBLE SPEECH *Kayoko Okada¹, Jon Venezia¹, William Matchin¹, Kourosh Saberi¹, John T. Serences², Gregory Hickok¹*; ¹University of California, Irvine, Cognitive Sciences, ²University of California, San Diego, Psychology – Previous neuroimaging work that uses standard subtraction methodologies has shown that selective responses to intelligible versus unintelligible speech are found in regions of the superior temporal sulcus whereas early auditory areas in Heschl's gyrus and immediately surrounding regions in the supratemporal plane do not discriminate between intelligible and unintelligible acoustic control stimuli. The present study investigated this issue using multivariate pattern classification analyses. In a block-design fMRI experiment, we presented subjects with two intelligible speech conditions, clear speech (sentences) and noise-vocoded speech, as well as two unintelligible speech conditions, spectrally rotated speech and spectrally rotated noise-vocoded speech. Standard subtractive analyses replicated previous results showing bilateral anterior and posterior STS activity for intelligible compared to unintelligible conditions whereas early auditory areas in the supratemporal plane showed no difference. Using pattern classification analysis, however, we found that despite the lack of amplitude differences, early auditory regions nonetheless yielded reliably different spatial activation patterns to intelligible versus unintelligible speech in

both hemispheres. This result calls into question previous conclusions based on typical subtraction methodologies and suggests that regions that are not speech selective in terms of the voxel cluster-level amplitude of the physiological response may contain a finer-grained organization that processes speech differently from non-speech acoustic signals.

Linguistic Processes: Other

G59

ELECTROPHYSIOLOGICAL INVESTIGATION OF NULL ARGUMENTS: OMITTED STIMULUS POTENTIALS *Sophie G. Tate¹, Hiroko Nakano¹; ¹Saint Mary's College of California, Psychology* – The current study investigated electrophysiological processes of null arguments in English speakers. A null argument refers to a dropped subject or object argument in a sentence. A null argument structure is not grammatical in English, but it is in some languages such as Spanish (subject drop) or Japanese (subject and/or object drop). In this study, English monolinguals listened to paired sentences: a context sentence, e.g., "Oh, the bottom of the door is dented"; a follow-up test sentence, which contained an overt object argument (Pronoun or Lexical) or null argument (Null), e.g., "Did you kick it?", "Did you kick the door?", or "Did you kick \emptyset ?", respectively. ERPs measured at the onset of the null argument showed early positive deflection, which prolonged for several hundred milliseconds (Omitted Stimulus Potentials). The amplitude of the positivity for the Null condition was larger than those for the both Pronoun and Lexical conditions. The OSP observed with this linguistic material shares some similarities and dissimilarities (e.g., latency and prolongation) with the OSPs elicited by randomly omitted flashes of light or tones in series of presentation as well as with the general P300 and the P600. The OSP observed in this study may effect a detection of perceptual deviation as well as syntactic processes of an argument structure. The nature of the OSP component is discussed.

Linguistic processes: Other

G60

PATHS, MANNERS, AND OBJECTS *Alexander Kranjec^{1,2}, Eileen Cardillo^{1,2}, Anjan Chatterjee^{1,2}; ¹Hospital of the University of Pennsylvania, Neurology, ²The Center for Cognitive Neuroscience, the University of Pennsylvania* – Languages segregate information about an object's trajectory (PATH) and an object's intrinsic motion (MANNER) into different parts of speech (e.g. prepositional phrases and verbs in English). Previous work using fMRI (Wu, Morganti & Chatterjee, 2007) found dissociable neural networks mediating the representation of an object's path versus its manner of motion, suggesting a further parsing of the where motion processing stream into dorsal areas for path and ventral areas for manner. These results support the hypothesis that neural segregation of motion processing parallels the structuring of events by language. There are reasons for thinking that these two kinds of motion processing rely on distinct reference frames. For example, compared to path, manner entails motion intrinsic to an object's general form, generating the further hypothesis that processing manner attributes is more closely linked to object processing. To test this, we extended the one-back task from Wu et al. to include multiple agents. In a blocked design, participants attended to changes in either the form of the agent, its path, or its manner. Participants found path changes equally salient regardless of whether they co-occurred with manner or agent changes. In contrast, participants had greater difficulty detecting a change in manner performed by a different agent. Results support a neural model of motion processing in which manner more than path of motion is linked to the identification of objects.

G61

EFFECTS OF MULTIPLE REPETITIONS ON THE FUNCTIONAL NEUROBIOLOGY OF READING *Karen Aicher^{1,2}, Jay Rueckl^{1,2}, W. Einar Mencl¹, Stephen Frost¹, Shin-Yi Fang^{1,2}, Kenneth Pugh^{1,3}; ¹Haskins Laboratories, ²University of Connecticut, ³Yale University School of Medicine* – Increased familiarity with words and nonwords has been associated with changes in cortical activation patterns. Whether the activation increases or decreases in response to a learning task has been hypothesized to be related to the extent to which the particular item has been overlearned at the time of measurement. We examined the response of twenty typical readers to different repetition conditions on a pseudoword oral reading task using functional magnetic resonance imaging (fMRI). During a pre-scanning training session, participants were asked to read monosyllabic, pronounceable pseudowords into a microphone. Pseudowords were presented once, twice, four times, or eight times during that session. Participants then completed a similar oral reading task in the scanner with the repeated items from the out-of-scanner training session, as well as novel pseudowords. Repetition related changes in activation were noted in left hemisphere areas strongly associated with reading functions. Specifically, more repetition led to increased activation in the middle temporal gyrus, which has been hypothesized to be part of a ventral reading system which may be semantically tuned. Increased activation was also noted in the supramarginal gyrus, which has been considered to be part of a dorsal reading system, and has been associated with phonological analysis. Nonmonotonic changes were noted as a function of repetition in some areas, including the inferior frontal gyrus, an area that has been postulated to be part of an anterior circuit which may be involved with phonological memory and recoding. Implications for normal and impaired readers are discussed.

G62

PERCEIVING CATEGORY, AFFECT AND GENDER IN THE SAME SET OF WORDS: AN MEG STUDY USING VISUAL-AUDITORY PRIMING TASK *Yang Zhang¹, Toshiaki Imada^{2,3}, Masaki Kawakatsu³, Keita Tanaka³, Atsushi Aoyama³, Sharon Miller¹, Iku Nemoto³; ¹University of Minnesota, Speech-Language-Hearing Sciences, ²Institute for Learning and Brain Sciences, University of Washington, ³Research Center for Advanced Technologies, Tokyo Denki University* – Human speech contains not only the structure of a language but also important information about the speaker's identity and emotional affect. This study employed whole-head magnetoencephalography (MEG) to examine Japanese adults' perception of category, affect and gender for a set of English words. Seven subjects participated in the visual-auditory priming task. The visual stimuli that were presented 500 ms prior to auditory stimuli consisted of static pictures of letters ("L" or "R") for Category Condition, happy or sad cartoons for Affect Condition, and male or female cartoons for Gender Condition. The digitally edited auditory stimuli used the same set of words recorded from native English speakers (one male and one female) producing the words "right" and "light", intended to convey either happy or sad mood. Subjects were required to respond whether the auditory word was congruent with the preceding visual prime or not. The experiment started with a familiarization phase, which was immediately followed by the test phase. At least 80 trials were averaged for congruent and incongruent responses in each condition. As expected, behavioral results in both accuracy and reaction times revealed an increasing order of difficulty from gender to affect to category perception across the subjects. Minimum Current Estimate analysis of the MEG data indicated different patterns of hemispheric and regional involvement for the three conditions when the congruent responses were subtracted from the incongruent responses. Taken together, the results support the plurality of neural representations of speech at the cortical level and their dependency on selective attention.

G63

NEURAL CORRELATES OF LANGUAGE LEARNING IN EXCEPTIONAL CIRCUMSTANCES: AN EVENT-RELATED POTENTIAL STUDY Nils Skotara^{1,2}, Monique Kügöw^{1,2}, Uta Salden¹, Barbara Hänel-Faulhaber³, Brigitte Röder²; ¹Research Centre 538: Multilingualism, University of Hamburg, ²Biological Psychology and Neuropsychology, University of Hamburg, ³Educational sciences, Section II: Perception & Communication, University of Hamburg – Most studies investigating sensitive or critical periods for language acquisition compare native speakers and second language (L2) learners. A possible sensitive or critical period for the acquisition of a first language (L1) can only be investigated in people grown up in exceptional circumstances, for example in deaf people born to hearing parents unable to use a natural language with their child. The present study compared (1) native signers of German Sign Language (DGS) who had learned written German as an L2, (2) late signers who had learned both, DGS as an L1 and written German (as an L2) after school enrolment, and (3) hearing L2-learners of German. Written German sentences were presented while the EEG was recorded. In half of the sentences a semantic (implausible object) or a syntactic violation (verb agreement violation) was embedded. Participants had to decide whether or not the sentence was correct. The behavioural data revealed a better performance for hearing L2-learners and native signers than for late signers. A subgroup of late signers performed similarly as the native signers. In all groups, semantic violations elicited an N400 followed by a late positivity and syntactic violations elicited a P600. After syntactic violations a left lateral negativity was observed in hearing L2-learners. By contrast, a bilateral negativity was observed for the native and late signers. These data suggest that language deprivation affects the cerebral organization of language processing.

G64

MULTIPLE PHONOLOGICAL REPRESENTATIONS BECOME ACTIVE WHEN READING JAPANESE KANJI: CASCADING ACTIVATION AFTER ALL? Rinus Verdonschot^{1,2}, Katsuo Tamaoka³, Clemens Poppe⁴, Niels Schiller^{1,2}; ¹Leiden Institute for Brain and Cognition, ²Leiden University Centre for Linguistics, ³Graduate School of Language Education, Reitaku University, ⁴Centre for Japanese and Korean Studies, Leiden University – An unresolved issue in psycholinguistics is whether activation spreading is limited to selected instead of 'merely' activated lemmas. For instance, Levelt et al. (1991) found that a to-be-named target lemma (e.g. sheep) spreads activation to the word-form level but not to categorically or associatively related lemmas (like goat or wool), supporting discrete processing. Peterson and Savoy (1998), however, reported evidence for phonological activation of (near-) synonyms like couch and sofa, providing evidence for cascading processing. These latter results were attributed by discrete models to be special cases of processing. We employed a masked priming paradigm using Japanese kanji which are more commonly synonymous. Many kanji symbols are 'synonymous' in the sense that they have multiple readings though the meaning does not necessarily change (unlike homographs). For instance, the symbol for water, 水, can be read as /mizu/ or /sui/ and instances of both readings can easily be found, e.g. 海苔 (/kai-sui/; seawater) or 雨 (/ama-mizu/; rainwater). Therefore, this symbol has two possible readings, but its meaning water does not change. Using katakana transcriptions (phonetic script) of these possible pronunciations we were able to show that multiple katakana targets could successfully be primed by the same kanji prime. These findings provide further evidence for cascaded processing in lexical access.

G65

RESPONSES TO TWO TYPES OF BEHAVIORALLY RELEVANT VARIABILITY IN SPEECH IN A PASSIVE FMRI PARADIGM Jason D. Zevin¹, Jianfeng Yang¹, Jeremy I. Skipper¹, Bruce D. McCandliss¹; ¹Sackler Institute for Developmental Psychobiology, Weill Cornell Medical College – In order to explore the networks that underlie perception of different aspects of speech, we conducted a passive listening experiment designed to elicit change detection responses due to two different types of change -

- change between speakers and change between phonetic categories -- relative to a repeat condition in which both speaker and phonetic category were held constant, but other acoustic parameters varied naturally (intonation, duration, voice quality, etc.). Contrasts comparing both change conditions to the repeat baseline revealed a common network engaged by behaviorally-relevant acoustic changes both with respect to voice and phonetic category, whereas contrasts between the two change conditions revealed independent networks specific to each type of change. Exploratory analyses of correlations among regions in the broader change network and how these are modulated by condition will complement the simple contrasts and provide greater detail about how the functional anatomy for speech perception flexibly reorganizes in the face of changes in the predictability of different stimulus attributes.

G66

RELATIVE CONTRIBUTION OF PHONOLOGICAL SKILLS AND MEMORY IN READING: THE CASE OF PROFOUNDLY DEAF INDIVIDUALS Elizabeth A. Hirshorn¹, Matthew W.G. Dye¹, Peter C. Hauser², Daphne Bavelier¹; ¹Brain and Cognitive Sciences & Center for Language Sciences, University of Rochester, ²National Technical Institute for the Deaf, Research and Teacher Education, Rochester Institute of Technology – In hearing people, one of the best predictors of reading fluency is phonological awareness, which depends heavily on access to sound. With little-or-no access to the sounds of spoken language, deaf individuals may need to rely on different routes to literacy. This work evaluates the cognitive processes through which profoundly deaf individuals achieve such literacy. We developed new deaf-friendly assessments for factors known to predict reading skills in hearing individuals. These include picture-based phonological tasks and tests of memory (serial and free recall). Factors hypothesized to predict reading in deaf individuals, such as speech-reading and sign language fluency, were also examined. Results confirmed the strong relationship between phonological skills and reading in hearing individuals. In contrast, memory measures, especially free recall, were the best predictors of reading skills in deaf individuals. Interestingly, speech-reading was a good predictor of reading in hearing but not in the deaf. Brain imaging during single word and sentence processing by deaf readers revealed similar neural networks to those previously described in the literature. Interestingly, phonological skills correlated strongly with activation in single word processing areas, whereas free recall correlated strongly with activation in sentence level processing areas. Deaf readers, therefore, seem to differentially weigh phonological and memory strategies as a function of task demands during reading. Since reading is typically used in the service of text comprehension, this work highlights the importance of memory skills in reading fluency in deaf individuals.

G67

BOTH BEHAVIORAL AND NEURAL INDICES OF PHONOLOGICAL ABILITY PREDICT READING FLUENCY IN SKILLED ADULTS: AN FMRI INVESTIGATION OF PASSAGE READING Allison Zumberge¹, Frank Manis^{1,2}, Zhong-Lin Lu^{1,2}; ¹Neuroscience Graduate Program, University of Southern California, ²University of Southern California, Psychology – Studies of reading development and disability have identified phonological ability as a major contributor to reading fluency in children. The relationship seems to hold across a wide range of adult, skilled readers, as well, but its neural basis has yet to be identified. Additionally, reading tasks used in functional MRI studies of phonological ability generally employ single-word stimuli, a design with many benefits but little ecological validity. The present study investigated the relationship between reading fluency and fMRI activity within the phonological processing network using a self-paced passage reading task. First, we identified regions of interest for phonological processing with fMRI, using adults' performance on a phonological lexical decision task involving judgments about whether a pseudohomophone or pseudoword sounded like a real word. This task activated a network of brain regions that only partially overlapped with

the network activated by the passage-reading task, which additionally recruited middle and polar temporal regions. In order to examine the predictive power of phonological ability on reading fluency, both behavioral and neural indices of phonological processing were correlated with behavioral scores on an oral passage reading task. While neural activity in anterior and posterior IFG during the passage-reading task was positively correlated with overall reading fluency, posterior IFG contributed to the accuracy component of fluency while anterior IFG and occipito-temporal region contributed to the rate component. The results reveal that somewhat different phonological and orthographic processing regions in the brain contribute to accuracy and rate components of oral reading skill.

G68

ASYMMETRIC PHONOLOGICAL PREDICTIONS IN SPEECH PERCEPTION: MEG EVIDENCE So-One Hwang¹, Philip Monahan¹, William Idradi^{1,2}, ¹University of Maryland, Linguistics, ²Neuroscience and Cognitive Science Program, University of Maryland – Do phonological processes influence speech perception symmetrically? In this study, we examine a pervasive cross-linguistic generalization: coda obstruent clusters must agree in voicing. That is, in many languages (including English) word-final phonetic sequences such as [dz] and [ts] are acceptable whereas *[ds] and *[tz] are not. This grammatical constraint implies symmetric processing difficulties with heterogeneous clusters, e.g. *[tz], *[ds]. However, Lombardi (1991) proposes instead that only [+voice] is lexically represented, default [-voice] being underspecified, implying asymmetric processing of heterogeneous clusters. Using MEG, we examine the time course of the prediction of the upcoming signal comparing symmetric and asymmetric predictions. Given that early auditory processes are observable by 100ms and lexical effects by 300ms, we expect to find differences within this time-window. Four types of clusters were created by splicing or cross-splicing VCC tokens: vd-s [uds, ubz, ugs], vd-z [udz, ubz, ugz], vl-s [uts, ups, uks] and vl-z [utz, upz, ukz]. Participants (n=13) passively listened to randomly presented stimuli during MEG recording (160-channel; KIT, Japan). Because of the complexity of the stimuli, we analyzed RMS difference waveforms to cluster types with the same fricative. In the time window 100-300ms, we find significant differences between the MEG response to vd-s as compared to vl-s (p<0.05). This finding suggests that only marked features induce predictions about the upcoming speech signal, and these effects are present in early cortical responses. Such findings are consistent with phonological underspecification theories, e.g. Lombardi (1991) and Obleser, Lahiri and Eulitz (2004).

G69

EFFECTIVE FUNCTIONAL CONNECTIVITY OF PHONOLOGICAL AND SEMANTIC PROCESSING DURING WORD READING Cheryl M. Capek^{1,2}, Simandeep Poonian¹, Joseph T. Devlin^{1,2}; ¹Cognitive, Perceptual and Brain Sciences, University College London, UK, ²Institute of Cognitive Neuroscience, University College London, UK – Numerous lesion and neuroimaging studies of language processing have shown that reading reliably engages left hemisphere regions including the ventral occipito-temporal cortex (vOTC), temporo-parietal regions and the inferior frontal cortex (IFC). In addition, neuroimaging and neurostimulation studies have found evidence of functionally distinct subdivisions within the left IFC, with phonological processing preferentially involving more posterior regions (i.e., pars opercularis) and semantic processing preferentially involving more anterior regions (i.e., pars orbitalis/triangularis). Identifying the manner by which these brain regions are engaged in phonological and semantic processing offers valuable insight into how a distributed brain network mediates successful reading. In the present study, we used functional magnetic resonance imaging to identify the functional neural organization of word reading in monolingual speakers of British English as they read blocks of word pairs, alternating with a fixation baseline. For each word pair, participants performed either a phonological (rhyme) or semantic (category)

judgment task. Participants displaying activation in four left hemisphere regions of interest (ROIs), namely vOTC, supramarginal gyrus, pars opercularis and pars orbitalis/triangularis were included in the effective functional connectivity (dynamic causal modeling; DCM) analysis (n=23). Bayes Factors (BFs) were employed to assess different DCM models of fronto-parietal-vOTC connectivity. The results showed strong bidirectional, intrinsic connections between the four ROIs, with the strongest connections from the vOTC to the parietal and frontal ROIs. The results provide evidence of both bottom-up and top-down processing in the brain network mediating reading.

G70

STATISTICAL CUES TO PHONETIC CATEGORY STRUCTURE

Emily Myers¹, Sheila Blumstein¹; ¹Brown University, Cognitive and Linguistic Sciences – Recent research suggests that the statistical distribution of speech sounds plays a role in shaping sensitivities to acoustic-phonetic space and ultimately in forming the sound categories of one's native language. These studies have shown that participants familiarized with stimuli from a non-native phonetic continuum show greater sensitivity to the endpoints of the continuum when they hear tokens sampled from a bimodal distribution than when they hear tokens sampled from a unimodal distribution. What is less clear are the neural mechanisms which mediate these effects. In the current study, functional magnetic resonance imaging was used to monitor activation patterns in participants who had been familiarized with tokens from a bimodal or unimodal distribution taken from a non-native continuum. Neural sensitivity to phonetic differences was measured using a short-interval habituation paradigm, in which four repeated phonetic tokens were followed by either a different token from the continuum (Change trials) or a fifth repeated token (Repeat trials). Behavioral sensitivity was also measured after scanning using a discrimination task. Both groups showed neural sensitivity to the endpoints of the novel continuum, as indicated by greater activation for Change trials than Repeat trials. However, the Bimodal group showed the greatest response in the left supramarginal gyrus and posterior superior temporal gyrus, whereas the Unimodal group showed the greatest response in the posterior and anterior left superior temporal sulcus. These results suggest that activation in the supramarginal gyrus reflects the emergence of phonetic category representations, whereas activation in temporal areas reflects earlier stages of acoustic processing.

G71

THE ROLE OF AWARENESS IN SEMANTIC AND SYNTACTIC PROCESSING: AN ERP ATTENTIONAL BLINK STUDY

Laura Batterink¹, Christina Karns¹, Yoshiko Yamada¹, Eric Pakulak¹, Helen Neville¹; ¹University of Oregon – The role that automatic and controlled processes play in semantic and syntactic processing is not well understood. In semantic priming studies, there is a lingering debate about whether the N400, an ERP component elicited by unexpected linguistic stimuli, reflects an automatic or controlled, post-lexical process. Syntactic priming, specifically word category priming, has been even less well characterized. We used an attentional blink (AB) paradigm, which can be used to manipulate the role of awareness in the processing of target words, to assess automaticity in semantic and syntactic processing. We compared ERP responses to targets occurring within the AB period to targets occurring outside the AB period, and compared ERPs to correctly-reported versus missed targets. In the semantic block, primes and targets were either semantically related or unrelated, and in the syntactic block, primes and targets formed either syntactically congruent or incongruent phrases. In the semantic block, targets occurring both within and outside the AB period elicited an N400. However, N400 amplitude was significantly reduced during the AB period, and missed targets did not elicit an N400. In the syntactic block, a late negative syntactic congruency effect was elicited by targets occurring outside the AB period while targets occurring within the AB period showed no effect of congruency. Semantic results support the argument that the N400 is primarily an index of a controlled, post-lexical process. Syntactic findings suggest that the brain

response to some syntactic violations depends on awareness and availability of attentional resources.

G72

INVESTIGATING THE DEFICIT IN PHONOLOGIC ALEXIA: AN EYE-TRACKING STUDY Tamar D. Gefen¹, Elizabeth H. Lacey^{1,2}, Sarah Ferguson Snider¹, Susan Nitzberg Lott¹, David P. Roeltgen¹, Rhonda B. Friedman¹; ¹Georgetown University Medical Center, Center for Aphasia Research and Rehabilitation, ²Interdisciplinary Program in Neuroscience, Georgetown University – Phonologic alexia (PhA) is an acquired disorder characterized by impaired reading of pseudowords relative to real words and, often, a greater difficulty reading functors (e.g., "it", "for") than concrete nouns. We hypothesize that the deficit is due to insufficient activation of phonological codes, causing impairment in reading words with low semantic value, especially when these words are surrounded by words with higher semantic value, as in text. This would predict that reading functors surrounded by words with high semantic value would be more difficult than reading functors surrounded by words with little, or no, semantic value. We investigated our hypothesis by testing functor reading in a chronic PhA patient, TJN, using an eye-tracking technique. Three sets of 40 functors were matched for frequency, number of syllables and number of letters. Functors were embedded in three-word phrases, surrounded by either two highly concrete words (CON), two abstract words (ABS), or two non-pronounceable letter strings (LS). TJN was asked to read aloud only the functor. Dwell times (DT) and number of fixations were evaluated. Results revealed longer DT on functor words in the CON condition (821 ms) than in the ABS (630 ms) or LS condition (598 ms); number of fixations on the functor displayed the same pattern. In contrast, DT on surrounding words (non-functors) or letter strings did not vary significantly across conditions. These results are consistent with our hypothesis that surrounding words with high semantic value interfere with the reading of functors in patients with PhA.

G73

DOMAIN-SPECIFIC OR SHARED MECHANISMS OF PROSODIC PHRASING IN SPEECH AND MUSIC? NEW EVIDENCE FROM EVENT-RELATED POTENTIALS Karsten Steinhauer^{1,2}, Stefanie Nickels³, Conrad Duncan², Kanwar Anit Singh Saini^{1,2}; ¹Centre for Research on Language, Mind, & Brain, McGill University, ²School of Communication Sciences & Disorders, McGill University, ³Saarland University, Psychology – Prosodic information (the intonation and rhythm of speech and music) has a major impact on how listeners parse and interpret the auditory signal. Prosody guides syntactic sentence analysis, supports language acquisition, and underlies our cognitive organization of melodies (Lerdahl and Jackendoff, 1983). Whether the neurocognitive mechanisms underlying prosodic phrasing are shared between language and music is controversial. In speech, prosodic boundaries reliably elicit a positive-going ERP component with short latencies (0-300ms) time-locked to PRE-boundary words: the Closure_Positive_Shift (CPS; Steinhauer et al., 1999). A CPS-like ERP pattern was also reported for musical boundaries, however much later (around 500ms following POST-boundary tones) and only for highly trained musicians (Neuhaus et al., 2006), while non-musicians displayed negativities. This contrasts strongly to the speech-CPS, which has been found for hummed sentences, and even in pre-linguistic infants (e.g., Pannekamp et al., 2006). Our ERP study employed a speech/music-continuum to localize the transition from music-like to speech-like boundary effects in 16 non-musicians. All stimuli were derived from sentences with boundaries that elicited a CPS in a previous study and ranged from (i) the original speech signals to (ii) computer-generated "hummed" versions and (iii) sine waves preserving the pitch contour to (iv) corresponding melodies played with either piano or horn timbre. Data revealed CPS components at boundaries across conditions, however with varying latencies. This finding demonstrates that musical phrasing can elicit a CPS even in non-musicians, compatible with common mechanisms in speech and language. Factors contributing to latency effects and differences among studies will be discussed.

G74

MORPHOMETRIC AND FUNCTIONAL NEUROANATOMY OF RAPID NAMING, PHONOLOGICAL PROCESSING AND WORD IDENTIFICATION IN CHILDREN WITH A WIDE RANGE OF READING ABILITY: IMPLICATIONS FOR THE DOUBLE-DEFICIT HYPOTHESIS OF DEVELOPMENTAL DYSLEXIA Jessica M. Black¹, Masanori Nagamine¹, Allan L. Reiss¹, John D. E. Gabrieli², Fumiko Hoeft¹; ¹Center for Interdisciplinary Brain Sciences Research, Stanford University School of Medicine, ²Harvard-MIT Division of Health Sciences and Technology (HST) and Brain and Cognitive Sciences, Massachusetts Institute of Technology – The double-deficit hypothesis (DD) posits that naming speed is an independent core deficit in addition to the phonological processing deficits seen in individuals with developmental dyslexia. According to this theory, individuals with a 'double-deficit' have more severe deficits in reading than those with single deficits or without any deficits. It is not yet clear, however, how these deficits are related to each other and to reading. Examination of the neural substrates of these processes may have substantial implications not only in understanding the DD, but also for the identification and treatment of reading disabilities. We therefore examined the relationship between morphometric and functional neuroanatomy and these skills. Participants were 62 children (age 13.5 + 2.6) representing a wide range of reading skills from severely impaired (meeting the criteria for dyslexia) to superior. A standard battery of neuropsychological assessment was given including rapid naming of letter and number (RAN) and real word identification (ID). In addition, we collected high-resolution MRI data to examine regional gray matter volume and functional magnetic resonance imaging (fMRI) data during a real word rhyme judgment task to examine phonological processing. Voxel-based morphometry (VBM) analyses identified overlapping regions that showed significant positive correlations with regional volume and RAN as well as ID in the left supramarginal, posterior superior temporal, precentral and inferior frontal gyri. Regions involving the cerebellum showed negative correlation. These regions also showed significant associations with fMRI activation during phonological processing. These findings suggest that these regions may be critical in the DD.

G75

RETHINKING THE P600/P300 DEBATE: EVENT-RELATED POTENTIAL ADDITIVITY AS AN INDEX OF OVERLAP IN NEUROCOGNITIVE RESOURCES Geoff Valentine¹, Lee Osterhout¹; ¹University of Washington, Psychology – Many claims have been made about the domain specificity of the neural mechanisms subserving syntactic processing using evidence from event-related potentials (ERPs). Violations of linguistic syntactic expectancy elicit the P600 component of the ERP waveform while a wide range of violations of expectancy across many domains elicit a P300b. Although superficially similar (both are late positivities), these components are additive which has led some to conclude that, by definition, they are driven by at least partially distinct neurocognitive processes. We carried out two studies in which we recorded ERPs from 64 channels on the scalp while subjects read English sentences. In the first experiment a 2x2 design was employed in which the critical word was either consistent with or violated expectation in syntax and/or capitalization. In the second experiment we again used a 2x2 design in which the critical word could violate expectation in capitalization and/or text color. If the assumption of the independence of the electrophysiological sources of the P600 and the P300b components is correct, then additivity should only be present in the syntax/capitalization and not the capitalization/color conditions. The presence of substantial additivity in both experiments suggests that a binary division of the late positive complex into the P600 and P300b is artificial, and, moreover, that the amount of additivity between two conditions can be used as an index of the amount of neurocognitive resources they share.

G76

STRUCTURAL AND PRAGMATIC LANGUAGE PROFILES OF MALES AND FEMALES WITH AN EXTRA X CHROMOSOME

Nancy Raitano Lee¹, Gregory Wallace^{1,2}, Liv Clasen¹, Jonathan Blumenthal¹, Rhoshel Lenroot¹, Jay Giedd¹; ¹Child Psychiatry Branch/NIMH/National Institutes of Health, ²Laboratory of Brain and Cognition/NIMH/National Institutes of Health – The presence of an additional X chromosome characterizes Klinefelter (XXY) and Trisomy X (XXX) syndromes. Intelligence tends to be in the low average to average range for these disorders; however, language deficits are often reported. The nature of these deficits, and in particular, the presence of pragmatic (i.e., social) language impairment, has not been thoroughly investigated. This study utilized the Children's Communication Checklist - 2, a parent-report measure of structural and pragmatic language skills with eight scales divided into two domains (Structural language= Speech, Syntax, Semantics, Coherence; Pragmatic language= Initiation, Scripted Language, Context, Non-verbal Communication) to compare the language profiles of 17 XXY males (age: 12.09±2.94) and 21 XXX females (age: 9.06±2.32). Overall, both groups scored below the normative mean of 100 for the measure (Composite score means for XXY= 89.41±10.53 and XXX = 85.48±19.11; p's<.05). On the individual structural language scales, the XXY group scored below the normative mean on two scales, Semantics and Coherence (this latter scale measures the ability to communicate the content of one's thoughts clearly), while the XXX group scored significantly below the normative mean on all four scales (all p's <.05 with Bonferroni correction). For the pragmatic language scales, both groups scored below the normative mean on the Context scale (a scale that assesses abstract, non-literal language, flexibility, and humor; p<.05 with Bonferroni correction). These results will be discussed in relation to the larger XXY and XXX neurobehavioral phenotypes.

G77

INFLUENCES ON LANGUAGE-RELATED LEARNING MECHANISMS: AN FMRI STUDY OF WORD SEGMENTATION IN CHILDREN

Kristin McNealy¹, Larissa Borofsky¹, John Mazziotta¹, Mirella Dapretto¹; ¹UCLA Brain Mapping Center – Significant progress has recently been made in delineating the functional representation of language in the developing brain. However, we still know relatively little about the neural basis of the actual process of language learning, and even less about how the neural correlates of language learning might be related to individual differences in linguistic skills and experiential factors. In the present study, we began to address these issues by relating several behavioral measures collected in a large sample of ten-year-old children (n=78) to brain activity associated with a critical aspect of language learning (i.e., word segmentation, the detection of word boundaries in a novel stream of continuous speech). Using fMRI to examine on-line word segmentation, we previously demonstrated that children and adults exhibit learning-related signal increases over time in bilateral superior temporal gyri (STG) and left inferior parietal lobule (IPL). Here, we found that children's literacy skills were positively related to signal increases in bilateral STG; in contrast, both children's reading ability and verbal IQ were negatively correlated with signal increases in IPL. Interestingly, the degree of fluency in a second language was also positively correlated with signal increases in bilateral STG, suggesting that these regions play an important role in supporting successful language-related statistical learning. These findings begin to elucidate the complex relationship between linguistic experience and language learning and have implications for current theories of the neural basis of language acquisition. Support Contributed by: National Science Foundation, UCLA Ahmanson-Lovelace Brain Mapping Center, UCLA-FPR Center for Culture, Brain, and Development

G78

AN ELECTROPHYSIOLOGICAL STUDY OF THE EFFECTS OF READING SKILL ON WORD AND PSEUDOWORD PROCESSING IN ADULTS

Maya Misra¹, Beth Friedman², Joyce Tam¹, Kristen Mettley¹, Bridgid Zvirblis¹; ¹The Pennsylvania State University, University Park, PA, ²University of Pittsburgh, PA – Previous studies have shown that, even among typical adults, variations in language abilities may be associated with differing patterns of neural responses to linguistic stimuli measured with event-related potentials (ERPs). The current study focused on the effects of reading skill on ERPs, with a specific interest in evaluating evidence for sensitivity to phonology among adult readers. Prior research has suggested that while phonology is activated automatically during reading, phonological effects may vary with skill level, even among practiced adult readers. The current study was designed to further evaluate evidence that different reading strategies may be employed by proficient readers of English. Participants completed a detailed reading history questionnaire and were assessed with a battery of standardized tests designed to measure orthographic and phonological processing as well as connected text reading and comprehension. Participants then returned to the lab at a later date to complete a semantic monitoring task including word and pseudoword stimuli which varied systematically in their orthographic and phonological properties while 32 channels of ERPs were recorded. Preliminary results suggest that there was significant variability in performance on tests of phonological memory, spelling, and connected text reading fluency and comprehension among these skilled readers. Furthermore, the amplitude of the N400 component of the ERP waveform was sensitive to subtle variations in reading skill, particularly as indexed by the behavioral measures of connected text reading and comprehension. Results will be discussed in terms of models of skilled reading.

G79

PRIMING METHODS IN APHASIA: REVISITING SLOW LEXICAL ACCESS

Josee Poirier¹, Tracy Love^{2,3}, Lewis Shapiro²; ¹SDSU/UCSD Joint Docotral Program in Language & Communicative Disorders, ²San Diego State University, ³University of California, San Diego – A slowdown in lexical processing has been implicated in sentence comprehension deficits in aphasia. Support for such protracted processing comes from the use of Cross-Modal Priming (CMP). Sentences are presented aurally, while participants are required to make a decision on a visual probe that occurs at strategic points during the unfolding of the sentence. Faster RTs to associatively related probes compared to unrelated probes reflect priming of the target lexical item. Left anterior-lesioned aphasics, unlike unimpaired controls, do not show associative priming (AP) in the immediate vicinity of the target lexical item; instead, AP is only observed 'downstream' (Love et al., 2008). In fact, in List Priming Paradigm studies where lexical decisions are made to individual words that occur one after the other, aphasic individuals reveal AP only at Stimuli-Onset-Asynchronies of >1500ms (Henik et al, 1993; Prather et al.,1997). We hypothesized that the delayed activation patterns in sentences observed with CMP may be due to the long SOA required to elicit AP effects. In a CMP sentence comprehension study, we probed for an overt noun at its offset, using either associatively related probes (e.g., nurse-doctor), or identity probes (IP; e.g., nurse-nurse). Eight left anterior-lesioned aphasics completed the study. We computed related-to-control RT ratios, where a ratio <1 indicates priming. Identity priming was observed (mean:0.949, t(7)=-2.726, p=0.01,one-tailed) but associative priming was not (mean:1.000, t(7)=0.253, p>0.05,one-tailed). We discuss this distinction between CMP-AP and CMP-IP in terms of hypothesized lexical and syntactic deficits in aphasia.

G80

AN FMRI INVESTIGATION OF REPEATED NAME AND DEFINITE REFERENCE IN DISCOURSE

Amit Almor^{1,2}, Veena Nair³, Jeremy May¹, Timothy Boiteau²; ¹University of South Carolina, Psychology,

²University of South Carolina Linguistics Program, ³University of Wisconsin Madison, Radiology – Repeated reference is an important part of coherent discourse but very little is known about the brain basis of processing repeated reference in discourse. A recent functional magnetic resonance imaging (fMRI) study (Almor, Smith, Bonilha, Rorden, & Fridriksson, 2008) found that reading a repeated proper name reference (e.g., Joe) to a salient discourse referent leads to increased activation in temporal regions and intra-parietal sulcus (IPS) in comparison to reading a pronoun reference (e.g., he). This was interpreted as indicating the involvement of spatial brain circuits (IPS) in the management and manipulation of representations of discourse referents (temporal regions). Here we report two fMRI experiments that further evaluated this hypothesis. The first experiment tested whether the salience of referents in the context of the discourse affects these activations. In support of the original hypothesis, we found that the referent salience affected activation in parietal regions. The second experiment tested whether similar activations occur for definite description references (e.g., the man) to salient and non-salient referents. Although we found that referent salience also affects the activation associated with repeated definite references, the activation was in different regions than for repeated names. Activations associated with repeated definite description references did not occur in any parietal regions but instead included several frontal areas as well as the left and right caudate. These findings thus suggest that the processing of linguistic reference in discourse involve multiple circuits and mechanisms that are associated with the use of different referential forms.

G81

THE BRAIN USES CO-SPEECH GESTURES TO SET THE CONTEXT FOR SPEECH UNDERSTANDING Jeremy Skipper¹, Ran Liu¹, Bruce McCandliss¹, Jason Zevin¹; ¹Sackler Institute for Developmental Psychobiology, Weill Medical College of Cornell University – Does the brain use the wealth of contextual information that accompanies speech during real-world communication? Or is this information treated as noise, secondary to the process of linguistic interpretation? We collected fMRI data while participants watched a television game show. We used a combination of analysis techniques including independent component, peak-and-valley (based on extensive stimulus annotation), and directional functional connectivity (i.e., Granger causality) analysis to discover meaningful patterns in data resulting from a natural stimulus. Peak-and-valley analyses of the independent component time series identified different networks of interest (NOIs) with high selectivity for stimulus periods containing speech, co-speech gesture, and non-communicative hand and arm movements respectively. The speech selective NOI was comprised of primarily bilateral anterior superior temporal and ventral premotor cortex. The co-speech gesture selective NOI comprised bilateral SMA, dorsal premotor, insula, and parietal areas. The non-communicative hand and arm movement NOI comprised bilateral occipital and parietal areas. Functional connectivity analysis showed that the co-speech gesture NOI drove the speech NOI. This was not the case for the non-communicative hand and arm movement NOI. These results suggest that the motor system is involved in extracting meaningful information from co-speech gesture that later influences areas sensitive to verbal content. This supports a model of communication in which the brain actively makes use of context to predict forthcoming sensory information to constrain linguistic interpretation. At least some forms of context, therefore, are not secondary but integral to achieving understanding in natural settings.

G82

AN FMRI INVESTIGATION ON PAST TENSE PROCESSING OF NATIVE AND NONNATIVE ENGLISH SPEAKERS So-Hee Kim¹; ¹The University of Texas at Austin – The goal of this study was to determine whether native (L1) and nonnative (L2) speakers of English use the same brain regions when they generate regular and irregular past tense verb forms. By using event-related functional magnetic resonance imaging (fMRI), the study compared the neural responses of 16 Korean speakers of English (16 males, age range 19-35, mean age \pm SD = 25.12 \pm 5.12)

with the neural responses of 16 native English speakers (1 female, age range 19-35, mean age \pm SD = 25.87 \pm 5.00) as both types of speakers internally generated the morphologies of regular and irregular past tense verb forms in English. According to the neuroimaging data, both types of language speakers, at least to some degree, activated the same respective brain regions when they processed regular and irregular past tense verb morphological inflections. Specifically, in both L1 and L2 speakers, under non-contrast imaging analysis conditions, regular past tense generation involved left-hemispheric lateralization patterns, whereas irregular past tense generation elicited widespread bilateral brain responses. Thus, no notable imaging contrasts were found between L1 and L2 speakers when they generated regular and irregular past tense verbs, respectively. The study concluded that past tense morphological processing involved neural regions common to both native and nonnative English speakers.

G83

COMPREHENSION OF M-SEQUENCE MODULATED SPEECH SOUND: ACTIVATION IN THE RIGHT INFERIOR FRONTAL GYRUS AND THE LEFT INFERIOR PARIETAL LOBE AS REVEALED BY FMRI Hiroshige Takeichi^{1,2,3,4}, Sachiko Koyama^{5,4}, Atsushi Terao⁶, Fumiya Takeuchi^{7,4}, Yuko Toyosawa^{4,8}, Harumitsu Murohashi^{8,4}; ¹BSI, RIKEN, ²RNC, RIKEN, ³IML, University of Tokyo, ⁴RISTEX, JST, ⁵RIES, Hokkaido University, ⁶School of Social Informatics, Aoyama Gakuin University, ⁷Faculty of Health Sciences, Hokkaido University, ⁸Faculty of Education, Hokkaido University – We have developed a new technique for a one-minute assessment of speech comprehension using degraded speech sound by m-sequence modulation and electroencephalograms (EEG) analyzed by circular-cross-correlation function and independent component analysis (Takeichi et al., 2007). As a result, a correlation peak was observed in an independent component correlation function with 400 ms delay. This peak was dependent on whether the modulated speech sound was comprehensible to the subjects. Here we report the results of an fMRI experiment on twenty three right handed Japanese speakers to examine brain areas related to verbal comprehension of the modulated speech sound. A question here was whether the neural system deals with the modulated speech either by increasing the activity of the areas for routine speech processing, or by recruiting additional areas. Activations were observed as follows: the left temporal cortex and a posterior cingulate retrosplenial area in a contrast between the non-modulated forward and reverse speech stimuli; the right inferior frontal gyrus (RIFG) in a contrast between the modulated forward and reverse speech stimuli; and the left inferior parietal lobe (LIPL) in a contrast between the modulated and non-modulated speech stimuli. RIFG and LIPL might have been recruited additionally for contextual processing in comprehension of the speech modulated by m-sequence. Estimated scalp projection of the component correlation function suggested posterior and leftward bias thus a signal source in LIPL.

G84

NEURAL CORRELATES OF DIFFERENCES IN PHONEME-PRODUCTION LOAD IN SCHIZOPHRENIC AND HEALTHY SUBJECTS Alexander Herman¹, Leighton Hinkley¹, Mary Vertinsky¹, Sophia Vinogradov¹, Srikantan Nagarajan¹; ¹University of California, San Francisco – Schizophrenics exhibit significant executive function deficits, as assessed by a variety of methods, including digit recall, word recall and higher level tests. Furthermore, working memory deficits in schizophrenics have been linked to language comprehension deficits. The brain regions implicated in working memory dysfunction in past studies reflect the functional anatomy of healthy working memory: fMRI studies have shown, for instance, decreased activity in dorsal lateral prefrontal cortex and hippocampus, amongst other areas, even controlling for task performance. MEG and EEG studies also suggest altered activity within the superior temporal plane and diminished inter-hemispheric synchronization. We will present results from a study of the cortical oscillations associated with speech preparation in schizophrenics and controls. Subjects performed a verbal working memory task in which they heard a pre-

recorded two or four phoneme sequence and were instructed to repeat the phoneme sequence, while magnetoencephalographic neural responses were recorded. Schizophrenic subjects exhibited a large variance in the number of correct responses compared to healthy subjects. For this particular analysis, only correct trials were analyzed. Source localization and time-frequency analysis was performed using CTF and NUTMEG software packages. Response-locked differences in activation were computed between the four and two phoneme task for schizophrenic subjects and control subjects separately, and group statistical analyses were performed on contrasts between the conditions. Our results reveal a network of brain regions associated with a load-effect in phoneme-production preparation including the superior temporal gyrus, mouth pre-motor and and dorsolateral prefrontal cortical areas. Furthermore, we show that schizophrenic subjects devoted more cognitive resources in this network to increased phoneme-load than did healthy subjects, suggesting less efficient processing in speech preparation in schizophrenic subjects.

Perceptual processes: Other

G85

AN fMRI ANALYSIS OF STIMULUS SPECIFIC AND STIMULUS-INVARIANT ACTIVATION IN PERCEPTUAL LEARNING *Matthieu Mundy¹, Kim Graham¹, Paul Downing², Rob Honey³, Dominic Dwyer³; ¹Wales Institute of Cognitive Neuroscience, Cardiff University, ²Wales Institute of Cognitive Neuroscience, University of Bangor, ³School of Psychology, Cardiff University* – Unsupervised exposure to a pair of highly similar stimuli can improve subsequent discrimination between them. This is true with many types of stimuli e.g., pictures of faces, random checkerboards, dots and visual scenes (e.g. Mundy et al., 2007). Of particular importance, the schedule of exposure modulates this effect. Alternating two similar stimuli (e.g. AX, BX, AX, BX) during exposure produces larger improvements in discrimination than an equivalent amount of blocked presentation of the two stimuli (e.g. AX, AX... BX, BX...). This schedule effect is the same regardless of the nature of the stimuli used, which implies that the cognitive mechanism for perceptual learning is similar in all cases. However, an earlier imaging study we performed suggested that different neural mechanisms may be recruited in tasks using different types of stimuli (Mundy et al., 2008; see also Graham et al., 2006). In the current event-related fMRI study participants were given intermixed and blocked exposure to confusable face-pair, scene-pair and dot-pair stimuli and subsequently were asked to perform same/different judgements as an index of perceptual learning. Areas of cortex recruited during perceptual learning were identified by contrasting activation associated with discrimination following intermixed presentation with that following blocked presentation. Stimulus-invariant activation was seen in early visual cortex; the exact visual regions involved were pinpointed using a retinotopic mapping technique. Stimulus-selective activation was seen in the parahippocampal place area (scenes), fusiform face area, and perirhinal cortex (faces).

G86

BEHAVIORAL AND ELECTROPHYSIOLOGICAL EFFECTS OF GRADUAL BODY INVERSION *Denise Minnebusch¹, Philipp Keune², Boris Suchan¹, Irene Daum¹; ¹Institute of Cognitive Neuroscience, Neuropsychology, Ruhr-University of Bochum, Germany, ²Institute of Psychology, Clinical Psychology, University of Tübingen, Germany* – It is a matter of debate, whether the perception of human body forms, like the perception of human faces, is based on configural processing mechanisms. Evidence for configural face processing is the face inversion effect: Faces presented upside down are more difficult to recognize than uprightly presented stimuli and this behavioral face inversion effect correlates with an electrophysiological inversion effect. Body postures produce inversion effects similar to those found for faces both on behavioral

and electrophysiological level. In a previous study, the inversion effect was inverted for human bodies presented without heads, with better recognition performance for inverted relative to upright bodies. Comparable findings were obtained on the electrophysiological level. However, the relationship between electrophysiological and behavioral inversion effects remains unclear. The present study aimed to investigate the development of behavioral and electrophysiological body inversion effects depending upon the degree of divergence from the 0° (360°) toward the 180° positions. Additionally, body stimuli were presented with heads (masked face) and without heads, in order to obtain a more detailed description of the effect of the presence of a head at different degrees of display. For human bodies presented with heads, there was a quadratic relationship between the angles of rotation and the behavioural performance as well as the electrophysiological effect. For human bodies presented without heads the results are inconsistent. The results indicate that for body forms presented with heads, different processing mechanisms appear to be involved than for body form presented without heads.

G87

CORTICAL MEG RESPONSE TO VISUAL SOCIAL INTERACTION: HOW GENDER MATTERS *Marina Pavlova^{1,2}, Michele Guerreschi^{1,3}, Werner Lutzenberger², Ingeborg Krägeloh-Mann¹; ¹Children's Hospital, University of Tübingen Medical School, Tübingen, Germany, ²MEG-Center, Institute of Medical Psychology and Behavioral Neurobiology, Tübingen, Germany, ³University of Padova, General Psychology, Padova, Italy* – The ability of humans to predict and explain other people's actions is of immense value for adaptive behavior and non-verbal communication. Gender differences are often evident in the comprehension of social signals, but the underlying neurobiological basis for these differences is unclear. Combining visual psychophysics with magnetoencephalography (MEG), in healthy adult participants, we assessed gender effects in the induced oscillatory neuromagnetic response to visual social interaction through movement. A robust difference in the induced gamma response was found between females and males over the left prefrontal cortex, a region which has been implicated in perceptual decision making. The induced gamma response peaked earlier in females than in males. Contrary to popular wisdom, the outcome of this study indicates that gender effects are not evident in the network engaged in processing of visual social interaction, but in the regions engaged in perceptual decision making. We assume that differences in brain processing may not only elicit but also prevent behavioral differences, for example, impulsive perceptual decisions, if they are maladaptive.

G88

MOVEMENT-SELECTIVITY OF THE MIRROR SYSTEM DURING IMITATIVE AND COMPLEMENTARY ACTION CONTEXTS *Brenda Ocampo¹, Ada Kritikos¹, Ross Cunnington^{1,2}; ¹School of Psychology, University of Queensland, ²Queensland Brain Institute, University of Queensland* – Viewing actions performed by others activates neural circuits typically involved in the motor planning and execution of those very same actions. Some have suggested that this 'mirror system' is intrinsically involved in imitation, by matching perceived actions directly onto the corresponding motor representations of the observer. Recent evidence has shown, however, that the mirror system is active during the observation and preparation of complementary, non-identical actions (Newman-Norlund et al., 2007). This implies that the mirror system might activate internal motor representations that are dynamically (rather than directly) related to the actions that we observe. We do not know, however, whether the activations found within the mirror system during preparation of complementary actions were due to stimulus-response associations rather than an internal motor mapping of perceived actions. Using functional magnetic resonance imaging (fMRI), we examined the BOLD signal in the inferior frontal gyrus and bilateral inferior parietal lobes while participants observed and executed object-directed actions (whole hand and precision grips towards a wine glass) in

both imitative and complementary contexts. Importantly, in a control condition, participants responded to symbolic cues (upwards and downwards pointing arrows) in both action contexts. The degree of fronto-parietal activation (particularly in IFG) for the complementary condition that was specific to hand actions (and could therefore be attributed to the movement-selective mirror system) rather than more general response selection demands that were constant for both the hand and arrow conditions, will be discussed.

G90**LINE LENGTH, VELOCITY, AND ACCELERATION INTERACTIONS IN LINE BISECTION**

Marc Hurwitz¹, James Danckert¹; ¹University of Waterloo, Waterloo, Ontario, Canada – When asked to bisect a line, right-handed people typically bisect lines to the left of centre - referred to as pseudo-neglect. Analyses of line bisections show that one of the strongest influences on performance is the scan direction participants take prior to making their judgment. Several theories to explain this phenomenon have been postulated including hemispheric specialization, allocation of visual attention, and endpoint weightings. However, it is also possible that there are space-time interactions involved in line bisection. Because experiments have used a 'free' scanning paradigm, i.e., participants are asked to scan in a certain direction and then bisect the line, it does not control for velocity or acceleration of the smooth pursuit eye movements being made. To control for these factors, we ran a number of line bisection experiments using a touch screen computer and eye tracking to record responses. Participants were first shown a line, followed by a marker that moved across the line at different acceleration and speed levels, and were then asked to quickly and accurately bisect the line by pointing to it. Independent manipulanda included line length, placement on screen, direction of scan, velocity and acceleration of the marker. Results replicated a number previous findings including an influence of line length and scan direction on bisection. While acceleration itself had no influence on line bisection, line length influenced the perception of the speed of the marker suggesting an influence of acceleration on perception but not action.

G91**ARTISTIC PRODUCTION FOLLOWING LEFT BRAIN DAMAGE**

Page Widick¹, William B. Smith II¹, Rebecca Sternschein¹, Bianca Bromberger¹, Anjan Chatterjee¹; ¹The University of Pennsylvania, Neurology and the Center for Cognitive Neuroscience – Neuropsychological investigations of art production offer critical insight into the neural bases of aesthetics. However, progress in the field is hampered by inadequate measurement instruments. We designed The Assessment of Art Attributes (AAA) to quantify descriptive artwork attributes. The AAA assesses 6 formal-perceptual (color temperature, saturation, stroke, balance, depth, complexity) and 6 content-conceptual attributes (accuracy, animation, abstraction, fantasy, symbolism, emotionality) of art. Target slides consisted of 24 lesser-known paintings by well-known artists. Sixty artistically naïve young normal subjects judged each of the randomly presented paintings on each attribute on a 5-point Likert scale. Significant consistency in attribute judgment supported the use of the AAA. Thirty artistically naïve subjects were then shown paintings from two artists with left hemisphere stroke, Zlattu Boyadzhiev and Katherine Sherwood, half of which were painted before their strokes and half of which were painted afterward. For each artist and each attribute paired t-tests were used to test the hypothesis that an attribute had changed following brain damage. After their stroke, both artists' paintings were judged as significantly more vibrant, loose, flat, and distorted ($p < 0.004$). These paintings were also judged as more abstract, fantastical and symbolic. These observations suggest that the artists may be drawing on a looser perceptual and semantic organizational structure mediated by their intact right hemisphere when producing art.

G92**INDIVIDUAL DIFFERENCES IN MEMORY FUNCTION PREDICT TIME PRODUCTION ACCURACY AND VARIABILITY INDEPENDENT OF AGE**

Brian C. Rakitin¹; ¹Cognitive Neuroscience Division, Taub Institute, Columbia University – How does aging affect interval timing, and to what extent is the timing of intervals in the super-second range related to verbal episodic memory and other mental functions? In order to address these questions interval time production data were collected from thirty-two aging participants and thirty-two young participants. The repeated measures, factorial design crossed two tasks, single interval production (SIP) and repetitive tapping, and three target intervals - 0.55, 1.55, and 2.55 s for half the participants and 1.0, 3.0, and 5.0 s for the other half. Compared to young participants, aging participants had greater scalar and non-scalar intra-individual variability. The age difference was largest in SIP, which has greater memory and attention demands than tapping. Verbal memory-test scores were the best neuropsychological predictors of a number of timing performance variables, and the strength of this prediction varied by task (greater for SIP than tapping) but not by age group. These results suggest aging most affects temporal attention and memory, and that there is a relation between temporal and verbal memory function in both young and aging participants.

G93**BEHAVIORAL AND ERP RESULTS SUGGEST PUTATIVE ALARM PHEROMONES ENHANCE THREAT PERCEPTION IN HUMANS**

Denis Rubin¹, Greg Hajcak², Lillianne Mujica-Parodi¹; ¹Stony Brook University, Biomedical Engineering, ²Stony Brook University, Psychology – Mammals are known to possess alarm pheromones, which rapidly transmit warning of danger to others of the same species, via shared physiological and emotional stress response. Our previous fMRI research showed, for the first time, that humans activate the excitatory components of the limbic system (amygdala, hypothalamus), in response to fear, but not exercise, sweat. Our current study builds directly upon this work to examine how putative alarm pheromones affect behavior. Axillary sweat samples were collected from 32 Donor Subjects (50% female) during their first-time tandem skydive (stress condition) and, for the same Donor Subjects, while running on a treadmill (control condition). Pooled samples were used as olfactory stimuli, which were then presented via an olfactometer to an unrelated group of 8 Detector Subjects, all males. While inhaling stress or exercise sweat (counter-balanced for order) subjects were asked to rate male faces of varying emotional valence, ranging from neutral to angry, in order to assess perception of aggressiveness using psychometric curves. We also collected ERP data for subject responses, analyzing data for late-positive potentials, a neural marker for salience. Differences in slope between the fitted psychometric curves suggests that discrimination between threat and non-threat sharpened when subjects inhaled the putative alarm pheromone ($F = 5.9$, $p = 0.045$). Likewise, the late-positive potential component of the ERP was increased for the stress sweat condition ($F = 26$, $p = 0.004$). Our preliminary results suggest that humans, like other mammals, may possess alarm pheromones, which have behavioral implications for threat assessment.

G94**AGING REDUCES NEURAL SELECTIVITY AND INCREASES FACE ADAPTATION**

Joshua Goh¹, Atsunobu Suzuki¹, Denise Park²; ¹Beckman Institute, University of Illinois at Urbana-Champaign, ²Center for Brain Health, University of Texas at Dallas – Age-related ventral-visual activity is characterized by reduced selectivity between categories of visual stimuli such as faces and houses that typically elicit highly specialized responses in the fusiform and parahippocampal brain regions respectively of young adults (Park et al., 2004). This study demonstrates that older adults' less selective neural response (dedifferentiation) to faces is due to a coarser neural representation than that of young adults for individual faces. In this event-related fMRI adaptation study, 20 young and 20 older participants made same-different judgments to serially presented face-pairs that

were either identical (repetition of the same face), moderately different (second face was morphed with 40% of prior face), or completely different (faces from two individuals). In the fusiform regions, older adults showed greatest adaptation during the exact-repetition condition and intermediate adaptation during the moderately-different condition relative to the completely-different condition. Young adults showed a similar pattern of adaptation, but with reduced adaptation magnitudes. This suggests that older adults' fusiform area was not able to represent facial differences at the same level of sensitivity as young adults. Individual subjects' adaptation magnitudes positively correlated with behavioral face discrimination thresholds for morphed faces ($r = .38$). Greater age-related adaptation during the exact-repetition condition suggests older adults' fusiform face region is particularly sensitive to similarity, whereas young adults have a neural response that is more sensitive to facial differences. The data provide strong evidence for an age-related decrease in representational contrast in the fusiform area that is linked to behavioral differences during perceptual discrimination.

G95

NEUROIMAGING OF TEMPORAL PROCESSING: RESULTS OF A VOXEL-WISE META-ANALYSIS Martin Wiener¹, Peter Turkeltaub², H. Branch Coslett²; ¹University of Pennsylvania, Psychology, ²University of Pennsylvania, Neurology – The past decade has witnessed an explosion of neuroimaging studies investigating the neural correlates of time perception. Unfortunately, little concordance exists among these studies for which neural regions are necessary. We addressed this important issue by conducting a comprehensive, voxel-wise meta-analysis, using the Activation Likelihood Estimation (ALE) algorithm, which models each stereotactic coordinate as a 3D Gaussian distribution, then tests the likelihood of activation across all voxels in the brain (Turkeltaub et al. 2002). We included 463 sets of activation foci across 51 experiments, constituting the majority of neuroimaging studies explicitly investigating temporal processing. Only results from control-task subtractions were employed. Additionally, we divided the data set along two dimensions: whether the durations tested were subsecond or suprased, and whether the duration was dependent on a motor response or not; these data sets were then analyzed by a series of subtraction analyses (Laird et al. 2005). The results of the total meta-analysis revealed a bi-hemispheric network of cortical and sub-cortical structures, including the cerebellum, thalamus, basal ganglia and supplementary motor area, as well as several right-hemispheric cortical structures. The results of the subtraction analyses further revealed a much smaller number of structures depending on the task constraints. These results will be discussed in the context of contemporary neural theories of timing and constitutes the first quantitative neuroimaging meta-analysis of temporal processing.

G96

NAVIGATING ACROSS THE LIFESPAN: PATH INTEGRATION DEFICITS IN PATIENTS WITH MILD COGNITIVE IMPAIRMENT Naohide Yamamoto¹, John W. Philbeck¹, Paul Fedio², Samuel J. Potolicchio³, Anthony J. Caputy³, Mateja de Leonni Stanonik³, Carly E. Kontra¹; ¹George Washington University, ²Catholic University of America, ³George Washington University Medical Center – Impaired navigation is prevalent among patients with Alzheimer's disease (AD). It appears even in patients with mild cognitive impairment (MCI), a disorder sometimes interpreted as an early stage of AD. Currently, a common interpretation of this navigation impairment is that AD/MCI patients tend to get lost easily because they cannot remember correct routes or appropriate landmarks. In other words, the navigation impairment is largely attributed to their memory problems. However, given that successful navigation requires not only good spatial memory but also intact perception of 3-D space and self-motion, it is important to examine whether these patients have deficits in perceptual processes as well. The present study addressed this issue by testing MCI patients' abilities to determine their current position in space by monitoring internally-generated self-motion signals, a process known as path integration. We employed a variety of path integration tasks:

Some required participants to keep track of either linear or rotational motion, and others required taking into account both types of motion. MCI patients performed many of these tasks less accurately than young neurologically-intact adults, even though the patients showed little or no impairment in visually perceiving object locations and remembering them over a brief period of time. The findings to date suggest that MCI patients have selective deficits in path integration, and indicate that deficient path integration may play a role in the navigation problems commonly seen in AD-related disorders. On-going work will compare these results with tests of patients with mild AD and non-demented elderly control participants.

G97

EVENT RELATED POTENTIAL AND EEG MU FREQUENCY ANALYSIS OF EMOTIONAL FACE PROCESSING: PRE AND POST 20 WEEKS OF NEUROFEEDBACK TRAINING IN CHILDREN TYPICALLY DEVELOPING AND WITH AUTISM SPECTRUM DISORDERS Oriana R. Aragon^{1,3}, Jia-Min Bai¹, Jaime A. Pineda^{1,2}; ¹University of California, San Diego, Cognitive Science, ²University of California, San Diego, Neuroscience, ³California State University, San Marcos, Psychology – The significance of emotional face processing in understanding nonverbal cues in our everyday social interactions has prompted researchers to look for specific neural correlates involved in this fundamental ability. Research has shown deficits for those with ASD in the perception of faces, emotional content displayed in facial expressions, and reduced activation in hallmark face processing brain regions. Research suggests that these differences may indicate deficits in mirror neuron system (MNS) engagement as evidenced by a lack of activation in inferior frontal gyrus during imitation tasks and the lack of mu suppression, an index of MNS activity, during observed actions. Two recent electrophysiological (EEG) studies done in our laboratory focused on the mu rhythm, an oscillation over the sensorimotor cortex believed to reflect downstream modulation from premotor mirror neurons during the observation of biological motion. Data showed that operant conditioning of mu rhythms via neurofeedback training (NFT) normalizes mu suppression during observed actions. The current study assessed mu suppression and the N170, P280 and N400 ERP components, pre and post 20 weeks of NFT. Matched ASD and typically developed (TD) participants underwent a 1-back paradigm with static emotional faces (anger, disgust, happy) and buildings for control. Pre-assessment data show differences in ERP components between ASD and TD groups. Furthermore, ERP differences in the TD group when comparing faces and buildings were diminished in the ASD group. Post training ERP and mu data is in analysis. The findings to date provide further evidence of impaired facial processing in individuals with ASD.

G98

EFFECTS OF PSILOCYBIN ON NEURAL SUBSTRATES OF VISUAL GESTALT PROCESSING B. Rael Cahn^{1,2,3,4}, Michael Kometer^{3,4}, Mark Geyer¹, John Polich², Franz Vollenweider^{3,4}; ¹UCSD, Psychiatry, ²The Scripps Research Institute, ³University of Zurich, Psychiatry, ⁴Heffter Research Center Zurich – Psilocybin is a naturally-occurring hallucinogen and potent serotonin agonist previously shown to depend on 5HT-2a agonism to produce much of its psychological effects. A Kanizsa stimulus visual paradigm was presented to healthy volunteers during placebo, low-dose, and high-dose psilocybin conditions to elicit event-related brain potentials (ERPs) in the different brain states, followed by the administration of a standardized questionnaire to assess induced altered state of consciousness. The stimuli consisted of Kanizsa and non-Kanizsa stimuli at equal probability with stimulus categorization response required. Psilocybin caused a more focal V1-distributed increased P1 amplitude as well as significantly decreased N170 and P300 amplitudes. LORETA analysis indicated that N170 amplitude was significantly enhanced in V1/V2 and right lateral occipital cortex for Kanizsa vs. non-Kanizsa stimuli in placebo condition, but not different in psilocybin conditions. These findings suggest that psilocybin induces a

brain state wherein there is increased early processing of visual stimuli and strongly decreased processing at the stimulus-categorization (N170) and attentional engagement (P300) stages. Theoretical implications related to induced altered state of consciousness are discussed.

G99

SELF PERCEPTION IN HANDWRITING - AN ERP STUDY *Reiko Sawada¹, Hirokazu Doi², Nobuo Masataka¹; ¹Primate Research Institute, Kyoto University, ²Nagasaki University* – Self perception is a fundamental capability for social cognition, and one of most noticeable phenomena. There is no doubt that humans can identify the products of their past action, such as handwritten characters and voices. When we open the old diary, we can recognize our handwriting easily and immediately. Why we can identify self handwriting? By several recent studies, self processing is unique and distinct from other types of semantic processing. However, the neural mechanism underlying self perception of handwriting has not been clearly elucidated. We investigated neural correlates for the process of the self information in handwriting. We measured event-related potentials (ERPs) during the observation of self and other handwriting under known and unknown character conditions. When analyzing the peak amplitudes of P1, N170 and P250, larger N170 and smaller P250 were recorded for self handwriting only at the right hemisphere than other handwriting. In addition, larger N170 was recorded for known characters at both hemispheres, smaller P250 was recorded only at left hemisphere than unknown characters. We found the self information is processed in different way from characters' familiarity after 300 ms stimulus onset. As previous studies, our results shows that perception of self information in handwriting is correlated with neural activity in the right hemisphere and the information for characters were processed in left hemisphere.

G100

THE PREDICTION OF OCCLUDED ACTIONS DEPENDS ON PREMOTOR CORTEX FUNCTIONS *Waltraud Stadler¹, Ricarda I. Schubotz², Anne Springer¹, Wolfgang Prinz¹; ¹Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, ²Max Planck Institute for Neurological Research, Cologne, Germany* – Lateral and medial portions of the premotor cortex seem to play a core role in action simulation. As a consequence, activation in these areas should increase with the length of the simulated action sequence. To investigate this supposition, an fMRI study was designed in which participants watched short movies showing everyday actions that were repeatedly occluded. In order to vary the length of the simulated action, occluder duration varied between one and three seconds. The same stimuli were used in three different conditions. In the PREDICTION condition, participants were asked to indicate whether actions continued with coherent timing after occlusions. In contrast, the FREEZING condition required to hold visual action information in memory during occlusion. In a non-action related condition, occlusions were just counted (COUNTING). In premotor regions of interest (dorsal premotor cortex, PMd, and pre-supplementary motor area, pre-SMA), activation was significantly higher in the PREDICTION condition as compared to the other two conditions. Moreover, pre-SMA responded to increasing occluder duration with sustained activation in PREDICTION but not when action dynamics were not task-relevant (COUNTING condition). Premotor activation being particularly high during the prediction of dynamic action information replicates earlier findings from our laboratory. Sustained pre-SMA activation with longer occlusions is in line with the involvement of this area in the organisation of motor sequences and with its role during internal action guidance. The present results underline the relevance of the premotor cortex in driving action simulation.

G101

INCREASED COHERENCE IN PARIETAL CORTICES OF TIME-SPACE SYNESTHETES: A HIGH-DENSITY EEG STUDY *Ursina Teuscher^{1,2,3}, David Ruhl^{2,3}, David Brang¹, David Stone², Seana Coulson¹, Vilayanur S. Ramachandran¹, Claudia Tesche²; ¹University of California, San*

Diego (UCSD), ²University of New Mexico, Albuquerque (UNM), ³Mind Research Network, Albuquerque (MRN) – Synesthesia is a condition in which stimuli presented in one modality consistently and involuntarily evoke sensations in another, unrelated modality. For example, sound may be experienced as flavored or numbers as colored. An often-overlooked form of this condition is time-space synesthesia, in which elements of temporal sequences are perceived as being at discrete locations in space. The most common manifestation of this is for a synesthete to perceive the months of the year in a particular shape in their visual field. To investigate the basis of time-space synesthesia, we collected 128-channel EEG data from five synesthetes and five individually-matched controls in a modified Posner spatial-cuing paradigm. Centrally-presented month terms were tailored to direct synesthetes' attention to either the left or right side of the screen depending on the shape of their perceived calendar (e.g., if a synesthete perceives January on the right, we used 'January' to direct their attention rightward). Subjects were then required to identify a target in either the attended or unattended area. Since a large number of neuroimaging studies have implicated the posterior parietal cortex in the perception of both spatial patterns and temporal sequences, we hypothesized that, regardless of behavioral performance, synesthetes would exhibit increased EEG coherence in parietal areas. We report here preliminary results finding altered patterns of parietal coherence in time-space synesthetes. Such coherence differences indicate more synchronous activation within areas of the parietal cortex in synesthetes when processing time units as spatial cues. Implications for neural models of synesthetic experience are discussed.

G102

A BEHAVIORAL METHOD FOR STUDYING MIRROR NEURON ACTIVITY: REPETITIVE ACTION AFFECTS VISUAL PERCEPTION *Arthur Glenberg^{1,2}, Gabriel Lopez-Mobilia¹, Michael McBeath¹, Michael Toma¹, Marc Sato³, Luigi Cattaneo⁴; ¹Arizona State University, ²University of Wisconsin, ³GIPSA-LAB - UMR CNRS 5216, University of Grenoble, ⁴Center for Mind/Brain Sciences, University of Trento* – Mirror neurons may underlie the ability to make sensorimotor predictions when observing action, and thus they may contribute to "reading" intentions of other animals and facilitating social interaction. Neurophysiological and brain imaging studies have shown that observation of both biological and non-biological movements activates a fronto-parietal network of motor regions which forms the core of the human mirror-neuron system (MNS). However, these results are intrinsically correlational, and whether mirror neurons contribute to action understanding remains debated. We have developed a behavioral method based on use-induced plasticity to study mirror neurons. Participants engage in a repetitive motor task such as moving beans from one location to another. This activity adapts neural systems used in the control of the action. Participants then engage in a second task. We know that the second task uses the same neural systems adapted in the motor task when the second task is affected by the direction of bean movement. We report the data from experiments in which the second task is the measure of bias to see ambiguous motion in one direction or another. The direction of bean movement (toward or away from the participant) influences the bias such that previous action toward the participant increases the bias to see ambiguous movement in the away direction. Similar results have been found when the second task is a language task. These results suggest that a MNS is being tapped, and they provide method for studying the causal contribution of MNS to cognitive and social processes.

Poster Session H

Methodological Issues: Electrophysiology

H1

AFFECTIVE SEMANTIC PRIMING AS PUTATIVE ENDOPHENOTYPE OF PSYCHOSIS: AN EVENT-RELATED POTENTIAL STUDY

Stefanie Pfeifer¹, Niels Schiller², Jim van Os^{1,3}, Wim Riedel⁴, Lydia Krabbendam¹; ¹South Limburg Mental Health Research and Teaching Network, EURON, Psychiatry and Neuropsychology, Maastricht University, Maastricht, The Netherlands, ²Faculty of Social Sciences and Cognitive Psychology Unit, Leiden Institute for Brain and Cognition (LIBC), Leiden University, Leiden, The Netherlands, ³Division of Psychological Medicine, Institute of Psychiatry, London, UK, ⁴Maastricht University, Neuropsychology and Psychopharmacology, The Netherlands – Background: Evidence is accumulating that semantic networks are abnormal in patients with psychosis. The effect of emotionality on the semantic network is less well understood. The aim of the present study was to investigate with Event-Related potentials whether the N400 of patients is abnormal when presented with positive and negative affective words and whether the affective semantic priming effect can be seen as putative endophenotype. Method: Thirteen patients with non-affective psychosis, 14 siblings and 16 controls participated in an affective lexical decision task with three conditions (positively, negatively and unrelated) and two stimulus onset asynchronies (SOAs), 250ms and 500ms. Results: For SOA250, controls showed no difference between the three conditions in N400 amplitude. Patients showed a decrease in N400 amplitude in the unrelated condition compared to the affective conditions, and an earlier onset of the N400 in the positive condition. Siblings showed no difference between the three conditions in N400 amplitude, but the positive condition showed the earliest onset, followed by the negative and the unrelated condition. For SOA500, controls showed an increased N400 amplitude for the unrelated condition compared to the affective conditions. An increased N400 amplitude for the unrelated condition was also found in patients, as well as an N400 priming effect for both affective conditions, which was strongest for the positive words. This priming effect was also seen in siblings. Conclusion: Patients with psychosis and siblings showed an increased sensitivity to words with affective valence. Affective semantic priming abnormalities can be considered an endophenotypic marker of psychosis.

H2

CROSS-DOMAIN EFFECTS OF LANGUAGE AND MUSIC EXPERIENCE ON THE REPRESENTATION OF PITCH IN THE HUMAN AUDITORY BRAINSTEM

Gavin M. Bidelman¹, Jackson T. Gandour¹, Ananthanarayan Krishnan¹; ¹Purdue University, Speech Language Hearing Sciences, West Lafayette, IN – Neural encoding of pitch in the auditory brainstem is known to be shaped by long-term experience with language or music, implying that early sensory processing is subject to experience-dependent neural plasticity. In language, pitch patterns consist of sequences of continuous, curvilinear contours; in music, pitch patterns consist of relatively discrete, stair-stepped sequences of notes. The aim of this study was to determine the influence of domain specific experience (language vs. music) on the encoding of pitch in the brainstem. Brainstem frequency following responses (FFRs) were recorded from native Chinese, English amateur musicians, and English non-musicians in response to iterated rippled noise homologues of a musical interval (major third; M3) and a lexical tone (Mandarin tone 2; T2). Pitch strength (?50ms sections) and tracking accuracy (whole contour) were computed from the FFRs using autocorrelation algorithms. The Chinese and musicians showed higher pitch tracking accuracy than the non-musicians regardless

of domain. Relative to non-musicians, musicians showed more robust pitch strength across all sections whereas Chinese did so only in those sections containing the most rapid changes in pitch. Musicians, moreover, exhibited greater pitch strength than Chinese in one section containing an instantaneous change in pitch (onset of the second note, M3) and two sections within T2 corresponding to notes along the diatonic musical scale. We conclude that despite mutual benefits of their divergent pitch experience, cross-domain enhancement of pitch representation from music to language is greater than the reverse in the brainstem.

H3

STIMULUS-DRIVEN OSCILLATORY RESPONSES TO NUMERICAL CHANGES: A NOVEL FREQUENCY-TAGGING EEG PARADIGM

Melissa Libertus^{1,2}, Elizabeth Brannon^{1,2}, Marty Woldorff^{1,2,3}; ¹Duke University, Center for Cognitive Neuroscience, ²Duke University, Psychology & Neuroscience, ³Duke University, Psychiatry – Frequency-tagging paradigms have been successfully used in previous research to investigate neural indices of conscious perception and attentional modulation. Here we employ this technique to investigate neural tuning to non-verbal numerical information in the absence of a task. Twelve adults passively viewed rapid streams of multiple-element images that flickered at a frequency of 12.5 or 25 Hz. Every 400 ms across a period of 2400 ms, a new flickering image of stimulus elements was presented that contained the same number of elements. After 2400 ms, the number of elements changed by a 1:3, 1:2, or 2:3 ratio (e.g., from 8 to 24 elements). Extraction of the power at the flicker frequency using a Fast-Fourier transformation showed an increase in power over repeated presentation of the same numerosity across the 2400-ms periods over posterior scalp sites (adaptation effect) for both the 12.5 and 25 Hz stimulation frequencies. Furthermore, the power change at these locations over the first 400 ms after a change in numerosity was smallest following a 2:3 ratio change and largest following a 1:3 ratio change (ratio effect). Thus, the adaptation and ratio effects together suggest a driven oscillatory stabilization of the neural network encoding numerosity and a destabilization pattern following a numerosity switch that follows Weber's Law, i.e. following the ratio rather than the absolute difference in a numerosity change determines the power at the stimulation frequency. Future research will be aimed at applying this method to studies with human infants.

H4

ENHANCING DOMINANT MODES IN EVENT-RELATED BRAIN POTENTIALS BY MEANS OF THE SYMBOLIC RESONANCE ANALYSIS

Peter beim Graben¹, Heiner Drenhaus², Stefan Frisch^{3,4}; ¹School of Psychology and Clinical Language Sciences, University of Reading, UK, ²Institute of Linguistics, University of Potsdam, Germany, ³Day-Care Clinic of Cognitive Neurology, University of Leipzig, Germany, ⁴Max-Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany – We present the symbolic resonance analysis (SRA) as a viable method for addressing the problem of enhancing a weakly dominant mode in a mixture of evoked responses obtained from a nonlinear dynamical system. We demonstrate this using results from a numerical simulation with Duffing oscillators in different domains of their parameter space, and by analyzing event-related brain potentials (ERPs) from a language processing experiment in German as a representative application. In this paradigm, the averaged ERPs exhibit an N400 followed by a sentence final negativity. Contemporary sentence processing models predict a late positivity (P600) as well. We show that the SRA is able to unveil the P600 evoked by the critical stimuli as a weakly dominant mode from the covering sentence final negativity. Reference: beim Graben, P., Drenhaus, H., Brehm, E., Rhode, B., Saddy, D.

& Frisch, S. (2007). Enhancing dominant modes in nonstationary time series by means of the symbolic resonance analysis. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 17, 043106.

H5

INTRINSIC FUNCTIONAL CONNECTIVITY IN MEG *Avniel*

Ghuman¹, Jonathan McDaniel¹, Alex Martin¹; ¹Laboratory of Brain and Cognition, NIMH – Determining functional connectivity is critical for understanding the dynamics of the normal and disordered brain. Recent functional magnetic resonance imaging (fMRI) studies demonstrate that measuring correlations between brain regions in intrinsic activity can be used to reveal specific neural networks. This approach holds great promise for studying networks in both the healthy and impaired brain because it allows functional connectivity to be assessed without concern for the influence of task-related modulations on intrinsic patterns of functional connectivity. Because of its superior temporal resolution, examining resting state connectivity with magnetoencephalography (MEG) or electroencephalography (EEG) should further enhance our knowledge of neural circuitry. However, traditional MEG/EEG analysis methods are not well suited for resting state data. Moreover, there is a lack of consensus as to the best method for examining connectivity in resting state MEG/EEG data. To address this problem, we adapted wavelet-based methods for determining functional connectivity and assessed the performance of these methods using physiologically plausible synthetic data. We found that the relative performance of the methods varied with the proportion of coherent activity and the duration of coherent bursts. These results suggest that our ability to reveal functional connectivity using resting state electrophysiological data will depend on the use of multiple measures. We apply these methods to resting state data collected in MEG and examine their ability to identify functional networks in the brain.

H6

ANALYSIS OF SPEECH AND SLEEP EEG IN CHILDREN WITH NEURODEVELOPMENTAL DISORDERS *Vladimír Komárek¹, Lenka Neuschlová¹, Zbynek Hrnčíř¹, Jana Tuková²; ¹Charles University Hospital Motol, Prague, Czech Republic, ²Czech Technical University, Prague, Circuit Theory, Czech republic* – Purpose: To determine role of epileptiform activity in our samples of children with neurodevelopmental disorders and to evaluate sensitivity of computerized methods of speech and EEG analysis. Method: Subjects - 37 children aged 39 - 112 months with developmental language disorder (DLD group) and 27 children (mean age 7,1 years) with pervasive developmental disorder (PDD group) underwent overnight sleep video-EEG monitoring. The control group was 20 mentally non-retarded deaf children with cochlear implantation (mean age 8,4 years). Psychological evaluation: Stanford-Binet Intelligence scale-4th Revision, Gessel Developmental Schedules. Speech analysis: vowel classification by a supervised Self-Organizing Maps (SSOM). EEG evaluation: 31 linear and non-linear (CER) analysis. Statistics: multiple regression analysis, Wilcoxon test, Mann-Whitney test, Spearman and Pearson correlations. Results: Our study confirmed higher incidence of epileptiform discharges (12/37) in DLD group. Computerized speech analysis differentiated dysphatic and healthy children. The Spearman correlation was most sensitive tool for correlation between computerized speech analysis (SSOM) and slow sleep EEG signal in DLD group. We also found a significant decrease in EEG coupling and information drive in the PDD group in comparison with control. This result support the hypothesis of underconnectivity in children with PDD. Conclusion: Correlation of computerized speech and EEG analysis can be in future suitable tool for assessing degree of neurodevelopmental impairment as well as of possible therapeutical effect.

H7

ALPHA NEUROFEEDBACK TRAINING AND ITS IMPLICATIONS FOR STUDIES OF COGNITIVE CREATIVITY *Henk Haarmann¹, Timothy George¹, Alexei Smaliy¹, Kristin Grunewald¹, Jared Novick¹; ¹University of Maryland College Park* – We report a method for increasing alpha brain waves through Electroencephalography neurofeedback training

(NT), intended for subsequent research on cognitive creativity. Increased alpha power over right posterior cortex is associated with greater originality in divergent thinking (Grabner et al., 2007) and overcoming impasses during insight problem solving (Jung-Beeman et al., 2004; sensor location PO8). NT aimed at increasing alpha power has successfully demonstrated a causal connection between alpha activity and cognitive function, particularly mental rotation (Hanslmayr et al., 2005). This finding creates the prospect of using alpha NT to also test a hypothetical causal connection between alpha activity and cognitive creativity. To identify an alpha NT protocol appropriate for such a study, thirteen college students participated in three sessions of alpha NT. The neurofeedback information was derived from a sensor placed over right lateral parietal-occipital scalp (PO8) and displayed as a moving bar whose height corresponded to degree of alpha activity. Participants' alert state involved increasing the height of this bar by adopting a calm and alert state during nine 2.5-minute NT segments interleaved with four 1-minute baseline segments. The alpha NT resulted in a statistically reliable within-session increase in alpha and theta (but not beta) activity and a between-session increase in alpha activity. There was also a within-session reduction in state anxiety. Thus, alpha NT is a reliable method for increasing alpha activity in regions associated with cognitive creativity. Implications for the use of this method to understand and improve performance on cognitive creativity tests will be discussed.

H8

SPACE-TIME-FREQUENCY ANALYSIS OF EEG DATA IN SEMANTIC MEMORY

Thomas Ferree¹, Matthew Brier², John Hart^{2,3}, Michael Kraut⁴; ¹University of Texas Southwestern Medical Center at Dallas, Radiology, ²Center for Brain Health, School of Behavioral and Brain Sciences, University of Texas at Dallas, ³University of Texas Southwestern Medical Center at Dallas, Neurology, ⁴Johns Hopkins University School of Medicine, Radiology, Baltimore, Maryland – Time-frequency analysis is a valuable tool for studying event-related oscillations during cognitive tasks. In a complete experiment, however, the numerical results span space, time, frequency, task conditions, and subjects. The goal of this study was to develop a method for combining statistical testing with data reduction. For data reduction, we used principal component analysis (PCA) applied sequentially to spectral, spatial, and temporal dimensions. We contrasted two methods for combining statistical testing with PCA. The first method, used widely to analyze event-related potentials, places data reduction prior to statistical testing. The second method, which was developed in this study, places statistical testing prior to data reduction. The results of both methods were compared in a semantic memory task, in which twenty-five subjects decided whether word pairs elicited recall of a third object. Sixty-two channel EEG data were analyzed with short-window Fourier transform. In numerous tests of stability and validity, we found that the second method, which we call STAT-PCA, performed vastly better. We also found that the principal components returned by STAT-PCA agreed well with the group-averaged data, confirming that this multistep analysis method reveals the most prominent features in the data. Finally, STAT-PCA permits the detection of activity that is not only different between conditions, but also common to both conditions, for the most complete yet parsimonious view of the data. It is concluded that STAT-PCA is well suited for analyzing event-related oscillations during cognitive tasks, and its foundations imply that it should generalize well beyond this particular task.

H9

NEUROELECTRIC ASSESSMENT OF BINGE DRINKING: GENDER AND TASK EFFECTS

Kelly Courtney¹, John Polich²; ¹San Diego State University, ²The Scripps Research Institute – Young adult university students were assessed with a battery of electroencephalographic (EEG) and event-related brain potential (ERP) tasks to assay the effects of "binge drinking" amount in non-binge drinking controls, low-binge drinkers (5/4 drinks/occasion, NIAAA definition), and high-binge (?10 drinks/occasion) drinkers (n=8/group x 3 binge categories x 2 genders). Resting EEG

mean frequency was greater in non- and low-bingers compared to high-binger subjects, with the largest group difference in the alpha band (8-12 Hz). A mental head rotation task found high-bingers produced smaller P300 amplitudes for both easy and hard conditions than non- and low-binge subjects, especially in females. A polygon shape matching task yielded a group by condition by gender interaction, such that female high-bingers exhibited smaller P300 amplitudes than the non- and low-bingers in the match condition but similar amplitudes in the mismatch condition. Male high-bingers exhibited similar patterns to the male low- and non-bingers. A memory scanning task generated a group by gender interaction, with female non-bingers exhibited significantly higher amplitude than the female non- and low-bingers. Males exhibited a diminished group difference. A Stroop ERP task produced similar outcomes for the congruent and incongruent stimuli. No binge group effects were obtained for the distracter or target stimulus in a visual three-stimulus oddball task. The findings suggest that high-binge drinking is associated with subsequent neuroelectric changes relative to non- and low-binge drinking, especially in female bingers.

H10

LOOKING FORWARDS AND BACKWARDS: STIMULUS AND RESPONSE LOCKING WITH EVENT RELATED POTENTIALS DURING OVERT LANGUAGE PRODUCTION

Trevor Blackford¹, Krysta Chauncey¹, Phillip J. Holcomb¹, Gina R. Kuperberg^{1,2}; ¹Tufts University, Medford MA, ²Massachusetts General Hospital, Charlestown, MA – An overwhelming majority of event related potential (ERP) studies have focused on brain responses to external stimuli such as pictures or tones. ERP studies appear in stark contrast to the majority of psychological studies that examine overt behavioral responses. This difference is due to the nature of the electroencephalogram (EEG) recordings ERPs are derived from. EEG recordings are very sensitive to electrical signals produced by muscle activity during behavioral response initiation, which obscure the electrical signals produced by the cognitive activity of interest. These drawbacks have discouraged the study of ERPs evoked by initiation of behavioral responses. In the current study we examined EEG data collected during an overt language production task through ERPs derived separately by stimulus-locking forward and response-locking backwards. Participants were shown pictures of objects in a cross modal priming task and were asked to name the object upon presentation. Production ERPs were created by time-locking to the onset of the participants' articulation. Although large articulation related artifacts were present following the analysis window, we did observe a reliable effect prior to articulation. Differences were seen according to the relationship of the prime to the target. This finding suggests that time-locking to articulation is a viable method of investigating language processing. Furthermore, the results provide converging evidence with the stimulus locked ERPs which showed an modulation of the N400 component associated with object understanding to the relationship of the prime and the target.

Methodological Issues: Neuroimaging

H11

NEUROCHEMISTRY OF HUMAN COGNITION

Rajendra Badgaiyan^{1,2,3}; ¹Division of Nuclear Medicine, Massachusetts General Hospital, Boston, ²Harvard Medical School, Boston, ³Shriners Hospital, Boston – Neuroimaging study of human cognition is focused primarily on localization of the brain areas involved in the processing of cognitive components. There is therefore, little or no information concerning neurochemical changes associated with the processing. We explored the possibility of detecting and mapping neurochemical changes during task performance using a dynamic molecular imaging technique. Since the technique exploits the competition between a neurotransmitter and its ligand for receptor occupancy, by dynamically measuring the concentration of a radiolabeled dopamine ligand (11C-raclopride or 18F-fallypride) during

a control and a task condition, we have been able to detect and map changes in dopaminergic activity during performance of a number of cognitive and behavioral tasks. The data acquired in these experiments indicate that in some tasks dopamine is released in the areas that are activated in fMRI experiments. These tasks include emotional memory (amygdala, medial temporal lobe, prefrontal cortex), implicit motor memory (right caudate, bilateral putamen), explicit motor memory (bilateral caudate and putamen) and response inhibition (right caudate). In a cued-recall task (word stem completion) however, we observed significant dopamine release in the striatum, even though most fMRI experiments have not reported striatal activation. Because fMRI findings are not consistent with the observation of impaired task performance in patients with striatal lesions, it was unclear whether the striatum is involved in the processing of explicit memory. These findings suggest that molecular imaging can be used to resolve controversies in cognitive concepts and to investigate an unexplored aspect (neurochemistry) of human cognitive control.

H12

CONSISTENCY AND VARIABILITY IN FUNCTIONAL LOCALISERS

Joseph T. Devlin^{1,2}, Keith J. Duncan^{1,2}, Chotiga Pattamadilok^{1,3}, Iris Knierim^{1,4}; ¹Cognitive, Perceptual and Brain Sciences, UCL, ²Institute of Cognitive Neuroscience, UCL, ³Fonds de la Recherche Scientifique-FNRS & Université Libre de Bruxelles, ⁴Université Pierre et Marie Curie, Ecole Normale Supérieure – A critical assumption underlying the use of functional localiser scans is that the voxels identified as the functional region-of-interest (fROI) are essentially the same as those activated by the main experimental manipulation. Intra-subject variability in the location of the fROI violates this assumption, reducing the sensitivity of the analysis and biasing the results. Here we investigated consistency and variability in fROIs in a set of 45 volunteers. They performed two functional localiser scans to identify word- and object-sensitive regions of ventral and lateral occipito-temporal cortex, respectively. In the main analyses, fROIs were defined as the category-selective voxels in each region and consistency was measured as the spatial overlap between scans. Consistency was greatest when minimally selective thresholds were used to defined "active" voxels ($p < 0.05$ uncorrected), revealing that approximately 65% of the voxels were commonly activated by both scans. In contrast, highly selective thresholds ($p < 10^{-4}$ to 10^{-6}) yielded the lowest consistency values with less than 25% of the voxels active in both scans. In other words, intra-subject variability was surprisingly high with between one third and three quarters of the voxels in a given fROI not corresponding to those activated in the main task. This level of variability stands in striking contrast to the consistency seen in retinotopically defined areas and has important implications for designing robust but efficient functional localiser scans.

H13

IN-VIVO ANATOMICAL DISSECTION OF A CASE OF RIGHT-SIDED NEGLECT AFTER LEFT HEMISPHERE DAMAGE

Monica Toba^{1,2}, Michel Thiebaut de Schotten^{1,3,4}, Francesca Ciaraffa^{1,2,6}, Marianne Blanchard⁵, Catherine Loeper-Jeny⁵, Paolo Bartolomeo^{1,2}; ¹Inserm Unit 610, Neuropsychology of the focal cerebral lesions, GH Pitié Salpêtrière, Paris, France, ²UPMC - Paris VI, Paris, France, ³Natbrainlab, Section of Brain Maturation, Institute of Psychiatry, King's College London, London, UK, ⁴Centre for Neuroimaging Sciences, Institute of Psychiatry, King's College London, London, UK, ⁵Hôpital National de Saint-Maurice, Saint-Maurice, France, ⁶Dipartimento di Neuroscienze - Istituto di Neuropsicologia - Università Cattolica Sacro Cuore (UCSC) - Policlinico A.Gemelli-Roma, Italy – Spatial neglect usually affects left-sided objects after right hemisphere damage. The anatomical correlates are debated, with recent evidence suggesting an important role for fronto-parietal disconnection in the right hemisphere. Here we describe the less usual occurrence of a patient with neglect for right-sided objects after left hemisphere damage. The patient presented 2 focal strokes in the left hemisphere, affecting respectively the left occipital lobe and the region extending from the post-

central gyrus to the temporal-parietal junction. After the second stroke, the patient presented with fluent aphasia, agraphia, working memory impairment and mild right-sided neglect (bells cancellation, 4 omissions on the right, 1 on the left; Ogden figure, 1 omission on the right; line bisection, leftward deviation by 13.5%). DTI-tractography demonstrated disconnections in the fronto-parietal and temporo-parietal regions, concerning principally the left superior longitudinal fasciculus (SLF) and the U-shaped fibers linking the superior and inferior frontal gyri. The corpus callosum was disconnected at the level of each lesion. In vivo white matter dissection in this patient with right-sided neglect suggests a role for left SLF disconnection, which complements analogous evidence for right SLF disconnection in left neglect.

H14

GROUP ANALYSIS OF WORD-PSEUDOWORD EFFECTS IN MAGNETOENCEPHALOGRAPHY VIA SENSOR- AND SOURCE-LEVEL STATISTICAL PARAMETRIC MAPPING Jason R Taylor¹, Richard N Henson¹; ¹MRC Cognition and Brain Sciences Unit – Population inference from Magnetoencephalographic (MEG) data is complicated by MEG's sensitivity to neuroanatomical variability between individuals and to differences in head position relative to the sensors. Further, existing approaches rarely compensate for multiple comparisons over space and time. In the present study, these problems were overcome by (i) virtually transforming all subjects' heads to a common location, (ii) applying random field theory to statistical parametric maps (SPMs), and (iii) constraining distributed source dipoles to a canonical cortical mesh, inverse-normalised to each subject's native space. Nineteen right-handed English adults saw words (W) and pronounceable pseudowords (PW; 480 each; duration 300 ms; presented sequentially at fixation) and indicated whether each was a word or nonsense word (button-press; hand counter-balanced). Whole-head MEG was acquired with 306 sensors (Elekta Neuromag). Neuromag's MaxFilter utility was used to apply signal-space separation to remove noise, for head-movement compensation, and for head-position transformation. Blink artefacts were removed using independent component analysis (EEGLAB). All further processing was done with SPM/Matlab. 3D SPMs on sensor data (2D topography x time) revealed significant W/PW differences from 300-400ms and 525-675ms, with topographies suggesting dipolar sources in bilateral temporal (left>right) and parietal regions. For each subject, source localisation was performed on epochs (-300 to 1000 ms; several approaches were evaluated). Source estimates were converted to image volumes for each condition in time-windows identified by sensor SPMs, smoothed (12-mm Gaussian kernel), and normalised. Group SPMs revealed activity (pseudowords>words) in perisylvian language regions; activity showing the opposite pattern (words>pseudowords) was localised to right parietal cortex.

H15

AN IMPROVED TOOLBOX FOR THE VISUALIZATION AND META-ANALYSIS OF FUNCTIONAL ACTIVATIONS ON THE CORTICAL SURFACE Timothy Herron¹, Xiaojian Kang^{2,3}, David Woods^{1,2,3,4}; ¹US Veterans Affairs, Neurology, Research, Martinez, CA, ²University of California Davis, Neurology, Davis, CA, ³Center for Neuroscience, University of California Davis, Davis, CA, ⁴Center for Mind and Brain, University of California Davis, Davis, CA – The recently introduced MatLab toolbox VAMCA (Visualization And Meta-analysis on Cortical Anatomy) provides surface-based visualization of mean cortical functional activations using data published as stereotaxic 3D coordinates [Herron et al, CNS 2008; Herron et al, SfN 2008]. VAMCA uses a database of cortices from 72 healthy subjects to locate activations on a standardized cortical surface by extending the technique of multi-fiducial mapping [van Essen, Neuroimage, 28:635, 2005]. Non-parametric statistical tests are provided for determining (a) whether two groups of foci have distinct cortical locations; (b) the extent of overlap of the two groups' foci; and (c) whether two groups of foci are differentially concentrated in any anatomically defined regions of interest (ROI). Here, we extend

VAMCA's functionality in three ways. First, we permit the inclusion of data from normalized 3D functional activation images (e.g., from published illustrations) using semi-automated image capture, normalization and projection onto the cortical surface. We also add the capability of mapping stereotaxic coordinates with standard errors and/or volumes (mapped as 3D ellipsoids). Second, we describe improved procedures for mapping an individual subject's activations to VAMCA's normalized cortical surface by using brains in the database with similar cortical anatomy. Third, a new distance metric, the "least axon distance", is described. This new metric provides a functionally relevant alternative to the stereotaxic 3D and spherical 2D distance metrics currently used in VAMCA's statistical tests.

H16

CEREBRAL CORTICAL COMPLEXITY MEASURES IN NORMAL AGING AND ALZHEIMER'S DISEASE Richard King^{1,2}, Kristen Kennedy², Karen Rodrigue², Naftali Raz³, Denise Park²; ¹University of Texas Southwestern Medical Center, ²University of Texas at Dallas Center for BrainHealth, ³Wayne State University – Fractal dimension is a compact metric for shape complexity. The human cerebral cortex acquires fractal properties (i.e. shape invariance over a limited range of spatial scales) secondary to folding. Changes in cortical shape due to normal aging or neurodegenerative disease may differentially affect the value of fractal dimension. Quantification of these effects may help to identify neurodegenerative processes. Design/Methods: High-contrast (MP-RAGE) magnetic resonance images were acquired from two sources: 1) Cross-sectional images from 230 healthy adults ranging in age from 20 to 80. 2) Control and moderate AD images (N=50) from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database. Three-dimensional tessellated polygon models of the cortical ribbon were generated from the MR images using FreeSurfer. Fractal dimension was computed using custom software. Results: For the healthy adults, values for each age grouping were as follows: 20-39: 2.59; 40-49: 2.58; 50-59: 2.57; 60-69: 2.58. Within the ADNI control subject dataset, the values were as follows: 60-70: 2.59; 70-80: 2.60; 80-90 2.60. Trends with aging were not significant. Moderate AD patients had a significantly lower fractal dimension than age-matched controls (2.599 vs. 2.575; p<0.05). Conclusions: 3D Bi-hemispheric fractal dimension values are less sensitive to structural effects associated with aging, but do detect more severe changes associated with moderate Alzheimer's disease. Local measures or non-biased atlas generation methods may improve sensitivity. Fractal dimension of the cortex may serve as a biomarker for identifying neurodegenerative disease.

H17

MULTIMODAL NEUROIMAGING OF EARLY WORD KNOWLEDGE IN HUMAN INFANTS: A NOVEL MEG-MRI APPROACH REVEALS A N400M-LIKE MEG RESPONSE Katie Travis¹, Jeff Elman², Matt Leonard², Tim Brown^{1,3}, Megan Curran², Eric Halgren⁴; ¹University of California, Neuroscience, San Diego, ²University of California, Cognitive Science, San Diego, ³University of California, Psychiatry, San Diego, ⁴University of California, Radiology, San Diego – Due to the difficulties of imaging infants, the neural bases of normal language development remain obscure. In adults, good spatiotemporal accuracy in localizing brain activation during word processing has been achieved by combining magnetoencephalography (MEG) with magnetic resonance imaging (MRI). In the present study, we apply this method to infants (12-15 months). Functional measures of brain activity are obtained with MEG when an infant is engaged in a language task. Anatomical information is acquired with MRI while the infant is asleep. Sources of brain activity are estimated with anatomically constrained MEG (aMEG). We demonstrate that it is feasible to use aMEG to measure and localize brain activity related to semantic word knowledge in infants. Semantic word knowledge was assessed as infants viewed pictures and listened to words that were either paired congruently or incongruently. To observe differences related to semantic and not perceptual processes, picture and word stimuli were balanced across conditions. Preliminary event-related analyses

reveal a differential response to the incongruent condition at approximately 420ms following word onset. The timing of the observed response is consistent with adult MEG (Halgren et al., 2002) and infant EEG (Friedrich and Friederici, 2005) studies employing similar semantic tasks. To our knowledge, we present some of the first evidence of a N400m-like response in younger (<14 months) infants. Future analyses will integrate MEG-MRI to address the spatiotemporal dynamics of the observed response. Results are considered in the context of applying aMEG as a tool for studying the neural dynamics of early language processes.

H18

DISTINGUISHING EVENTS DURING FREE RECALL WITH FMRI

Ilke Öztekin¹, Nicole M. Long¹, David Badre¹; ¹Brown University – Free recall has been a central paradigm in behavioral memory research and has provided core data for computational models of memory. Unfortunately, to date, the neural mechanisms that support recall have not been fully investigated due to technical challenges associated with probing individual recall events using neuroimaging methods. Of particular concern is the extent to which the latencies and uncontrolled lags associated with recall events can confer sufficient design efficiency. In order to investigate the feasibility of testing free recall with fMRI, we used both theoretically (Rohrer & Wixted, 1994) and empirically derived free recall latency distributions to generate simulated fMRI data sets and assessed design efficiency (Dale, 1999; Friston et al., 1999) across a range of parameters that describe free recall performance and fMRI designs. Results specify the design and performance parameters that can provide comparable efficiency between free recall designs and more traditional jittered event-related designs. These findings suggest that assessing BOLD response during free recall using functional magnetic resonance imaging (fMRI) is possible, under certain conditions, and can serve as a powerful tool in understanding the neural basis of memory search and overt retrieval.

H19

A BETTER APPROACH TO IDENTIFYING FUNCTIONAL REGIONS OF INTEREST: USING RIDGE LOGISTIC REGRESSION FOR VOXEL SELECTION

Joonkoo Park¹, Ji Zhu², Thad Polk¹; ¹University of Michigan, Psychology, ²University of Michigan, Statistics – Multivariate pattern analysis techniques are powerful methods for using neuroimaging to read the mind, that is, determining the perceptual or cognitive state associated with a specific pattern of brain activation. These techniques are typically employed to classify activation patterns over a predetermined region of interest (or potentially the whole brain). Here, we show how a multivariate approach (ridge logistic regression) can be used to identify voxels whose collective activity best discriminates among different experimental conditions. We demonstrate that this approach is superior to the conventional univariate approach to identifying functional regions of interest (ROIs), both in a simulated dataset and in a real fMRI dataset involving the visual processing of faces, houses, chairs, and pseudowords. In particular, mind reading is more accurate when based on activity from an ROI identified using this multivariate approach compared with ROIs identified using the conventional univariate approach.

H20

THE IMPACT OF EXPERIMENTAL DESIGN ON THE DETECTION OF INDIVIDUAL VARIABILITY IN FMRI

Craig Bennett¹, Scott Guerin¹, Michael Miller¹; ¹University of California, Psychology, Santa Barbara – Experimental design in functional neuroimaging is a compromise between several competing goals. Statistical power, hemodynamic response estimation, counterbalancing, and stimulus constraints all influence design layout. In this study we sought to examine how these compromises impact the estimation of individual hemodynamic variability across two types of memory tasks. The experiment was a 2x3 design with principal factors of task type (episodic word recognition and n-back working memory) and stimulus presentation strategy (block, m-sequence, and genetic optimization). Participants completed 12 functional imaging runs to yield 100 stimulus presentations per condition.

We used multiple methods to quantify individual variability in the data. First was cross-correlation of the whole-brain t-statistic maps from each participant. This analysis yielded a normalized global measure of similarity between subjects. We also calculated a voxelwise measure of variance from the t-statistic maps. This allowed for the direct comparison of regional variability between levels of each factor. Event-related designs (m-sequence, genetic optimization) generated greater between-subject variability in the t-statistic maps. This was observed in the cross-correlation data as a lower average correlation between volumes. This effect was also observed in the voxelwise variance data as greater average variability within each super-threshold cluster of voxels. The pattern of results was similar across both episodic and working memory tasks. Together, this evidence supports the idea that event-related experimental designs are best for the detection of individual hemodynamic variability in memory. [Supported by the Institute for Collaborative Biotechnologies through grant DAAD19-03-D-0004 from the U.S. Army Research Office]

H21

VISUAL CORTEX IN YOUNGER AND OLDER ADULTS: A COMPARISON OF ACTIVATION FROM DIFFERENT BASELINE STATES

Joanna Hutchison^{1,2}, Hanzhang Lu³, G. Andrew Hillis¹, Traci Sandoval¹, Bart Rypma^{1,2}; ¹University of Texas at Dallas-BrainHealth, Brain and Behavioral Sciences, ²University of Texas Southwestern Medical Center-Psychiatry, ³University of Texas Southwestern Medical Center-Advanced Imaging Research Center – When comparing functional magnetic resonance (fMRI) signals across different population groups, differences in baseline activation levels can cause misinterpretation of results if one uses typical statistical analyses that assume equivalent baseline activation levels. The present study was conducted to determine whether or not older and younger persons differ in baseline activation levels in visual cortex, based upon the observation that several studies have documented differential cortical activation in older individuals compared to younger individuals (for overviews, see Cook et al., 2007; and Rajah & D'Esposito, 2005); differing baseline activation levels in older versus younger persons could account for this apparent difference in activation levels between the groups during task activity. We tested this hypothesis by presenting three types of stimuli to younger and older subjects (cf. Pasley et al., 2007): a foveal annular sinusoidal grating (resulting in a negative baseline), a parafoveal annular sinusoidal grating (resulting in a resting baseline), and a combined stimulus in which the negative (i.e., foveally-presented) stimulus was presented earlier in onset than the positive (i.e., parafoveally-presented) stimulus such that a negative baseline state was achieved prior to the initiation of the positive stimulus. Preliminary blood oxygen level dependent (BOLD) response amplitude data indicate different cortical activation levels in older compared to younger persons, suggesting that older persons have an altered resting baseline. Such results suggest the need to adopt data analysis and interpretation methods that account for population differences in baseline activation levels.

H22

COMBINING STRUCTURAL AND FUNCTIONAL MEASURES OF NEURAL CONNECTIVITY USING WHITE MATTER ANISOTROPY AND CONSTRAINED PRINCIPAL COMPONENT ANALYSIS

Liang Wang^{1,2}, Paul Metzak^{1,2}, Jennifer Whitman^{1,2}, Todd Woodward^{1,2}; ¹University of British Columbia, Psychiatry, Vancouver, Canada, ²BC Mental Health and Addictions Research Institute, Vancouver, Canada – The purpose of this study was to investigate the relationship between white matter tracts and functional magnetic resonance imaging (fMRI) networks involved in source memory. FMRI and diffusion tensor imaging (DTI) data for 15 healthy subjects were acquired on a 3Tesla scanner. Fractional anisotropy (FA) of white matter tracts in the whole brain was estimated using FSL software, and tract-based spatial statistics (TBSS) were computed to align FA images from multiple subjects for voxelwise statistical analysis. Using constrained principal component analysis (cPCA) with a finite impulse response (FIR) basis set, three components were extracted, and rotated using promax rotation. The subject-specific

structure matrix for each component was used as an index of functional connectivity (FC), and was correlated with FA values for each voxel in the FA skeleton. The first functional component involved bilateral cerebellum and parahippocampus, typically associated with motor and memory networks. The second involved the primary visual cortex and parietal areas, typically associated with visual attention. The third involved the dorsal anterior cingulate and parieto-temporal cortex, typically associated with executive and decision-making processes. Using cluster mass correction for multiple comparisons, significant correlations between FA values and the indices of functional connectivity were detected in inferior longitudinal tracts for all functional components, and for the superior longitudinal tracts for the third component. This suggests that during a source memory task, all functional systems are supported by inferior longitudinal tracts, but executive and decision-making systems are additionally supported by superior longitudinal tracts.

H23

THE NEUROIMAGING INFORMATICS TOOLS AND RESOURCES CLEARINGHOUSE (NITRC) David Kennedy¹; ¹University of Massachusetts Medical Center – We report on the use of a new neuroimaging informatics knowledge environment for MRI entitled: Neuroimaging Informatics Tools and Resources Clearinghouse (NITRC). Initiated in October 2006 through the NIH Blueprint for Neuroscience Research (1,2), NITRC's mission is to create a user-friendly knowledge environment for the functional magnetic resonance imaging (fMRI) and associated structural analysis community. Through the identification of existing tools and resources valuable to this community, NITRC's goal is to develop a knowledge environment to enhance, adopt, distribute, and contribute to the evolution of neuroimaging tools and resources. Located on the web at www.nitrc.org, this site promotes tools and resources, vocabularies, and databases, thereby extending the impact of previously funded, neuroimaging informatics contributions to a broader community. It is anticipated that this will give fMRI researchers greater and more efficient access to the tools and resources they need, better categorize and organize existing tools and resources, facilitate interactions between researchers and developers, promote better use through enhanced documentation and tutorials all while keeping the set of resources up-to-date with the most recent resource upgrades and updates. In Summary, NITRC, a new neuroimaging knowledge environment, is now online. We encourage the fMRI community to try it out and provide feedback on its design, tools, resources, and content. NITRC is a knowledge environment for the fMRI community where tools and resources are presented in a coherent and synergistic environment for the advancement of MRI-based neuroscience research.

Methodological Issues: Other

H25

ASYNCHRONY OF BOLD SIGNAL ACROSS BRAIN REGIONS

Xu Cui¹, Allan Reiss¹; ¹Stanford University – The hemodynamic response of neural activation as measured by fMRI has different characteristics across different brain regions. Here we studied the temporal aspect of BOLD signal; that is, the asynchrony (lead-lag) of BOLD signal across different brain regions, in a large dataset of about 200 subjects crossing 5 different fMRI experiments. We found that (1) the middle part of the brain (motor cortex) usually leads anterior and the posterior regions (prefrontal and occipital cortex); (2) this pattern of temporal activation is generally task independent; (3) inter-subject variance is large; (4) intra-subject variance - the variance of a single subject at different times - is very small if the two time points are close (e.g., within a few hours) but can be larger when the two times are distant (e.g., 1 year). The cause of this newly detected temporal pattern is unknown; though it likely reflects the asynchrony of vascular events rather than conduction of electrical signals. Our result shows that it is important to consider individual variance dur-

ing fMRI data analysis, and that a standard hemodynamic function may not fit some brain regions as well as others when considered across a population sample. The correlation of this temporal activation pattern with age, gender and psychiatric disease is currently being investigated; our results may provide a new signature of developmental or mental states. Future work, including investigation of hemodynamic response using near infrared spectroscopy imaging, is required to reveal the mechanism underlying the pattern we have detected.

H27

TMS STIMULATION INTENSITY IN COGNITIVE CONTROL TASKS: THE ADEQUACY OF THE MOTOR THRESHOLD

Franziska M. Korb^{1,2}, Jakob A. Kaminski^{1,3}, Derek V. M. Ott¹, Arno Villringer^{1,3}; ¹Max Planck Institute for Human Cognitive & Brain Sciences, Leipzig, ²University Clinic, Cologne, ³University Clinic, Leipzig – Transcranial Magnetic Stimulation (TMS) has become an important experimental tool for exploring brain functional neuroanatomy. However, the use of TMS in the investigation of higher level cognition (e.g. cognitive control) is complicated by the difficulty in determining the appropriate stimulation intensity needed to influence cortical regions supporting such functions. Typically, TMS studies use the motor threshold (MT) to determine stimulation intensities, even if the employed tasks place no particular demands on the motor system. Here, we evaluated the adequacy of MT as reference in determining individual stimulation intensities in the study of non-motor, higher-level cognition. To this end, systematically varying stimulation intensities of repetitive TMS were applied to an individually localized region of the posterior middle frontal gyrus (pmFG) involved in working memory immediately prior to performance of an n-back task. We propose that MT-sensitivity of non-motor cortical regions such as the pmFG should result in similar between-subjects behavioral effects. If that is not the case, behavioral effects should rather correlate with absolute stimulation intensities. Results indicated that task-related behavioral effects were dependent on stimulation intensity variation. Thus, an empirical determination of the appropriate stimulation intensity may be necessary for valid employment of TMS in the study of non-motor processes.

H28

HOW DOES RTMS WORK? EVALUATING DISRUPTION VS. BIASING MECHANISMS

Jeffrey S. Johnson¹, Massihullah Hamidi^{3,4}, Bradley R. Postle^{1,2}, Giulio Tononi²; ¹University of Wisconsin-Madison, Psychology, ²University of Wisconsin-Madison, Psychiatry, ³University of Wisconsin-Madison Neuroscience Training Program, ⁴University of Wisconsin-Madison Medical Scientist Training Program – Although transcranial magnetic stimulation (TMS) has become a valuable tool in cognitive neuroscience, the mechanisms by which it affects brain function remain unclear. One commonly held view holds that repetitive (r)TMS influences behavior by producing transient "virtual lesions" in targeted tissue. Although consistent with reports of rTMS-induced declines in performance, this "disruption" assumption is difficult to reconcile with instances of rTMS-induced improvements in performance. One such case is that 10 Hz rTMS applied to the superior parietal lobule can improve performance on a spatial (but not object) delayed-recognition task. A replication with simultaneous EEG found that 10 Hz rTMS affects alpha-band power at parietal electrodes, with individual differences in these effects (rTMS increasing vs. decreasing alpha-band power) predicting whether rTMS impairs or improves behavioral performance (Hamidi et al., CNS 2007). But did 10-Hz rTMS produce these effects by imposing an (exogenous) oscillatory rhythm (i.e., by disrupting) or by biasing endogenous task-related oscillations? In the present study, three subjects from Hamidi et al. (CNS 2007) participated in a second experiment in which delay-period rTMS was replaced with 10 Hz visual flicker. We reasoned that 10 Hz flicker would produce widespread entrainment of neural activity to the flicker frequency, and comparison of these EEG results with those from the rTMS study would shed light on whether the latter also reflected (disruptive) entrainment to an exogenous stimulus. Results

indicated that the effects of 10 Hz rTMS are qualitatively different from those of visual flicker, and thus favor a biasing account of rTMS.

H29

SOURCE LOCALIZATION FOR COGNITIVE NETWORK DETERMINATION USING DUAL INDEPENDENT COMPONENT ANALYSIS OF HUMAN EEG AND FMRI DATA

Kevin Brown¹, Stephanie Ortigue¹, Scott Grafton¹, Jean Carlson¹; ¹University of California, Santa Barbara – Understanding the brain as a complex system requires integration of fine spatial and fast temporal information processing linked to cognitive operations. We present novel source localization algorithms for cognitive network determination that combine data from human EEG and FMRI studies acquired at separate sessions. Our methods make heavy use of independent component analysis (ICA) in order to (i) separate task-related activity from nontask-related activity and artifacts and (ii) reduce the size and complexity of the source determination inverse problem. Our methods match EEG and FMRI information simultaneously, either by fitting both EEG and FMRI dynamics or by regularizing the underdetermined EEG inverse problem using information about areas of activity obtained from ICA decomposition of FMRI. We focus particular attention on solution robustness as a function of choices made during inversion: the amount of head model detail, the relative weighting of the two imaging modalities, and the form of the model used to calculate the expected blood oxygenation level dependent (BOLD) response. We also investigate source localization efficacy as experimental design parameters are varied. We demonstrate the efficacy of our algorithms using human rapid event-related evoked visual response data. An important conclusion of this work is the link between source localization and experimental design; the appropriate algorithm for solving the EEG inverse problem will be dependent on the goals of the study and the details of its design.

Neuroanatomy

H30

FUNCTIONAL TOPOGRAPHY OF THE HUMAN CEREBELLUM: AN FMRI STUDY

Catherine Stoodley^{1,2}, Eve Valera^{1,2}, Jeremy Schmahmann^{1,2}; ¹Massachusetts General Hospital / Harvard Medical School, ²Athinoula A. Martinos Center for Biomedical Imaging – The role of the cerebellum in motor control is well-established, but there is increasing interest in the non-motor role(s) of the cerebellum. Studies in patients indicate that motor control is somatotopically organized in the cerebellar anterior lobe; and clinical data also demonstrate that patients with damage to the cerebellar posterior lobe can experience a variety of non-motor symptoms, including difficulties in language, spatial and executive functions, and affective processing (the Cerebellar Cognitive Affective Syndrome). Tract tracing studies in animals show that cerebro-cerebellar and spino-cerebellar connections map to different regions of the cerebellum, providing anatomical support for our hypothesis that there are functional subdivisions of the cerebellum: the anterior lobe processes sensorimotor information; the posterior midline is involved in affective processing; and lateral hemisphere regions of the posterior lobe are engaged with information related to cognitive tasks. Additionally, we have predicted that the right cerebellar hemisphere is preferentially active during language tasks, and the left cerebellar hemisphere during spatial processing. This functional topography has yet to be shown experimentally in the cerebellum of healthy controls. We therefore used 3T functional MRI to investigate the patterns of cerebellar activity in healthy adult males (n=5; mean age 26.4 years) during motor (finger tapping), language (verb-for-noun generation), spatial (mental rotation), working memory (n-back) and affective tasks (viewing images from the International Affective Picture Scale). The data will be analyzed to investigate group activation patterns as well as within-subject topography. These findings may provide new insights into the functional topography of the human cerebellum.

H31

EFFECTS OF AGING ON MAXIMIZING GAINS AND MINIMIZING LOSSES IN A CHOICE TASK

Darrell Worthy¹, Jennifer Pacheco¹, Bo Zhu¹, David Schmyer¹, W. Todd Maddox¹; ¹University of Texas at Austin – Previous research suggests that the dorsolateral prefrontal cortex and the basal ganglia are especially susceptible to the effects of aging (Raz, 2000). These areas have also been implicated in reward processing and representation (Schultz, 2000). We hypothesized that elderly participants' ability to maximize gains and minimize losses will be attenuated. To test this we had healthy elderly participants (61 - 81 years old) and matched controls perform two decision-making tasks where they drew from one of four decks of cards on each trial and received points for each draw. In the Gains task they gained points on each draw and attempted to maximize points earned. In the Losses task they lost points with each draw and attempted to minimize losses. As predicted, gains maximization and loss minimization was attenuated in the elderly, with a larger attenuation for losses than for gains. Model-based analyses using a simple reinforcement learning model indicated that elderly participants were unable to adequately exploit the option with the highest expected value compared to younger participants. When attempting to minimize losses elderly participants showed a tendency to give less weight to recent information than younger participants. These results suggest that age-related cognitive decline may negatively affect one's ability to choose from alternative options in order to maximize reward and minimize losses.

H32

ATYPICAL READING/LATERALITY PROFILE ASSOCIATED WITH REVERSED PLANUM TEMPORALE ASYMMETRY

Christine Chiarello¹, Suzanne Welcome¹, Christiana Leonard²; ¹University of California, Riverside, ²University of Florida, Gainesville – Reading skill varies substantially among college students. We are investigating the neuroanatomical correlates of this variation. Two hundred students performed reading assessments and seven divided visual field (DVF) tests of word processing, and received structural MRI scans. A cluster analysis of the reading and DVF data classified 183 individuals into one of four groups differing in their reading skill and the strength of their VF asymmetries. Here we focus on the 17 individuals whose performance profiles could not be classified (i.e., outliers). Although they did not form their own cluster based on the variables used in the cluster analysis, they shared some characteristics that differed from those in the four groups. They obtained high scores for IQ and Passage Comprehension, but not Word Identification. Their responses were slower (but not less accurate) in the DVF tasks. Their VF asymmetries were highly variable across tasks and persons. These individuals were also more likely than those in the four clusters to have very consistent hand preferences. Remarkably, 41% of these outliers showed reversed (e.g., rightward) asymmetry of the planum temporale (compared to 19% in the rest of the sample). Thus, individuals with atypical profiles of reading and VF lateralization also evidenced atypical asymmetry in a language-relevant region. Within a population of normal readers, reversed planar asymmetry is not associated with poor reading skill, and hence may not be a predictor of dyslexia. However, this structural feature may be associated with an unusual reading/asymmetry profile.

H33

A COMPARISON OF CORTICAL ANATOMY BETWEEN COLLEGE STUDENTS WITH DIFFERENT READING SKILLS

Suzanne Welcome¹, Christine Chiarello¹, Paul Thompson², Elizabeth Sowell²; ¹University of California, Riverside, ²University of California, Los Angeles – Resilient readers are characterized by poor phonological processing skills in the absence of a deficit in reading comprehension. Such individuals may rely on alternate neural mechanisms to support skilled reading. We compared the cortical anatomy of resilient readers to that of poor readers (with impaired phonological processing and comprehension) and proficient readers (with no deficits in reading). We used cortical pattern matching algorithms to obtain measurements of radial expansion and

gray matter thickness (in millimeters) from structural MRI data. Compared to proficient readers, both resilient and poor readers show less leftward asymmetry of gray matter thickness in the temporo-parietal region, a region thought to support print-to-sound conversion. Resilient readers show greater gray matter asymmetry in medial frontal and medial posterior regions than either poor or proficient readers. It is possible that medial morphology relates to compensatory processing in resilient readers. Poor, but not resilient readers, show a reduction in radial expansion in the frontal region. This suggests that frontal anatomy may relate to text comprehension ability rather than phonological processing skill. The results of this study indicate that resilient readers may represent a separate population of readers, distinguishable from poor and proficient readers by their cortical anatomy. Additionally, phonological and comprehension skills may be associated with different aspects of brain morphology.

H34

MICROSTRUCTURAL BRAIN ALTERATIONS AND WORKING MEMORY IN PSYCHOSIS: RELATIONSHIP WITH GENETIC LIABILITY Petra Habets¹, Jim van Os^{1,2}, Rainer Goebel^{3,4}, Machteld Marcelis¹; ¹South Limburg Mental Health Research and Teaching Network, EURON, Psychiatry and Neuropsychology, Maastricht University, Maastricht, The Netherlands, ²Division of Psychological Medicine, Institute of Psychiatry, De Crespigny Park, London, UK, ³Maastricht University, Cognitive Neuroscience, The Netherlands, ⁴F.C. Donders Centre for Cognitive Neuroimaging, Nijmegen, The Netherlands – Background: Working memory (WM) deficits in schizophrenia seem to reflect dysfunction of cortical regions such as the anterior cingulate gyrus, the prefrontal and parietal cortex. Cortical thickness measurements can be used to identify small cytoarchitectural alterations. We hypothesized that alterations in cortical thickness in the above mentioned brain regions are associated with changes in WM performance, which was tested in patients and their siblings. Methods: T1-weighted MRI scans were acquired on a 3 Tesla scanner from 92 patients with schizophrenia and 100 non-psychotic siblings. BrainVoyager QX was used to measure cortical thickness in 77 regions of interest, using the Laplace method. With multilevel random regression, the association between cortical thickness and performance on the Auditory Verbal Learning task was examined within patients and siblings, adjusted for potential confounders. Results: In the patients, decreased cortical thickness in the anterior cingulate and left superior temporal gyrus was associated with impaired WM. In the siblings, decreased cortical thickness in Broca's area and the right inferior frontal sulcus was associated with impaired WM. In addition, there were some negative associations, mainly in parietal (patients) and temporal (relatives) regions. Conclusions: Psychotic patients and their siblings showed positive and negative associations between cortical thickness and WM, in brain regions previously identified as components of a distributed WM network, although the involved cortical regions differed between the groups. These differential relationships could indicate distinct WM neurocircuitry problems in patients and relatives and possibly explain the differences in WM performance between these groups.

H35

MORPHOLOGICAL STUDY ON THE CORRELATION BETWEEN IQ AND CREATIVITY Judith Segall¹, Raneé Flores¹, Shirley Smith^{3,1}, Jeremy Bockholt¹, Robert Chavez¹, Alison Marshall¹, Rachael Grazioplene¹, Rex Jung^{1,2,3,4}. ¹Mind Research Network, ²University of New Mexico, Neurosurgery, ³University of New Mexico, Psychology, ⁴University of New Mexico, Neurology – Numerous psychometric studies have noted an association between measures of creativity and intelligence up to an IQ of 120, but not thereafter (Sternberg, 1999). We sought to determine the morphological relationship between creativity and cortical thickness in a cohort of healthy subjects, who were grouped between those with a Full Scale Intelligence Quotient (FSIQ) of ≥ 120 and those >120 . We obtained T1 images and creativity measures (Miller & Tal, 2007) in a cohort of 37 neurologically and psychiatrically normal subjects (FSIQ ≥ 120 – 8 females

and 11 males; FSIQ ≥ 121 – 8 females 10 males) ranging in age from 18 to 29. Five independent judges rated creative products of each subject, with high inter-rater reliability ($r = 0.89$), from which a "Creativity IQ" (CIQ) was calculated. T1 images were analyzed using FreeSurfer to obtain cortical measurements, which were then used in the general linear model to correlate cortical thickness to CIQ controlling for gender and FSIQ. We found that CIQ was significantly related ($p < .0001$) to decreased cortical thickness, bilaterally, in the superior parietal gyrus for subjects with a FSIQ ≥ 120 , increased left parsorbitalis thickness, and increased right caudal anterior cingulate thickness. For subjects with FSIQ ≥ 121 there was a stronger correlation between the FSIQ and thickness than between CIQ and thickness. The results support the notion that creativity and cortical thickness are correlated up to an IQ of 120, but that FSIQ predominates in terms of cortical thickness correlates at FSIQ >120 .

H36

GREY MATTER DENSITY AS ENDOPHENOTYPE FOR ADHD AND AUTISM Hilde Geurts^{1,2}, Steven Scholte¹; ¹University of Amsterdam, Psychonomics, Psychology, ²Leo Kanner Huis, Autism Team Amsterdam – Background: ADHD and autism are well known overlapping neurodevelopmental disorders of which the etiology is not fully understood. One way to unravel the relationship between the associated behavioral symptoms and the neurobiological underpinnings is to study endophenotypes. A potential endophenotype are structural differences in grey matter. Identification of overlapping and disease-specific brain abnormalities might help to explain similarities and differences in the neurocognitive profiles of ADHD and autism. The assumption is that also in the normal population this link between brain characteristics and disorder characteristics can be made. Method: Structural MRI (method voxel based morphometry) was obtained from 96 healthy adults who filled out ADHD and autism questionnaires. Results: Characteristics of both disorders are associated with grey matter density in the frontal cortex, while only ADHD characteristics are related to grey matter density in the striatum and only autism characteristics with the middle temporal gyrus. Not only are these the known brain areas related to these disorders, but also the direction of the correlations were as expected. Hence, the results showed that the association between questionnaire scores and the patterns of grey matter density are in line with findings in patients with ADHD and autism. Conclusion: This study shows that structural differences in grey matter indeed are a potential endophenotype for neurodevelopmental disorders such as ADHD and autism.

H37

SEX, HAND PREFERENCE AND BRAIN ASYMMETRY Christiana M. Leonard¹, Stephen D. Towler¹, Suzanne Welcomme², Christine Chiarello²; ¹University of Florida, ²University of California, Riverside – It is commonly believed that women and individuals with mixed hand preference have less strongly lateralized brains than men with consistent hand preference. We were able to test this idea in a sample of 200 normal young adults with volumetric MRI scans. Individuals were classified as consistent if they performed all actions on the 5 point Bryden scale with the same hand. Perisylvian measures (planum temporale, planum parietale and Heschl's gyrus) and medial frontal measures (cingulate and paracingulate gray matter) were entered into a discriminant analysis in order to classify hemispheres as either right or left. Contrary to our prediction, these measures were more successful in classifying the hemispheres of mixed handed women ($n = 41$, $F(5,76) = 21.74$) than consistent handed women ($n = 59$, $F(5,112) = 9.88$), mixed handed men ($n = 56$, $F(5,106) = 9.61$), or consistent handed men ($n = 44$, $F(5,82) = 8.88$). (All F 's were significant, $p < .0001$.) In mixed handed women, all five measures contributed significantly ($p < .01$). In consistent handed women and mixed handed men all measures with the exception of the paracingulate contributed significantly. In consistent handed men, neither of the medial frontal measures contributed significantly to successful hemisphere classification. These findings remained unchanged when left handers ($n = 26$) were excluded. The relationship between sex, hand preference and brain

asymmetry continues to resist simple conceptualizations. This research was supported by NIH grant DC006957 to CC.

H38**FUNCTIONAL AND STRUCTURAL CONNECTIVITY OF THE HUMAN INTRAPARIETAL SULCUS AND ANGULAR GYRUS**

Lucina Uddin¹, Kaustubh Supekar¹, Hitha Amin¹, Daniel Nguyen¹, Michael Greicius¹, Vinod Menon¹; ¹Stanford University School of Medicine, Psychiatry and Behavioral Sciences, Stanford, CA – The caudal inferior parietal lobe (IPL) of the human brain is a heterogeneous region involved in a wide array of cognitive functions ranging from spatial attention to language and mathematical cognition. We examined functional and structural connectivity of distinct subregions within the IPL using resting state fMRI and diffusion tensor imaging (DTI) in order to better understand its functional architecture and relationship to associated neural networks. We used probabilistic cytoarchitectonic maps to divide the caudal IPL into five regions of interest (ROIs) per hemisphere: the anterior and posterior angular gyrus (PGa, PGp), and three subregions within the intraparietal sulcus (hIP2, hIP1, and hIP3). Resting state functional connectivity results indicated differential coupling between the ROIs, with each ROI being functionally coupled to distinct networks. The PGa was linked to the basal ganglia and ventral premotor areas, while the PGp showed connectivity with ventromedial prefrontal cortex, precuneus, posterior cingulate, and hippocampal cortices. The anterior-most IPS ROI, hIP2, was linked with ventral premotor and insular cortex, while the posterior-most IPS ROI, hIP3, showed connectivity with the striate and extrastriate visual cortex. Deterministic tractography revealed structural connectivity between many, but not all, of the functionally connected regions. Our findings provide new evidence for functional heterogeneity of the IPL in relation to its cytoarchitectonically-defined subdivisions and offer a novel framework for interpreting the growing body of functional neuroimaging literature reporting activations in the IPL.

H39**GENETIC MARKER OF PRO-INFLAMMATORY RESPONSE IS ASSOCIATED WITH AGE-DEPENDENT REDUCTION IN WHITE MATTER INTEGRITY**

Kristen Kennedy¹, Naftali Raz²; ¹Center for BrainHealth, University of Texas at Dallas, Dallas, TX, ²Institute of Gerontology, Wayne State University, Detroit, MI – Reduced white matter microstructural integrity is found in normal aging throughout the brain. The mechanisms of this age reduction are poorly understood, but may be partly under genetic control. The purpose of the current study was to investigate the influence of a genetic marker of inflammation, interleukin-1 beta G allele, on regional white matter integrity (fractional anisotropy, FA and apparent diffusion coefficient, ADC) as assessed by Diffusion Tensor Imaging (DTI) in a sample of 41 normal, healthy adults (44-81 years old). We found that carriers of the G allele displayed lesser integrity in the genu and splenium of the corpus callosum and in prefrontal and occipital white matter than IL-1? A homozygotes, and the effect of the marker became stronger with advancing age. These preliminary data suggest that persons who are genetically predisposed to stronger pro-inflammatory response may acquire greater white matter damage with age than individuals without this predisposition. It is these individuals who may most benefit from anti-inflammatory intervention. Supported in part by grant R37 AG-11230 from NIH.

Memory: Other**H40****HUMAN LONG-TERM ASSOCIATIVE MEMORY CAPACITY**

Joel L. Voss^{1,2}; ¹Northwestern University, Psychology, ²The Beckman Institute, University of Illinois Urbana-Champaign – Long-term memory depends on the retention of associative information, such as the relationship between a friend's face and his name, a home and its neighborhood, and a mint and its odor. Many have considered memory's overall capacity, but rele-

vant data are scant. Some previous experiments on humans have assessed memory capacity by testing retention for thousands of visual impressions, and have concluded that there are virtually no constraints on how much information can be successfully retained. However, no previous studies of capacity have investigated associative memory processing that is essential to long-term memory. I studied long-term associative memory with 58,560 memory trials for picture-response associations during approximately one year of testing. Estimated capacity was on the order of several thousand associations, and this and other indicators of memory function were remarkably similar to those obtained for baboons (*Papio papio*) under comparable circumstances. These findings suggest conservation of long-term memory mechanisms and effectiveness in humans relative to nonhuman primates, despite at least 20 million years of divergent evolution and vastly different behavioral and cognitive repertoires. Furthermore, in contrast to the limitless capacity estimates derived from studies on the retention of visual impressions in humans, the current findings indicate more profound limitations for the associative processes that support our ability to remember the past.

H41**SUBJECTIVE LIKELIHOOD OF IMAGINED FUTURE EVENTS INFLUENCES ACTIVITY IN THE MENTAL TIME TRAVEL NETWORK**

Julia A. Weiler^{1,2,3}, Boris Suchan¹, Irene Daum^{1,2}; ¹Institute of Cognitive Neuroscience, Neuropsychology, Ruhr-University Bochum, Germany, ²International Graduate School of Neuroscience, Ruhr-University Bochum, Germany, ³Ruhr-University Research School, Bochum, Germany – Humans possess the remarkable ability to vividly imagine past events as well as potential future scenarios, an ability termed mental time travel. For past events, a clear distinction can be made into events that did happen (true memories) and those that did not happen (false memories). However, no such distinction is possible for future events at the time of imagination. Nevertheless, we have a sense of the likelihood of occurrence of future events and this might influence brain activity. We conducted a functional magnetic resonance imaging study in which 16 healthy human subjects had to vividly envision potential personal future events for the upcoming Christmas holiday. After Christmas had passed, subjects had to judge for each of the previously imagined future events, whether it actually took place during Christmas or not (termed "true" and "false" future events in analogy to the memory literature). A comparison of the activation patterns for true and false future events revealed significant differences. True future events elicited higher activation in the left middle frontal gyrus, right inferior frontal gyrus, right precuneus, and left middle temporal gyrus, while the reverse contrast mainly activated the right anterior cingulate. In line with our expectations, subjects rated those events that were later classified as true as more probable than those that were later defined as false. These results show that distinct brain regions are modulated by this judgment of the likelihood of future events.

H42**ERPS REVEAL THE ROLE OF REMINDING IN THE SPACING EFFECT IN MEMORY**

Laura Matzen¹, Kara Federmeier², Aaron Benjamin²; ¹Sandia National Laboratories, ²University of Illinois at Urbana-Champaign – The spacing effect, where participants have better memory for repeated items that are spaced far apart in a study list than for repetitions that are massed together, is a robust finding in the memory literature. One explanation for this effect is that the second presentation of an item reminds the participants of the first, reactivating the original memory trace and giving them practice with retrieving the item. At long lags, more effort is required to reactivate the memory trace, leading to a bigger benefit to later memory performance. In the present experiment, we used event-related potentials (ERPs) to test this explanation for the spacing effect. Participants studied words that were presented once or repeated at a lag of 2 or 10. At short lags, repeated words had a reduced N400 and a large LPC, indicating both priming and explicit processing. At long lags, there was no reduction in the N400 for repeated words but the large LPC remained. Critically, the ERPs elicited at study were backsorted

based on subsequent memory for the words. We found that the amplitude of the LPC for the repetitions was predictive of subsequent memory, and that the Dm effect for repeated items appeared only for the second presentation of the word, not for the first. Both of these findings support the hypothesis that the spacing effect is caused by explicit reminding during study.

H43**NEURAL MARKERS OF INHIBITION IN EPISODIC MEMORY**

Maria Wimber^{1,2}, Karl-Heinz Baeuml², Zara Bergstroem¹, Gerasimos Markopoulos¹, Hans-Jochen Heinze¹, Alan Richardson-Klavehn¹; ¹University of Magdeburg, Neurology and Stereotactic Neurosurgery, ²University of Regensburg, Experimental Psychology – Retrieving particular episodes from memory strengthens the retrieved information, but at the same time also weakens related, non-retrieved information, causing so called retrieval-induced forgetting of the non-retrieved episodes. Such forgetting is thought to be the consequence of inhibitory control processes that reduce interference from concurrently active memory traces, thereby supporting retrieval of the relevant information. We studied the neural correlates of retrieval-induced forgetting using event-related functional magnetic resonance imaging during the final cued recall. Across participants, forgetting showed a strong positive correlation with neural activity in the left inferior prefrontal cortex (BA 47) and the left lateral temporal cortex (BA 22), regions associated with the retrieval of weakly represented memories. By contrast, retrieval-induced strengthening was correlated with activation increases in medial (BA 7) and lateral (BA 40) parietal areas, possibly reflecting the increased episodic strength of previously retrieved memories. Our findings demonstrate that retrieval-induced facilitation and forgetting involve distinct neural processes, and provide the first direct evidence for a possible functional-anatomical marker of inhibition in human episodic memory.

H44**THE PROSPECTIVE BRAIN: HOW FUTURE ACTIONS BREED INTRUSIVE COGNITIONS AND INTERFERE WITH CURRENT TASKS**

Meredith Lanska¹, Taylor Rigby¹, Timothy Gerrits¹, Ezequiel Morsella^{1,2}; ¹San Francisco State University, Psychology, ²University of California, Neurology, San Francisco – Based on neuropsychological evidence that simulating future events depends on neural machinery that is also used for remembering past events, it has been proposed that the function of episodic memory is to simulate potential future actions (Schacter & Addis, 2007). Together with research revealing the future-looking tendency of perception, memory, cognitive control, language, and action-production, this has led to the view of the 'prospective brain' (Schacter, Addis, & Buckner, 2007). To add to this literature, we propose that intrusive cognitions, too, reflect the prospective nature of the brain. These cognitions can occur when one is trying to clear one's mind before going to sleep, only to have thoughts about future tasks perturb consciousness. We hypothesize that these cognitions are triggered automatically by future tasks that may benefit from forethought. Accordingly, during a meditation-like exercise requiring one to clear the mind of excess thought and focus on just one thing (breathing), participants (n = 149) reported more intrusive cognitions about a future task that could benefit from forethought than when they anticipated no future task or anticipated a task that, though of comparable difficulty and content, could not benefit from forethought, $F(2, 146) = 4.974, p < .01$. We also examined how merely knowing that one must perform a future task interferes with a current task requiring cognitive control. Together, these findings have implications for understanding basic mechanisms in psychopathological conditions such as rumination and obsessive-compulsive disorder. More generally, they illuminate under-explored aspects of the prospective brain.

H45**ENHANCED BY EXPERIENCE: SUPERIOR SOURCE MEMORY FOR FAMILIAR OVER NOVEL SCENES IS ASSOCIATED WITH POSTERIOR HIPPOCAMPAL ACTIVATION AT ENCODING**

Jordan Poppenk^{1,2}, Morris Moscovitch^{1,2}; ¹University of Toronto, ²Rotman Research Institute – Memory formation is associated with activation of the anterior hippocampus at encoding, although most studies reporting this effect have used only novel materials. These materials, according to the novelty-encoding hypothesis, are better encoded than familiar ones. We tested this hypothesis behaviorally while exploring whether novel and familiar materials were associated with different neural predictors of subsequent memory. We scanned participants using functional magnetic resonance imaging (fMRI) while they studied novel and familiarized scenes under two sets of instructions. In a subsequent source memory task, participants determined which instructions had been associated with each scene. Responses on the memory test were used to back-sort fMRI encoding trials into remembered and forgotten categories, which were compared to identify brain regions that predicted memory. This contrast was performed separately for novel and familiarized scenes. There were two major findings: first, by eliminating confounding effects of source confusion which plague studies on novelty effects, we showed that source memory associated with familiarized scenes was in fact better than memory associated with novel ones. Second, memory for both scene types was predicted by a common network in occipital and parietal cortices but by unique loci in the hippocampus: the right anterior hippocampus predicted memory for novel scenes only, whereas posterior hippocampus predicted memory for familiarized scenes only. We conclude, contrary to the novelty-encoding hypothesis, that memory is superior for familiar than for novel items, and that this superiority is associated with activation of the posterior hippocampus during encoding.

H47**DISSOCIATING THE ELECTROPHYSIOLOGICAL CORRELATES OF RECOLLECTION AND FAMILIARITY IN OLDER AND YOUNGER ADULTS**

Tracy H. Wang¹, Marianne de Chastelaine¹, Brian Minton¹, Michael D. Rugg¹; ¹Center for the Neurobiology of Learning and Memory and Neurobiology & Behavior, UC Irvine, Irvine, CA – Previous aging studies investigating the contributions of recollection and familiarity to recognition memory have shown that recollection declines more markedly with age than does familiarity. There is considerable evidence that recollection and familiarity have distinct event-related potential (ERP) correlates. The aim of the present study was to determine to what extent ERP correlates of recollection and familiarity differ between older and younger adults, focusing on the question whether the seeming resistance of familiarity to aging is mirrored in its neural correlate. Twenty-four older adults (63-77 yrs) and 16 young adults (18-29 yrs) participated in a recognition memory study employing a modified R/K procedure in which subjects rated the confidence of their familiarity-based recognition decisions. The older adult group was split into two subgroups based on estimates of mean familiarity strength (n=12 each). This allowed us to equate estimates of familiarity-driven recognition between the young subjects and the high-strength subgroup of older adults. Strikingly, the putative ERP correlate of familiarity - the 'mid-frontal old/new effect' - was evident in the young subjects only, and was undetectable in both older sub-groups. By contrast, the putative ERP correlate of recollection - the left parietal effect - was evident in all three groups. The absence of the mid-frontal old/new effect in our older subjects raises the possibility that familiarity-based recognition depends upon qualitatively different memory signals in older and young adults.

H48**THE RECOLLECTION OF TO-BE-REMEMBERED AND TO-BE-FORGOTTEN ITEMS IN ITEM-METHOD DIRECTED FORGETTING**

Liang-Tien Hsieh¹, Daisy Hung^{1,2}, Ovid Tzeng^{1,2}, Shih-kuen Cheng¹; ¹Institute of Cognitive Neuroscience, National Central

University, Taiwan, ²Institute of Neuroscience, Laboratory for Neuropsychology, National Yang-Ming University, Taiwan – The recollection processes associated with the retrieval of To-Be-Remembered (TBR) and To-Be-Forgotten (TBF) items in item-method directed forgetting were examined by using a two-step source judgment task. At study, each study word was accompanied with either a "Remember" or a "Forget" instruction directing the subjects to remember or to forget the accompanied study word respectively. At test, both TBR and TBF items intermixed with unstudied new words were presented and the subjects performed an initial old/new judgment to identify both TBR and TBF items and then determined their source information (i.e., being accompanied with a "Remember" or a "Forget" instruction at study). The recollection of TBR and TBF items were examined by the correct source identifications. Results from the initial old/new identification revealed that the hit rate to TBR items was higher than the hit rate to TBF items, showing the directed forgetting effect. However, no difference was found in the percentage of correct source judgments between TBR-Hits and TBF-Hits, suggesting that the percentage of recollected items among TBR-Hits was similar to the percentage of recollected items among TBF-Hits. Despite of such similarity, however, it is likely that the recollected TBR items may differ from the recollected TBF items in terms of the contextual richness of the recollected information. Such speculation gained support from another ERP study showing that the parietal old/new effect? which is an electrophysiological signature of the recollection process? was more pronounced for TBR-Hits than for TBF-Hits in the time window of 400-900 ms.

H49

PERFORMANCE ON A STRIATAL LEARNING TASK DISTINGUISHES ADDICTED FROM CASUAL CIGARETTE SMOKERS Lesley Fellows¹, Tal Ben-Simhon¹, Alain Dagher¹, Michael Frank²; ¹McGill University, ²University of Arizona – Addiction is characterized by a loss of control over drug use, a process that is thought to be mediated by drug-related dopamine effects in the striatum. Cigarettes are highly addictive for most people, but about 8% of those who smoke cigarettes retain control over their smoking behavior. We aimed to determine if individual differences in striatal learning help explain why these so-called 'tobacco chippers' are resistant to the development of full-fledged addiction despite repeated exposure to cigarettes. We compared performance of demographically-matched addicted smokers (N=30) and tobacco chippers (N=27) on a probabilistic reinforcement learning task that has been shown to be sensitive to differences in dopamine neurotransmission. Participants were tested twice, once after overnight abstinence, and once while smoking at their usual rates. Overall learning did not differ between the two groups, or across conditions. However, the basis of that learning was significantly different: 'Go' learning from positive feedback was relatively better in chippers, while 'no go' learning from negative feedback was relatively better in addicted smokers when they were tested while smoking as usual. This suggests that chippers may be in a relatively hyperdopaminergic state compared to smokers while smoking at their usual rate, a claim supported by neuro-computational modeling. These data are consistent with the hypothesis that drug-induced dopamine release is blunted in the addicted state, and are the first demonstration of neurobehavioral differences in smokers who differ in their resistance to addiction.

H50

IDENTIFICATION OF A NOVEL ROLE OF PROTEIN INHIBITOR OF ACTIVATED SIGNAL TRANSDUCER AND ACTIVATOR OF TRANSCRIPTION 1 IN FACILITATING SPATIAL MEMORY FORMATION IN RATS Eminy Lee¹; ¹Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan – It is well known that long-term memory formation requires de novo RNA and protein synthesis. By using PCR differential display, we have previously identified the serum- and glucocorticoid-inducible kinase gene whose expression level is much higher in the dorsal hippocampus of fast-learning rats than slow-learning

rats from the Morris water maze learning task. Recently, we have identified another cDNA fragment that also showed a significantly higher expression level in the fast-learning rats. After cloning and sequencing of this cDNA fragment, it shows 100% sequence homology to the 3'-end region of the rat protein inhibitor of activated STAT1 (pias1) gene. To confirm that pias1 expression is associated with spatial learning, naïve rats were either subjected to water maze training (n=6) or assigned to the non-trained group with the platform and visual cues been removed (n=6). The dorsal hippocampus was dissected out at the end of training and subjected to protein measure by western blot. Results revealed that water maze training significantly increased PIAS1 protein level in the hippocampus. In further examination of the role of PIAS1 in spatial memory formation, we have found that transfection of the wild-type PIAS1 plasmid to rat hippocampus facilitated, whereas transfection of PIAS1 siRNA impaired spatial memory performance (n=8 each group). PIAS1 was well known to play an important role in the immune system, but the present results suggest that PIAS1 also plays an important role in spatial memory formation.

H51

SLEEP-DEPENDENT EXTRACTION & CONSOLIDATION OF EPISODIC MEMORY DETAILS Els van der Helm¹, Ninad Gujar¹, Caitlin Watts¹, Matthew P. Walker¹; ¹Sleep and Neuroimaging Laboratory, Psychology, and Helen Wills Neuroscience Institute, University of California, Berkeley – Although the benefit of sleep on procedural-skill consolidation is well established, the role of sleep in declarative memory processing remains incomplete. Using a nap paradigm, here we investigated the impact of wake and sleep on the offline consolidation of ITEM versus CONTEXT memory. Participants (n=27) studied two lists of words at 12noon, which were each associated with a different set of contextual cues. Post-learning, subjects were assigned to either a Nap group (n=13), obtaining a 90min sleep opportunity, or a No-Nap group (n=14) which remained awake. Six hours post-learning (6PM) subjects performed a recognition test. For each recognition trial, subjects made two possible responses indicating 1) whether the item was old or new (ITEM-memory), and 2) if old, which study list the item came from (CONTEXT-memory). No offline difference in ITEM-memory was found between the two groups. In contrast, a significant consolidation benefit for CONTEXT-memory occurred following sleep in the Nap group (p=0.04). Furthermore, within the Nap group, the extent of CONTEXT-memory retention was positively correlated with the amount of stage-2 NREM sleep (r=0.57, p=0.04). Most interestingly, CONTEXT-memory not only correlated with Stage-2 NREM, but a specific electrophysiological signature of NREM-sleep spindles, especially in prefrontal regions (r=0.72, p<0.01). The findings clarify the role of sleep in declarative memory processing, indicating that sleep preferentially benefits more hippocampal-dependent aspects of episodic representations (contextual details). Moreover, sleep does not appear to represent a passive time of minimal interference, but a proactive state modulating episodic memory by way of specific electrophysiological oscillations.

H52

ANTICIPATORY ELECTROPHYSIOLOGICAL CORRELATES OF VOLUNTARY MEMORY CONTROL Simon Hanslmayr¹, Bernhard Pastötter¹, Karl-Heinz Bäuml¹; ¹Regensburg University – For the proper functioning of our memory system voluntary control processes are needed. In everyday life, voluntary suppression of episodic memories is important to keep our memory free from e.g. outdated information (the old address of a friend) or emotionally straining events (traumatic experiences). In the laboratory, such voluntary suppression can be studied using the Think/No-Think paradigm, in which previously learned item associations are suppressed several times, inducing later forgetting of the information. The present study investigated whether anticipatory mechanisms mediate such voluntary forgetting. Doing so, the subjects received a cue whether to prepare to think or not to think of a previously studied face-word association. This Think/No-Think cue appeared prior to a

memory cue (face) which pointed to a previously studied word. Examining event-related potentials (ERP) we identified an early anticipatory process which was related to the Think/No-Think cue, and a later process which was related to the memory cue. Both ERP effects were due to a decreased positivity over anterior and temporal electrode sites, and both effects predicted later forgetting. In addition, the memory-cue-related ERP effect could be predicted by the anticipatory ERP effect. The results demonstrate the existence of anticipatory voluntary memory control processes mediating the forgetting of unwanted memories. We suggest that the effects reflect the action of top-down driven control processes which down-regulate the activity in memory-relevant brain areas already prior to the presentation of a memory cue.

H53

NEURAL INDICES OF CONTENT-DEPENDENT RETRIEVAL PROCESSING *Damian Cruse¹, Edward Wilding¹; ¹CUBRIC, School of Psychology, Cardiff University, UK* – Functional magnetic resonance imaging (fMRI) studies of episodic retrieval have demonstrated patterns of neural activity that depend upon the kinds of information which are retrieved. The poor temporal resolution of fMRI data, however, makes it difficult to determine whether these activations reflect a) recollection of different kinds of information or b) subsequent processing resulting from recollection. The high temporal resolution of ERPs allows investigation of the timing of content-specific retrieval processing, and toward this end participants studied one of two lists of words. Half studied an equal number of words shown in pink or yellow. The remainder studied an equal number of words spoken by a male or female voice. At test, all participants made old/new judgments followed by a source (pink/yellow or male/female) and confidence (high/low) judgment. The ERPs associated with high confidence correct source judgments strongly suggest qualitative differences in neural activity depending upon whether colour or voice information was retrieved. Furthermore, the 800-1100 ms post-stimulus time course of these differences is important, because it follows a common lateralised posterior positivity (the left-parietal ERP old/new effect) which is a content-independent index of recollection. As a result, the content-dependent ERP signature identified here likely reflects processes that are engaged differentially as a consequence of recollection. In combination with previous ERP findings in which these classes of retrieval processes either overlapped with or preceded the left-parietal ERP old/new effect, these data points emphasise that these kinds of retrieval processing operations operate at multiple loci during memory retrieval and assessment.

H54

ERP OLD/NEW EFFECTS ELICITED BY FACES THAT ATTRACT HIGH OR LOW CONFIDENCE MEMORY JUDGMENTS *Yee-Ying Yick¹, Edward Wilding¹; ¹CUBRIC, School of Psychology, Cardiff University, UK* – Event-related potential (ERP) studies of memory retrieval where faces have been used as stimuli have revealed inconsistent and sometimes contradictory results, notably regarding whether ERPs index two fundamental memory processes - recollection and familiarity. We investigated the sensitivity of ERPs to these processes using faces as stimuli and a different retrieval task to those employed previously. In two experiments, participants made old/new memory judgments to faces and rated their confidence (high/low) in their decisions. In keeping with one account of the natures of recollection and familiarity, ERP signatures of recollection were assumed to be indexed by old/new effects that were evident for high confidence old judgments only. ERP signatures of familiarity were assumed to be indexed by effects that co-varied with recognition confidence for old and for new test faces. The two experiments differed at encoding only, and old/new discrimination was superior in the second experiment, due primarily to a larger proportion of high confidence old judgments. There were ERP old/new effects associated with high confidence old judgments in both experiments, but in neither were there robust old/new effects associated with low confidence correct judgments to old faces. These data points provide little support for the view

that ERPs index familiarity associated with faces, although an alternative interpretation is that the null result reflects the limited degree to which familiarity is a useful basis for distinguishing between old and new stimuli in these kinds of tasks.

H55

REPETITION PRIMING IN MUSIC: AN ERP STUDY *Sean Hutchins^{1,2}, Caroline Palmer³, Karsten Steinhauser^{4,5}; ¹International Laboratory for Brain, Music, and Sound Research, Université de Montréal, ²Université de Montréal, Psychology, ³McGill University, Psychology, ⁴School of Communication Sciences & Disorders, McGill University, ⁵Centre for Research on Language, Mind, & Brain, McGill University* – Repetition is very common in the musical domain. Previous experiments have demonstrated that repetition of musical tones is associated with faster production times and decreased error rates for those tones (Hutchins & Palmer, 2008). These effects are similar to repetition priming effects in language. In addition, event-related potential studies have shown that repetition priming elicits a positivity that reduces the N400 amplitude (Kutas & Van Petten, 1994). This study examines whether repetition of musical tones has an effect on EEGs. Trained musicians heard short sequences of computer-generated music and made delayed judgments as to whether the timbre of the final tone was different from that of the first four tones. This final tone (target) was either a pitch repetition of a previous melodic tone (prime), or was previously unheard. Primes were either adjacent to the target tones, or were separated by two intervening tones. Melodic tonality was also controlled for. ERPs were collected across 64 scalp sites for the 1000 ms immediately following the final tone. Repetition yielded both a late posterior positivity and a small early frontal negativity. In addition, strong differences were found between neural responses to same and different timbre tones. These results show a distinct neurological effect of repetition, and provide evidence that repetition priming in music may be similar to priming in the language domain.

H56

THE BRIGHTEST CANDLE: COGNITIVE AND PHARMACOLOGICAL ADVANTAGES FOR YOUNG E4 CARRIERS *Natalie Marchant¹, Sarah King¹, Naji Tabet², Jennifer Rusted¹; ¹University of Sussex, ²Institute of Postgraduate Medicine, Brighton and Sussex Medical School* – The presence of the apolipoprotein (APOE) e4 allele increases the risk of developing Alzheimer's Disease (AD) later in life. Little is known however, about the cognitive consequences of possessing this allele in earlier years, nor about its interaction with the cholinergic system (which is compromised in AD). The current study administered 1 mg of the cholinergic agonist nicotine via nasal spray to healthy non-smoking young adults (aged 18-30) with either e3/e3 or e4+ (at least one e4 allele) genotype. They were matched on age, sex and IQ, in a placebo controlled, double blind 2 (drug: placebo, nicotine) x 2 (genotype: e3/e3, e4+) between subjects design. Cognitive functioning was investigated with a test of prospective memory (PM). PM, which requires the interruption of an ongoing activity to retrieve and act upon a previously-formed intention, incorporates both memory and attentional components, is impaired in early AD patients and is facilitated by nicotine. Sustained attention, verbal fluency and episodic recall were also measured. Paradoxically, e4+ participants outperformed e3 participants on all placebo measures of cognitive performance. In addition, this genotype advantage was potentiated by nicotine on all measures of PM performance. These results confirm the suggestion that the e4 allele confers a cognitive advantage in younger adulthood before producing detrimental consequences in later life. Moreover, these results are the first to demonstrate that young adults carrying an e4 allele show an enhanced response to nicotinic receptor stimulation.

H57

RETRIEVAL INFLUENCES ON THE ENCODING OF NEW MATERIAL *Stacey Danckert¹, Colin MacLeod¹, Myra Fernandes¹; ¹The University of Waterloo* – Based on a procedural account of memory, retrieval involves concurrent encoding of new information (Kolers &

Roediger, 1984). Yet, few studies have considered how new information is processed during retrieval. In the context of a recognition memory test, Jacoby and colleagues (2005) showed that when new words^othe foils on the recognition test^owere presented among 'old' words that had been deeply encoded during prior study, they were subsequently better recognized than were foils presented among 'old' words that had been shallowly encoded. In Experiment 1 of the current study, we replicated this "memory-for-foils" effect. In Experiment 2, we showed that the effect was not simply a consequence of strength differences created during encoding. In Experiment 3, we contrasted pictorial to non-pictorial imagery and demonstrated that the effect is robust enough to occur under a different encoding state. In Experiment 4, we examined the quality of memory for foils, demonstrating that the effect was based primarily on recollection and not on familiarity. Overall, we provide support for the source-constrained retrieval hypothesis of Jacoby et al. (2005): During attempts at recognition, subjects may re-enter the initial encoding state, which in turn influences encoding of new items. In a broader sense, we show that new information can be significantly influenced by how surrounding items are encoded and retrieved. Future studies will use functional neuroimaging to provide a deeper understanding of the neural processes underlying the memory-for-foils effect.

H58

NEURAL AND BEHAVIORAL MARKERS OF INCORPORATING RECOMMENDATIONS INTO RECOGNITION JUDGMENTS

Akira O'Connor¹, Ian Dobbins¹; ¹Washington University, Psychology, St. Louis – Outside the laboratory individuals often make use of extra-mnemonic information when evaluating their own memories. Although the neural systems that directly support episodic retrieval are heavily studied, those enabling observers to incorporate extra-mnemonic information into memory assessments are unknown. Using event-related functional magnetic resonance imaging (fMRI) we investigated this inferential skill, specifically examining the ability of observers to optimally incorporate external recommendations into recognition judgments. Participants underwent recognition memory scans in which a previously validated computer recommendations ("likely old" or "unlikely old") preceded each recognition probe item, and they were free to use or ignore each recommendation when rating each subsequently appearing memory probe. Behavioral measures suggested considerable individual variability in the ability or willingness to effectively incorporate the recommendations into memory judgments, and fMRI data suggested this ability relies upon prefrontal cortex (PFC). Whereas dorsolateral prefrontal cortex (DLPFC) regions were sensitive to the validity of the recommendation, anterior PFC regions were sensitive to the direction of recommendation. These findings suggest dissociable roles across regions that are often jointly implicated during episodic recognition research.

H59

THE EFFECT OF SLEEP AND TASK-RELATED COGNITION ON EGOCENTRIC AND ALLOCENTRIC SPATIAL MEMORY PERFORMANCE

Erin Wamsley^{2,1}, Joseph Benavides¹, Robert Stickgold^{2,1}; ¹Beth Israel Deaconess Medical Center, ²Harvard Medical School – Several studies now demonstrate that post-training sleep is beneficial for the retention of hippocampus-dependent memory following encoding. However, the most fundamental role of the sleeping brain may not be to "enhance" memory performance, but to facilitate the systems-level reorganization of memory traces across time. Here, we examined the effects of post-training NREM sleep on qualitative aspects of spatial memory. Participants (n=39) were trained on a 3D-style virtual maze task at 12:30pm. Following training, subjects either immediately lay down to begin a 1.5 hr nap opportunity (n=18), or else remained awake (n=21). At retest (5:30pm), participants completed recognition tests from an Egocentric Perspective (1st person view) and Allocentric Perspective (overhead map view), regarding critical decision points in the maze. Each participant was also classified as having an egocentric or allocentric spatial representation preference, using the "Tunnel Task" of Gramann et al (JEP, 2005). Rather than exerting a particular effect on egocentric vs. allocen-

tric test performance, sleep was selectively beneficial for the test format which matched participants' spatial representation preference (sleep x preference interaction: $p=.04$). Furthermore, the overall effect of sleep on maze completion times was dependent on whether participants reported mentation (thoughts, feelings, dreams) related to the maze task between learning and retest (sleep enhanced performance only when related cognition was reported: $p=.006$). These observations suggest that the process of sleep-dependent memory consolidation is contingent upon the specific manner in which a task is encoded, and is correlated with task-related cognition during the retention interval.

H60

EMOTION AIDS ATTENTIONAL PROCESSES IN BINDING SOURCE AND ITEM INFORMATION IN OLDER ADULTS: A BRAIN FMRI STUDY

Amanda Kutz¹, Paul Newhouse¹, Julie Dumas¹; ¹University of Vermont, Psychiatry – This study examined the effect of emotion on source memory, item memory, and related brain activation in older and younger adults. Source memory has been consistently found to decline with age, while the effect of aging on memory for emotional stimuli has been inconsistent. Emotional information has also been shown to interrupt binding processes between source and item information. Importantly, binding processes are also thought to be impaired in aging. Using event-related fMRI, 12 younger (ages 18-30) and 12 older adults (ages 60 and older) viewed emotional (positive and negative) and neutral words during an incidental encoding task. Each word appeared in a frame that was either red or blue. Recognition memory was tested after the scanning session and measures of subsequent memory were used to examine brain regions activated during encoding for words that were correctly recognized. Age differences in memory were only found for source memory for neutral items. No age differences were found for source memory for emotional words or any of the item memory measures. The activation data showed that older adults had greater activation in right frontal regions for both item and source memory when encoding emotional information. When examining source memory for negative information, older adults also had greater activation in right parahippocampal regions compared to younger adults. These data showed that emotional information did not impair item and source binding for older adults. Compensatory activation of right frontal regions may aid in attentional processing of emotional information for older adults.

H61

SUPPRESSING UNWANTED VISUAL MEMORIES BY EXECUTIVE CONTROL

Ean Huddleston¹, Emily Peterson², Michael Anderson¹; ¹University of St. Andrews, ²University of Oregon – 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 for faces, and parahippocampal place area for scenes. Here we report a behavioral experiment using these stimuli. During the learning phase, 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, and for other words, participants were instructed to not think of the associated picture. Results showed impaired memory for those pictures participants tried to suppress, compared to pictures from baseline pairs, extending retrieval suppression effects to memories of faces and scenes. This paradigm validates a procedure that can be used to target neocortical contributions to retrieval suppression using fMRI.

H62

FUNCTION AND ACTION KNOWLEDGE REPRESENTATIONS IN LEFT MIDDLE TEMPORAL GYRUS Michael Souza^{1,2}, Espen Helskog^{2,3}, Pedro Paz-Alonso², Carter Wendelken², Silvia Bunge^{1,2}; ¹UC Berkeley, Psychology, ²Helen Wills Neuroscience Institute, UC Berkeley, ³University of Oslo, Psychology, Norway – Accessing and utilizing action-relevant knowledge about manipulable objects is an important aspect of human behavior. Left posterior middle temporal gyrus (pMTG) activation is frequently observed in neuroimaging studies employing manipulable objects (Johnson-Frey, 2004; Lewis, 2006). However, it is unclear whether left pMTG represents knowledge regarding how objects can be used, or whether this region more generally represents knowledge about actions and functions associated with a stimulus. To address this question, we conducted an initial functional MRI study specifically designed to test the hypothesis that left pMTG represents functional semantics for manipulable objects (N=13). We asked participants to view manipulable objects and to (1) consider the object's primary use (Function), (2) rehearse the most prominent color in the object (Repeat), (3) imagine using the object (Imagery), or (4) mentally rotate the object (Rotate). Activation in left pMTG was solely driven by the Function condition, consistent with a role in functional semantics. However, it could be argued that differences in difficulty between conditions drove this effect. To address this possibility, participants in Experiment 2 are asked to consider (1) the object's primary use (Function), (2) how one's body moves when using the object (Action), or (3) the physical properties of the object (Appearance). We predict that left pMTG activation will again be driven by Function, even though participants report that Function is less difficult than Appearance. Thus far, our data suggest that action-relevant knowledge is housed in the posterior temporal lobes, just anterior to area V5, which processes biological motion.

H63

HOW SLOW CAN YOU GO? UNIQUE FMRI CORRELATIONS WITH EEG ACTIVITY BELOW 0.1 HZ DURING SLEEP Dante Picchioni¹, Silvina Horowitz², Masaki Fukunaga², Walter Carr³, Thomas Balkin¹, Jeff Dwyer², Allen Braun²; ¹Walter Reed Army Institute of Research, ²National Institutes of Health, ³Naval Medical Research Center – Activity in slow EEG bands during sleep is associated with the restorative aspects of sleep. There is a growing interest in activity below 0.1 Hz, which may mediate these restorative effects and the putative cortical plasticity associated with sleep-dependent learning. Assessing the fMRI correlates of the fluctuations in spectral power in this EEG band can provide information on the neural correlates of these restorative processes. We sought to determine the unique fMRI correlates of activity in the 0.05-0.099 band, as differentiated from activity in the 0.66-0.99 and 1.0-3.9 bands. Each band was modeled separately and the three sets of correlations were subjected to a conjunction analysis. The relative uniqueness of each band was assessed by comparing the percentage of voxels in the conjunction category where there was a significant correlation for the band in question and a non-significant correlation for the other two bands. The category for the 0.05-0.099 band contained the largest percentage. The significant positive correlations for unique activity in the 0.05-0.099 band were mostly in sub-cortical areas (medial thalamus, hypothalamus, hippocampus) while negative correlations were mostly in neocortical areas that represent the default-mode network. These data suggest that EEG activity below 0.1 Hz plays the most prominent role in sleep-dependent processes compared to other slow bands. Correlations in the thalamus could be related to the generation of this activity. Correlations in the hippocampus and neocortical areas (including nodes in the default-mode network) could reflect interactions between these brain systems that subserves a process of selective cortical plasticity.

H64

THE GENERATION OF PICTURES CAN BENEFIT BOTH ITEM AND SOURCE MEMORY Zachary Rosner^{1,2}, Kaiping Peng^{1,2}, Arthur Shimamura¹; ¹University of California, Psychology, Berkeley, ²Peking University, Psychology, China – Previous research has demonstrated that generating responses such as rhymes, antonyms, or semantic associates to stimuli during encoding facilitates memory for items as compared to passively reading the same information (Slamecka & Graf, 1978). However, this generation effect has been found to impair memory for source information such as stimuli color or font (Mulligan, Lozito & Rosner, 2006). Still, generation effects on less object-oriented features of source memory remain controversial, as Marsh (2006) manipulated procedural aspects to find both positive and null generation effects for location memory. Two contrasting accounts for the positive and negative effects of generation on item and source memory are item-context tradeoff, which argues that active generation forces one to attend to a target item at the expense of forming contextual associations, and transfer-appropriate processing, which claims that item recognition benefits from more conceptual processing during generation, while source memory benefits from more perceptual processing during passive learning. In this study, a picture fragment completion task was used in a series of three experiments in which source was manipulated for object color, object location, and background color. While generation improved item recognition universally, it improved object color memory, had no effect on object location memory, and slightly (non-significantly) impaired background color memory. These findings suggest that impaired source memory is not a necessary consequence of enhanced item memory, which directly disputes the item-context tradeoff account. Rather, picture fragment completion likely increases conceptual processing and differentially affects perceptual processing of distinct aspects of an item's features.

H65

EFFECTS OF MULTIPLE SOURCE CHARACTERISTICS ON WORD AND SPEAKER RECOGNITION: AN ERP STUDY Sandra Campeanu^{1,2}, Claude Alain^{1,2}, Fergus Craik^{1,2}; ¹Rotman Research Institute, Baycrest Centre, Toronto, Canada, ²University of Toronto, Psychology, St. George Campus, Canada – Context reinstatement has been shown to facilitate word and source recognition. In an auditory ERP experiment, participants performed both recognition tasks with words spoken in four voices. Two voice parameters varied between speakers, with the possibility that none, one or two of these parameters was congruent between study and test. Results indicate that reinstating the study voice at test facilitates both word and speaker memory, compared with no benefit when only one voice parameter is similar. This implies that voices are encoded as acoustic patterns rather than as the sum of their vocal attributes. ERPs revealed, in addition to three expected memory-related modulations, a pre-recollection positivity associated with this reinstatement benefit in both tests. This positivity, likely reflecting acoustic recognition, occurred at 400ms over parietal regions in the word test and started as early as 120ms and 175ms over right frontal and right temporal areas, respectively, in the speaker test.

H66

NEURAL CORRELATES OF SUCCESSFUL MEMORY ENCODING ARE INFLUENCED BY SUBJECTIVE PROBABILITIES OF FUTURE RECOGNITION: EVIDENCE FROM EVENT-RELATED POTENTIALS Ida-Maria Skavhaug¹, Edward L. Wilding², David I. Donaldson¹; ¹University of Stirling, ²Cardiff University – The neural correlates of successful memory encoding differ depending on the nature of the task performed at study (Otten and Rugg, 2001). We investigated the influence of Judgments of Learning (JOLs - subjective judgments of the likelihood of remembering studied material on a later test) on the neural correlates of successful memory encoding using Event-Related Potentials (ERPs). In Experiment One, participants saw word pairs and made a JOL for each pair. In Experiment Two, participants completed the same task, but were instructed to simply press a button to initiate the next trial,

rather than to make a JOL. In both experiments memory for the pairs was assessed on subsequent old/new recognition memory tasks. Discrimination was higher in Experiment One than in Experiment Two. Moreover, there were different ERP correlates of successful encoding in the two experiments: Experiment One produced a relatively early (550-1000ms) onsetting ERP effect with a focus at parietal electrodes, whereas the effects in Experiment Two onset later and lasted longer (1000-2000ms) with a focus at frontal electrodes. One explanation for the changing pattern of memory encoding ERP effects is that it reflects nothing more than poorer discrimination in Experiment Two. This is unlikely, however, because the differences across task remain for a subset of participants for whom discrimination is comparable in the two experiments. The ERP findings therefore provide evidence for the existence of JOL-specific neural correlates of subsequent memory.

H67

EXAMINING RECOGNITION MEMORY PROCESSES USING A SLOW-REVEAL PARADIGM: A RESPONSE-LOCKED EVENT-RELATED POTENTIAL STUDY Catherine A. MacLeod¹, Mark E. Wheeler², David I. Donaldson¹; ¹University of Stirling, ²University of Pittsburgh – Dual-process models propose that two independent retrieval processes support recognition memory; familiarity and recollection. Using stimulus-locked averaging, Event-Related Potential (ERP) studies of recognition memory have identified a set of old/new effects, including putative correlates of familiarity (the 300-500msec mid-frontal effect) and recollection (the 500-800msec left-parietal effect). ERPs reveal a close temporal relationship between these effects, with the potential for overlap between the termination of activity associated with familiarity and the onset of that associated with recollection. Moreover, despite extensive investigation, relatively little is known about their causal role in making recognition decisions. In an attempt to investigate the functional significance of the ERP effects we examined old/new effects using response-locked averaging during a recognition memory test for pictures – considering neural activity leading up to the recognition response. Furthermore, to reduce the temporal proximity between retrieval processes (and hence allow for better differentiation between them) we introduced a slow-reveal paradigm, whereby stimuli were gradually uncovered at test over a 5 second period. The response-locked ERPs showed an old/new effect in the 400msec preceding the response; this effect was maximal over fronto-central electrodes and resembles the traditional stimulus-locked activity associated with familiarity. Intriguingly, despite good behavioural performance and the use of pictures as stimuli, ERP activity typically associated with recollection was not apparent; suggesting perhaps that the slow-reveal paradigm encourages retrieval based solely on familiarity. Regardless, the results highlight the utility of response-locking procedures, and suggest a contributory role for the mid-frontal old/new effect in making recognition memory decisions.

H68

DIRECTED FORGETTING OF NEGATIVE AND NEUTRAL PICTURES - AN EEG STUDY Anne Hauswald¹, Johanna Kissler¹; ¹University of Konstanz – People are able to intentionally segregate and differentially rehearse or inhibit elements in episodic memory, resulting in reduced retrieval of irrelevant elements. So far, it is largely unclear, whether this ability extends to emotional memories. The present study investigated behavioral and electrophysiological mechanisms of intentional forgetting of neutral and negatively arousing complex pictures using the item method variant of directed forgetting. Event-related potentials (ERPs) were recorded as participants viewed series of neutral and negative complex colored pictures, each followed by a cue designating the previous picture as 'to-be-remembered' or 'to-be-forgotten'. Results from a subsequent forced choice recognition memory task using the 'remember-know' procedure indicated that directed forgetting occurred for neutral, but not for negative pictures. Moreover, both directed forgetting and emotion affected the recollection, but not the familiarity component of recognition memory. ERPs revealed three dis-

tinct effects: First, a parietal positivity between 450 and 700 ms after picture on-set was more pronounced for negative than for neutral pictures. Second, regardless of the content of the preceding picture 'remember', but not 'forget' cues were associated with a larger parietal positivity between 400 and 500 ms after cue on-set. Third, an enhanced frontal positivity between 450 and 700 ms after cue on-set appeared selectively for 'forget' cues following neutral pictures. The results indicate that negative pictures are exempt from directed forgetting and suggest that processes of selective rehearsal (parietal positivities) as well as additional frontal mechanisms, possibly indicative of inhibitory processes contribute to successful directed forgetting of neutral pictures.

H69

A RIGHT HEMISPHERE ADVANTAGE IN FACE PROCESSING MODULATES HEMISPHERIC ASYMMETRIES IN FACE PRIMING: BEHAVIOURAL AND FMRI EVIDENCE Elias Mouchlianitis¹, Rik Henson¹; ¹MRC Cognition and Brain Sciences Unit – Our previous studies on repetition priming of faces (Mouchlianitis & Henson, EPS January 2008) found larger left-hemisphere (LH) effects, when primes were central and probes lateralised. Contrary, Bourne & Hole (2006, Experiment 1) presented lateralised primes and central probes and found a right-hemisphere (RH) priming advantage. We postulated that RH encoding is critical for inducing facilitation in repetition priming, but when probes are lateralised LH priming is larger due to lower baselines in the RH, that suppress priming. Experiment 1 used long lag familiar face priming with two sessions, one with lateralised probes, and one with central probes. Results showed that the prime/probe location indeed modulates priming effects, with more LH priming for lateralised probes, and RH priming for central probes. In Experiments 2 and 3 we used short-lag priming with both primes and probes being lateralised, and sessions with 120ms and 80ms to control for baseline differences. Results showed that reliable priming was only found in the RH-prime/LH-probe condition, for both presentation times. In Experiment 4, fMRI was used with a similar paradigm, with the inclusion of houses as control stimuli. Results showed a main effect of the right FFA, which, however, did not interact with neither priming or visual field (possibly due to low temporal resolution of fMRI). These results indicate that there is a RH advantage in early face processing stages that possibly modulates hemispheric differences in face priming.

H70

NEUROPLASTICITY-BASED COGNITIVE TRAINING IMPROVES SELF-REFERENTIAL PROCESSING IN SCHIZOPHRENIA PATIENTS: BEHAVIORAL AND FMRI ASSESSMENTS Karuna Subramaniam¹, Tracy Luks¹, Stephanie Aldebot¹, Adelaide Hearst¹, Arul Thangavel¹, Melissa Fisher¹, Coleman Garrett¹, Gregory V. Simpson¹, Srikanth Nagarajan¹, Sophia Vinogradov¹; ¹UCSF – Prior research indicates that schizophrenia patients are impaired at identifying themselves as the source of self-generated information and show decreased activation within the dorsal medial prefrontal cortex (dMPFC) compared to healthy controls (HCs) during this task. Here, we investigate whether this deficit is amenable to a behavioral intervention. Twenty-four patients and 12 HCs underwent an fMRI self-referential source-memory task at baseline. Twelve patients were then randomly assigned to 16 weeks of computerized targeted cognitive training (TCT) focusing on auditory and visual processing, affect recognition, and mentalizing tasks, while the remaining 12 patients played computer games (CGs). All subjects repeated the fMRI task after 16 weeks. In this task, before scanning, subjects are presented with semantically constrained sentences where the final word is either experimenter-supplied or left blank for subjects to fill in themselves. During scanning, subjects are presented with these words, and decide whether they were experimenter-presented or self-generated. BOLD fMRI was measured on a 3T-GE scanner. Whole-brain analyses focused on regions showing greater activation for correctly remembered self-generated versus externally-presented items (self-referential effect). At baseline, HCs showed dMPFC activity, while patients showed bilat-

eral frontal deactivation. After behavioral intervention, compared to baseline, CGs showed increased activation in bilateral occipital gyri, while TCTs showed increased activation in dMPFC. These fMRI results indicate a possible "restorative" effect of training in schizophrenia patients, not observed in control group patients, whereby behavioral and neural activation patterns during self-referential processing are "normalized."

H71

SLEEP AND STIMULUS REWARD VALUE BENEFIT VISUAL DECLARATIVE MEMORY *Matthew Tucker¹, Robert Stickgold^{1,2}; ¹Beth Israel Deaconess Medical Center, ²Harvard University* – Research examining the benefits of sleep for declarative memory performance has never addressed the influence of motivational factors on this relationship. The current study (N=173 Harvard undergraduate students) examined differences in performance on a visual paired associates task (picture pairs) after 12hr and 24hr intervals, and when performance was rewarded (\$1 for every correct answer at retest) or unrewarded (flat fee for participation). All groups performed similarly on a cued recall test at training, recalling 21.9 picture pairs out of 30. Following a 12hr interval, wake subjects that were unrewarded performed the worst, while sleep subjects that were rewarded performed the best, actually recalling more picture pairs than at training. The overall benefit of reward was significant (main effect, $p=.01$), while the effect of sleep was profound (main effect, $p<.000001$). Interestingly, at the 24hr time point performance in all groups converged such that there were no between-groups differences in performance. The effect of sleep ($p<.01$), but not reward ($p=.16$), remained significant, indicating that sleep, regardless of when it occurs over a 24hr interval, benefits performance compared to equivalent intervals filled with wakefulness. The magnitude of the effect of sleep on visual declarative memory observed in this study appears to be more pronounced than in studies that have used more traditional verbal memory tasks (word pairs).

H72

INDIVIDUAL DIFFERENCES IN PROCESSING SPEED AND RESTING STATE NEURAL ACTIVITY *Rajasekhar Byrapureddy^{1,3}, Michel Motes^{1,2,3}, Bart Rypma^{1,2,3}; ¹School of Behavioral and Brain Sciences, University of Texas at Dallas, ²University of Texas Southwestern Medical Center, Psychiatry, ³Center for Brain Health, University of Texas at Dallas* – Individual differences in processing speed appears to account for individual differences in cognitive task performance. Previous work from our lab suggests relationships between regional connectivity and processing speed. Baseline resting-state brain activity has been suggested to explain activation decreases in certain brain areas during cognitive task performance but relationships between resting-state activity and cognitive performance are not well understood. In this study, we assessed relationships between individual differences in processing speed and resting state activity. Subjects performed a computerized Digit-Symbol Substitution Test (DSST) and a resting task with eyes closed during fMRI scanning. Subjects were divided into faster and slower performers based on reaction times obtained on the DSST task. Preliminary results indicate differences in resting state correlation maps and Granger connectivity maps, and between faster and slower performers.

Perceptual processes: Low-level vision**H73**

LONGITUDINAL EVALUATION OF VISION FUNCTION IN CHILDREN WITH CORTICAL VISUAL IMPAIRMENT *Tonya Watson¹, Deborah Orel-Bixler¹, Gunilla Haegerstrom-Portnoy¹; ¹University of California, Berkeley* – PURPOSE: Cortical visual impairment (CVI) is bilateral visual impairment caused by damage to the posterior visual pathway (optic radiations, visual cortex, or both). Current literature reports great variability in the prognosis of CVI. The purpose of this

study was to evaluate change in vision function in patients with CVI using a quantitative assessment method. METHODS: Visual acuity and contrast sensitivity was assessed using the sweep VEP. 39 children participated in the visual acuity assessment and 34 of the 39 children participated in the contrast threshold assessment. At the time of the first VEP, the children ranged in age from 1 to 16 years (mean: 5.0 years). The time between measures ranged from 0.6 to 13.7 years (mean: 6.5 years). RESULTS: 49% of the children studied showed significant improvement of visual acuity. The average improvement was 0.43 log unit (20/205 to 20/76) in those who improved. The initial visual acuity was worse in those who improved compared to those who did not improve ($p<.001$). 47% of the children studied showed significant improvement of contrast threshold. In those who improved, the average amount of improvement was 0.57 log unit (10% to 2.6% Michelson). The initial contrast threshold was significantly worse in those who improved ($p=0.001$). Also, the change in contrast threshold was related to age of the child ($p=0.017$). CONCLUSIONS: Significant improvement in vision can occur over time in some children with CVI. Further investigation is warranted to better understand the prognosis for visual recovery in children with CVI.

H74

VISUAL GIST OF NATURAL SCENES DERIVED FROM IMAGE STATISTICS PARAMETERS *H.Steven Scholte¹, Sennay Ghebrea², Arnold Smeulders², Victor Lamme¹; ¹University of Amsterdam, Psychology, ²Intelligent Systems Lab, University of Amsterdam* – Natural images are highly structured in their spatial configuration. In the past it has been shown that the contrast distribution of natural images is almost always adequately described by a Weibull type distribution (Geuseboek & Smeulders, 2003) in which 2 free parameters are fitted. We have recently shown that these parameters explain up to 50% of the variance in the early ERP and these parameters correlate 0.84 and 0.93 with the modeled output of X and Y cells of the LGN (Scholte et al., submitted). Here we will present BOLD-MRI data that show that beta and gamma also explain single trial activity in the occipital and temporal cortex and the parietal cortex respectively. Also, the beta and gamma parameters seem to order the natural images along the dimensions of the number of objects that are present in the scene and depth organization of the scene. We will test this hypothesis by estimating beta and gamma for artificial stimuli with a predetermined number of objects and depth organization, and by evaluating brain responses to such stimuli. Our results indicate that the summary statistics of the Weibull distribution (beta and gamma) may be used by the brain to efficiently and very rapidly extract information about the visual gist of natural scenes.

H75

THE EARLY VISUAL SYSTEM SELECTIVELY POOLS FROM SCALE-TUNED NEURONS TO IDENTIFY DISTINCTIVE EDGES AT ALL NATURAL SCALES *Sennay Ghebrea¹, Steven Scholte², Victor Lamme², Arnold Smeulders¹; ¹University of Amsterdam, Informatics Institute, ²University of Amsterdam, Psychology* – Natural images contain edges over a broad range of spatial scales. It has been shown that the power spectra of natural images fall with increasing spatial frequency and that visual neurons are well matched to this property: visual neurons have roughly equal power in any given frequency bandwidth (Field, 1997). We hypothesized that if the visual system evolved to process edges at multiple spatial scales with equal probability, then it must be using a scale pooling mechanism reflecting this. We tested two well-known scale pooling mechanisms: the neuron with strongest response determines the post synaptic response (Riesenhuber & Poggio, 1999), and the smallest neuron with reliable response defines post-synaptics (Elder & Zucker, 1998). Here, we show that only minimum reliable scale selection leads to constant power over spatial scales. In addition, we show that the distribution of edges at minimum reliable scales has Weibull properties strongly correlating with early brain activity: the two Weibull distribution parameters, beta and gamma, explain 67% and 58% respectively of the variation in ERP. In contrast, beta and gamma estimations from dis-

tributions of maximum edge responses explain 64% and only 41% respectively. In other work we have shown that beta and gamma correlate 93% and 84% with modeled output of small X and large Y cells of the LGN (Scholte et al., submitted). These results taken together suggest that the early visual system uses a mechanism like minimum reliable scale selection to process all distinctive image structures, from fine (beta) to coarse (gamma) scale.

H76

ELECTROPHYSIOLOGICAL CORRELATES OF LOW LEVEL VISUAL PERCEPTION IN AUTISM SPECTRUM DISORDERS

Hwan Cui Koh¹, Elizabeth Milne¹, Olivier Pascalis¹; ¹University of Sheffield, UK – Individuals with Autism Spectrum Disorders (ASD) have shown greater sensitivity for orientation of 'simple' stimuli, but poorer sensitivity for orientation of more 'complex' stimuli, than typically developing (TD) individuals (Bertone et al, 2005). According to the authors of this work, 'simple' stimuli are processed pre-dominantly in primary visual cortex, whereas perception of more 'complex' stimuli requires engagement of extra-striate cortex. This study investigates electrophysiological correlates of perceiving visual stimuli of varying complexity. EEG was recorded from 11 ASD children/adolescents (mean age=130months, mean FSIQ=107) and 11 TD children/adolescents (mean age=133months, mean FSIQ=109), while they passively viewed 'simple' stimuli i.e. parallel 1st order gratings, and more 'complex' stimuli i.e. parallel 2nd order, and hyperbolic 1st and 2nd order gratings. ERP analysis focused on P100, a positive peak occurring 100-200ms post stimulus-onset. P100 amplitudes were larger in the ASD group than in the TD group ($F(1,20)=6.536$, $p=0.019$). ICA analysis investigated gamma power (35-40Hz). One cluster of components showed gamma power to peak sooner (before 114ms post stimulus-onset) in the ASD group, than in the TD group ($F(4,148)=10.8$, $p<0.001$). A second cluster showed gamma power was higher to 'simple' gratings than 'complex' gratings in the ASD group, but not in the TD group ($F(1,21)=9.1$, $p=0.007$). Furthermore, gamma power was higher in the ASD group than TD group for parallel 1st order gratings ($t(df=21)=2.10$, $p=0.048$), but lower for parallel 2nd order gratings ($t(df=21)=2.63$, $p=0.016$). Results from this cluster provide electrophysiological support for differential processing of 1st and 2nd order gratings in individuals with ASD.

H77

PEELING PLAIDS APART: CONTEXT COUNTERACTS CROSS-ORIENTATION CONTRAST MASKING

Elliot Freeman¹, Preeti Verghese²; ¹Brunel University, Uxbridge, UK, ²Smith Kettlewell Eye Research Institute, San Francisco – Contrast discrimination for an image is usually harder if another is superimposed on top. We asked whether such contrast masking may be enhanced or relieved depending on cues respectively promoting integration of both images as a single pattern, versus segmentation into two independent patterns. We measured contrast discrimination thresholds for a foveal grating masked by a superimposed orthogonally-oriented grating. For drifting gratings, contrast discrimination thresholds were sharply elevated for equal-diameter components, but doubling mask diameter returned thresholds to baseline levels. Both such masking and 'unmasking' effects were much weaker for static stimuli. Our results are consistent with common-fate motion reinforcing perception of a single coherent plaid pattern, while the extended surround helps to identify each component independently, thus peeling the plaid apart again. These results challenge current models of early vision, suggesting that higher-level surface organization influences contrast encoding, determining whether the contrast of a probed grating may be recovered independently from that of its mask.

H78

INTERMEDIATE LEVELS OF UNCOORDINATED GAMMA-BAND ACTIVITY FACILITATE BEHAVIORAL RESPONSES TO SIMPLE VISUAL STIMULI

Lauren Emberson^{1,2}, Keiichi Kitajo³, Lawrence Ward⁴; ¹Sackler Institute for Developmental Psychobiology, Weill Medical School of Cornell University, ²Cornell University, Psychology, ³Lab for Dynamics of

Emergent Intelligence, RIKEN Brain Sciences Institute, ⁴University of British Columbia, Psychology – Activity in the brain is ongoing and dynamic. In most experimental paradigms, neural activity can be characterized in two ways: the large-scale coordinated response to a stimulus presented in isolation and the relatively 'quiet', uncoordinated activity in-between. As a field, we almost exclusively study the former by relating levels and patterns of coordinated post-stimulus activity to behavior. By contrast, the current study relates uncoordinated activity in gamma-band in EEG recordings prior to stimulus onset to the resulting behavioral response. We examined pre-stimulus gamma-band activity (30-to-50Hz) for two reasons: first, pre-stimulus gamma is truly uncoordinated activity having no spectral peaks (coordinated neural activity at a particular frequency) and incoherent phase. Second, previous research provides evidence that differences in reaction time in the current task are related to post-stimulus gamma-band activity. Thus, we relate the effect of uncoordinated activity present at stimulus onset and the coordinated activity evoked in the same frequency band after stimulus presentation. After determining each participant's threshold for detecting a change of luminance, experimental stimuli (presented just above threshold) were held constant. The task was carefully designed to prevent anticipation effects by thwarting temporal prediction of the stimulus. Even though, participants were unable to predict stimulus onset, we find that power in the gamma-band for one second prior to stimulus presentation significantly and non-linearly predicts to reaction time. Thus, we assert that an intermediate amount of pre-stimulus gamma-band activity facilitates the coordinated responses evoked by stimulus onset. These results provide evidence that ongoing uncoordinated activity is behaviorally-relevant.

H79

INTERACTION EFFECTS OF HUE AND SPATIAL FREQUENCY ON PERCEIVED EQUILUMINANCE

Alissa Winkler¹, Charles Chubb¹, Charles E. Wright¹; ¹University of California, Irvine, Cognitive Sciences –

INTRO: We document dramatic, between-observer differences in the interaction effects of hue and spatial frequency (SF) on equiluminance settings derived from the minimum motion method. METHOD: We estimate equiluminant settings separately for a saturated red and green to a fixed neutral gray within annular square-wave grating stimulus. Estimations for each color condition are also made in 5 "low-SF" and 10 "high-SF" cycles/deg. visual angle displays. RESULTS: Observers fall on a continuum between two extreme data patterns: in one extreme, when the stimulus is low-SF, a green needs to be made much lower in photometric luminance (L) to be perceived as equiluminant to gray than when the stimulus is high-SF (L_{Low}-L_{High}=-diff). In the other extreme, the reverse pattern holds: the equiluminant green settings for low-SF stimuli have higher L than for high-SF stimuli (L_{Low}-L_{High}=+diff). Most strikingly, whichever pattern an observer produces for green, is likely to reverse for red: e.g., an observer producing a -diff for green tends to produce a +diff for red, though the magnitudes are similar. A slight high-SF bias makes observers toward the distribution's center produce two small +diffs. The results for all observers (N=20) fall on a linear locus between these extremes ($r=-.9$, $p<.0001$). CONCLUSION: We speculate that the interaction between hue and spatial frequency may reflect an observer's l:m cone ratio. The variation across observers may then reflect difference in this ratio. If this speculation is confirmed, the tests we have developed could provide a simple, psychophysical method of estimating l:m cone ratios.

H80

SPATIAL ATTENTION LIMITS THE SPEED OF BINOCULAR RIVALRY

Chris Paffen¹, Ignace Hooge¹; ¹Experimental Psychology & Helmholtz Institute, Utrecht University, Utrecht, the Netherlands – When the eyes are presented with images containing interocular conflict, an observer typically reports perceiving only one of the images at a time. This phenomenon is called binocular rivalry. During binocular rivalry, the percept continuously alternates between each of the images. Paffen and Alais (2006) recently showed that drawing away attention from rival

images by means of a secondary task reduced the number of alternations reported. Their finding suggests that the number of alternations is highest when attention is fully available for reporting them. Based on this, we hypothesized that increasing the number of rival targets does not increase the number of alternations. If attention plays no role in tracking alternations of multiple targets, increasing the number targets will increase the number of alternations. A display contained 1, 2 or 3 rival targets. Targets were placed in a circular arrangement around the fixation point, and consisted of Gabors with orthogonal orientations for the two eyes. Observers were instructed to press a button whenever a perceptual alternation was perceived. The number of alternations reported increased only slightly with increasing number of rival targets. Control experiments ruled out the possibility that an inability to report alternations occurring at high frequency was responsible for the small increase in the number of alternations. The results suggest that attention plays an important role in the speed at which alternations occur. When spatial attention needs to be distributed over multiple targets, fewer alternations per target occur.

H81

LEFT VERSUS RIGHT VISUAL FIELD ASYMMETRY IN TEXTURE DENSITY JUDGMENTS

Jennifer Corbett¹, Jason Fischer¹, Thomas Harp¹, David Whitney¹; ¹Center for Mind and Brain & Psychology at UC Davis – Performance in a texture discrimination task is impaired in central versus parafoveal areas, due to the increased resolution of foveal vision (a Central Performance Drop, CPD; Kehler, 1987). Here we examined whether texture discrimination is subject to performance asymmetries not attributable to such differences in resolution. Specifically, we investigated whether texture discrimination differs between the left and right visual fields, both of which contain information from each. Observers determined the number of dots in a texture display presented in the upper right, upper left, lower right, or lower left quadrant of the visual field. Judgments of texture density were superior in the left versus right visual field, but similar across the upper and lower visual fields. This asymmetry suggests that each hemisphere may contribute independently to the perception of texture.

Perceptual processes: Multisensory processing

H82

VIEW-INDEPENDENCE OF VISUO-HAPTIC OBJECT REPRESENTATIONS

Simon Lacey¹, Marisa Pappas¹, Alexandra Kreps¹, Kevin Lee¹, K. Sathian^{1,2,3,4}; ¹Emory University School of Medicine, Neurology, Atlanta, GA, ²Emory University School of Medicine, Rehabilitation Medicine, Atlanta, GA, ³Emory University School of Medicine, Psychology, Atlanta, GA, ⁴Rehabilitation R&D Center of Excellence, Atlanta VAMC, Decatur, GA – We previously showed that cross-modal recognition of unfamiliar objects is view-independent, in contrast to view-dependence within-modally, in both vision and haptics. Does the view-independent, bisensory representation underlying cross-modal recognition arise from integration of unisensory, view-dependent representations or intermediate, unisensory but view-independent representations? Two psychophysical experiments sought to distinguish between these alternative models. In both experiments, participants began from baseline, within-modal, view-dependence for object recognition in both vision and haptics. The first experiment induced within-modal view-dependence by perceptual learning, which was completely and symmetrically transferred cross-modally: visual view-independence acquired through visual learning also resulted in haptic view-independence and vice versa. In the second experiment, both visual and haptic view-dependence were transformed to view-independence by either haptic-visual or visual-haptic cross-modal learning. We conclude that cross-modal view-independence fits with a model in which unisensory view-dependent representations are directly integrated

into a bisensory, view-independent representation, rather than being gated by unisensory, view-independent representations.

H83

AUDIOVISUAL INTEGRATION ENHANCES ILLUSORY FILLING-IN OF SPEECH

Antoine J. Shahin¹, Lee M. Miller^{1,2}; ¹University of California, Center for Mind and Brain, Davis, California, ²University of California, Neurobiology, Physiology and Behavior, Davis, California – Phonemic restoration occurs when speech is perceived to be continuous through noisy interruptions, even when the speech signal is artificially removed from the interrupted epochs. This temporal filling-in illusion helps maintain robust comprehension in adverse environments and illustrates how contextual knowledge through the auditory modality (e.g. acoustic, lexical) can improve perception. This study investigated how audio-visual speech affects phonemic restoration. We hypothesized that audiovisual integration of speech should improve phonemic restoration, allowing the perceived continuity to span longer temporal gaps. Subjects listened to tri-syllabic words with a portion of each word replaced by white noise while watching lip-movement that was either congruent, temporally reversed (incongruent), or static. For each word, subjects judged whether the utterance sounded continuous or interrupted, where a "continuous" response indicated an illusory percept. Results showed that illusory filling-in of longer white noise durations (longer missing segments) occurred when the mouth movement was congruent with the spoken word compared to the other conditions, with no differences occurring between the static and incongruent conditions. Thus, phonemic restoration is enhanced when applying prior knowledge through multisensory integration.

H84

WHEN PHOTISMS HELP AND WHEN THEY HURT - THE IMPACT OF COLOUR INCONGRUENCY ON OBJECT SUBSTITUTION MASKING IN GRAPHEME-COLOUR SYNAESTHETES

Jutta Peterburs¹, Michelle Jarick², Mike Dixon²; ¹Ruhr-University Bochum, Germany, Institute of Cognitive Neuroscience, Neuropsychology, ²University of Waterloo, Psychology, Ontario, Canada – Grapheme-colour synaesthesia is a fascinating condition whereby black graphemes elicit colour experiences. Research has shown that synaesthetic colours (photisms) can directly influence the perception of externally presented digits and enhance a synaesthete's performance on visual masking tasks. Currently, research is lacking experiments that show both superior and inferior performance of synaesthetes relative to control participants in order to rule out motivational factors and experimenter expectation as possible explanations for performance differences between these groups. We tested four grapheme-colour synaesthetes (projectors) and 21 non-synaesthetic control participants with an object substitution masking paradigm involving achromatic (black), congruently and incongruently coloured target digits (with respect to a given synaesthete's photisms) to show such a double-dissociation. While control participants exhibited object substitution across all conditions, this effect was alleviated for synaesthetes for achromatic targets, indicating that the synaesthetes benefitted from their photisms. On trials with incongruently coloured targets, however, the synaesthetes' performances were reduced (relative to performance on the achromatic condition), suggesting that their photisms provided a source of interference. Hence, motivational factors and experimenter expectation cannot account for performance differences observed between control participants and synaesthetes. The results furthermore indicate that externally perceived colour might be able to activate digit-related information, corroborating recent findings of bidirectionality of grapheme-colour synaesthesia in some projector synaesthetes.

H85**ELECTROPHYSIOLOGICAL CORRELATES OF AUDIO-VISUAL INTEGRATION OF SPOKEN WORDS IN TYPICAL DEVELOPMENT AND AUTISM SPECTRUM DISORDER** Odette

Megnin¹, Atlanta Flitton¹, Catherine Jones¹, Michelle de Haan¹, Tony Charman¹, Torsten Baldeweg¹; ¹UCL Institute of Child Health – The present study examines electrophysiological (ERP) correlates of audio-visual (AV) integration of spoken words in 19 typically developing adolescents and 14 adolescents with autism spectrum disorder (ASD). There are a number of reasons why we might expect to see differences in an autistic population, including (but not limited to) findings of atypical unimodal auditory processing (e.g. Bomba & Pang, 2004), atypical unimodal visual processing, particularly with regards to face processing (e.g. McPartland et al, 2004), and multi-sensory processing differences (e.g. Bebko et al, 2006; Magnée et al, 2008). In a previous ERP study examining AV integration of speech in typical adults we found a speeding up and attenuation of the auditory N1 component and a shorter latency and increased amplitude auditory P2 component with AV speech stimuli and these effects were specific to an AV condition with informative or predictive lip movements. An additional novel finding of that study was that the N1 attenuation correlated with an earlier increased fronto-polar negativity (FPN) raising the possibility of a top-down modulation effect. Preliminary results of the present study suggest that in both autism and typical development, participants fall into subgroups with only approximately half showing the adult pattern of audio-visual integration. Amongst those showing the FPN and N1 attenuation effects, there are also differences between the autism and typically developing adolescents, suggesting that AV integration may change across development and also that the process may be different in ASD.

H86**INDUCED AND EVOKED SEX DIFFERENCES IN EEG MEASURES OF A PERCEPTION/ACTION MATCHING SYSTEM** Jonathan Silas¹,

Joe Levy¹, Maria Nielsen¹, Lance Slade¹, Amanda Holmes^{1,2}; ¹Roehampton University, ²Birkbeck College – Recent EEG research is said to support the involvement of a perception/action matching system (P/AMS) in social cognition. Induced decreases in 'mu' power, during performance and observation, index activation of a P/AMS system (Cochin et al., 1999). Evoked event related potentials (ERPs) indexing motor activity have also been demonstrated during the observation of movement, linking ERPs to a P/AMS (Kilner et al., 2008; van Schie et al., 2008). To date, only modulation of induced activity has been studied in relating a P/AMS to social cognition (Bernier et al., 2007; Oberman, et al., 2005). We recorded 128-channel EEG from male and female participants while they observed and performed simple movements. Participants also completed several questionnaires pertaining to aspects of social cognition, such as empathy and systemising traits (IRI, EQ, SQ-R). Females showed stronger mu attenuation during observation (but not performance) of an action, and males showed increased mean amplitude in motor-related ERPs for both performance and observation of an action. However, neither induced nor evoked activity was associated with social cognition psychometrics. Our results suggest that both evoked and induced components of the EEG are modulated by sex differences in a P/AMS. These results suggest that there may be two dissociable processes underlying a P/AMS. Furthermore, we argue that during the observation of simple movements, socio-cognition does not modulate a P/AMS.

H87**THE SPREAD OF ATTENTION ACROSS MODALITIES AS A FUNCTION OF AUDIO-VISUAL TEMPORAL ASYNCHRONY**

Sarah E. Donohue¹, Maria A. Paolova¹, Kenneth C. Roberts¹, Tineke Grent-¹-Jong¹, Marty G. Woldorff¹; ¹Center for Cognitive Neuroscience, Duke University – A fundamental task in daily life is the accurate perception and integration of information from multiple modalities. This can be done in a robust and reliable manner by using cues from space and time, with stimuli more proximal in space and/or time more likely to be inte-

grated. Further, it has been shown that attention to stimuli in one modality (vision) can spread to irrelevant but synchronous stimuli in another modality (audition), even when they arise from different locations, an effect reflected by a late frontal ERP negativity and enhanced fMRI activity in auditory cortex (Busse et al., 2005). Here, we investigated such attentional spread when the irrelevant auditory event was either simultaneous with the visual, delayed by 100 ms (inside the temporal window of integration), or delayed by 300 ms (outside the window). EEG was recorded from 18 participants, and time-locked averages were obtained for each of the delay conditions. When the irrelevant auditory stimulus was synchronous with the attended visual event, the late frontal negativity was enhanced, replicating Busse et al. (2005). When the auditory stimulus was delayed by 100 ms, this late negative wave was slightly attenuated relative to the simultaneous condition and shifted in time by 100 ms. When the auditory stimulus was delayed by 300 ms, the late negative wave was substantially attenuated and shifted by 300 ms. These results suggest that attention can only spread effectively between visual and auditory stimulus events when they occur sufficiently close in time, presumably thereby facilitating appropriate multisensory integration.

H88**BRAIN ACTIVATION DURING OBSERVATION OF SOCIAL INTERACTION BETWEEN HUMANS OR DOGS** Miiamaaria

Kujala¹, Riitta Hari¹; ¹Brain Research Unit, Low Temperature Laboratory, and Advanced Magnetic Imaging Centre, Helsinki University of Technology, Finland – We aimed to find out how brain activations differ when subjects observe interaction between humans or between dogs, and whether expertise on dog behavior affects the results. Brain activity of 37 healthy subjects (19 experts and 18 non-experts in dog behavior; half of all female) was recorded with 3-T fMRI. The subjects viewed color photos where humans and dogs were either alone (ALONE), friendly interacting with a conspecific (INTER), or facing away from a conspecific (AWAY). Altogether 280 stimuli were presented in 25-s blocks (10 stimuli per block, 2.5 s each). Analysis of variance revealed significant effects of interaction level (INTER, AWAY, ALONE) in the brain's "social circuitry", including the posterior superior temporal sulcus (pSTS), posterior cingulate cortex, posterior intraparietal sulcus, temporal poles, and fusiform gyri bilaterally. Species (HUMAN, DOG) had an effect bilaterally in the pSTS, posterior cingulate cortex, posterior intraparietal sulcus, hippocampi, and amygdalae. In both groups, amygdala was activated more strongly to interacting humans than dogs. The effect of expertise was marked in the hippocampi, which responded more strongly to dogs than humans in experts. Moreover, the right lateral occipital cortex (rLOC) responded similarly to interaction of humans and of dogs in experts, but only to interaction of humans in control subjects. To conclude, interaction between humans or between dogs activated the viewer's social brain circuitry similarly, with some species-dependent emphasis. Dog expertise modulated activity in the memory-linked hippocampus and in the LOC associated with object (or body) recognition.

Perceptual Processes: Multisensory Processing**H89****VISUAL MODULATION OF SOMATIC PAIN USING OPTICAL MEANS** Eric Altschuler^{1,2}, Paul McGeoch², V. S. Ramachandran²;

¹UMDNJ, PM&R, ²UCSD, Center for Brain and Cognition – We have shown using a simple optical trick (mirror visual feedback (MVFF)) that visual input can powerfully modulate somatic pain in a clinically useful manner: Phantom limbs are often reported to be fixed in a painfully awkward position. We had patients view the reflection of the normal hand optically superimposed on the phantom via a parasagittally placed regular plane mirror. Moving the real arm made the phantom APPEAR to move and reduced the pain in the phantom the first demonstration of

visual modulation of somatic pain. Ourselves and others have found that MVF shows promise in treating complex regional pain syndrome, anesthesia dolorosa, hemiparesis following stroke and hand dysfunction in orthopaedic patients. McCabe and colleagues and Moseley and colleagues found a perception of change and change of temperature during MVF. Gawande noted use of MVF in a patient after brain tumor surgery with an arm that felt painfully "swollen, and found that ensuing shrinkage of the arm also shrank the somatic pain! In normal subjects we noted that viewing one's hand through a minifying Fresnel lens caused the hand to feel shrunken and alienated from one's body image (Sci Am Mind 18 (4), 16-19 (2007)). We used this procedure on a patient who had painful severe neuropathic leg pain. Remarkably, optical shrinkage of the foot and its optical alienation caused a corresponding shrinkage of associated pain. Taken collectively these results demonstrate powerful modulation of somatic pain using visual feedback observations that dissolve conventional barriers between vision, pain and skin.

Perceptual processes: Multisensory processing

H90

MISMATCH NEGATIVITY REVEALS EARLY AUDIOVISUAL INTEGRATION OF VISUAL LETTERS AND AUDITORY LETTER NAMES Allison J.D. Andres¹, Janis E. Oram Cardy¹, Marc F. Joanisse^{1,2}; ¹School of Communication Sciences and Disorders, The University of Western Ontario, ²The University of Western Ontario, Psychology – Reading involves integrating visual stimuli (letters) with known auditory categories (phonemes). Prior studies have used electrophysiology and neuroimaging to examine the temporal and cortical mechanisms of audiovisual integration, however it remains unclear at what stage in perception this process actually occurs. In particular, there is significant debate whether stimuli are integrated during primary sensory processing, or following independent processing in their respective sensory cortices. In this study we recorded event-related potentials (ERPs) in 22 adult participants in response to visual letters presented simultaneously with auditory letter names. A key novelty of this study was that auditory stimuli were presented in an unattended fashion, using the mismatch negativity (MMN) paradigm, simultaneously with a visual letter identification task. It was hypothesized that if audiovisual integration occurs at an early point in sensory processing, we should observe modulations to MMN amplitude when the attended visual stimulus was congruous with the auditory stimulus (i.e., seeing "E" and hearing 'ee') compared to when it was not (seeing "E" and hearing 'oh'). As expected, we observed significant MMNs for auditory oddball stimuli, at around 200 ms post stimulus onset. However we also observed that the magnitude of this effect was greater in congruent trials. A similar effect was also found for the P300 component. The data suggest that audiovisual integration of letters does occur concurrently with primary sensory processing.

H91

AUDIO-VISUAL SYNCHRONY ENHANCES WORKING MEMORY UPDATE: AN EVENT-RELATED POTENTIAL (ERP) STUDY Natalya Kaganovich^{1,2}, George Hollich², Christine Weber-Fox¹; ¹Purdue University, Speech, Language, and Hearing Sciences, ²Purdue University, Psychological Sciences – Multisensory representation plays an important role in learning and memory. Behavioral studies in infants show the importance of audio-visual synchrony for perceptual learning (Bahrick & Lickliter, 2000) and speech stream segregation (Hollich, Newman, & Juszyk, 2005). In adults, memory formation is also enhanced by multisensory stimuli (Shams & Seitz, 2008). However, the facilitative effect of audio-visual synchrony on working memory has not been fully investigated. We hypothesized that a detection of change from audio-visually synchronous contexts will be easier compared to detection of change from asynchronous ones even when the degree of change is identical. We

employed an oddball paradigm with audio-visual stimuli (a 1000 Hz tone and a lighted circle, 50 ms in duration). The onsets of the two stimuli were either synchronous or separated by 400 ms in standards. They were always offset by 200 ms in deviants. The physical change from standard to deviant was thus identical across conditions (200 ms). Two modality sequences were used: audio-visual and visual-auditory. Behavioral measures of sensitivity to change (d') were combined with electrophysiological measures. We compared ERPs in response to the same deviant stimulus when it was preceded by either a synchronous or an asynchronous standard. We found no differences in early sensory components. However, regardless of the order of modalities, targets preceded by audio-visually synchronous standards elicited a significantly larger P300 component compared to targets preceded by asynchronous standards. These findings indicate that multi-modal synchrony may enhance working memory update processes as indexed by the P300.

H92

SENSORIMOTOR NETWORKS: PREFERENTIAL RELATIONSHIPS BETWEEN AUDITORY REGIONS AND MOTOR MOUTH CORTEX Jonathan Power¹, Alexander Cohen¹, Fran Miezins¹, Bradley Schlaggar¹, Steve Petersen¹; ¹Washington University, Neurology and Psychology, Saint Louis – Humans are proficient, relative to other species, in linguistic communication and object manipulation. These proficiencies may require optimized networks subserving specific sensorimotor combinations, such as audition/speech production and vision/hand movement. Recently developed analytical methods, utilizing functional connectivity MRI (fcMRI) to examine network relationships between brain regions, could reveal such optimizations. To investigate these putative networks, we examined 22 fMRI studies involving 523 subjects performing myriad tasks all involving combinations of auditory or visual input with speech or finger-pressing responses. Ninety-three regions of interest (ROIs) were defined based on activation in these tasks, and timecourses for each of these ROIs were derived from concatenated resting-state fcMRI data from 40 adults. A 93x93 correlation matrix of correlations between each ROI's timecourse with all other ROI timecourses was used to construct a network, which was then subjected to community detection analysis using edge removal (Girvan & Newman, 2002) and modularity optimization (Newman, 2006). Both methods revealed communities within the network. Notably, regions of sensorimotor cortex representing "mouth" and "finger" clustered in separate communities. The mouth regions were closely related to several temporal (including auditory) and subcortical regions, while the finger regions were more closely related to multiple frontal and parietal regions, which then linked to occipital regions. These specific sensorimotor network relationships are consistent with human specializations underlying language and object manipulation, respectively. The extent to which these relationships represent specializations existing at birth versus the result of years of conjoint activation could be examined through developmental studies.

H93

ENHANCED CROSS-MODAL PROCESSING IN SYNESTHESIA David Brang¹, Lisa E Williams¹, Vilayanur S Ramachandran¹; ¹University of CA, San Diego – Synesthesia is a heritable trait in which a sensory stimulus presented in one modality evokes a sensation in a different modality. Recent research has suggested that neurotransmitter imbalances and excess neural connections mediate these synesthetic experiences. Crucially, this over-connectivity occurs not only between the sensory cortices engaged for a particular synesthete's associations, but also within parietal structures, known to be critical in binding the senses together in normals. In typical individuals, there are a number of perceptual effects that highlight the integration of sensory information from multiple modalities. Given that the proposed overconnectivity in synesthesia occurs in brain areas thought to mediate multisensory integration in typical individuals, we hypothesized that general cross-modal integration may also be enhanced in synesthetes. To test this idea, we ran 9 grapheme-color synesthetes on two classic cross-modal tasks utilizing interactions between

the visual and auditory domains - the Shams double-flash illusion, and intersensory facilitation of reaction time. On these tasks, synesthetes' accuracy and reaction times differed significantly from those of control subjects, reflecting an overall increase in cross-modal processing in synesthetes. As none of our subjects experienced auditory synesthetic concurrents, these findings reflect generalized differences in cross-modal processing between groups. These results support, for the first time, that part of the synesthesia phenotype is an extreme form of normal cross-modal integration, as well as the notion that the overconnectivity in synesthesia is diffusely expressed. Subsequently, these results allow generalization of other findings from synesthesia research, to aid in the understanding of cross-modal processing in all individuals.

H94

THE UNIVERSALITY OF SENSORY ANALOGIES: A STUDY WITH THE HIMBA TRIBE OF NAMIBIA Catherine Mulvenna^{1,2}; ¹University College London, ²University of California, Los Angeles – Crossmodal correspondences are an example of basic higher-level cognition. It is a seemingly natural process to align properties of two different sensory modalities (such as frequency/pitch with reflectance/lightness) resulting in relative analogies such as 'high pitch=strong light', and vice versa. This phenomenon spans several dimensions including reflectance, luminance, curvature, intensity and frequency. It has long been demonstrated that cognitive effects of these correspondences include facilitation/interference in speed and accuracy of identifying a stimulus that is presented with relatively corresponding/non-corresponding stimulus. However, little is understood about whether this phenomenon is relative (to culture, language) or universal. Here, 45 members of the semi-nomadic Himba tribes of Kaokoland, northwest Namibia, carried out an audio-visual matching task. This tribe historically live remote from the developing culture of the rest of the country, speaks an ancient tribal language with no written component, and has minimal exposure to modern African or Western music. Participants heard randomized sequences of high and low pitches and made a binary forced choice decision between light and dark images based on what 'goes best with the sound.' Auditory stimuli varied in familiarity to the tribes-people: high, medium and low, represented by human voice, cello, computer-generated beeps. A local interpreter acting as the naïve instructor enabled a double-blind design, and minimized implicit information being communicated to participants. For all stimuli, the tribes-people followed the analogy of 'high pitch=high light.' This supports universal over relativist theories of sensory analogies, and hard-wired 'basic correspondences' in sensory processing.

H95

MODULATIONS OF EARLY VISUAL EVOKED POTENTIAL IN THE PROFOUNDLY DEAF Davide Bottari¹, Anne Caclin², Marie-Hélène Giard², Francesco Pavani^{1,3}; ¹University of Trento, Cognitive Science and Education, Italy, ²INSERM U821, Lyon, France, ³Centro Mente e Cervello, University of Trento, Italy – Behavioural studies have revealed enhanced reactivity to visual events in the deaf. Here we examined the electrophysiological response to visual stimuli in deaf and hearing controls during a speeded simple-detection task. After the appearance of a warning-signal (500ms), a visual target was randomly presented with either a short (500ms) or long ISI (1800ms), at central (3°) or peripheral (8°) locations with respect to fixation. Behaviourally, deaf were faster than hearing controls, particularly for targets appearing at the short ISI. In addition, controls responded more slowly for peripheral than central targets, whereas this difference did not emerge for the deaf. The ERPs revealed activation at occipito-parietal sites in the deaf, before any visual stimulation. Moreover, the C1 component in response to the warning-signal peaked earlier in deaf than controls. Deaf also displayed prolonged and ampler visual analysis in the second phase of the P1 component, which in turn produced a delay of the N1 onset. While the P1 was ampler for central than peripheral targets in the controls, comparable P1 amplitude emerged in the deaf regardless of target location. Finally, the CNV preceding targets at short ISI had a larger amplitude range in

deaf than controls. These results show quantitative and qualitative changes in very early visual-evoked potentials (C1, P1). Because modulation of the late P1 complex has been recently linked to exogenous attention capture, these findings point to a key role of this attention component in enhanced reactivity in the deaf.

Perceptual processes: Somatosensory processing

H96

SINISTRALS' UPPER HAND: EVIDENCE FOR HANDEDNESS DIFFERENCES IN THE REPRESENTATION OF BODY SPACE Sylvio Hach¹, Simone Schuetz-Bosbach¹; ¹Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany – A difference in the perception of extrapersonal space has been shown to exist between dextrals (right-handers) and sinistrals (left-handers). On the classical line bisection task, this difference is evident in a greater left bias for dextrals compared to sinistrals. Different modalities and regions of space can be affected. However, it has not yet been investigated whether a systematic bias also exists in the perception of personal or body space. We investigated this with the use of three tasks which assess different aspects of personal space in both an implicit and explicit way. The results showed that; (i) dextrals possess an asymmetric estimation of their body, while no such asymmetry was present for sinistrals, (ii) sinistrals display superior access to an overall spatial representation of their body and (iii) no handedness differences exist for an explicit measure of body representation. Possible mechanisms underlying the handedness differences shown for the implicit tasks are a stronger lateralisation or a greater activation imbalance for dextrals and/or greater access to right hemispheric functions such as an "up-to-date" body representation by sinistrals. In contrast to implicit tasks, explicit measures of how body space is represented may not be affected due to their relying on different processing mechanisms. These results are the first to describe handedness differences in the maintenance of and access to representations of the body in the neurologically normal population. Furthermore, they suggest that personal or body space is processed in a similar way to extrapersonal space and is affected by the same constraints.

H97

MODULATION OF ROLANDIC ALPHA AND BETA BAND ACTIVITY DURING VIBROTACTILE WORKING MEMORY REFLECTS DYNAMIC ADJUSTMENT OF SOMATOSENSORY CORTEX FUNCTION Claudia Preuschhof^{1,2}, Ruth Schubert³, Torsten Schubert⁴, Hauke R. Heekeren^{1,2}; ¹Max Planck Institute for Human Development, Berlin, Germany, ²Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, ³Neurophysics Group, Charité - University Medicine Berlin, Campus Benjamin Franklin, Berlin, Germany, ⁴General and Experimental Psychology, Ludwig-Maximilians University, München, Germany – The role of the primary somatosensory cortex (S1) for vibrotactile working memory (WM) is still under debate. The rolandic alpha and beta rhythms indicate the activation level of S1. Using electroencephalography, we investigated the dynamics of the rolandic rhythms during the encoding and delay period of a vibrotactile WM task. Fourteen participants had to decide which of two sequentially presented vibrotactile stimuli had the higher frequency. We found enhanced rolandic alpha and beta power during the middle delay indicating functional inhibition of S1. In contrast, frontal and posterior alpha and beta power amplitudes were enhanced during the entire delay, which might be related to the functioning of a fronto-parietal attentional network involved in WM maintenance. During the early delay, high performers already exhibited maximum levels of alpha power whereas low performers reached maximum power only in the middle of the delay. This suggests that inconsistent findings regarding the role of S1 during the early delay are related to encoding efficiency. The most pronounced effect for

the rolandic rhythms was a reduction of baseline power in the pre-trial period indicating a tonic up-regulation of the contralateral S1 caused by sustained attention to the stimulated finger. The pattern of results suggests that S1 does not maintain the vibrotactile stimuli. However, the activation level of S1 seems to be dynamically adjusted to optimize task performance. In addition, there is a dissociation between the rolandic alpha and beta rhythms related to somatomotor processing and fronto-posterior alpha and beta rhythms involved in top-down control.

H98**A PSYCHOMORPHOMETRIC INVESTIGATION OF THE HUMAN**

HAND Matthew Longo¹, Patrick Haggard¹; ¹Institute of Cognitive Neuroscience, University College London – Morphometric techniques, involving the geometric analysis of landmark data, have become increasingly widespread in the biological sciences as tools for the analysis of biological shape. This method provides a precise, quantitative characterization of the veridical structure of a biological form, such as a body part like the human hand. Here, we apply this method to study the mental representation of a body part (the hand), by having participants point to where they believed landmarks on their (occluded) hand to be. These landmarks provide an implicit map of the structure underlying the mental representation of the hand, which can then be compared to the veridical structure of the participant's hand. Several systematic biases in the representation of the hand were observed, which corresponded to characteristic features of primary somatosensory representations. In contrast, when participants were asked to pick from a series of hand templates the one that most closely matched the shape of their own hand, such biases were not observed. This suggests that the implicit representation of the body is quite different from the explicit, conscious image we have of ourselves. This implicit body image observed here may reflect a representation nearer to the 'homuncular' representation of the body.

H99**MULTIPLE MEDIATORS OF EXPECTANCY EFFECTS ON PAIN PERCEPTION: INTERACTIONS AMONG HIGHER-ORDER BRAIN REGIONS AND PAIN MATRIX ACTIVITY**

Lauren Atlas¹, Niall Bolger¹, Martin Lindquist¹, Tor Wager¹; ¹Columbia University – A wealth of cognitive neuroscience research suggests that expectations can have a powerful influence on perception across multiple sensory modalities. We focus here on expectancy effects in pain, a phenomenon of both basic and clinical interest. While studies have shown that expectancies modulate brain activity in frontal and limbic regions, the brain pathways that mediate expectancy effects on pain experience have not been examined. In this study, we use whole-brain mediation analysis to address whether: a) expectancies influence a core set of regions (the "pain matrix") thought to mediate pain; b) pain matrix activity mediates expectancy effects on pain reports; and c) frontal and limbic brain mediators influence pain through connections to the pain matrix, or through other mechanisms. Auditory cues elicited expectations for low or high noxious thermal stimulation. On a subset of trials, cues were followed by a single temperature calibrated to elicit moderate pain. Compared with low-pain cues, high-pain cues produced robust increases in reported pain ($p < .0001$) and activity throughout the pain matrix. Mediation analyses revealed that a subset of pain matrix regions (thalamus, anterior insula, dACC, and pons) formally mediated expectancy effects on pain reports. Other mediator regions included those supporting value-processing (putamen, ventral striatum, caudate) and cognitive control (DLPFC, DMPFC, pgACC). Some higher-order regions (e.g. ventral striatum) affected pain perception through connections to the pain matrix, while others (e.g. DMPFC) affected pain reports independently. These results contribute to a model of how brain systems involved in expectancy interact with pain-processing regions to create the pain experience.

H100**TEMPORAL COURSE IN TACTILE ENCODING: FROM A SOMATOTOPIC TO AN EXTERNAL FRAME OF REFERENCE**

Elena Azañón^{1,2,3}, Matthew R. Longo³, Salvador Soto-Faraco^{1,2,4}, Patrick Haggard³; ¹Departament de Psicologia Bàsica, Universitat de Barcelona, Spain, ²Parc Científic de Barcelona, Universitat de Barcelona, Spain, ³Institute of Cognitive Neuroscience, University College London, UK, ⁴Institució Catalana de Recerca i Estudis Avançats (ICREA), Spain – Localizing and reacting to tactile events on our skin requires the coordination between primary somatotopic projections and an external representation of space. Given that the primary somatosensory cortex (SI) maps skin location independently of posture, the brain must re-align tactile coordinates in order to locate events in external space. Here we track the time course of how these externally-based representations are built. In the first study participants held their arms crossed and performed a discrimination task on lateralised visual targets presented near the hands, after receiving a tactile cue. During the first hundred milliseconds after the cue, reaction times to the lights were speeded up for anatomically congruent but spatially incongruent tactile cues. This pattern reversed after about two hundred milliseconds so that tactile cues produced a facilitation of targets presented at the same external location. From the time course of the cueing effects as well as the results of previous studies, we reasoned that some structures in the posterior parietal cortex may be critical for tactile remapping. Thus, in a second study participants held their arms in a vertical position and judged the elevation of a tap on their forearm with reference to a part of their head. Single-pulse TMS was applied, targeting the ventral intraparietal area, in order to disrupt tactile remapping processes. The results of both studies expose the temporal course in the encoding of tactile space, from a somatotopic frame of reference, reflecting the neural organization in SI, to the external representations prevailing in orienting behaviours.

H101**SERIAL AND PARALLEL PROCESSING OF VISUO-TACTILE INPUTS AS REVEALED USING MEG**

Andrea Quintero¹, Kim Russo¹, Leighton Hinkley², Srikantan Naganathan², Elizabeth Disbrow^{1,2,3}; ¹Center for Neuroscience University of California Davis, ²University of California, Radiology, San Francisco, ³University of California, Neurology, Davis – Manipulation of the world around us requires the interaction of inputs from somatic, visual and motor systems to make accurate judgments regarding the physical attributes of an object, the sensory context in which the object is located and the object's relation to some internal representation of the body. The temporal dynamics of these interactions are not fully understood. In this study, we examined the cortical temporal spatial spectral patterns of processing a simple combination of tactile and visual stimuli by measuring fluctuations in oscillatory activity using time-frequency optimized adaptive spatial filtering reconstructions of magnetoencephalography data. We used a 275 channel CTF omega 2000 whole head MEG system (VSM MedTech, Coquitlam, B.C., Canada) to compare whole-brain responses to right, left and bilateral stimulation of the second digit. Tactile stimuli were pneumatic air pulses (30psi, ISI 2sec +/- 200ms) presented simultaneously with either a continuous central red fixation point on a gray background or a reversing checkerboard synchronized to tactile stimulation. We collected 256 trials/condition using a sample rate of 1200Hz. Results indicate that combined tactile and visual inputs are processed by a network consisting of primary and secondary somatosensory cortex (S1 & S2), posterior parietal cortex (PPC) and pre-motor cortex (PMC). Activity in these regions overlapped in both time and frequency, with activation progressing from S1 (onset = 50ms) to S2 (onset = 175ms) and PP (onset = 150ms), followed by PM (onset = 225ms). This spatial-spectral-temporal processing pattern reflects the known connectivity of putatively homologous regions of macaque monkey cortex.

Poster Session I

Higher level cognition: Executive functions

11

NEURAL EVIDENCE OF A ROLE FOR SPATIAL RESPONSE SELECTION IN THE LEARNING OF SPATIAL SEQUENCES

Hillary Schwarb¹, Nehal Patel¹, Carla J. Burrus¹, Eric H. Schumacher¹; ¹Georgia Institute of Technology – Despite two decades of behavioral research, considerable disagreement remains regarding the locus of the cognitive mechanisms (e.g., stimulus encoding, response selection or response production) responsible for the learning and expression of spatial sequences. Functional neuroimaging may offer valuable insights to this controversy. The cortical mechanisms underlying spatial response selection (i.e., right dorsal prefrontal, dorsal premotor and superior parietal cortices) are well known. These regions as well as supplementary motor area, striatum and the hippocampus have also been implicated in sequence learning. Such neural overlap suggests that spatial response selection may play an important role in spatial sequence learning. These cognitive mechanisms, however, have not been manipulated in the same experiment so the true extent of the overlap is unknown. The current study directly investigates the role of spatial response selection in sequence learning using the serial reaction time (SRT) task. Both spatial sequence learning and spatial response-selection difficulty were orthogonally manipulated to directly identify the neural overlap of these two cognitive mechanisms. Functional magnetic resonance imaging (fMRI) results demonstrate near complete overlap in all of the regions investigated (dorsal premotor, supplementary motor, superior parietal and striatum). Only right dorsal prefrontal cortex was selectively influenced by the response selection difficulty manipulation. The hippocampus was unresponsive to either manipulation. These findings emphasize the importance of spatial response selection for successful spatial sequence learning.

13

ENHANCING GAMMA BAND POWER (36-44HZ) WITH NEUROFEEDBACK IMPROVES FEATURE BINDING FLEXIBILITY AND INTELLIGENCE

Andre Keizer^{1,2}, Maurice Verschoor, Roland Verment, Bernhard Hommel^{1,2}; ¹Leiden University, Institute for Psychological Research, ²Leiden Institute for Brain and Cognition – Neural synchronization in the gamma band has been associated with feature binding and intelligence. Using neurofeedback, we aimed at changing the power of the gamma band and investigated whether these changes would influence behavioral measures of feature binding and intelligence. The results show that people are indeed able to alter the power in the gamma band if provided with neurofeedback. Moreover, the increase of gamma band power was related to a decrease of binding costs and an increase in intelligence, suggesting that the control of feature binding and intelligence share a common underlying mechanism.

14

PREFRONTAL DOPAMINE LEVELS PREDICT TRANSIENT COMMITMENT TO ATTENTIONAL SET

Sean James Fallon¹, Caroline Williams-Grey², Adam Hampshire¹, Roger Barker², Adrian Owen¹; ¹MRC Cognition and Brain Sciences Unit, Cambridge, ²Cambridge Centre for Brain Repair, University of Cambridge – Dopaminergic stimulation of the prefrontal cortex (PFC) contributes to numerous aspects of cognitive control. It has been suggested that dopamine facilitates the ability to form and sustain an attentional set. An attentional set is the top down segregation of certain features in the environment as either relevant or irrelevant. A sin-

gle nucleotide polymorphism (val108/158met) in the gene that codes for the catechol O-methyltransferase (COMT) enzyme has been shown to lead to alterations in the levels of PFC dopamine. Individuals, who are homozygous for the met allele of the COMT gene, will have relatively higher levels of PFC dopamine compared to val homozygotes as a result of the differential ability of these two groups to inactivate dopamine. Here we present an fMRI study investigating the effect of this polymorphism on the ability to form and shift attentional sets on the basis of positive or negative feedback, in genotyped older adults and patients with Parkinson's Disease (PD). Differential levels of hypothesised prefrontal dopamine, as modulated by disease and COMT genotype, predicted the formation of attentional sets and increased haemodynamic response in the PFC, in a manner consistent with an inverted-U shape function. Specifically, there was an interaction between val158met and disease, in that healthy met homozygotes displayed greater levels of attentional set formation and BOLD activity in the right dorsolateral PFC, whilst for PD patients this pattern was reversed. We suggest that this apparent reversal of the COMT effect in PD is the result of dopaminergic medication in this patient group.

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AGING, EXECUTIVE FUNCTIONING AND SELF-REPORTED MEMORY STRATEGY USE

Badiâa Bouazzaoui¹, Michel Isingrini¹, Severine Fay¹, Lucie Angel¹, Sandrine Vanneste¹, David Clarys¹, Laurence Taconnat¹; ¹UMR CNRS 6234 University François-Rabelais of Tours, France – The purpose of this study was to investigate age differences in self-reported memory strategy use in relation to the executive functioning decline accompanying aging. A large sample (n = 315) from 21 to 90 years responded to a strategy use questionnaire (Metamemory in Adulthood instrument, Dixon and Hulstsch, 1983) allowing to differentiate self-reported internal (e.g., rehearsal, imagery...) from external (e.g., making lists for shopping, keeping a calendar to writing down appointments) memory strategy use. Neuropsychological tests of executive functioning (WCST, Verbal fluency, Category exemplar generation), and fluid intelligence (Cattell culture fair test) were also administered. Results showed that (1) aging increases the use of external memory strategies when conversely it decreases the use of internal memory strategies, (2) executive functioning and self-report of strategy use were related, participants who reported to use more frequently internal strategies were those with high level of executive functioning whereas participants who reported using more frequently external strategies were those with low level of executive functioning, and (3) executive functioning accounted for a sizeable proportion of the age-related variance in strategy use, largely for internal strategies and moderately for external strategies. These findings highlighted that the relationship observed in previous studies between executive functions and laboratory memory strategy tasks can be extended to questionnaire self-rating memory strategy use. They also support the proposal that preserved executive functioning in old age appeared as a relevant protective factor of the capacity to implement self-initiated internal strategies in order to prevent age-related memory difficulties.

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IF AT FIRST YOU DON'T SUCCEED, TRY, TRY AGAIN: ERRORS INFLUENCE DECISION-MAKING IN A VOLUNTARY TASK SWITCHING PARADIGM

Joseph Orr¹, Wendelin Diab¹, Joshua Carp¹, Daniel Weissman¹; ¹University of Michigan – When performance monitoring processes detect that we are performing poorly at a task (e.g., making errors, experiencing high levels of response conflict, or responding more slowly than usual), they are thought to enhance the activation of that task's representation in working memory, thereby promoting better performance

in the next trial. However, distinguishing such enhancements from the priming of specific stimuli, responses, and stimulus-response associations has proven exceptionally difficult. To provide an unambiguous test of the task-set enhancement hypothesis, we assessed the performance of 32 healthy adults in a number Stroop version of the voluntary task switching paradigm. Critically, in each trial the decision about which task to perform (i.e., numerical or physical size comparison, indicated using one of two fingers on the left hand) utilized different stimulus-response associations than the subsequent decision about which of two digits was largest (indicated using one of two fingers on the right hand). Consistent with the task-set enhancement hypothesis, participants chose to repeat the same task (rather than switch to a different task) significantly more often after making an error, experiencing high levels of response conflict, or responding more slowly than usual. These findings provide novel, unambiguous support for the task-set enhancement hypothesis that cannot be explained by the priming of specific stimuli, responses, or stimulus-response associations. Moreover, they extend current models of cognitive control by revealing an important interaction between performance monitoring processes that promote optimal task performance and decision-making processes that choose one of several possible tasks to perform in the future.

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EEG PHASE SYNCHRONY REVEALS A MEDIAL-LATERAL FRONTAL COGNITIVE CONTROL NETWORK FOLLOWING ERRORS James Cavanagh¹, Mike Cohen^{1,2}, John Allen¹; ¹University of Arizona, ²University of Amsterdam – Error-related activity in the medial prefrontal cortex (mPFC) is thought to work in conjunction with lateral prefrontal cortex (IPFC) as a part of an action monitoring network, where errors signal the need for increased cognitive control. The neural mechanism by which this mPFC-IPFC interaction occurs remains unknown. We hypothesized that transient synchronous oscillations in the theta range reflect a mechanism by which these structures interact. To test this hypothesis, we extracted oscillatory phase and power from current-source-density-transformed electroencephalographic data recorded during a Flanker task. Theta power in the mPFC was diminished on the trial preceding an error and increased immediately following an error, consistent with predictions of an action monitoring system. These power dynamics appeared to take place over a response-related background of oscillatory theta phase coherence. Theta phase synchronization between FCz (mPFC) and F5/6 (IPFC) sites was robustly increased during error trials. The degree of mPFC-IPFC oscillatory synchronization predicted the degree of mPFC power on error trials, and both of these dynamics predicted the degree of post-error reaction time slowing. Oscillatory dynamics in the theta band may in part underlie a mechanism of communication between networks involved in action monitoring and cognitive control.

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DISSOCIATING FRONTAL AND PARIETAL CONTRIBUTIONS TO EXECUTIVE CONTROL Chris Dodds¹, Sharon Morein-Zamir¹, Trevor Robbins¹; ¹University of Cambridge, Experimental Psychology, UK – A central debate in cognitive neuroscience concerns the extent to which the prefrontal and parietal cortices can be fractionated according to their differential involvement in specific executive control processes. On the one hand, compelling evidence has been presented for a high degree of functional localization within these regions. Studies have consistently shown that the ability to withhold a prepotent response is dependent on the integrity of the right inferior prefrontal cortex, whilst regions within the parietal cortex are involved in the flexible shifting and reorienting of attention. On the other hand, taken as a whole the functional neuroimaging literature shows a remarkably consistent pattern of activity in a frontoparietal network across a wide range of different cognitive demands. In the present study we investigated whether it was possible to dissociate frontal and parietal contributions to executive control within a single task. Twenty healthy participants completed a novel task while undergo-

ing fMRI scanning. The task required subjects to perform two different executive functions - inhibition of a prepotent response and attentional shifting. We found that a network of frontal and parietal regions was commonly recruited during stop and shift trials. However, direct comparison of activation during stop and shift trials revealed highly localised activations in the right inferior frontal gyrus during response inhibition and in the left inferior parietal lobe during attentional shifting. These results show that process-specific responses in frontal and parietal regions can be distinguished from a more general pattern of frontoparietal recruitment across different cognitive demands.

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EXECUTIVE FUNCTIONING IN RECURRENT MAJOR DEPRESSION INVESTIGATED USING THE DELIS KAPLAN EXECUTIVE FUNCTION SYSTEM Marit Schmid¹, Mari Strand^{1,2}, Guro Årdal¹, Åsa Hammar^{1,2}; ¹University of Bergen, Biological and Medical Psychology, Norway, ²Division of Psychiatry, Haukeland University Hospital, University of Bergen, Norway – Executive functioning in Recurrent Major Depression investigated using the Delis Kaplan Executive Function System. Marit Schmid a, Mari Strand a,b, Guro Årdal a & Åsa Hammar a, b a Department of Biological and Medical Psychology, University of Bergen, Norway b Division of Psychiatry, Haukeland University Hospital, University of Bergen, Norway Abstract Focus on the association between Major Depressive Disorder (MDD) and cognitive functioning have increased over the last decade and several neuropsychological tests have been developed to assess cognitive functioning. The aim of the study was to examine Executive Function (EF) in patients with MDD using four tests (Verbal fluency, Color- Word Interference test, Trail making test, Tower) from the newly developed Delis Kaplan Executive Function System (D-KEFS). D-KEFS is the first set of EF tests designed to check for underlying causes of observed deficits. We expected that patients with recurrent MDD would show impairment on tests that measure EF, and that basic cognitive skills are spared. Executive Functioning (EF) was investigated in patients with a DSM-IV diagnosis of recurrent Major Depression (MDD), in the acute phase of illness. Twenty six MDD patients (age 17-55) with a Hamilton Depression Rating Scale (HDRS) score of > 20 were included in the study. Twenty five healthy control subjects were matched for age, gender, and education. The results demonstrate that the patient group showed a tendency towards lower performance on most measures of EF compared to the control group. Significant differences were found on tests measuring inhibition, switching, and category fluency. There were no differences between the two groups on measures of basic cognitive skills. In conclusion, patients show impairment on measures of EF, whilst basic cognitive skills are spared.

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AN INTERACTION BETWEEN PRIOR PROBABILITY AND VISUAL NOISE IN VISUAL CORTEX Sarah Hillenbrand¹, Kathleen Hansen¹, Leslie Ungerleider¹; ¹Laboratory of Brain and Cognition, NIMH – In this study we sought to identify regions of cortical activation associated with the use of prior probability (PP) during perceptual decisions in noisy visual conditions. We hypothesized that, in noisy conditions, activity levels in visual cortex would increase with PP. To test this hypothesis, we acquired fMRI data while subjects performed a perceptual decision task (deciding whether abstract parametric shapes belonged to distribution A or B, where distribution A was on average smoother than distribution B). Subjects made decisions under two PP conditions (50/50, equal PP that each shape belonged to A or B, vs. 80/20, higher PP that each shape belonged to one of the two distributions) and two noise conditions (noise vs. no noise). Stimulus discriminability was manipulated in the noisy condition by using varying levels of noise to obscure the shapes, and in the noise-free condition by overlapping the shape distributions such that many shapes were somewhat or very ambiguous. In the noisy condition, cortex near LO (a location where selectivity for visually-presented shapes and objects has been observed) showed a significant interaction with increased activity at high PP and increased visual noise. In

the noise-free condition, this region did not show an analogous interaction between PP and ambiguity; thus, the observed interaction between PP and stimulus discriminability is specific to noisy visual conditions.

II1

COMMON AND DISTINCT PREFRONTAL REGIONS FOR SWITCHING BETWEEN TASK MAPPINGS, TASK RULES, AND TASK ORDERS

Christine Stelzel^{1,2,3}, Ulrike Basten^{1,2,3}, Christian Fiebach^{1,2,3}, ¹University of Heidelberg, Psychology, Germany, ²University of Heidelberg, Neuroradiology, Germany, ³University of Heidelberg, Neurology, Germany – Switching between task representations leads to performance costs (i) when different responses are assigned to identical stimuli ('task-mapping switch'), (ii) when the rules relating stimuli and responses change ('task-rule switch'), and (iii) when the order of two tasks in a dual-task situation changes ('task-order switch'). All types of switching have been associated with the lateral prefrontal cortex (IPFC). However, it is not known yet whether these switching processes involve common or distinct prefrontal regions. We tested the three switching processes within one fMRI session. Participants performed choice reactions on visually presented digits: smaller/greater five or odd/even decisions. In task-switch blocks, a cue indicated which task rule to perform in the following trial ('task-rule switch'). In dual-task blocks, both cues were presented with a delay and participants responded in the order of cue presentation to both stimuli ('task-order switch'). Cues appeared to the left or right of a fixation cross, indicating the response hand for the relevant tasks ('task-mapping switch'). Behaviorally, switching costs were present for all three manipulations. No brain regions were significantly active in the conjunction of all three switching contrasts. The left inferior frontal junction (IFJ) region was commonly activated by switching between task mappings and task rules but not by task-order switching which was related to the right IFJ. In addition to this left-right dissociation, task-rule switching and task-order switching commonly activated a region in the right anterior middle frontal gyrus, supporting a hierarchical IPFC view with more abstract control processes located in more anterior IPFC regions.

II2

EYE MOVEMENT CONTROL AS A PROBE OF IMPULSIVE DECISION MAKING

Robert Adam^{1,2}, Paul Bays^{1,2}, Masud Husain^{1,2}, ¹Institute of Cognitive Neuroscience, ²Institute of Neurology, University College London – Why do some people dash across the street at the last minute or 'put the pedal to the metal' almost before the light goes green, while others are more cautious? Here we introduce a novel oculomotor task to examine decision making. In our task, a traffic (stop) light dictates when subjects should make a horizontal saccade as fast as possible in return for a hyperbolically decaying reward. Subjects are cued by the onset of an amber light to prepare to make a saccade when the light turns green. The duration of the amber signal is variable but randomly selected from a fixed distribution so that subjects build an expectation of the GO (green) signal. Under these circumstances some subjects generate anticipatory saccades in addition to the reactive distribution that follows GO onset. Disproportionately rewarding early saccades encourages subjects to behave 'impulsively', increasing anticipatory responses. Young participants (n=20) demonstrated increasing anticipatory behaviour with lengthening amber durations prior to the GO. Anticipations were rare, however, in older volunteers (n=20). We modelled the two types of behaviour - anticipatory and reactive - as two linear rise-to-threshold processes, one triggered by amber onset and the second by the GO stimulus. Using maximum likelihood estimation we found best fit values for the mean and variance of two re-normalized saccade distributions: an early anticipatory process and a later reactive response. The findings show how eye movement control can be used as a quantitative probe of impulsivity, with few parameters required to generate a well fitting model.

II3

GLUCOSE ENHANCEMENT OF EVENT-RELATED POTENTIAL MARKERS ASSOCIATED WITH EPISODIC MEMORY AND EXECUTIVE FUNCTION

Louise Brown¹, Leigh Riby², Andrew Meikle¹, ¹The University of Edinburgh, Psychology, ²Northumbria University, Division of Psychology – The ingestion of a glucose containing drink has been shown to improve cognitive performance, particularly for episodic memory functioning. However, it remains unclear the extent to which task domain moderates the glucose enhancement effect. The aim of this research was to determine whether facilitation is restricted to known event-related potential (ERP) components related to episodic memory (i.e., left-parietal effect; recollection), or if frontal lobe functioning (i.e., central-frontal negativity; conflict monitoring) can also benefit. In a mixed design 35 participants were administered either 25g glucose dissolved in an orange-flavoured drink, or a placebo product (a matched saccharin drink). Blood glucose monitoring performed at the start, mid-point, and end of each session confirmed that blood glucose levels increased mid-session for the glucose group only. After consumption of the drink and a subsequent 15 minute delay period, two tasks traditionally associated with episodic memory (an old/new recognition task) and frontal lobe functioning (the Stroop task) were carried out in a counter-balanced order. Consistent with previous behavioural research, an analysis of the grand average ERPs revealed facilitation of the left-parietal episodic memory component. However, glucose also moderated the frontal ERP component related to conflict monitoring. These findings therefore support the idea that glucose impacts on neural mechanisms involved in episodic memory but, contrary to expectations, glucose was also found to facilitate frontal lobe function. These data are discussed in relation to recent fMRI data which also suggest that both the medial-temporal lobes and pre-frontal cortex are sensitive to the action of glucose.

II4

ARE SPECIFIC PREFRONTAL REGIONS NECESSARY FOR SELF-ORDERED SPATIAL WORKING MEMORY PERFORMANCE? EVIDENCE FROM A LESION STUDY

Ami Tsuchida¹, Lesley Fellows¹, ¹Montreal Neurological Institute, McGill University – Executive components of working memory, such as the ability to monitor information and implement effective strategy, are critical for goal-directed behaviour, and thought to depend on prefrontal cortex (PFC). The self-ordered spatial working memory (SWM) task has been widely used to investigate the neural substrates of such components across species. Lesion studies in rats and non-human primates have specifically implicated dorsolateral PFC in the successful performance of this task, and much of the neuroimaging work in humans has also emphasized a specific role for this area. However, there is no direct evidence for such specificity from neuropsychological studies in humans. The effect of damage to specific regions within PFC was examined by administering the SWM task to 36 subjects with focal frontal lobe damage, and 53 demographically-matched control subjects. Contributions of prefrontal sub-regions to task performance were tested with both region-of-interest and voxel-based lesion symptom mapping (VLSM) methods. Surprisingly, the group with lateral prefrontal damage was the least impaired among the patient groups: groups with dorsomedial or ventromedial damage made more errors, with the ventromedial group having notably poor performance. VLSM confirmed this pattern, indicating significant effects of damage to broad areas within medial prefrontal and orbitofrontal cortex, but not lateral PFC. The results suggest the executive processes tapped by the SWM depend on a network of prefrontal regions, rather than isolated contributions from dorsolateral PFC.

II5

CHANGES IN ERP COMPONENT AMPLITUDES REFLECT THE UPDATING OF VALUE FUNCTIONS IN A REINFORCEMENT LEARNING TASK

Olav Krigolson¹, ¹University of British Columbia, Psychology – In order to successfully optimize behaviour, we utilise feedback to modify the information on which we have based our decisions. The

error-related negativity (ERN), a component of the event-related brain potential (ERP), is thought to reflect a reinforcement learning prediction error elicited by feedback evaluation. To date, only a few studies have attempted to demonstrate that the ERN is actually followed by improvements in subsequent performance. In other words, if the ERN reflects a prediction error signal, then on trials following its occurrence there should be corresponding changes in the ERP which reflect the updating of the value functions used for response selection. In the present study, participants performed a two choice n-arm bandit gambling task. Within each block of trials, gambles were repeated so that participants could use the outcome of their initial response (win, loss) to improve response selection on subsequent trials. An analysis of feedback locked waveforms revealed a difference between initial win and loss trials in line with previous accounts of the ERN. Analysis of waveforms locked to stimulus presentation revealed no differences correlated with response selection on the initial trial. However, on subsequent trials, increases in lateralised ERP components were observed which predicted the subsequent response. In sum, the results of the present experiment support the hypothesis that the ERN reflects a prediction error. Further, the increases in lateralised ERP component amplitude observed here are indicative of a process in which the prediction error modifies value functions in order to improve future performance.

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MECHANISMS FOR RETRIEVAL AND SELECTION DURING LANGUAGE PRODUCTION *Hannah Snyder¹, Natalie Hutchison¹, Yuko Munakata¹*; ¹University of Colorado Boulder, Psychology – During language production, words must constantly be retrieved and selected for production in the face of multiple possible alternatives. There is broad consensus that our ability to respond in such underdetermined situations requires cognitive control and relies on left ventrolateral prefrontal cortex (VLPFC). However, there has been little investigation, or even speculation, as to specific mechanisms that may support retrieval and selection of responses. Regardless of whether separate areas of VLPFC support these processes (e.g. Badre & Wagner, 2007), the specific mechanisms could be common or distinct. We present a biologically-plausible neural network model that implements a language-production task (verb generation). The model reproduces the effects of competition and association strength found in human participants, taking longer to produce a response when there are multiple competing responses, and when stimulus-response association strength is low. Recurrent connections in PFC appear to be essential both for resolving competition, and for boosting activation of weakly associated responses ('retrieval'), while k-winners-take-all inhibition is also essential for selection when competition is high. This model suggests that basic neural properties of PFC, together with synaptic weights established through Hebbian learning, may be sufficient to account for effects of both association strength and competition. In addition, the model predicts that participants with reduced neural inhibition should exhibit difficulty resolving competition. We confirm this prediction, demonstrating increased selection costs in participants high in trait anxiety (associated with poor GABAergic function). Implications for understanding cognitive control in both normal populations and those with anxiety disorders are discussed.

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TRAINING WORKING MEMORY AND VISUAL ATTENTION ON THE INTERNET *Gregory Kellett¹, Michael Scanlon², Kunal Sarkar², David Drescher², Mark Geisler¹*; ¹San Francisco State University, ²Lumos Labs, Inc. – Prior research has shown that cognitive abilities are adaptive and can be improved via targeted cognitive behavioral training methods; however, use of these methods is limited outside of the laboratory. We investigated the efficacy of a web-based cognitive training program which participants could complete at home, by measuring improvement of visual attention and working memory in healthy adults. Volunteer participants (mean age=54) were made up of 14 people receiving the treatment and 9 receiving the control (no treatment) condition, for a total

of 23 participants. All participants were given initial cognitive assessments, a training (or control) intervention and then cognitive assessments again post-training. Both training and testing were conducted online at each participant's respective home. Trained subjects completed twenty-minute sessions of online cognitive exercise once daily for five weeks, while control participants received no training. Exercises consisted of one visual attention and three working memory tasks. Results and compliance data were captured online and saved to a secure server automatically. The trained group improved significantly ($p < 0.01$) in measures of visual attention and working memory while the control group did not. Training reduced the average error in localization of transient and non-central visual stimuli while also improving performance on measures of spatial working memory. There were no significant performance shifts in the control group. These results provide evidence that web-based cognitive training can transfer to improvement on tests of working memory and visual attention, and indicate a practical method for home-based cognitive development.

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DISSOCIATING OUTCOME EXPECTANCY (P300) AND ACCURACY (FRN) IN RELATION TO POST-ERROR SLOWING

Elena Núñez Castellar¹, Simone Kuehn^{2,1}, Wim Gevers³, Wim Fias¹, Wim Notebaert¹; ¹Ghent University, Belgium, ²Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, ³Université Libre de Bruxelles, Belgium – During the last years a growing number of studies have used event-related potentials (ERPs) to investigate the mechanisms underlying error processing. However, how these mechanisms are associated with behavioral adjustments, which follow the commission of an error, remains unclear. In the present study we investigate how the slowing down observed in the trial immediately following an error (post-error slowing) is linked to outcome expectations and error feedback. An adaptive four-choice reaction time task was used to manipulate outcome expectancy. Subjects performed the task in two conditions: 75% correct responses (expectancy for correct) and 35% correct responses (expectancy for error). Behaviorally, the results show post-error slowing in the 75%-correct condition and post-correct slowing in the 35%-correct condition, indicating that outcome expectancy mismatch is crucial for post-error slowing. Feedback-locked ERP analyses revealed Feedback Related Negativity (FRN) for errors irrespective of outcome expectancy and increased P300 amplitude for unexpected outcomes irrespective of accuracy. The results suggest that FRN is unrelated to the slowing after unexpected outcomes while the P300 is. The results support the hypothesis that post-error slowing is caused by attentional orienting to unexpected events.

119

RESOLUTION OF CONFLICT BY BILINGUALS AND MUSICIANS: EVIDENCE FROM ERP

Sylvain Moreno¹, Ellen Bialystok¹, Zofia Wodniecka², Claude Alain³; ¹York University, ²Jagiellonian University, ³Rotman Research Institute & University of Toronto – Bilinguals and musicians have been shown to perform better than monolinguals in executive function tasks involving conflict (Bialystok, 2001; Costa et al., 2008; Bialystok & DePape, in press). For bilinguals, these findings have been attributed to their need to switch constantly between their two languages and inhibit interference from the other language. The recruitment of executive processes into language processing for bilinguals alters the development and efficiency of these processes for bilinguals. For musicians, these findings have been attributed to their training requirements which involve high levels of control, attention, and memorization, again involving executive processes. Here, we recorded ERPs in 42 young adults who were either English monolinguals, English-Hebrew bilinguals, or monolingual musicians while they performed a visual Go-Nogo task. This paradigm involved two different executive function processes: conflict detection and response inhibition mechanisms. Our hypothesis was to observe the effect of different life experiences on specific aspects of executive functioning. Bilingualism is based in language conflict and so should influence conflict detection processes and not response inhibition mecha-

nisms; musical training incorporates motor responses into the executive function system and so should modify response inhibition mechanisms, but their ear training should also influence conflict detection processes. Our results supported these hypotheses: Bilingualism influenced the N2 ERPs wave component related to conflict detection and musical training influenced N2 and P3 ERPs wave components related to conflict detection but also to response inhibition. The results are used to refine conceptions of the effect of experience on executive functioning.

I20

EEG AND FMRI IMAGING OF AN EXPERT MEDITATOR IN EIGHT JHANAS Michael Hagerty^{1,2}, Julian Isaacs², Leigh Brasington, Larry Shupe³, Eberhard Fetz³, Steven Cramer⁴; ¹University of California, Davis, ²Wellspring Institute, ³University of Washington, ⁴University of California, Irvine – We report the first fMRI images and EEG recordings of an expert in the 8 advanced Buddhist meditations called jhanas, and test 5 hypotheses on how the jhanas differ from the closed-eye resting state in 8 different brain regions. We hypothesize simple changes in the brain regions responsible for each of the 5 principal experiential features of jhana states. These features are: (1) internal verbalizations fade, (2) external awareness dims, (3) the sense of personal boundaries is altered, (4) the experience of evaluations, goals, and "shoulds" diminishes, and (5) attention is highly focused on the object of meditation. The results strongly confirm reduced activity in the brain regions related to the first 3 hypotheses, with all 16 of the planned comparisons significant and in the predicted direction. With respect to Hypothesis 4, results are mixed, with all 4 predictions significantly confirmed in the alpha1 band, but all 4 disconfirmed in the theta band. However, fMRI shows reduced BOLD signal in predicted areas. Lastly, Hypothesis 5 was mostly confirmed, with 5 of the 6 planned comparisons in the predicted direction. The EEG spectra show strong, significant, and consistent differences in specific brain regions when the meditator is in a jhana state compared to normal resting consciousness, and the fMRI largely confirm these results, with higher BOLD signal only in executive areas. The strength of these effects appears to be larger than any other meditation discipline studied so far.

I21

AN ASSOCIATION BETWEEN MALADAPTIVE COPING AND INHIBITORY DEFICITS IN THE STROOP TASK: PAIN CATASTROPHIZING SCORES CORRELATE WITH INCONGRUENT COLOR NAMING TIMES Kristin Janschewitz¹, Theresa Khoo¹, Barbara Knowlton¹; ¹University of California, Los Angeles – It has been demonstrated that persistent negative thinking and poor coping impact health. Since inhibition is normally needed to control thoughts and actions, inhibitory deficits may underlie emotion regulation deficits that contribute negatively to health. Specifically, catastrophizing interpretations about health-related information may contribute to the experience of distress in chronic physical disorders. In the current study, 23 undergraduate students completed a Stroop task in which they were asked to name the ink colors of words that denoted congruent or incongruent colors. Participants' scores on the Pain Catastrophizing Scale (PCS; Sullivan, Bishop & Pivik, 1995) were also obtained. It was found that PCS scores significantly positively correlated with naming times in the incongruent ($p=.03$) but not congruent conditions. These results suggest that deficits in relatively high-level (cognitive) inhibition for neutral material are associated with maladaptive coping styles in otherwise healthy participants. We suggest that basic cognitive control problems may factor into the experience of distress in clinical populations in which intrusive thoughts are considered characteristic of impaired emotion regulation. The current study is part of a larger effort to examine the relationship between cognitive control, emotion, and health outcomes.

I22

CARDIORESPIRATORY FITNESS MODERATES NEURAL MECHANISMS OF COGNITIVE CONTROL IN OLDER ADULTS Ruchika Prakash¹, Michelle Voss¹, Kirk Erickson², Jason Lewis¹, Laura Chaddock¹, Katherine Morris³, Shawna Doerksen³, Amanda Szabo³, Edward

McAuley³, Arthur Kramer¹; ¹University of Illinois at Urbana-Champaign, Beckman Institute and Department of Psychology, ²University of Pittsburgh, Psychology, ³University of Illinois, Kinesiology and Community Health, Urbana-Champaign – A growing body of literature provides evidence for the prophylactic influence of cardiorespiratory fitness on cognitive functioning of older adults. In here, we examined the neural mechanisms underlying such fitness benefits in the context of theories of healthy aging. Specifically, employing a modified version of the Stroop task, we questioned whether higher levels of cardiorespiratory fitness were associated with an increase in cortical regions responsible for imposing attentional control along with a concomitant up-regulation of task-relevant representations. To isolate regions of the ventral visual cortex involved in processing task-relevant attributes and task-irrelevant attributes, we presented our participants with localizer scans to identify areas of the brain that were sensitive to color processing and word processing and subsequently studied modulation of these regions as a function of the Stroop task. Higher fitness levels were associated with improved behavioral performance on the most demanding incongruent condition of the Stroop task. This was accompanied with an increase in the recruitment of prefrontal cortices in the most challenging condition for higher-fit individuals, providing evidence that cardiorespiratory fitness can act as a potential moderator of the age-related neural inflexibility demonstrated in previous studies. Consistent with models of selective attention, we found a modulation of both the task-relevant and task-irrelevant attributes relative to the baseline. However, only activation in the color-sensitive areas was associated with improved behavioral performance, but not with cardiorespiratory fitness. Our results thus provide insights for the differential mechanisms by which fitness has a favorable influence on cognitive control in older adults.

I23

LARGE-SCALE ASSESSMENT OF COGNITIVE PERFORMANCE AND PLASTICITY Michael Scanlon¹, Gregory Kellett^{1,2}, Jacob Rothstein¹, Kunal Sarkar¹, David Drescher¹; ¹Lumos Labs, ²San Francisco State University – An individual's cognitive performance can influence their living or working performance; and a wide range of health conditions can lead to impairments in cognitive ability. It may be possible, however, to improve human cognitive performance with appropriately directed training. We used the data saved by the web-based cognitive training application "Lumosity" to compare cognitive status and plasticity across demographics, and to construct a normalized scale that can be used for future testing. The Lumosity software saves the results of each neuropsychological test and training task completed by each user. Because Lumosity is a popular consumer product, the data is comprised of a diverse and large number of participants (>40,000 individuals), making it possible to assess demographic sub-populations with sufficient statistical power to detect subtle differences. We first established population normalized score distributions for each task. Using these norms, we measured participants' baseline abilities in areas including working memory, short-term memory, reaction time, and cognitive control, as well as real-world skills such as arithmetic computation and face-name memory. We found significant performance differences between age groups, and these differences depended on the particular cognitive function examined. Additionally, by observing changes in scores during and following training, we were able to compare cognitive plasticity at different ages and across different cognitive domains. The capability to efficiently evaluate cognitive status, alter it with appropriate treatments, and then assess changes from baseline has both academic and clinical importance, and this research suggests a viable method to achieve this capability.

I24

NEURAL CORRELATES OF AGE-RELATED DIFFERENCES IN EXECUTIVE FUNCTIONS AND MAGNITUDE PROCESSING Chih-Mao Huang¹, Denise C. Park²; ¹University of Illinois, Psychology, Urbana-Champaign, ²Center for Brain Health, University of Texas at Dallas – There is increasing evidence that patterns of bilateral neural activation

that occur with age in frontal as well as parietal areas are functional and supportive of cognition in older adults and are a type of compensatory neural scaffolding (Park & Reuter-Lorenz, in press). In this fMRI study, we examined age differences in an executive control task where stimulus congruity was manipulated, using a numerical Stroop paradigm. Fifteen young and 13 old participants were instructed to decide which digit of a digit pair was either numerically (numerical comparison task) or physically (physical comparison task) larger. The physical size of digits and numerical distance between the digits were varied such that numerical and physical magnitude of digits could be congruent, neutral or incongruent with each other. Compared to young adults, older adults had a longer reaction time for both physical and numerical magnitude comparisons and also had a larger incongruity effect (incongruent vs. congruent trials). In addition, older adults, in contrast to young, showed bilateral recruitment in parietal and frontal areas, with a dissociation of task type from locus of bilaterality. For incongruous judgments of size magnitude, bilateral recruitment occurred in frontal areas, but for judgments of distance magnitude, the bilaterality occurred in parietal regions. The study provides evidence for highly specific compensatory recruitment for different executive processes involving the same physical stimuli, and is supportive of the Park and Reuter-Lorenz STAC (Scaffolding Theory of Cognitive Aging) model which makes specific predictions about the loci of compensatory recruitment with age.

I25

THE TIMING TO KNOW THE SIGNIFICANCE OF ERRORS MODULATES THE ERROR PROCESSING Asuka Murata¹, Junichi Katayama²; ¹Graduate School of Education, Hokkaido University, ²Faculty of Education, Hokkaido University – Previous studies have demonstrated that the error-related negativity (ERN) reflects the mismatch between the representations of the goal and the outcome of our behavior. The goal of our behavior varies depending on the environment. As for time, there are different timings when we know the impact of our behavior. To investigate an effect of the timing to know the significance of errors on the ERN, an arrowhead version of flankers task was administered. Participants were instructed to press the left or right button in accordance with the direction of the central target. The first and second cues appeared approximately 2000 ms and 500 ms before the presentation of arrowheads, respectively. Either the first or second cue informed whether or not participants could gain monetary reward for correct in the present trial. Motivated trials, in which participants were shown the reward by the first or second cue, were categorized to long notice (LN) or short notice (SN) trial, and the rest was labeled as not motivated (NM) trial. Hit rates were higher for LN and SN than for NM trials, indicating that participants changed their strategy according to the motivational incentive regardless of the timing. All error trials elicited clear ERN. The ERN was larger for LM than for SN trials, indicating that the timing to know the significance of errors changed the degree of mismatch between the representations of goal and outcome. The finding suggests that the goal representation is modulated by temporal alterations of motivation for achieving the goal.

I26

EFFECT OF MOTOR IMAGERY ON BILATERAL TRANSFER, BEHAVIORAL AND NIRS EXPERIMENT Kaoru Amemiya^{1,2}, Tomohiro Ishizu², Tomoaki Ayabe³, Shozo Kojima²; ¹The University of Tokyo, Graduate School of Medicine, ²Keio University, Faculty of letters, ³National institute for physiological sciences, Sensory-Motor Integration – The aim of this experiment was to investigate the imagery effect on the ipsilateral and transfer training and its correlating brain area using NIRS (Near Infrared Spectroscopy). Using finger tapping paradigm, right handers were randomly distributed to physical training group, imagery training group or control group. Each group participants typed the predetermined sequence physically or mentally, or counted numbers (control group) during NIRS recording. After each training sessions (5 session of 30 seconds), they were tested the old sequence and newly transfer

sequence. The results showed that physical training led to the improvement of the old sequence. On the other hand, mental training led more transfer to the new sequence than did the physical training, as well as the improvement of the old sequence. The NIRS data revealed the imagery activated the supplementary motor area (SMA), as the same level at the physical execution. Although the activation level of the SMA correlated with the improvement of the physical training, there was significant correlation neither with the improvement nor with the transfer in the case of imagery training. This behavioral and NIRS experiment suggested the following hypotheses. One is that the imagery training is effective to achieve the abstract representation more than physical execution. The imagery training might activated the SMA differently from the case of the physical training. The last one is that the SMA might not be the predictive factor of the transfer.

I27

USE OF TWO-DIMENSIONAL SURFACE MAPPING TO DISSOCIATE TWO ADJACENT ACTIVATIONS IN RIGHT POSTERIOR INFERIOR PREFRONTAL CORTEX ASSOCIATED WITH DISSIMILAR FUNCTIONS Satoshi Hirose¹, Junichi Chikazoe¹, Koji Jimura¹, Ken-ichiro Yamashita¹, Yasushi Miyashita¹, Seiki Konishi¹; ¹The University of Tokyo School of Medicine, Physiology – Response inhibition and negative feedback processing activate similar regions in the right posterior inferior frontal gyrus (pIFG). The locations of these regions were determined on the basis of group analysis of recruited subjects, but the subject groups differed between studies. It is unclear, therefore, whether these two cognitive requirements increased activity of a single common focus in the pIFG or they increased activity of two separate foci in the pIFG. In order to test these two possible patterns of functional organization of the pIFG, the present functional magnetic resonance imaging study employed the same subjects to perform the two tasks, one of which required response inhibition and the other required negative feedback processing. The region associated with response inhibition was calculated based on the anti-saccade task used in Chikazoe et al. (2007). On the other hand, the region associated with negative feedback processing was calculated based on the modified Wisconsin Card Sorting Task (Konishi et al., 2002). Because of the individual difference in sulcal structures, the pIFG activation in each subject was analyzed using two-dimensional surface mapping based on Caret (Van Essen et al. 2001). By comparing the coordinates of the two activations of individual subjects, it was revealed that the two regions were adjacent but separate, and that the region associated with response inhibition was located caudal to that associated with negative feedback processing. These results suggest that the right pIFG is functionally heterogeneous, and that the functional organization of subregions within the pIFG should be further investigated.

I28

PREFRONTAL BRAIN ACTIVATION DURING THE PROCESSING OF HIERARCHICAL SEQUENTIAL EVENTS Jörg Bahlmann¹, Ricarda Schubotz², Jutta Mueller¹, Dirk Koester³, Angela Friederici¹; ¹Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, ²Max Planck Institute for Neurological Research, Cologne, Germany, ³Leiden Institute for Brain and Cognition, and Leiden University, The Netherlands – A number of studies exist that investigated sequence processing in serial reaction time tasks or artificial grammar tasks. However, little is known about higher order sequence processing (e.g., hierarchical organization of event sequences). Here, we manipulated the regularities within sequentially occurring, non-linguistic visual symbols by applying two types of prediction rules. In one rule (the adjacent dependency rule), the sequences consisted of alternating items from two different categories. In the second rule (the hierarchical dependency rule), a hierarchical structure was generated using the same set of item types. Thus, predictions about non-adjacent elements were required for the latter rule. Functional Magnetic Resonance Imaging (fMRI) was used to investigate the neural correlates of the application of the two prediction rules. We found that the hierar-

chical dependency rule correlated with activity in the pre-supplementary motor area, and the head of the caudate nucleus. In addition, in a hypothesis-driven ROI analysis in Broca's area (BA 44), we found a significantly higher hemodynamic response to the hierarchical dependency rule than to the adjacent dependency rule. These results suggest that this neural network supports hierarchical sequencing, possibly contributing to the integration of sequential elements into higher-order structural events. Importantly, the findings suggest that Broca's area is also engaged in hierarchical sequencing in domains other than language.

I29

NEURONAL REPRESENTATIONS OF GOAL PROXIMITY IN A MULTITRIAL REWARD SCHEDULE

Ruth M. Schmitt^{1,2,3}, Andrea Gaebel^{1,2,3}, Christian J. Fiebach^{1,2,3}, ¹University of Heidelberg, Psychology, Germany, ²University of Heidelberg, Neuroradiology, Germany, ³University of Heidelberg, Neurology, Germany – Goal-directed behavior is putatively influenced by motivational aspects of anticipated performance outcomes. However, in complex environments, these desired effects are typically not achieved immediately. Rather, several action steps are necessary to reach a predicted result. Recent monkey studies identified anterior cingulate (ACC) neurons that code the proximity to an anticipated reward. In humans, to our knowledge, evidence for such stepwise alterations of reward-related brain activity during a sequence of actions is still missing. We addressed this question in an fMRI study by integrating Knutson's Monetary Incentive Delay (MID) task into a multitrial reward schedule paradigm, using two different reward contingencies: in the delayed condition, participants received a large amount of money only after successful completion of 4 consecutive trials. In the immediate condition, a small amount of money was earned after every successful trial. A classical MID task was furthermore employed to localize reward anticipation signals in the striatum, rostral cingulate zone (RCZ) of the ACC, and dorsal premotor cortex (dPM). In the multitrial paradigm, all three regions exhibited a response profile sensitive to progress through the schedule. RCZ and dPM activation were additionally modulated by contingency condition, indicating that these areas encode proximity to actual goal attainment. These findings corroborate the assumption of a performance monitoring function of the ACC, suggesting that increased reward expectation signals the need for accordant adjustments in cognitive control. Differential dPM activation points towards an increased motivation in the delayed contingency condition resulting in augmented motor control as an expected result approaches.

I30

THE RELATIONSHIP BETWEEN WORKING MEMORY CAPACITY AND A NEURAL INDEX OF CONTROLLED RECOLLECTION

Rachael Elward¹, Edward Wilding¹, ¹CUBRIC, School of Psychology, Cardiff University, UK – It is widely assumed that control can be exerted over conscious recollection, and one possibility is that this occurs via inhibitory mechanisms. According to one account, inhibition is a resource demanding process and as such is linked to the availability of working memory capacity. In order to test this account, performance on the O-span test (an assessment of working memory capacity) was correlated with a neural index of the control of recollection derived from event-related potentials (ERPs). Participants studied a list of items and in a subsequent test phase responded on one key to new (unstudied) items and on another to studied items (targets). Some of the new items repeated, and participants responded to these 'non-targets' on the same key as for new items. ERPs were acquired during the test phases and the ERP measure of control over recollection was the difference between the size of the left-parietal ERP old/new effect for targets and for non-targets. This ERP old/new effect indexes recollection in a graded fashion, and larger parietal old/new effects for targets than for non-targets have been interpreted as an index of the degree to which control over the recollection of non-targets has been exerted. There was a significant positive relationship between O-span scores and the magnitude of this neural index of recollection control. This implies that the extent to which cognitive con-

trol resources (and possibly inhibition processes) are available influences the degree to which recollection of some kinds of information can be prioritised over others.

I31

DIFFERENTIAL EMOTIONAL AND COGNITIVE PROCESSES ELICITED BY CONFLICTS IN THE GO/NOGO AND THE SIMON TASK

Werner Sommer¹, Schacht Annekathrin¹, ¹Humboldt-University, Berlin, Germany – Conflicts have been suggested to require effortful processing and, therefore may be aversive (Botvinick, 2007). Two classical experimental paradigms, which are known to elicit cognitive conflicts, are the Go/NoGo task and the Simon task. Whereas the conflict in NoGo trials consists in the inhibition of a predominant response tendency, the Simon conflict is characterized by incompatible response activations. Nevertheless, similar monitoring processes have been claimed to be reflected in the N200 component of event-related potentials (ERPs) elicited in both tasks. In the present study, participants performed a Go/NoGo and Simon task in a within-subject design using the same type of stimuli, while ERPs, skin conductance responses (SCRs), pupil diameter, and activity of the facial Corrugator muscle were recorded. Whereas NoGo trials elicited reduced SCRs and pupillometric responses, but prolonged Corrugator activity as compared with Go trials, incompatible and compatible Simon trials were indistinguishable in these parameters. Furthermore, the conflict-sensitive N2 and P3 ERP-components in both paradigms were similar in amplitude strength, but showed significantly different scalp distributions indicating dissociable neural generator systems. The present findings suggest different emotional and cognitive processes to be involved in both types of cognitive conflicts, none being aversive. In addition, the N200 findings call into question claims of common monitoring systems for all kinds of cognitive conflicts.

I32

ARE AGE EFFECTS IN PERFORMANCE MONITORING MODULATED BY DECISION UNCERTAINTY?

Melanie Schreiber¹, Anne Weigand¹, Norbert Kathmann¹, Tanja Endrass¹, ¹Humboldt Universität zu Berlin – Event-related brain potential (ERP) studies identified the error related negativity (ERN/Ne) and the correct related negativity (CRN) to be related to performance monitoring. The CRN has previously been explained with decision uncertainty. Pailing and Segalowitz (2004) showed that ERN/Ne and CRN amplitude differences attenuated when subjects were highly uncertain. Since our previous study revealed pronounced differences between ERN/Ne and CRN amplitudes in younger adults, but not in older adults, our present study aims to investigate whether age effects on ERN/Ne and CRN amplitudes are related to higher decision uncertainty in older adults. Participants performed a visual discrimination task with four difficulty levels to assess decision uncertainty while recording event-related potentials. They were asked to discriminate the volume of two dots and to decide which of the two dots was larger. Subsequent response accuracy ratings allowed us to compare aware and unaware correct and incorrect reactions as well as trials classified as uncertain. Results indicate that ERN/Ne and CRN amplitudes were reduced in older compared to younger adults. Both groups showed attenuated ERN/Ne amplitudes, while CRN amplitudes increased with higher task difficulty. The percentage of uncertainty ratings was larger in younger compared to older adults. Further, the distribution of uncertainty ratings corresponded not to the course of the CRN in the different task conditions. Therefore, the present findings signal that age effects of ERN/Ne and CRN amplitudes seem not (only) to be due to decision uncertainty. Alternative explanations including age-related differences in strategic adjustments are discussed.

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THE LOCUS OF INTERFERENCE IN PRIMED INHIBITION: AN ERP STUDY *Jonne Oldenburg¹, Frederick Verbruggen¹, Sara Assecondi², Wim Fias¹*; ¹Ghent University, Ghent, Experimental Psychology, Belgium, ²MEDISP-IBITECH-IBBT, Ghent University, Electronics and Information Systems, Ghent, Belgium – Recently, it was found that if, in a stop signal task, participants successfully inhibit their response to a stimulus, response to a subsequent presentation of that same stimulus is slower than the response to a different stimulus (Verbruggen et al., 2008). This delay is thought to be due to conflict between go and stop processes both activated by the stimulus that was previously associated with inhibition but to which now a response has to be made. We use ERP to investigate the nature of this association. Specifically, we were interested in the locus of the interference between go and stop processes. To this end, we compared response locked and stimulus locked LRP waves of repetition trials at which a response had to be made (trial N) but which could have either an inhibition trial or a response trial preceding them (Trial N-1). Results showed a latency difference between conditions at trial N which was stimulus locked rather than response locked. Thus, interference at trial N does not act directly on motor execution, but seems to affect duration of pre-motoric processes.

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NEURAL MECHANISMS UNDERLYING RESOURCE DEPLETION OF EXECUTIVE CONTROL *Jonas Persson¹, Patricia Reuter-Lorenz¹*; ¹Stockholm University, ²University of Michigan – Executive control coordinates, prioritizes and selects task relevant behaviours especially under conditions of conflict and competition. Behavioural results indicate that control efficiency in a second task is diminished when control demands are high in a first task immediately preceding it in time. This suggests that executive control is a finite resource that can be temporarily depleted. For example, performance on semantic retrieval with high interference is impaired when preceded by a working memory task with high interference but not a working memory task with low interference (Persson et al., *Neuropsychologia*, 2007). Here, we use fMRI to elucidate the mechanisms associated with resource depletion or "selective fatigue" of executive control. Participants, randomly assigned to the Depletion group or the Non-depletion Control group, completed a pre-test and post-test verb generation task that included a measure of interference resolution. Between pre- and post-test, the Depletion group performed item-recognition with recent probes (high interference), whereas the Controls performed item-recognition without recent probes (low interference). These groups differed neither in pre-test verb generation performance nor pre-test activations, including left inferior frontal gyrus (IFG) and temporal regions. After their respective item recognition tasks, the groups differed on verb generation behaviorally and neurally. The Depletion group performed less efficiently, showed reduced activation in left IFG, and increased recruitment in right IFG compared to Controls. Selective depletion of executive control results in reduced performance, reduced recruitment of task-specific regions, along with homologous increases activation that may relate to compensation. These results have implications for process-specific transfer and training.

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A CHRONOMETRIC ANALYSIS OF COGNITION IN DEPRESSION *Marc Berman¹, Derek Nee^{2,1}, Patricia Deldin¹, Melynda Casement¹, Hyang Sook Kim¹, Susanne Jaeggi^{1,3}, Martin Buschkuhl^{1,3}, Courtney Behnke¹, Patrick Bissett^{4,1}, John Jonides¹*; ¹The University of Michigan, Psychology, ²Indiana University, Psychology, ³University of Bern, Psychology, ⁴Yale University, Psychology – Major Depressive Disorder has been characterized by an inability to remove negative information from mind. This inability may be a driver of rumination, a process by which negative thoughts are recycled recursively and lead to worsened affect. Here we explore both the ability to remove negative information from mind with a directed forgetting paradigm, and spontaneous rumination as associated with major depressive disorder. We find that participants

with depression have more difficulty removing negative information from short-term memory and also have a long-term memory recall bias for negative information compared to age-matched controls who show the opposite pattern of results. In addition to these behavioral effects, we find neural differences between the two groups at the time of encoding, maintenance, and response selection. These differences include increased left Ventrolateral Prefrontal Cortex activation for controls vs. depressed and activation differences in the Amygdala and Parahippocampus as a function of stimulus valence (positive or negative) and Group (Control or Depressed). Lastly, we find that participants with depression, but not controls, activate a neural circuit involved in episodic retrieval and prospective memory during blank time intervals during our study, which may be the neural signature of spontaneous depressive rumination.

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THE RELATIONSHIP BETWEEN PERFORMANCE VARIABILITY AND DEGREE OF SELF-REPORTED COGNITIVE DIFFICULTIES IN TRAUMATIC BRAIN INJURY PATIENTS *Paula M. McLaughlin¹, Susan J. E. Murtha¹, Donald T. Stuss^{2,3}, Kelly J. Murphy⁴*; ¹York University, Psychology, ²Rotman Research Institute, Baycrest Centre, ³University of Toronto, Psychology and Medicine (Neurology, Rehabilitation Sciences), ⁴Baycrest Centre, Psychology – Traumatic brain injury (TBI) is associated with increased variability on cognitive testing and behavioral changes. We investigated whether self-reported cognitive difficulties were related to variability in TBI patients using the verbal fluency (word-generation) paradigm. Verbal fluency is considered a test of executive cognition because it requires initiation, self-monitoring, cognitive flexibility, strategic search and sustained effort. We examined dispersion (individual variability within a task) and consistency in performance (individual variability between two test sessions) on verbal fluency to letter (phonemic) and category (semantic) cues in 16 TBI patients and 16 matched controls. Participants also completed the cognitive failures questionnaire (CFQ), a measure of everyday slips in attention, and the dysexecutive questionnaire (DEX), a measure of behavioral difficulties related to executive functioning (e.g., impulsivity, distractibility and poor decision making). Performance variability was compared between groups and correlated with CFQ and DEX scores. Relative to control participants, TBI patients exhibited greater dispersion, but comparable consistency in verbal fluency performance. The TBI participants also reported more cognitive slips on the CFQ, though overall scores on the DEX were comparable to controls. Correlation analyses revealed TBI patients who showed greater dispersion on phonemic fluency trials also report more cognitive difficulties on the CFQ and DEX. There were no significant correlations involving the control group. Phonemic fluency typically requires more frequent switching between subcategories of words as compared to semantic fluency. The correlation findings indicate variability in cognitive flexibility on objective testing may be related to increased functional difficulties in everyday tasks requiring executive cognitive control.

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EFFECTIVE CONNECTIVITY EVIDENCE FOR A RELATIONSHIP BETWEEN SPATIAL RESPONSE SELECTION AND SPATIAL SEQUENCE LEARNING *Temilade Adedire¹, Hilary Schwarz¹, Eric H. Schumacher¹*; ¹Georgia Institute of Technology – Behavioral and neuroimaging research has demonstrated that spatial response selection plays an important role in spatial sequence learning (Schwarz & Schumacher, in press). Univariate analyses of orthogonal manipulations of both response-selection difficulty and sequence structure revealed significant activity in bilateral dorsal premotor cortex (dPMC), bilateral superior parietal cortex (SPC), supplementary motor area (SMA) and the right dorsal prefrontal cortex (dPFC). Univariate analyses of these data reveal that both spatial sequence learning and spatial response selection are mediated by dPMC, SPC and SMA; while response selection alone is mediated by right dPFC. Multivariate analyses of these data, however, may provide further understanding of the interaction between these two

cognitive processes. Here we use dynamic causal modeling (DCM) to analyze the effective connectivity in the regions identified above. DCM and Bayes factors provide a means to test and compare hypothesized models that outline the various regions and their interactions with each other and the experimental conditions. These models are developed using both anatomical and functional evidence of connections between regions-of-interest. Model fit comparisons allow us to determine which model best explains the functional data, and provide insight into the nature of processing in the frontal-parietal network controlling goal-directed behavior.

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TESTING HIERARCHICAL INTERACTIONS IN FRONTAL CORTEX DURING COGNITIVE CONTROL

Nicole M. Long¹, David Badre¹; ¹Brown University – The frontal lobes broadly support cognitive control, which refers to our ability to control our behavior based on internal representations of goals, plans, and context. Understanding the functional organization of the frontal cortex remains a fundamental goal for cognitive neuroscience. We used functional magnetic resonance imaging to test the hypothesis that regions along the rostro-caudal axis of frontal cortex are arranged hierarchically with respect to one another, such that more posterior regions are subordinate to anterior regions during selection of a response. Within a hierarchically organized system, superordinate processors will influence subordinate processors but not vice versa. In our experiment, subjects made a decision about task to perform (task selection), and then a decision about which response to make given the task being performed (response selection). We manipulated demands on task selection by varying the number of alternative tasks (one or two). We manipulated demands on response selection by arranging for more frequent encounters with certain response cues during a pre-test training phase. Those stimuli encountered more often during training are better learned and so should elicit faster responses relative to less frequently encountered items. Crossing selection level (response/task) with frequency (more/less) permitted a probe of whether changes in the ease of selection at a lower level (response) affects the ease of selection at the higher level (task). Initial results appear broadly consistent with asymmetric hierarchical interactions between adjacent regions of frontal cortex.

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SHARED CONTROL MECHANISMS OF CONFLICT ADAPTATION AND SWITCHING IN THE INTRA-PARIETAL SULCUS

Derek Nee^{1,2}, Joshua Brown¹; ¹Indiana University, ²University of Michigan – Previous research has demonstrated that when faced with conflicting demands, control processes up-regulate relevant information in order to facilitate performance. In other situations, control processes are involved in switching between different tasks. Hence, on the one hand, cognitive control involves reinforcing the present task, whereas on the other hand, cognitive control involves switching between tasks. It is unclear whether distinct neural substrates are involved in both reinforcing and flexible control, or whether a single collection of neural regions is involved in both. We investigated this issue using a Stroop-like task where subjects were required to switch between stimulus dimensions. Replicating previous results, when stimulus dimensions conflicted (incongruent trials), subjects demonstrated improved performance on subsequent incongruent trials (conflict adaptation). This performance enhancement was accompanied by increased activation in lateral prefrontal cortex (LPFC) and the intra-parietal sulcus (IPS), as well as increased activation in posterior regions representing the currently relevant stimulus dimension (e.g. fusiform face area (FFA)). Switching between stimulus dimensions also recruited the IPS, and activation in posterior representational cortices reflected the locus of the subjects' attention. Using multi-voxel pattern analysis (MVPA), we demonstrated that the IPS distinguished the relevant task dimensions even when no univariate signal differences were present. These results suggest that the IPS acts as the focus of attention, highlighting relevant information in the face of

conflict, and switching among different sources of information when flexible control is required.

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AGE-ASSOCIATED DIFFERENCES BETWEEN HIGH AND LOW PERFORMERS IN EFFICIENCY OF WORKING MEMORY PROCESSING

Kirk R Daffner¹, Jenna L Riis², Hyemi Chong³, Scott M McGinnis¹, Phillip J Holcomb⁴, Xue Sun¹, Elise Tarbi¹; ¹Neurology, Brigham and Women's Hospital, Harvard Medical School, ²Johns Hopkins Bloomberg School of Public Health, ³University of Texas Southwestern Medical School, ⁴Tufts University, Psychology – We investigated age-related differences in efficiency of neural processing between high and low performers on a working memory (WM) task. Event-related potentials were recorded in 23 young (mean age 23) and 18 old (mean age 73) subjects, matched for education and IQ, on a visual n-back WM paradigm with 3 levels of difficulty (0-back, 1-back, 2-back). Each age group was divided into high and low performers based on 2-back task accuracy. P3 amplitude served as an index of processing resources allocated to updating WM. Although high and low performers in both age groups did not differ in accuracy on the 0-back and 1-back tasks, high performers generated a much smaller P3 to n-back targets, suggesting that they manage relatively easy working memory demands more efficiently than age-matched low performers. As the WM demands increased under the 2-back condition, high, but not low performers, appropriated additional resources, as measured by P3 amplitude. This resulted in high performers having greater accuracy than low performers. Despite an augmentation in P3 amplitude, across young subjects, high performers still generated a smaller P3 to 2-back targets than low performers. In contrast, across old subjects, high performers now generated a larger P3 to 2-back targets than low performers. These results suggest that among old subjects, high performers meet the requirements of the 2-back condition by allocating more resources than low performers, a pattern that we anticipate finding in young subjects under WM conditions that are even more demanding.

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INVESTIGATING CONTROL MECHANISMS WITHIN AND BETWEEN MODALITY WITH A TEMPORAL FLANKER TASK

Erin Lightman¹, Hillary Schwarz¹, Eliot Hazeltine², Nehal Patel¹, Eric Schumacher¹; ¹Georgia Institute of Technology, ²University of Iowa – The architecture of executive control is uncertain. Some theorists suggest that it is mediated by an amodal central executive mechanism (e.g., Baddeley, 1986; 1996), whereas others propose a set of independent control mechanisms (e.g., Miller & Cohen, 2001). In a series of behavioral and fMRI experiments, we investigated whether control mechanisms are unitary or independent by examining conflict adaptation within and between stimulus modalities. We used a modified flanker task, in which the target and flanker stimuli differed in time rather than space, making it accessible for both visual and auditory stimuli. As in a traditional flanker task, larger congruency effects were observed after compatible trials than after incompatible trials. However, this sequential effect only occurred when modality remained constant between the consecutive trials. Participants showed no adaptive control when the stimulus modality switched, even when the stimulus modalities used identical stimulus-response (SR) mappings. These data suggest that sequential effects are restricted to an input modality; that a set of independent mechanisms mediate executive control; and that modalities rather than SR mappings constrain conflict resolution. The neural implications of separate modality-specific executive control mechanisms were investigated using fMRI.

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RISK-TAKING IN A GAMBLING TASK INCREASES OSCILLATORY THETA-BAND ACTIVITY IN RIGHT MEDIAL FRONTAL CORTEX

Greg Christie¹, Andrew Butcher¹, Matthew Tata¹; ¹University of Lethbridge – When participants in a gambling game receive feedback as to whether they won or lost, a stereotypical series of neural responses can be observed in the electroencephalogram (EEG) and the stimulus-locked Event-Related Potential (ERP). These include the Feed-

back-Related Medial Frontal Negativity (FRN), the feedback-related P300, and increases in induced theta-band (4 - 7 Hz) power over frontal scalp. This study used a modified version of the Iowa Gambling Task to investigate how risk modifies these responses. We found the FRN was not modulated by the riskiness of a bet, but both the P300 and induced theta-band activity were of greater amplitude following high-risk/high-reward bets relative to low-risk/low-reward bets. Using a bilateral Beamformer approach, we localized this induced theta-band activity to partially overlapping sources in right medial frontal cortex, possibly including Anterior Cingulate.

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EXECUTIVE FUNCTION AND PAIN RELY ON SHARED ATTENTIONAL RESOURCES Jason Buhle¹, Tor D. Wager¹; ¹Columbia University – It is widely assumed that distraction reduces pain. Similarly, it is assumed that pain distracts from concurrent, unrelated mental processing, reducing performance on difficult tasks. Taken together, these assumptions suggest a shared resources model for pain processing and cognitive executive functions. However, experimental tests of this model have yielded mixed results, leading to the recent proposal of alternative models in which pain and cognitive processes are relatively independent. We tested these contrasting positions using a novel concurrent pain and executive working memory paradigm. Both task difficulty and three levels of pain were individually calibrated for each participant. Participants reported less pain during working memory performance than during a visually matched control condition. Conversely, increasing levels of heat incrementally reduced task performance. We next used mediation analysis to test whether trial-by-trial fluctuations in pain predicted performance decrements within a given temperature. The effects of increasing levels of heat on task performance were completely mediated by subjective pain reports. In addition, causal effects analysis supported the existence of independent causal effects of both pain on performance and performance on pain. Taken together, these findings argue for shared resources between pain processing and executive working memory. Future studies could use this paradigm to understand more precisely which components of executive function are integral to pain processing.

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THE NEURAL BASES OF MESSAGE PROPAGATION Emily Falk¹, Sylwia Morelli¹, Locke Welborn¹, Karl Dambacher¹, Matthew Lieberman¹; ¹UCLA – Information exchange between individuals is at the heart of social interaction, and can result in the spread of important attitudes and behaviors (e.g. health behaviors, product trends, political attitudes). Research suggests that individuals are more likely to pass information to similar than to dissimilar others, however, the mechanisms that support the decision about which information to pass on have not been investigated. Recent studies have, however, explored the neural bases of understanding the mind of others; considering the contents of another individual's thoughts and intentions from a general "theory of mind" and considering their psychological characteristics is associated with activity in dorsomedial prefrontal cortex (DMPFC), while self-reflective processing and mentalizing about similar others is associated with activity in medial prefrontal cortex (MPFC). Here we present the results of two studies in which we explore the decision to pass information to a close other (study1) and a more distant other (study2). Results indicate that passing information on (relative to not passing information on) to both close others and more distant others is associated with increased activity in MPFC. Passing information on to distant others (relative to not passing information on) is further associated with activity in DMPFC. Thus, we find a common neural mechanism relating decisions to pass information on to both close and distant others, as well as a component that may be more specific to the effortful process of mentalizing about less familiar others in the context of deciding which information is worthy of social exchange.

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STRATEGIC MODULATION OF DECISION-MAKING UNDER RISK Tal Yarkoni¹, Todd Braver¹; ¹Washington University in St. Louis – When making decisions involving risk, people often deviate markedly from the predictions of normative choice models, and show a systematic tendency to minimize risk rather than maximizing expected value (EV). This bias is widely attributed to a tendency to assign greater emotional weight to negative prospects relative to positive prospects. However, it remains unclear to what extent such emotional responses are controllable and subject to strategic modulation. In the present study, participants were scanned with fMRI while engaging in a standard gambling paradigm involving repeated choice between two probabilistic rewards (e.g., 70% of 400 vs. 30% of 1000). We experimentally manipulated the manner in which rewards were computed as well as the nature of the feedback participants received. Results provided strong evidence that strategy choice is a critical determinant of decision-making under risk. Behaviorally, participants consistently maximized EV under some reward schedules while exhibiting robust risk aversion under others. Moreover, these differences persisted even when participants received no feedback about the outcome of their choices and stimuli were perceptually identical in all conditions. fMRI analyses identified qualitatively different patterns of activation associated with different decision-making strategies. Specifically, EV maximization strategies were associated with increased activation in frontoparietal regions implicated in numerical computation and visuospatial manipulation, whereas probability-maximizing heuristics were associated with increased activation in dorsal ACC and anterior insula when participants made risky choices. Collectively, these results suggest that risk aversion is a strategy-dependent phenomenon that can often be eliminated with little difficulty given appropriate environmental cues.

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NEURAL CORRELATES OF LOCAL AND GLOBAL EXPECTATIONS: A TEST OF THE JANUS MODEL Joseph Dien¹, Aminda O'Hare²; ¹University of Louisville, ²University of Kansas – A core feature of the Janus model of hemispheric lateralization (Dien, 2008) is the hypothesis that the left hemisphere focuses on making specific predictions about future events (local expectations) whereas the right hemisphere focuses on using base rates from past events to detect and respond to unexpected events (global expectations). In a key test of the Janus model, neural correlates of local and global expectations were examined. It has been noted in past event-related potential (ERP) studies that the P300 component following violations of sequences appears more frontally than the classic P300 seen in oddball paradigms (Jentsch & Sommer, 2001; Kotchoubey, et al., 1997; Squires, et al., 1976). It was hypothesized that this distinction reflects the elicitation of local versus global expectancies. Participants (n=21) completed a visual oddball task and a visual sequence task, with colored circles as stimuli, while ERPs were recorded from a high-density, 128 channel system. In the sequence task red and green circles appeared equally. As hypothesized, one ERP component was more sensitive to local expectations and another was more sensitive to global expectations. Crucially, the local expectancy component was clearly left-lateralized and the global expectancy component was clearly right-lateralized, yielding positive support for the Janus Model.

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RELATIONSHIP BETWEEN INDIVIDUAL DIFFERENCES IN RISK-TAKING AND CORTICAL ACTIVATION DURING A DECEPTION TASK: AN FMRI STUDY Michelle C. Phillips¹, Scott W. Meek¹, Laura Bradshaw-Baucom¹, Jennifer M. C. Vendemia¹; ¹University of South Carolina – The goal was to examine the relationship of individual differences in decision-making and risk-taking to brain activation during a task where one switched between truthful and deceptive responding. Undergraduates (M = 20.7 years) completed a sentence verification task with two stimuli and were randomly assigned to one of two deception per-

centage conditions: 50% (n=19) or 80% (n=21). BOLD responses were measured in an event-related design during truthful and deceptive responses. Decision-making and risk-taking were assessed with the Cambridge Gambling Task. Results revealed greater activation in regions of the left inferior and middle prefrontal cortex (BA 47,10) during deceptive responses ($p < .001$) in the 50% condition. In the 50% condition, deceptive responses were associated with greater activation in regions of the left inferior and superior parietal cortex (BA 40,7) ($p = .0356$), while in the 80% condition, truthful responses were associated with greater activation in right temporal and parietal lobes (BA 37,39,7) ($p = .000613$). Activation in regions of the prefrontal cortex (BA 10) was also greater during truthful responses ($p = .038$) in the 80% condition. Frontal activation in the 50% condition points to the role of workload while activation to infrequent truthful stimuli in the 80% condition points to the role of salience. The measure of decision-making ($M = .941$, $SE = .009$) was associated with individual differences in limbic system activation during deceptive responding ($p = .0213$). The measure of risk-taking ($M = .573$, $SE = .012$) was associated with differences in limbic system activation during truthful responding ($p = .0419$). These results point to a role for individual differences in response uncertainty during the task.

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DISRUPTED FUNCTIONAL CONNECTIVITY DURING WORKING MEMORY PERFORMANCE IN INDIVIDUALS WITH PREFRONTAL DYSFUNCTION RELATED TO PHENYLKETONURIA

Shawn Christ¹, Amanda Moffitt¹, Dawn Peck¹; ¹University of Missouri – Phenylketonuria (PKU) is rare genetic disorder characterized by an inability to metabolize phenylalanine, a common amino acid and precursor of tyrosine and dopamine. Prior research indicates that the prefrontal cortex (PFC) is particularly susceptible to dysregulation of dopamine. Also, past studies have documented white abnormalities in individuals with PKU. In the present study, we utilized functional magnetic resonance imaging (fMRI) to evaluate potential PKU-related differences in functional connectivity between PFC and more distal brain regions during performance of a working memory task which relies heavily on PFC. Six individuals with early-treated PKU (mean age = 18.3 years) and six neurologically intact individuals (mean age = 18.4 years) were imaged while performing a 2-back working memory task. To evaluate functional connectivity, the correlation in activity between brain regions during task performance was calculated. Analysis of z-transformed data revealed significantly decreased connectivity ($p < .05$ corrected) among PFC regions (e.g., anterior cingulate, inferior frontal gyrus) as well as between PFC and other brain regions (e.g., inferior parietal lobule) in individuals with PKU as compared to their control counterparts. Taken together with prior behavioral findings, the present results provide converging evidence of prefrontal dysfunction in individuals with early-treated PKU. Results are discussed within the context of our current understanding of PKU, PFC, and working memory.

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REWARD-DEPENDENT MODULATION OF WORKING MEMORY IN LATERAL PREFRONTAL CORTEX

Jon Wallis^{1,2}, Steven Kennerley^{1,2}; ¹University of California at Berkeley, Psychology, ²Helen Wills Neuroscience Institute, University of California at Berkeley – Despite much research implicating lateral prefrontal cortex (PFC) in the process of spatial working memory, it is still unclear how this representation contributes to executive control and goal-directed behavior. One possibility is that PFC integrates reward information with spatial working memory to construct a reward map that can guide behavior towards rewarding stimuli in our environment. Past studies investigating this focused on dorsolateral PFC, but this area only weakly connects with areas processing reward. Ventrolateral PFC has better connections in this regard. Thus, we contrasted the functional properties of single neurons in ventrolateral and dorsolateral PFC as two subjects performed a task that required them to hold spatial information in working memory under different expectancies of reward for correct performance. We balanced the order of presen-

tation of spatial and reward information so we could assess the neuronal encoding of the two pieces of information independently and conjointly. Neurons in ventrolateral PFC encoded both spatial and reward information earlier, stronger and in a more sustained manner than neurons in dorsolateral PFC. In addition, when reward increased spatial selectivity, behavioral performance improved, whereas when reward decreased spatial selectivity, behavioral performance worsened. This pattern of integration is consistent with a role for ventrolateral PFC in attentional control. Our results provide further neurophysiological evidence that the cortex above and below the principal sulcus of the macaque is functionally distinct, and are consistent with the notion that ventrolateral PFC serves as a sensory gateway into PFC, ensuring the maintenance of task relevant information across delays.

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NEURONS IN THE FRONTAL LOBE ENCODE THE VALUE OF MULTIPLE DECISION VARIABLES

Steven Kennerley¹, Antonio Lara¹, Jonathan Wallis^{1,2}, ¹Helen Wills Neuroscience Institute-UC Berkeley, ²UC Berkeley, Psychology – Damage to the frontal lobe, particularly to anterior cingulate cortex (ACC), lateral prefrontal cortex (LPFC) and orbital frontal cortex (OFC), impairs decision-making in a variety of contexts. A possible explanation for these impairments is that neurons here represent decision value across multiple decision variables. To explore how these areas contribute to decision-making, we trained two rhesus macaques (*Macaca mulatta*) to make choices between pictures associated with different values varied along three physically different valuation scales. Each picture was associated with a specific probability of obtaining a fixed amount of juice (probability trials), a specific amount of juice (pay-off trials) or a specific number of lever presses required to obtain a fixed amount of juice (cost trials). We simultaneously recorded the activity of 610 neurons (257 from LPFC, 213 from ACC and 140 from OFC) while subjects made choices based on these three decision variables. The most prevalent selectivity was in ACC, where 84% of the neurons encoded value for at least one decision variable, followed by OFC (56%) and LPFC (49%). Neurons that encoded multiple decision variables were more common in ACC (57%) and OFC (30%) than in LPFC (19%). Time-course analyses revealed that decision value was encoded ~200ms before the upcoming motor response. Our results indicate that many frontal neurons encode an abstract value signal in the sense that choice value is encoded irrespective of the physical manner in which value is manipulated. The encoding of value across multiple decision variables by ACC emphasizes its role in efficient decision-making.

Motor control

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ANTERIOR CINGULATE CORTEX ENCODES ACTION-OUTCOME ASSOCIATIONS IN WORKING MEMORY

Chung-Hay Luk¹, Jonathan Wallis¹; ¹Helen Wills Neuroscience Institute, University of California, Berkeley – In a dynamic environment an action that satisfies a particular goal can often change. Hence, to select the most appropriate action, it becomes necessary to actively update remembered contingencies between actions and outcomes (AO associations). Two regions implicated in action selection are lateral prefrontal cortex (LPFC) and anterior cingulate cortex (ACC). While both regions connect to motor areas, only ACC receives strong inputs from areas processing reward, placing it in a better anatomical position to control outcome-guided action. To examine this, we trained a monkey to perform a task that required him to monitor AO contingencies on a trial-by-trial basis. The monkey performed two sequential movements, separated by a delay, each of which was rewarded with a specific juice (apple, orange or quinine) and then had to repeat the movement that was previously paired with his preferred juice. Thus, during the first delay, the monkey had to remember both the movement he made as well as the juice he received. We recorded the activity of

77 LPFC neurons and 84 ACC neurons during the performance of the task. In ACC, 24% of the neurons encoded which movement the monkey had made and 33% of the neurons encoded what juice the monkey had received. In contrast, in LPFC 40% of the neurons encoded the movement and 13% encoded the juice. These findings support the hypothesis that ACC rather than LPFC is important for the control of outcome-guided action.

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TRANSFER OF MOTOR MOVEMENTS *Sien Hu¹, Charles Wright¹*; ¹*University of California, Irvine* – Transfer of motor learning was investigated in a series of experiments using 4 different motor tasks that make different demands on the motor system and motor-learning mechanisms: Experiment 1 studied transfer of explicitly-learned, short, spatially defined, discrete movement sequences; Experiment 2 studied transfer of explicitly-learned, long, spatially defined, discrete movement sequences; Experiment 3 studied transfer of implicitly-learned regularities of long, spatially defined, discrete movement sequences; Experiment 4 studied transfer of explicitly-learned, long movement trajectories, defined in both space and time. Results suggest that, first of all, participants were able to transfer the learned, effector-independent knowledge in all experiments. Second, the degree of transfer was altered by differences in tasks but not by differences in the learning mechanism, i.e. implicit vs. explicit learning. Tasks that emphasized spatial knowledge had better transfer to the left side of the body contralateral to the spatial representation in the right hemisphere; the task that emphasized statistical regularities, generated from a finite-state grammar network, had better transfer to the right side of the body contralateral to the grammatical processing in the left hemisphere. Finally, acquisition of effector-specific knowledge also depended on tasks. In the task using simple sequences, participants optimized motoric coordination with the learned effector which created interference when they transferred to a different effector on the same side of the body. This motoric coordination also dominated cognitive strategies that could only be transferred to homologous body parts. In the tasks using long sequences or trajectories, the dominance of the motoric coordination was reduced.

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EVIDENCE FOR A LATERALIZED CONTINGENT NEGATIVE VARIATION DURING MANUAL BUT NOT MENTAL MOTOR PRACTICE *Sean Guillory¹, C. Chad Woodruff², Erica Wohldmann³*; ¹*Texas State University-San Marcos*, ²*Northern Arizona University*, ³*California State University-Northridge* – In the current study, we used event-related potentials (ERP) in an attempt to determine whether manual and mental practice can be dissociated electrophysiologically, as would be predicted from the work of Wohldmann, Healy, and Bourne (2007, 2008). More specifically, the results of Wohldmann et al. (2008) suggested that mental practice leads to the development and strengthening of an effector-independent mental representation, whereas physical practice leads to the development and strengthening of an effector-dependent representation. The present experiment examined an ERP component known as the Contingent Negative Variation (CNV) while subjects performed the data entry task used by Wohldmann et al. (2007, 2008). The CNV is taken to reflect cognitive and motor expectations of an upcoming stimulus (e.g. Brunia & van Boxtel, 2001). We hypothesized that the CNV would show significant laterality effects during an expectancy period for manual practice reflecting effector-dependence while no such laterality would be evident for mental practice, reflecting effector-independence. Consistent with our hypothesis, we found that CNV amplitudes showed hemispheric asymmetry under conditions of manual but not mental practice. Specifically, CNV amplitude was greater over the left hemisphere (electrode C3) than the right hemisphere (electrode C4) for manual practice, yet no hemispheric differences in CNV amplitude obtained for the mental practice condition. These results provide support for the claim made by Wohldmann et al. (2008) that motor representations established by mental practice do not include effector-dependent information.

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THE ROLE OF THE SUPERIOR TEMPORAL SULCUS AND THE MIRROR NEURON SYSTEM IN IMITATION *Pascal Molenberghs¹, Christopher Brander¹, Jason Mattingley¹, Ross Cunnington¹*; ¹*The University of Queensland, Queensland Brain Institute & School of Psychology* – It has been suggested that the mirror neuron system is on the basis of imitation but the relative contributions of different brain regions involved in imitating actions is still a matter of debate. To investigate the role of the mirror neuron system in imitation we used fMRI to examine patterns of neural activity under four different conditions: (1) passive observation of a pantomimed action (e.g., hammering a nail); (2) imitation of an observed action; (3) execution of an action in response to a word cue; and (4) self-selected execution of an action. A network of cortical areas, including the left supramarginal gyrus, left superior parietal lobule, left dorsal premotor area and bilateral superior temporal sulcus (STS), was significantly active across all four conditions. Crucially, within this network the STS bilaterally was the only region in which activity was significantly greater for action imitation than for the passive observation and execution conditions. Our results suggest that the STS does not only respond passively to biological motion but actively maps visual representation with motor responses during imitation.

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DOES THE MIRROR SYSTEM INFLUENCE THE PERCEPTION OF OBJECT PROPERTIES? *Maurizio Gentilucci¹, Giovanna Cristina Campione¹, Riccardo Dalla Volta¹, Claudio Secchi¹, Ivilin Stoianov¹*; ¹*Dipartimento di Neuroscienze University of Parma, Parma, Italy* – Can the implicit imitation, due to activity of the mirror system, influence the estimation of object intrinsic properties? Participants observed different types of grasp presented by video-clips showing an arm reaching-grasping either a small or a large sphere, using both a power and precision grasp. After the presentation, participants reproduced the sphere size, but the type of reproduction varied in the five experiments. In experiment 1 they opened their index finger and thumb, in experiment 2 they enlarged their index and middle fingers, similarly to a cutting pantomime, and in experiment 3 they opened their mouth; that is, the participants used the same effector and executed a movement similar to the grasp in experiment 1, used the same effector and executed a movement different from the grasp in experiment 2, and used a different effector and executed a movement similar to the grasp in experiment 3. In experiments 1 and 3 the kinematics of the reproduction was mainly influenced by the type-of-grasp observation; specifically object size was overestimated and underestimated after observation of power grasp and precision grasp, respectively, according to the fact that the power and precision grasps are used to interact with large and small objects, respectively. In experiments 4 and 5, in which the type of reproduction did not require any fingers' use nor had any relation with the grasp, the type of grasp did not affect the reproduction. The results of the present study suggest that the mirror system influences the perception of target properties.

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ACTION PREPARATION HELPS AND HINDERS PERCEPTION OF ACTION *Clare Press^{1,2}, Cecilia Heyes^{2,3}, Martin Eimer¹*; ¹*Birkbeck College, University of London*, ²*University College London*, ³*University of Oxford* – Several theories of the mechanisms linking action and perception require that the links are bidirectional, but there is a lack of consensus on the effects that action has on perception. We investigated this by measuring visual event-related brain potentials to observed hand actions while participants prepared responses that were spatially compatible (e.g. both were on the left side of the body) or incompatible, and action type compatible (e.g. both were finger taps) or incompatible, with observed actions. An early enhanced processing of spatially compatible stimuli was observed, which is likely due to spatial attention. This was followed by an attenuation of processing for both spatially and action type compatible stimuli, likely to be driven by efference copy signals that attenuate

processing of predicted sensory consequences of actions. Attenuation was not response-modality specific; it was found when participants prepared manual and vocal responses, in line with the hypothesis that action control is hierarchically organised. These results indicate that spatial attention and forward model mechanisms have opposite, but temporally distinct, effects on perception. This hypothesis can explain the inconsistency of recent findings on action-perception links, and thereby supports the view that sensorimotor links are bidirectional. Such effects of action on perception are likely to be crucial, not only for the control of our own actions, but also in sociocultural interaction; allowing us to predict the reactions of others to our own actions.

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MOTOR CORTEX ACTIVATION PRIOR TO ACTION OBSERVATION DEPENDS ON THE TASK-INDUCED SOCIAL RELATIONSHIP BETWEEN ACTOR AND OBSERVER Dimitrios

Kourtis¹, Natalie Sebanz¹, Günther Knoblich¹; ¹Donders Institute for Brain, Cognition and Behavior, Centre for Cognition, Radboud University, Nijmegen, The Netherlands – Neurophysiological studies suggest that in joint action tasks, one represents the action of one's partner, even prior to a prompted response. Interestingly, motor areas are activated during action observation and action anticipation in a qualitatively similar way as during motor execution. Our aim was to determine whether there are differences in motor activation when people anticipate observing an action performed by an interaction partner compared to an action performed by a person whom they never interact with. Electroencephalograms were recorded simultaneously from two persons sitting in front of a table facing each other ("partners"), while a third person ("outsider") was sitting at right angles with them. A small object was placed in the middle of the table, on top of which visual stimuli were projected, consisting of a cue, instructing the participant(s) to prepare an action, followed 1sec later by a go/no-go signal (go: 83.3% probability). "Partners" had either to swiftly lift the object and place it back or alternatively to pass it to their "partner". The "outsider" was only performing the lifting action individually. Pre-movement motor cortex activation, reflected in the Contingent Negative Variation (CNV) and the beta Event Related Desynchronization (ERD) amplitudes, was similar when participants prepared to act or anticipated to observe their "partner's" action. Importantly, both CNV and beta ERD amplitudes were significantly smaller when anticipating the "outsider's" action. This suggests that pre-movement motor cortex activation depends on the "social" relationship between two persons established through the frequency of interaction and/or the actors' spatial arrangement.

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INTERHEMISPHERIC INTERACTION IN SIMPLE RESPONSE TIME: A COMBINED FUNCTIONAL- AND DIFFUSION-TENSOR IMAGING STUDY Matthew Roser¹, Jon Fulford², Abdelmalek

Benattayallah²; ¹School of Psychology, University of Plymouth, ²MR Research Centre, Peninsula Medical School, Exeter – Behavioral studies suggest that the speeding of reaction times to bilateral-redundant targets relative to unilateral targets (the redundant-targets effect or RTE) involves the hemispheric interaction of response preparation processes. Studies of patients who have undergone partial callosotomy suggest that the posterior corpus callosum, connecting occipital cortices, mediates the size of the redundancy gain. To examine which callosal channels support the RTE, diffusion-tensor weighted (DTI) images, and functional images, were acquired for a group of 34 neurologically-normal subjects who performed a simple-response task. DTI data were analyzed using Tract-based Spatial Statistics (TBSS). Results showed that individual differences in redundancy gain were associated with variation in fractional anisotropy in distinct callosal regions and with the degree of functional activation in regions processing visual information and motor responses. These results suggest that structural connectivity in the brain mediates individual differences in rapid responding to visual stimulation.

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CORTICAL EXCITABILITY BETWEEN DOMINANT AND NON-DOMINANT HEMISPHERES IN HEALTHY ADULTS Matthew

Malcolm¹, Wen-Pin Chang²; ¹Colorado State University, ²University of Indianapolis – Neurological studies demonstrate a hemispheric asymmetry in the primary motor cortex (MI). The dominant MI acquires larger and more richly connected neural representations for movement than the non-dominant MI. One factor that could impact the neuron recruitment for movement is cortical excitability. However, a paucity of studies investigates whether hemispheric asymmetry will result in different cortical excitability between two hemispheres. The purpose, therefore, of this study was to determine any difference in the cortical excitability, indexed by recruitment curve (RC), between the two hemispheres in healthy adults with right-hand dominance using transcranial magnetic stimulation (TMS). Ten right-handed healthy volunteers (age= 23.5±3.1) without any neurological and psychiatric disorders participated in this study. We provided magnetic stimulation over both left and right MIs and recorded the electromyographic (EMG) activity over the first dorsal interosseous (FDI) and extensor digitorum communis (EDC) muscles in both left and right upper limbs. The results revealed that there was no difference in motor evoked potential (MEP) between left and right FDI. Similarly, there was no difference in the MEP between left and right EDC. The RC slope, obtained from the MEP, revealed no difference between left and right FDI as well as no difference between left and right EDC. Our results did not support the hypothesis that the dominant MI may have stronger cortical excitability than non-dominant MI. Our results indicate that the baseline cortical excitability between two MIs could be similar.

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AN INVESTIGATION OF BRAIN MECHANISMS UNDERLYING PARALLEL PROGRAMMING OF SACCADÉ SEQUENCES Yanbo

Hu¹, Robin Walker¹, Andrew T. Smith¹; ¹Royal Holloway, University of London – This event-related fMRI study investigated the brain mechanisms underlying parallel programming of saccade sequences. Participants made either a single saccade or a sequence of two saccades. There were four conditions: (i) a single voluntary saccade (a symbolic cue elicited the saccade) (SV), (ii) a single stimulus-elicited (reflexive) saccade (SR), (iii) a two-step (parallel programming) saccade condition in which advance knowledge of the second saccade target location was provided prior to stimulus onset (PP), and (iv) a two-step saccade condition without advance knowledge of the second target location (SP - serial programming condition). Behavioural measures were obtained outside the scanner and showed a significant latency reduction of the second saccade in the parallel programming condition compared to the serial programming condition. Fifteen subjects were then tested on the paradigm in an event-related functional imaging study using a 3-Tesla scanner. A region of interest analysis was carried out using MarsBaR-0.14 and SPM. Activity was observed during the response preparation period bilaterally in the frontal eye fields (FEFs) and parietal eye fields (PEFs). This was greater in the two-step parallel programming condition, relative to the two-step serial programming condition. Activity was seen in the supplementary eye field (SEF) (left only) when contrasting the two-step conditions with the single-step condition, but not when contrasting the parallel and serial two-step conditions. The findings support a role of the FEF and PEF, but not the SEF, in the parallel programming of saccade sequences.

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DIRECTIONAL TUNING IN HUMAN MOTOR CORTEX Chris

Couper-Smith¹, Esther Lau², Eskes Gail^{1,3}, McMullen Patricia¹, Carl Helmick³, Schmidt Matthias^{3,4,5}, Kirby Lee⁶, David Westwood^{1,2,3}, Chris Couper-Smith, Chris Couper-Smith; ¹Dalhousie University, Psychology and Neuroscience, ²University of Hong Kong, Psychology, ³Dalhousie University, Psychiatry, ⁴Dalhousie University, Radiology, ⁵IWK Health Centre, Diagnostic Imaging, ⁶Dalhousie University, Physical Medicine and Rehabilitation – Here we explore Georgopoulos' (1986) model of movement direction coding in human motor cortex using an fMRI adaptation design. Based on evidence

from monkey neurophysiology showing that motor neurons in the primary motor cortex (M1) exhibit preferred direction tuning curves where neural activity is strongest in the preferred direction and weakest for movements 180 degrees opposite, we examined the blood oxygen-level dependent (BOLD) response as a function of the directional similarity of repeated arm movements. In separate 18-second blocks, participants responded to arrows presented at fixation by making repeated joystick movements that called for movements that were offset by 0, ± 90 , or 180 degrees. Drawing on the logic of fMRI adaptation, if there are distinct regions in motor cortex with directional tuning preferences, then over the time course of each block, we should find a reduction of BOLD signal that is proportional to the degree of offset between successive reaching movements. That is, we predicted the greatest reduction of BOLD signal when repeated movements were made in the same direction relative to blocks of movements that were offset by ± 90 or 180 degrees. Our results demonstrate adaptation of the motor system in M1, pre-motor cortex (PMC), and cerebellum during the 0 \deg ; condition relative to the $\pm 90\deg$; and 180 \deg ; conditions. Interestingly, the results do not show adaptation of the $\pm 90\deg$; relative to the 180 \deg ; condition. The similarity of activation in the $\pm 90\deg$; and 180 \deg ; conditions is consistent with narrow (i.e. less than 90 \deg ;) directional tuning curves in motor cortex.

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FACTORS MEDIATING MOTOR CORTICAL REPRESENTATIONS Jessica Bernard¹, Rachael Seidler^{1,2,3,4}; ¹University of Michigan, Psychology, ²University of Michigan, Division of Kinesiology, ³University of Michigan, Neuroscience Program, ⁴University of Michigan, Institute of Gerontology – The somatotopic organization of the primary motor cortex (M1) is subject to changes due to a variety of factors including practice, experience, age, and disease. Another variable that has been suggested to mediate motor cortical representations is an individual's handedness (Volkmann et al., 1998). This study sought to clarify relationships between handedness, interhemispheric communication, and the organization of M1 representations. We used a TMS motor mapping procedure (Sparing et al., 2008) to investigate motor cortical representations. Additionally, subjects completed several different handedness evaluations and the Poffenberger Paradigm (Poffenberger, 1912) to assess interhemispheric communication. Results indicate that less strongly handed individuals have faster interhemispheric transfer times (IHIT; $p < .05$) and more symmetrical motor cortical representations ($p < .05$). We also found that those with faster IHIT show more ipsilateral motor activity ($p = .06$). These data indicate that experiential factors result in differences in motor cortical representations that are related to degree of handedness, and presumably hand use. Furthermore, these results extend correlational findings from the fMRI literature showing more symmetrical motor cortical activation in less strongly handed individuals (Dassonville et al., 1997). Additional data collection and analyses are ongoing.

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TASK SHARING WITH INTENTIONAL VS. UNINTENTIONAL AGENTS Silke Atmaca¹, Antje Hollaender¹, Dorit Wenke¹, Wolfgang Prinz; ¹Max Planck Institute for Human Cognitive and Brain Sciences – The present study investigated environmental conditions eliciting or hampering task sharing in a turn taking paradigm. More specifically, collecting both behavioral and EEG data, we examined how the 'nature' of a co-actor (intentional vs. unintentional agent) influences effects of task sharing. Pairs of participants performed a go-nogo Flanker task (Eriksen & Eriksen, 1974) in response to target letters arbitrarily linked to two responses. Each participant was assigned to one response key and a distinctive set of targets. The results of this 'joint condition' differed from results of participants performing the same go-nogo task on their own (individual condition). In a third condition, we tested whether the co-actor's actions needed to be intentional in order to evoke task sharing effects. That is, we compared the joint condition with a passive movement condition in which the co-actor's finger was pulled down by an

automatic key, controlled by a computer. The results of this 'unintentional condition' also significantly differed from results of the joint condition, indicating that taking turns with an unintentional agent resembles a situation where one is acting in isolation (individual condition). We understand the type of task sharing effects described in this study as a forward system, anticipating other agents' future actions and thereby extending the temporal limits of one's own action planning. Considering the present results, we conclude that task sharing mechanisms are only applied when the acting individual can attribute intentionality to a co-actor's actions.

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MOTOR INITIATION AND INHIBITION : A MAGNETOENCEPHALOGRAPHY STUDY Kimberly Russo¹, Leighton Hinkley², Andrea Quintero¹, Karen Sigvardt¹, Srikantan Nagarajan², Elizabeth Disbrow^{1,2}; ¹UC Davis, ²UC San Francisco – We investigated response initiation and inhibition, two subprocesses of motor planning. Subjects were shown a visual cue followed by a response target that instructed them to respond with a right, left, or bilateral button press. A mismatch between the cue and the target would either require the subject to activate a previously uncued response (uncued initiation) or suppress a prepared movement (response inhibition). We investigated the cortical response to initiation and inhibition by measuring fluctuations in oscillatory activity using time-frequency optimized adaptive spatial filtering reconstructions of magnetoencephalography (MEG) data. For uncued initiation, we observed activity in the left middle frontal gyrus (MFG) at 37.5 ms following the target, then the right and left posterior parietal cortex (PPC) at 287.5 ms and 387.5 ms respectively. In contrast, inhibition resulted in activity in the right MFG at 112.5 ms post target, followed by activity in the left and right superior temporal gyrus (STG) at 562.5 and 612.5 ms respectively, and activity in the precuneus at 632.5 ms. In initiation, the left MFG is known to play a role in establishing a task set, and PPC has been implicated in rapid activation of an uncued response (Aron et al., 2004; Gaveau et al., 2008). Inhibition results are consistent with a right cortical network responsive to unexpected stimuli (Corbetta et al. 2000; 2002; Arrington et al. 2000), which includes the right STG, MFG, and precuneus. The right MFG and precuneus have also been shown to be involved in inhibition of finger movement (Brass, 2001).

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IS INHIBITION INVOLVED IN THE STOP-SIGNAL AND GO/NO-GO TASKS? Chelan Weaver¹, Michael Anderson¹; ¹University of St. Andrews – Stop-signal and go/no-go paradigms have been used extensively to measure the ability to stop motor responses across myriad populations and species. Although both tasks clearly quantify aspects of stopping performance, it is unclear to what degree they share common processes or neural substrates. Further, it has not been shown that either task necessitates inhibitory control as defined by cognitive psychologists, in which stopping is accomplished by attenuating the response itself. To ascertain the involvement of inhibition in these paradigms, each was adapted to incorporate the independent probe method, a technique developed to isolate the aftereffects 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 the two types of motor-stopping. Robust aftereffects of inhibition were found in the adapted stop-signal task, but no evidence of inhibition was found in the adapted go/no-go task, suggesting that inhibitory control is recruited for revoking actions, but might not be utilized to prevent movements. These results provide a novel measure of inhibitory control in motor-stopping, measuring the functional consequences of inhibition rather than stopping speed or error rate.

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NEURAL CORRELATES OF MULTI-STEP ACTION PLANNING

Mattia Marangon^{1,2}, Stephane Jacobs^{1,2}, Scott Frey^{1,2}; ¹University of Oregon, ²University of Oregon, Psychology, Lewis Center of Neuroimaging – The way we grasp objects (e.g., over- vs. under-hand) depends on sensory information concerning the state of the body (e.g., posture) and the target object (e.g., location, orientation, form), as well as prediction of forthcoming task demands (e.g., intended rotation of the target object). This ability to predict the consequences of our own multi-step actions relies on the use of internal models and reflects the temporally-extended nature of internal action representations (Johnson-Frey et al., 2004). Previous work showed that a parieto-frontal circuit is involved in the transformation of sensory information into a motor plan for grasping (Johnson et al., 2002). Are these same circuits involved in grip selection decisions influenced by predicted demands of a forthcoming object rotation? Event-related fMRI was used to ask this question in 15 healthy, right-handed adults. Participants were asked to select the most comfortable way (over- vs. under-hand) to grasp a handle using either hand with the intention of rotating it in a cued direction or to only grasp the handle. Even if movement execution was not required, grip preferences were significantly affected by the predicted demands of handle rotation. Preparation for an imagined anticipatory grip selection activates the same parieto-frontal networks involved in both the rotation and no-rotation conditions. Specifically, brain regions involved are bilateral dorsal premotor cortex (dPMC), bilateral intraparietal sulcus (IPS) and cerebellum. Further, fMRI data suggest that prediction of these demands is accomplished in the very same neural structures as grip selection based on available sensory information.

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THE ROLE OF SOCIAL COGNITION IN CONTROLLING SHARED REPRESENTATIONS OF ACTION

Stephanie Spengler¹, D. Yves von Cramon^{2,4}, Marcel Brass^{2,3}; ¹Max Planck Institute for Human Cognitive and Brain Sciences, Independent Junior Research Group Body and Self, Leipzig, Germany, ²Max Planck Institute for Human Cognitive and Brain Sciences, Cognitive Neurology, Leipzig, Germany, ³Ghent University, Experimental Psychology, Ghent, Belgium, ⁴Max Planck Institute for Neurological Research, Cologne, Germany – In this neuroimaging study we argue that the control of shared representations of action shares common underlying computational mechanisms (the capacity for self-other differentiation and building of intentional states) with social cognitive abilities such as mentalizing and agency processing. Recent research showed that action observation leads to the automatic activation of the corresponding motor representation in the observer, constituting a 'shared representational system' for observed and executed action. However, this raises the fundamental question about the functional mechanisms underlying the control and distinction of shared representations. Brain imaging suggests that control of shared representations, indexed by the ability to control automatic imitative responses, activates anterior-fronto-median-cortex (aFMC) and temporo-parietal-junction (TPJ). Crucially, these regions are also consistently implicated in social-cognitive processing suggesting that the control of shared representations involves similar functional processes. In a within-subject, functional magnetic resonance imaging (fMRI) study, we directly tested whether the control of shared representations activates overlapping brain circuits with social-cognitive processes. As predicted, commonly activated regions occurred selectively in aFMC and TPJ. Controlling imitation recruited a region in aFMC, overlapping with activations during mentalizing and self-referential thoughts. In the TPJ an area overlapped between imitative control, mentalizing and agency processing. Individual ability for controlling imitation was further related to behavioral and neural correlates of mentalizing. Our findings support the idea of shared key processes, including the ability for representing one's own or others' intentions and for differentiating between self- and other-related actions or perspectives.

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ATTENTION AND THE READINESS FOR VOLUNTARY ACTION

Ross Cunnington¹, Julie Keegel¹, Marta Bortoletto¹; ¹The University of Queensland, School of Psychology and Queensland Brain Institute, Brisbane, Australia – Voluntary action is preceded by a readiness potential, a slowly increasing negative potential arising from activity of premotor and supplementary motor areas. Recent studies have suggested that attention directed towards the intention to initiate action selectively increases activity of the pre-supplementary motor area during voluntary action. The readiness potential, however, is generally thought to represent motor processes that are specifically related to the action to be produced, and the influence of more general attentional or motivational factors has rarely been examined. In this study, we examined the effect of attention on the readiness potential within a paradigm that focused participants' attention on their intentional decision to initiate action. We manipulated the degree to which participants could allocate attention to the voluntary movement task by giving a secondary working memory n-back task at high and low levels of attentional load. 64-channel EEG was recorded from 16 participants as they performed voluntary finger movements and judged their times of intentions within a standard Libet paradigm. The readiness potential amplitude was significantly reduced under conditions of high attentional load, when attentional resources available for the voluntary movement task were limited. Crucially, this effect was evident even in the earliest component of pre-movement activity, up to 1000 ms prior to movement. Results suggest that neural activity contributing to the early readiness potential represents cognitive processes that are dependent on attention, possibly including the intentional decision of the time to initiate action.

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ATTENTION TO TIMING AND SEQUENCING MODULATES ACTIVITY ASSOCIATED WITH THE PREPARATION FOR ACTION

Marta Bortoletto¹, Ross Cunnington¹; ¹The University of Queensland, School of Psychology and Queensland Brain Institute, Brisbane, Australia – Voluntary actions are preceded by cortical activity for 1-2 seconds, as indicated by the Readiness Potential (RP). The function of this long lasting activity is still poorly understood, whether it is related to preparation of single movements and movement order in a sequence or to processing of timing for movement initiation. The aim of this study is to directly compare RP and cortical activity related to movements with complex sequencing demands and movements with complex timing demands. 18 participants took part in the study. They were asked to perform self-paced sequences of 6 consecutive movements and to interpose intervals of a few seconds between sequences. The task involved three conditions in which participants paid attention to movement order in the sequence, to timing of sequence initiation or they performed simple sequences with low demands. 64 channels ERPs and fMRI were recorded. A second experiment was run to verify attentional demand and difficulty in each condition. Both attention to timing of sequence initiation and attention to sequencing induced a change in the brain activity during movement preparation. With complex timing, greater activity was found in the right prefrontal cortex and ERPs increased during the early part of RP. With complex sequencing, greater activity was found in parietal and premotor areas and activity increased only during the late RP. Therefore processes related to organising the content of actions and deciding the time to initiate actions arise from different brain regions and contribute to different times during the preparation and readiness for action.

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AN FMRI STUDY ON SENSORIMOTOR AND MOTORSENSORY CONTRIBUTIONS TO SPEECH PRODUCTION

Pascale Tremblay^{1,2}, Vincent Gracco^{1,2,3}; ¹School of Communication Sciences and Disorders, McGill University, Montreal, Canada, ²Center for Research on Language, Mind and Brain, ³Haskins Laboratories, New Haven, CT – The control of a wide range of human motor behaviors rely on both feedforward and feedback control schemes. Because of the inherent delays and potential instability in

the feedback loop, it has been suggested that the motor system may use feedforward projections to predict the consequences of motor actions. Specifically, it has been suggested that cortical signals are projected in parallel to brainstem motor nuclei and cortical sensory regions, the latter acting as an "efference copy" command. The sensory area most often associated with speech production, both as a target for a motor to sensory discharge and as a sensorimotor interface area, is a portion of the temporal cortex in and around the planum temporale (PT). For overt speech production, evidence for this mechanism is indirect and limited. The purpose of the present study was to examine, using fMRI, the extent to which speech production uses predictive, feedforward (motor to sensory) and reactive, feedback (sensory) processes during speech and non-speech oral sensorimotor actions. Results suggest that, if present, feedforward (motor to sensory) projections are minimal, and that feedback processes are predominantly responsible for activation in PT. Moreover, the feedback is mostly from the auditory rather than the somatosensory system. The significance of these results is discussed in the context of feedback and feedforward motor control mechanisms and the potential role of sensory and motor systems in speech production and perception.

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NEURAL EFFECTS OF MOBILITY TRAINING IN STROKE PATIENTS Julie A. Conder¹, Stacy L. Fritz², Debra E. Krotish³, Gordon C. Baylis¹; ¹University of South Carolina, Psychology, ²University of South Carolina, Exercise Science, ³University of South Carolina, Division of Geriatrics – This study used functional magnetic resonance imaging (fMRI) to explore the neural effects of a novel mobility therapy on stroke patients. Although many strokes result in death, there are over 3.5 million stroke survivors in the United States alone who experience disability caused by cell death from stroke. Intensive Mobility Training (IMT) is a novel method of challenging rehabilitation therapy that attempts to "re-train" intact neurons. IMT includes repetitive motion of the affected side of the body with a focus on gait training, range of motion, and balance. It is an intensive therapy that requires three hours of therapy each day for ten consecutive days. Participants performed three mobility tasks while in the scanner, which were designed to elicit neural activity related to movement of the affected lower extremity and the affected hand. Participants were required to perform flexion, extension and grip movements in response to visual cues indicating whether the left or right side should be moved. Two scanning sessions were conducted to capture neural activation before and after IMT. Scans included functional imaging during the mobility tasks and diffusion tensor imaging during rest. Results from functional scans indicate that intact regions of the brain may show differential activation as a result of the 10-day IMT treatment, and that these changes may be reflected in physical mobility gains.

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DEFICITS IN TARGET SELECTION FOR REACHING MOVEMENTS AFTER SUPERIOR COLLICULUS INACTIVATION Joo-Hyun Song¹, Robert D. Rafal², Robert M. McPeck¹; ¹The Smith-Kettlewell Eye Research Institute, ²Bangor University – The primate superior colliculus (SC) is important for the execution of saccadic eye movements, but recent evidence suggests that it also plays a role in the higher-level process of target selection for saccadic and pursuit eye movements, as well as in covert attention shifts. Thus, we speculated that SC activity may participate in a generalized salience map used for target selection for a variety of purposes. Consistent with this, we have found that in a task in which monkeys must reach to a target among distractors, SC activity discriminates the target of the reaching movement even when no eye movement is made. To determine if this SC activity plays a causal role in reach target selection, we tested the effects of temporary focal SC inactivation on monkeys' performance in two reach target selection tasks. In one task, a target was followed after a variable SOA by a distractor, and monkeys were rewarded for reaching to the target. In the second task, two potential targets were shown and a cue at the fovea indicated which was the target. Monkeys were required to maintain eye fixation throughout each

trial. In both tasks, after SC inactivation, when the target appeared in the inactivated part of the visual field, monkeys made more reaching errors to the distractor. In contrast, monkeys were unimpaired when the target was presented without distractors. These results establish that, in addition to its role in saccades, the SC plays a causal role in target selection for reaching movements.

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NEURAL CORRELATES OF TARGET SELECTION FOR REACHING MOVEMENTS IN SUPERIOR COLLICULUS Robert M. McPeck¹, Joo-Hyun Song¹; ¹The Smith-Kettlewell Eye Research Institute – The primate superior colliculus (SC) has long been regarded as a structure important for the execution of saccadic eye movements. However, recent studies have suggested that the SC also plays a role in the higher-level process of target selection. Specifically, SC activity is correlated with the selection of targets for saccadic and pursuit eye movements, as well as with covert shifts of attention. We speculated that the SC may contribute to a generalized salience map which is used to select targets not only for eye movements and attention, but also for other visually-guided actions such as reaching movements. To test this hypothesis, we recorded the activity of isolated intermediate-layer SC neurons in monkeys trained to perform a reach target selection task. The monkeys were rewarded for maintaining fixation and reaching to touch an odd-colored target presented in an array of distractors. Even though no eye movements were made in this task, SC activity robustly signaled the goal of the reaching movement. Many SC neurons discriminated the target before the onset of the reach, and this activity typically persisted throughout the trial, consistent with SC involvement in target selection for reaching movements. On the other hand, SC activity was poorly correlated with the detailed kinematics of the movements, suggesting that it is not involved in the low-level control of reaching movements. Overall, the pattern of results is consistent with SC involvement in a generalized salience map used for visually-guided actions and attention.

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COMPARING OVERT AND COVERT MOVEMENT WITH MAGNETOENCEPHALOGRAPHY Xing Tian¹, David Poeppel¹; ¹University of Maryland – What neural structures are active during real movement versus motor imagery is debated. Furthermore, the functional roles and temporal response profile of cortical regions engaged in overt versus imagined movement remain unclear. We ran two magnetoencephalography (MEG) experiments to pursue both questions. In the first experiment, participants were asked to either press or imagine pressing a button using the right thumb, immediately after a tone cue. The activation pattern in execution of thumb movement appeared above contra-lateral primary motor cortex (M1), whereas the topographic map in the imagery task was different, including more frontal areas, approximately in supplementary motor area (SMA) and premotor area (PM), and more posterior fields, approximately in parietal cortex. To monitor the motor preparation process, in the second experiment, a sequence of three tones with constant interstimulus interval of 1s was presented to participants, who were asked to either press or imagine pressing a button when the fourth tone was predicted to onset. This experiment replicated the observation that the activity pattern over M1 was only presented in motor execution. Moreover, activity approximately around SMA was activated in the overt task around 200ms before the actual movement. These results support the hypothesis that a subset of neural systems engaged in real movement is active during motor imagery. Moreover, SMA appears to be involved in both movement imagery and motor preparation. These results suggest that activation in SMA might serve as an indicator before real movement for brain-computer interface applications.

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FRONTAL AND PARIETAL CORTEX DECIDE WHERE TO LOOK Kyeong-Jin Tark¹, Clayton Curtis¹; ¹Psychology & Neural Science, New York University – Neurons in the frontal and parietal cortex are thought to transform incoming visual signals into saccade goals, a pro-

cess known as target or saccade selection. Here, we used fMRI to test the degree to which those areas are involved when non-visual information is used for selection. First, we asked if the same portions of the frontal and parietal cortex that are active during visual-guided saccades are also active during saccades made to the locations of sounds. Second, we compared the activity when subjects made externally-guided (i.e., visual/auditory) and internally-guided saccades. We scanned subjects while they made saccades to one of four differently colored dots. Selection was based on a visual cue (i.e., one of the dots blinked), an auditory cue (i.e., a white noise burst was emitted at one of the dot's location), or a semantic cue (i.e., the color of one of the dot's was spoken). We found that activity in the superior parietal lobule and inferior frontal gyrus was greater during aurally-guided and semantically-guided saccades compared to a visually-guided saccades. Moreover, we found robust responses in frontal and parietal cortex, in the putative frontal eye field and lateral intraparietal areas, but these responses did not differ according to the type of information used to guide saccades. Therefore, prioritized maps of space formed by the activity of populations of neurons in frontal and parietal cortex that are thought to guide where we look may be agnostic about what led to the priority.

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PREPARING TO STOP SELECTIVELY IS REFLECTED IN REDUCED CORTICOSPINAL EXCITABILITY Michael Claffey¹, Frederick Verbruggen², Adam Aron¹; ¹University of California, Psychology, San Diego, ²University of Ghent, Psychology, Belgium – Behavioral studies show that participants can selectively stop responses if given foreknowledge of which response to stop. Foreknowledge may be effective because it generates proactive inhibitory control over a response representation. If so, this should be reflected in reductions in corticospinal excitability after the foreknowledge instruction. To test this, we delivered transcranial magnetic stimulation to the left motor cortex and recorded motor evoked potentials (MEPs) from the right hand while participants performed a modified stop-signal task. On each trial, a cue was presented ('maybe stop left', MSL, 'maybe stop right', MSR or 'maybe stop XXX', MSX), followed 2 seconds later by a Go stimulus requiring simultaneous responses with both hands. On a minority of trials a stop signal was presented, requiring participants to stop one initiated hand but not the other - something for which they could prepare in MSL and MSR conditions, but not the MSX condition. Magnetic stimuli were delivered 1200, 1500 and 1800 ms post-cue. An ANOVA performed on MEPs from the right hand showed a marginally significant effect of cue ($F(2,12)=3.51, p=0.063$), with corticospinal excitability least for MSR, more for MSX and greatest for MSL. Behavioral performance was similar in MSL and MSR conditions. The muscle of interest was equally at rest in all conditions prior to magnetic stimulation (mean RMS 0.004 mV.s, SD = 0.001). We interpret the smaller MEPs in the foreknowledge period for the MSR condition as evidence of proactive inhibitory control when the right hand may need to be subsequently stopped.

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MOTOR ABNORMALITIES IN ADHD ADULTS Eve Valera^{1,2}, Jeremy Schmahmann¹, Thomas Zeffiro³, Stephen Faraone⁴, Thomas Spencer¹, Joseph Biederman¹, Larry Seidman⁵; ¹Harvard Medical School/Massachusetts General Hospital, ²HST Athinoula A. Martinos Center for Biomedical Imaging, ³Massachusetts General Hospital, ⁴SUNY Upstate Medical University, ⁵Harvard Medical School/Massachusetts Mental Health Center/Beth Israel Deaconess Medical Center – Attention-deficit/hyperactivity disorder (ADHD) is characterized by age inappropriate symptoms of inattention, and/or hyperactivity or impulsivity, and is estimated to affect approximately 5% of adults. Interestingly, a large number of ADHD individuals have been found to have motor abnormalities in both fine and gross motor tasks including, but not limited to, tapping, dynamic balance, handwriting, and manual dexterity skills. These difficulties have a detrimental impact on the lives of children with ADHD. Although there appears to be a growing literature for ADHD children, there do not

appear to be any analogous reports regarding "fine or gross" motor assessment or coordination in ADHD adults. Thus, we used the International Cooperative Ataxia Rating Scale (ICARS) to provide an objective assessment of ataxia severity in 24 ADHD adults and 22 matched controls. The ICARS is a 100-point semiquantitative validated scale comprising 19 items in 4 subscales: posture and gait disturbances, limb/kinetic functions, speech disorders and oculomotor disorders. The ICARS provides an assessment and score of the clinical signs of the cerebellar motor syndrome. Subjects were judged on facets of walking, standing, sitting, coordinated limb movement, tracing a pattern, speech, and oculomotor abilities. ADHD adults showed significantly higher scores for the total ataxia scale as well as for the posture and gait disturbances and limb/kinetic functions subscales. These data show that motor abnormalities in ADHD persist into adulthood and can be detected by clinical examination of the cerebellar motor system. These data also provide additional evidence of cerebellar abnormalities in ADHD adults.

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A TRANSCRANIAL MAGNETIC STIMULATION STUDY OF BRAKING A MOTOR RESPONSE Ian Greenhouse¹, Adam Aron¹, Frederick Verbruggen²; ¹University of California, Psychology, San Diego, ²University of Ghent, Psychology, Belgium – When people anticipate stopping a response, they slow their responding something we refer to as 'braking.' We hypothesized that braking may be reflected in pro-active inhibition of the motor system. To test this, we delivered transcranial magnetic stimulation to the left motor cortex and recorded motor evoked potentials (MEPs) from the right hand while participants performed a stop-signal task. Participants were instructed to respond to a choice stimulus, but to withhold the response when the choice stimulus was followed by a stop signal. On each trial, a cue was presented ('maybe stop', MS, or 'no stop', NS), followed 1 second later by a choice stimulus. Stop signals only occurred on MS trials. Magnetic stimuli were delivered at baseline (before the cue), 600 ms post-cue, 800 ms post-cue and 80 ms post-choice-stimulus. RT for MS trials was significantly slower than NS trials ($t = 5.36$). MEP amplitude was significantly greater at all test times compared to baseline ($p < .01$). Importantly, there was no difference between MS and NS conditions. Pre-magnetic-stimulus EMG showed the muscle of interest was equally at rest in all conditions (mean RMS 0.003 mV, SD = 0.001). Thus, while participants use the 'maybe stop' cue to brake their responses, this braking effect is not reflected prior to response selection. We speculate that, in this version of a braking paradigm at least, the control cue is encoded at a purely cognitive level during the foreperiod, and braking of the motor system only occurs once a particular motor affordance exists.

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GENERALIZED CORTICAL MECHANISMS SERVING MOTOR SEQUENCE LEARNING Leighton Hinkley¹, John Houde², Rebecca Webster³, Anne Findlay¹, Nancy Byl³, Srikantan Nagarajan¹; ¹University of California, Radiology, San Francisco, ²University of California, Otolaryngology, San Francisco, ³University of California, Physical Therapy and Rehabilitation Science, San Francisco – Implicit and explicit manual sequence learning is controlled by a well-defined network of brain regions that integrate motor and sensory information from the hand with cognitive parameters that generate associations between the movement elements (Ashe et al., 2006). The temporal dynamics and timing of activity between areas within this network have yet to be defined, and the extent to which functional modifications in this network generalize to other response modalities used to learn a motor sequence (e.g. vocal) is presently unclear. If movement sequences are encoded in a supramodal manner (Keele et al., 1995), learning a pattern with one body structure will result in performance improvements when repeating the sequence in an untrained effector and such transfer should remain symmetric. We examined changes in cortical activity that occur over the course of sequence learning using magnetoencephalography (MEG) while subjects performed a modified serial reaction time task (SRTT; Nissen & Bullemer,

1987). Data was acquired using a 275-channel whole-head biomagnetometer (CTF Systems, Vancouver BC) and analyzed in the time-frequency domain using Nutmeg (bil.ucsf.edu/nutmeg). Subjects were trained in the SRTT to learn an eight-step movement sequence in the manual (button press) and vocal (short vowels) response modalities. During movement sequence learning, we observed significant changes in beta (15-30Hz) and high-gamma (65-90Hz) power over the motor cortices as subjects implicitly learned the motor pattern. These findings expand upon the known role of the motor cortices in sequence learning by demonstrating that acquiring a movement sequence is associated with oscillatory changes over these areas.

Higher level cognition: Other

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WHERE IS "WHERE" IN THE BRAIN? *Ruth Seurinck¹, Wim Gevers^{1,2}, Simone Kühn^{1,3}, Filip Van Opstal¹, Wim Fias¹*, ¹Ghent University, Experimental Psychology, Faculty of Psychology and Educational Sciences, Ghent, Belgium, ²Unité de Recherche en Neurosciences Cognitives (UNeSCog), Université Libre de Bruxelles (ULB), Brussels, Belgium, ³Max Planck Institute for Human Cognitive and Brain Sciences, Cognitive Neurology, Leipzig, Germany – Spatial information can be conveyed to our brain in two ways. First, directly as perceptual information (i.e. as a location in the physical world), and second, indirectly, in a symbolic way such as arrows, words etc. The current fMRI-study aimed to identify the commonalities and differences between the neural coding of perceptual and symbolic spatial information. Spatial and non-spatial information (i.e. color) was presented in a symbolic or a non-symbolic perceptual format. Sixteen male, right-handed and Dutch-speaking subjects performed a verbal semantic and non-symbolic perceptual same-different task. In the verbal conditions two words were sequentially represented. To ensure that subjects accessed the meanings of the words, the words always originated from different languages (French and English). The words were translations of either the spatial concepts "right" or "left" (spatial task), or the color names "purple" or "green" (non-spatial task). Subjects decided if the words had the same meaning. In the non-symbolic conditions two colored circles were sequentially presented with openings on the left or right side. Subjects decided either if the openings were on the same side (spatial task), or the circles had the same color (non-spatial task). Areas within bilateral posterior parietal cortex were more involved in processing of spatial information than non-spatial information, irrespective of stimulus format. The symbolic format additionally recruited inferior frontal gyrus, while the non-symbolic format relied more on lateral pre-motor and occipital cortex.

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SENSORIMOTOR FORWARD MODELS ACCOMMODATE DIFFERENT LEVELS OF PREDICTION SPECIFICITY *Andreja Bubic^{1,3}, D. Yves von Cramon^{1,2}, Ricarda I. Schubotz^{1,2}*, ¹Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, ²Max Planck Institute for Neurological Research, Cologne, Germany, ³University of Leipzig, Leipzig, Germany – Prediction of external events relies on our motor system which is able to simulate the dynamics of our environment by developing internal representations of those events (i.e., forward models) and using them for prediction of incoming stimuli. Results from previous studies suggest that this process is subserved by a basic premotor-parietal network not only when subjects predict the exact identity of the upcoming stimulus, but also when they predict only one of its features. The present study investigates whether the involvement of this network is restricted only to the level of individual stimulus features or if it can generalize to a higher class of abstraction, namely a categorical one based on arbitrary rule-based conjunctions of those features. We directly compared the processing of external events of different specificity, namely perceptual sequences in which prediction of incoming stimuli could be

made on the level of individual stimuli ("token") with those in which predictions were restricted to the level of stimulus categories ("type"). The obtained results confirm that prediction across different levels of abstraction is supported by the same premotor-parietal network without significant modulation of activation within any of its key regions. Furthermore, the processing of two sequence classes could be differentiated by the engagement of additional lateral prefrontal, occipital and posterior temporal regions supporting categorization in "type" sequences. These findings suggest that forward models in perception can be defined on a higher level of abstraction in contrast to those within the motor domain which require high degree of precision and accuracy.

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IMPLEMENTING INSTRUCTED STIMULUS RESPONSE ASSOCIATIONS: AN FMRI STUDY *Egbert Hartstra¹, Simone Kühn^{1,2}, Marcel Brass¹*, ¹Ghent University, Experimental Psychology - Ghent Institute for Functional and Metabolic Imaging of the brain, Ghent, Belgium, ²Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany – In everyday life our actions are often guided by verbal instructions. Usually we can implement such instructions immediately without trial and error learning. This raises the fundamental question how verbal instructions are transformed into efficient motor behavior? While we know a lot about the linguistic and the motor side of this problem, our understanding of the implementation process is rather poor. The aim of the current study was to gain deeper insights into this implementation of verbal instructions both on a neural and a cognitive level. To this end we devised an fMRI experiment in which participants were required to permanently learn and implement new stimulus response associations. Preliminary results suggest that a fronto-parietal network is involved in setting up S-R mappings from verbal instructions. Furthermore, we compared repeated exposure to verbal instructions without implementation with repeated implementation of the S-R mapping.

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SYNCHRONIZED TAPPING AS A MODEL OF MINIMAL SOCIAL INTERACTION *Ivana Konvalinka¹, Peter Vuusti^{1,2}, Andreas Roepstorff^{1,3}, Chris D. Frith¹*, ¹Center of Functionally Integrative Neuroscience, University of Aarhus, ²Royal Academy of Music, Aarhus, ³Institute of Anthropology, Archeology and Linguistics, University of Aarhus – Human beings have an extraordinary ability to synchronize their actions, goals, and intentions in order to accomplish goal-directed tasks. In order to study the dynamics and mechanisms involved in entrainment in social interaction, a finger tapping experiment was carried out, where pairs of subjects were asked to tap on their respective keyboards following an 8-beat stimulus sent through their headphones. The subjects were instructed to keep the given beat as well as synchronize with the 'other'. They were in scenarios where they could either hear themselves tapping, the other, or the computer metronome. Analysis of their inter-tap intervals (ITI) suggests that dyads are unable to achieve full synchrony but rather adopt oscillatory behaviour, such that each member attempts to lock in phase with the other, thereby error-correcting their tapping onsets in opposite directions. Windowed cross-correlograms showed that there was no leader/follower in the interactive condition, revealing high correlation in both lag +1 and -1, which suggested shared continuous adaptation to the other's output. A dynamical systems approach was taken to model this behaviour, using a system of two oscillators coupled in both phase and frequency, corresponding to phase and period error correction.

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COGNITIVE AND NEURAL FOUNDATIONS OF RELIGIOUS BELIEF *Dimitrios Kapogiannis¹, Aron Barbey¹, Michael Su¹, Giovanna Zamboni¹, Frank Krueger¹, Jordan Grafman¹*, ¹Cognitive Neuroscience Section, NINDS/NIH – We propose an integrative cognitive neuroscience framework for understanding the cognitive and neural foundations of religious belief. We performed multidimensional scaling (MDS) analysis to ratings of dissimilarities between statements regarding religious beliefs, provided by 23 participants with varying degrees of religiosity. MDS

revealed three psychological dimensions of religious belief: God's perceived level of involvement, God's perceived emotion, and a continuum of doctrinal/experiential religious knowledge. We then performed functional magnetic resonance imaging to reveal the neural correlates of these dimensions. We scanned 40 demographically and religiosity-wise matched new participants. We discovered corresponding activation within networks processing Theory of Mind regarding intent and emotion, abstract semantics, episodic memory and imagery. Our results demonstrate, for the first time, that specific components of religious belief are mediated by well-known brain networks and support contemporary psychological theories that ground religious belief within evolutionary adaptive cognitive functions.

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LATERALISATION OF SELF-ESTEEM: AN INVESTIGATION USING A DICHOTICALLY PRESENTED AUDITORY ADAPTATION OF THE IMPLICIT ASSOCIATION TEST

Ryan McKay¹, Joanne Arciuli², Alikki Atkinson³, Elaine Bennett³, Elisabeth Pheils³; ¹Institute for Empirical Research in Economics, University of Zurich, ²Faculty of Health Sciences, University of Sydney, ³School of Social Sciences and Liberal Studies, Charles Sturt University – Self-esteem is one of the most prominent and influential constructs in psychological science, yet very few neuropsychological/neuroscientific investigations have been undertaken in this area of research. The current study investigated the possibility of hemispheric lateralisation of self-esteem. By creating an auditory version of the Implicit Association Test (IAT) for self-esteem, we were able to present stimuli dichotically and thereby compare left- versus right-hemispheric measurements of self-esteem in 46 healthy adults. Although left- and right-hemispheric self-esteem measurements were correlated, within-participant analysis revealed that self-esteem levels (as reflected by IAT score) were significantly greater when elicited under right-ear dichotic presentation (reflecting left hemispheric processing). We interpret this asymmetry with reference to the approach-withdrawal model of emotion processing and suggest avenues for future research.

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CREATIVITY: THE OTHER WHITE MATTER

Robert Chavez¹, Arvind Caprihan¹, Shirley Smith^{3,1}, Alison Marshall¹, Raneé Barrow¹, Rachael Grazioplene¹, Rex Jung^{1,2,3,4}; ¹Mind Research Network, ²University of New Mexico, ³Neurosurgery, ⁴University of New Mexico, ⁵Psychology, ⁶University of New Mexico, ⁷Neurology – A consensus definition of creativity refers to the production of something novel and useful within a given social context (Flaherty, 2005). The construct of creativity is comprised of numerous cognitive abilities, including convergent reasoning, divergent reasoning, focused attention, and insight, among others (Dietrich, 2007). The most researched of these, divergent reasoning (DR), refers to the capacity to produce multiple answers to a set problem (Guilford, 1957). Using diffusion tensor imaging (DTI) at 3 Tesla, we hypothesized that fractional anisotropy (FA) within association fiber tracts would relate to measures of DR. DTI and measures of creativity (Miller & Tal, 2007) were obtained from a cohort of 37 neurologically and psychiatrically healthy adults ranging in age from 18 to 29. Five independent judges rated creative products of each subject, with high inter-rater reliability ($r = 0.89$), from which a "Creativity IQ" (CIQ) was calculated. DTI data was processed using Tract-Based Spatial Statistics (Smith, et al. 2006) from which each subject's FA image was registered to a group "skeletonized" FA image. Applying a white matter atlas to obtain regions of interest, FA values were average across each voxel within each subject's particular fiber tract to calculate the mean FA of that tract. Using a partial correlation analysis controlling for age, we found mean FA within the left superior longitudinal fasciculus was related positively to CIQ ($r = .38$, $p = .021$). This report further demonstrates (Chavez et al., 2008) important relationships between white matter tract integrity and creativity in a cohort of healthy subjects.

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NEURAL RESPONSE TO FOOD CUES DURING HUNGER AND SATIATION IN HEALTHY-WEIGHT PARTICIPANTS

Anastasia Dimitropoulos¹, Jean Tkach^{2,3}; ¹Case Western Reserve University, ²Psychology, ³Case Western Reserve University, ⁴Radiology, ⁵Case Western Reserve University, ⁶Case Center for Imaging Research – Neural response to food cues differs as a function of hunger and satiety, yet the influence of food reward on hunger state may be critical to understanding mechanisms of overeating. The purpose of this research is to delineate differences in neural response to food stimuli of varying caloric value during fasting and satiation. Eleven lean adults (mean body mass index=22.37; 5 male) completed an fMRI block-design task with 3 conditions: high-calorie food (HI), low-calorie food (LO), and nonfood objects pre- and postmeal. In addition to T1-weighted and high-resolution 3D images, functional images were acquired on a 4.0T MR scanner (TR=1950, TE=22ms, flip angle=90). Group data sets were examined using GLM analysis contrasting the experimental conditions. Findings indicated greater activation to HI vs. LO during fasting in the orbitofrontal cortex (OFC), superior frontal gyrus, and amygdala ($p < .01$ corrected). Postmeal activations to HI vs. LO include the anterior cingulate and middle frontal gyrus ($p < .05$ corrected). Direct comparison of motivational salience (HI vs. LO) by hunger state (fasting vs. satiation) indicates greater activation in the OFC and amygdala to high-calorie foods during hunger. These results indicate increased activation in regions involved in food motivation, taste information processing and reward learning during hunger, when rewarding foods are most salient. These preliminary findings give insight into the effect of rewarding foods on the underlying neural mechanisms of food regulation during different hunger states. Understanding the effect of food reward during hunger and satiety may inform mechanisms of overeating and obesity in the general population.

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GENERAL VERSUS TASK-SPECIFIC ASSESSMENT OF ONE'S COGNITIVE ABILITIES. A MULTIDIMENSIONAL APPROACH OF THE METACOGNITIVE MONITORING

Audrey Perrotin¹, Amynta Hayenga¹, William Jagust^{1,2}; ¹Helen Wills Neuroscience Institute, ²University of California, Berkeley, CA, ³Lawrence Berkeley National Laboratory, ⁴Molecular Imaging and Neuroscience, Berkeley, CA – Metacognitive monitoring encompasses two broad dimensions: assessment of one's general cognitive abilities (off-line monitoring), and assessment of one's performance at a cognitive task (on-line monitoring). Moreover, metacognitive judgments can also be assessed in terms of accuracy relative to actual performance. Objectives- (1) To explore processes underlying the two monitoring forms, by observing their association with depressive affect, and global and more specific cognitive processes (episodic memory and executive functioning). (2) To examine the relationships between the two monitoring forms. Method- Healthy older adults (192 subjects) were assessed on metacognitive measures: general memory self-reports (off-line monitoring), and judgment of performance after different cognitive tasks (on-line monitoring). Subjects were also tested on a depression measure, and on neuropsychological measures evaluating global cognition, memory and executive functioning. Results- Correlations revealed that both off- and on-line monitoring judgments were specifically related to the depression measure, whereas both accuracy indexes were related to the global cognition measure. Regression analyses showed that memory abilities were the main determinant for the off-line monitoring accuracy, and executive abilities the best predictor for the on-line monitoring accuracy. Strong correlations were observed between the off- and on-line monitoring measures. Conclusion- Whatever the monitoring form, it appeared that metacognitive judgments and accuracy may rely on distinct factors. The accuracy index may nevertheless depend on different cognitive processes according the monitoring form. Moreover, the overlap between off- and on-line monitoring supports the view of a general monitoring ability. These results are considered in light of neuroanatomical data.

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USING FUNCTIONAL CONNECTIVITY TO MAP CONCEPTUAL CIRCUITS IN THE BRAIN *W. Kyle Simmons¹, Mark Reddish¹, Alex Martin¹*; ¹Laboratory of Brain and Cognition, NIMH/NIH – Thinking about people or tools elicits activity in distinct neural circuits. Evidence indicates that the constituent regions in these circuits represent properties that are salient in social- and tool-interactions. It remains unclear, however, whether the co-activation of regions within each circuit reflects accessing property-related information due to task demands, or their intrinsic connectivity. To address this question, we identified social- and tool-related activations in the posterior superior temporal sulcus and middle temporal gyrus respectively by scanning subjects while they learned facts about people and tools. Next we used the functionally localized regions as seeds in functional connectivity analyses of data collected while subjects engaged in a separate vigilance task scan. Importantly, regions within the social and tool-use networks maintained their connectivity with one another even though subjects were engaged in the vigilance task, and so were not thinking about people or tools. Thus, the social- and tool-property circuits identified in earlier research are not simply manifested during social or tool information processing tasks. Rather, they are "hard circuits" that are continuously present in the brain, irrespective of whether a person is thinking about others, or tools, at a given moment.

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THE DEFAULT NETWORK CONTRIBUTES TO INFERENCES ABOUT THOSE CLOSEST TO US *Fenna M. Krienen^{1,2}, Jessica R. Andrews-Hanna^{1,2}, Randy L. Buckner^{1,2,3}*; ¹Harvard University, Psychology, ²Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, MA, ³Howard Hughes Medical Institute at Harvard University, Cambridge, MA – The ability to consciously represent our own mental states and the mental states of other agents is one of the most intriguing human capacities (Frith & Frith, 2006). Many have noted the striking overlap of brain regions involved in social cognition and self-relevant mentation with regions comprising the "default network," a brain system that is found to be active during passive or "resting" task states (Gusnard and Raichle, 2001; Buckner et al, 2008; Schilbach et al., 2008). Here we investigate networks involved in mental state inference about others. "Others" varied on the dimension of familiarity (friends, strangers) as well as perceived similarity to the self, a dimension previously found to dissociate neural contributions to social inference (Mitchell et al, 2006). Healthy young adults (n = 28; 11 male) were scanned using fMRI while making inferences about targets' beliefs and preferences. Whole-brain analyses revealed dissociations between self, familiar, and unfamiliar others. Core default network regions were recruited when considering the self and familiar others. Making inferences about unfamiliar others resulted in an overall reduction in default network activation, with an increase in activation in additional regions. A region of interest analysis using default network regions derived from an independent dataset revealed that self and familiar others dissociated from unfamiliar others in a subset of regions, including posterior cingulate and medial prefrontal cortex. Our results suggest that the default network supports mentalizing about others in a manner sensitive to the target's relevance to the self.

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THE NEURAL CORRELATES OF VISUAL AND VERBAL COGNITIVE STYLES *David Kraemer¹, Lauren Rosenberg¹, Sharon Thompson-Schill¹*; ¹University of Pennsylvania – Cognitive styles, thought to reflect an individual's preferred mode of processing information, are believed to affect the way individuals learn, recollect, and reason. However, little direct evidence currently exists to link cognitive styles to specific neural systems. In the present study, visual and verbal cognitive styles were measured both by objectively quantifiable tests of cognitive abilities and self-report measures of processing style preference. During fMRI scanning, participants took part in a novel task involving both word-based and picture-based feature matching conditions. Results dem-

onstrate neural correlates of visual and verbal cognitive styles in brain areas that process visual and phonological information. Specifically, activity in a region that preferentially responded to viewing pictorial stimuli (R fusiform gyrus) correlated with self-reported Visualizer ratings. Likewise, activity in a phonology-related brain region (L supramarginal gyrus) correlated with self-reported Verbalizer ratings. These findings suggest that domain-specific cortical activity underlies processing in visual and verbal cognitive styles.

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OUT OF HAND: HOW EXPERIENCE AND RACE MODULATE NEURAL CORRELATES OF GESTURE OBSERVATION *Sook-Lei Liew^{1,2}, Lisa Aziz-Zadeh^{1,2}, Shihui Han³*; ¹Brain and Creativity Institute, University of Southern California, ²Division of Occupational Science and Occupational Therapy, USC, ³Peking University, Psychology, China – What are the neural correlates of gesture? How are they modulated by the race of the actor or by one's familiarity with the gesture? Recent neuroimaging findings suggest that gestures are processed in part by a mirror system that is active both when we observe and execute a given action. This system may be modulated by experience and beliefs about the other person. In this study, we used fMRI to examine the neural activation associated with observing both familiar and unfamiliar intransitive cultural gestures, such as a thumbs up or the word apple in American Sign Language. Due to the modulatory role of experience, we hypothesized that observing familiar gestures would generate distinct neural patterns from unfamiliar gestures in premotor and parietal regions important for action observation. Additionally, we asked whether physical similarity (i.e. same vs. different race) with the observed actor would affect activity in these regions. Eighteen Chinese participants viewed Chinese or Caucasian actors performing familiar or unfamiliar gestures while in the MR scanner. Our results suggest that while both familiar and unfamiliar gestures show activity in sensorimotor regions, familiar gestures activate areas associated with semantic processing (anterior temporal lobe) and emotional processing (insula), while unfamiliar gestures activate areas associated with action monitoring (superior parietal lobe, cerebellum). Additionally, we found a significant interaction between race of actor and familiarity of gesture, which suggests the importance of social context on simulation mechanisms and action understanding for Chinese subjects.

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IS NEURAL ENCODING OF RACE MANDATORY? AN ELECTROPHYSIOLOGICAL INVESTIGATION *Yina Ma¹, Shihui Han¹*; ¹Peking University, Psychology, China – Previous behavioral studies suggest that, although race encoding is independent of task demands, it is not inevitable and can be erased by manipulating coalition. The current work investigated whether alliance-related social attitudes modulate neural encoding of race by recording event-related potentials (ERPs) to racial ingroup and outgroup faces in a face orientation identification task. We found that an early frontal negativity (N100) differentiated outgroup and ingroup faces of the models when they had behaved aggressively but not when they had behaved amicably towards the observer. Moreover, the N100 amplitude correlated with participants' attitudes toward the models. The long-latency ERP components (N200 and P300) differentiated outgroup and ingroup faces of the models only when they had behaved amicably towards the observer. The ERP results indicate that neural encoding of race depends on observers' alliance-related social attitudes rather than occurring mandatorily.

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NEURAL OSCILLATIONS IN ASSOCIATION WITH SELF-REFLEXIVE THINKING *Yan Mu¹, Shihui Han¹*; ¹Peking University, Psychology, China – Previous behavioral studies indicate that self-related trait words are better remembered than those related to others. However, the neural mechanisms underlying this self-referential effect remain undefined. The current study explored whether the neural activity involved in encoding self-related trait may predict the individual differ-

ence in the self-referential effect during memory retrieval. The electroencephalogram (EEG) was recorded from 14 healthy adults while they made judgments of personality traits referenced to the self or to a public person. Subjects were given a memory test after the EEG recording session. To examine the relation between the non-phase-locked neural activity linked to encoding of self/other traits and the behavioral performances during the memory test, the time-frequency power of theta band (5-7Hz) and alpha band (8-13 Hz) neural activity was calculated within each 100-ms time window using Wavelet transform analysis method. We found that, relative to other-referential traits, self-referential traits induced reduced theta band power at 300-400ms but increased theta band power at 700-800ms. Alpha band (8-10Hz) power was stronger in the self- than other-referential conditions at 400-600ms. Moreover, we found that the frontal theta band activity at 700-800ms increased to negative than positive traits when referenced to the self. Most importantly, the frontal theta band activity at 700-800ms positively correlated with individuals' self-advantage in the recognition scores in the memory test. Our findings indicate that both theta and alpha neural oscillations differentiate the encoding of self- and other-referenced traits and theta band activity contributes to the individually differences in self-referential effect.

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THE EMOTIONAL EMBODIMENT DURING EXPERIENCING PROTAGONISTS' PHYSICAL ACTIVITIES IN NARRATIVE COMPREHENSION

Hidetsugu Komeda^{1,2}, Norihiro Sadato^{1,3}; ¹National Institute for Physiological Sciences, ²Japan Society for the Promotion of Science, ³Japan Science and Technology Agency – Readers construct mental representations associated with their experiential traces, such as motor and emotional representations in narrative comprehension. According to embodied cognition framework (Barsalou, 1999; Zwaan, 2004), understanding words about actions activates action-related brain areas. We used functional magnetic resonance imaging to test our hypothesis that reader's motor representation is activated when judging the increase of protagonists' physical activities. We constructed story-reading tasks, in which situation-sentences describing degree of protagonists' physical activities (low, middle, or high) were presented, followed by the target-sentences with high physical activities, with emotional valences (positive or negative). In high increasing stories about protagonist's physical activities, situation-sentences describe low activities and target-sentences do high activities. Low increasing stories starts from middle activities and result in high activities. Non-increasing stories are high activities consistently. Thus, the task was a 3 x 2 factorial design: the effect of degree of physical activities (high, low, and non-increase) and the effect of stories' emotional valences (positive vs. negative). The activation related to the target-sentence was positively correlated with the degree of increases in physical activities in the supplementary motor area, premotor cortex, primary motor area, dorsomedial prefrontal cortex, and supramarginal gyrus. As the supplementary motor and premotor cortex represents motor imaginary, they were activated in all stories about protagonists' physical activities. In the case of positive stories, medial orbitofrontal cortex and dorsomedial prefrontal cortex were activated. In conclusion, understanding protagonist's physical states activates reader's motor representation. In addition, medial orbitofrontal cortex is involved in the embodiment of emotions (Kringelbach, 2005).

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ACTION IDENTIFICATION: ITS NEURAL AND GENETIC CORRELATES

Abigail Marsh^{1,2}, Megan Kozak³, Maggie Reid², Henry Yu², Daniel Wegner⁴, R.J.R. Blair²; ¹Georgetown University, Psychology, ²National Institute of Mental Health, Mood & Anxiety Program, ³Pace University, Psychology, ⁴Harvard University, Psychology – Mentalization is the process by which an observer views a target as possessing higher cognitive faculties such as goals, intentions, and desires. The extent to which observers attribute these cognitive faculties to other actors can be assessed using action identification paradigms, in which observers select

either mentalistic or mechanistic descriptions of targets' actions (Vallacher & Wegner, 1985). Although action identification overlaps conceptually with Theory of Mind, little is known about the neural or genetic correlates of action identification. We conducted an action identification paradigm with 15 healthy adults during fMRI scanning in a three-run event-related task. These adults completed the Autism Quotient scale upon completion of the task. We also assessed the relationship between action identification patterns and oxytocin receptor (OXTR) genotype in a separate group of adults. fMRI results revealed, consistent with prior findings, that mentalization was associated with higher level action identifications. The amygdala and extrastriate body area played a role in making higher level action identifications, particularly for more highly mentalized actors. Other structures involved in action identification included ventral premotor cortex, a region of the mirror neuron network, and the temporo-parietal junction. Autism Quotient results and genotyping results supported the link between action identification and Theory of Mind. A reduced tendency to make higher level identifications was associated with higher scores on the Autism Quotient and with the OXTR allele previously associated with autism. In conclusion, the current data provide evidence for neural and genetic correlates of action identification.

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COGNITIVE PROCESSES IN OLDER ADULTS: POTENTIAL IMPACT OF STRESS AND PHYSIOLOGICAL FUNCTIONING

Irina Fonareva^{1,2}, Daniel Zajdel², Megan Herting¹, Whitney McGee¹, Barry Oken^{1,2}; ¹Oregon Health & Science University, Behavioral Neuroscience, ²Oregon Health & Science University, Neurology – The degree of cognitive deficits varies considerably among older adults, suggesting factors other than age might influence cognitive well-being. Stress level, sleep quality, and cardiovascular autonomic function, have been suggested as mediators of cognitive performance. We explored how these factors influence performance on tasks from different cognitive domains in a sample of older adults. Two groups of healthy seniors of both genders, caregivers for people with dementia and peers without caregiving responsibilities, completed cognitive battery including tests of episodic memory (Word Recall Task), processing speed (Attentional Network Task, ANT), and executive function (Stroop). Participants completed self-reports of stress level, sleep quality, and health status. Additionally, we objectively assessed sleep quality and autonomic physiologic measures including heart rate variability (HRV) using a novel ambulatory device allowing continuous recording of several EEG, ECG, and EOG channels for prolonged periods. Preliminary results revealed no differences in sleep quality parameters or HRV between the groups, but significantly increased self-perceived stress level in the caregiver group, $p=.002$. Using ANCOVA and controlling for age and stress level, we assessed differences in performance on the cognitive tasks between the groups. The analyses revealed that caregivers performed as well as controls on ANT but showed significantly more forgetting on the word recall task, $p < .03$, and made more errors during Stroop Color Interference test than controls, $p = .01$. Our results indicate that in older adults increased stress might mediate performance on critical cognitive domains such as episodic memory and executive function.

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AN FMRI STUDY OF SOCIAL COGNITION IN MEMBERS OF CONFLICT GROUPS

Emile Bruneau¹, Rebecca Saxe¹; ¹MIT, Brain and Cognitive Sciences – The majority of previous neuroimaging studies investigating cross-cultural social cognition have focused on groups that are not actively involved in conflict (e.g. Black and White Americans, Asians and White Americans). Psychological differences that may be contributing to inter-group conflicts around the world today, however, exist between groups that are both actively involved in conflict and not generally socialized to reconcile. To investigate differences in social cognition within individuals of conflict groups, we presented Arab, Israeli and control individuals with Arab and Israeli partisan statements about the Mid-

dle East, and control emotional/unreasonable and nonemotional/reasonable control statements unrelated to the Middle East. Subjects rated the 'reasonableness' of each statement during fMRI imaging. Random effects analysis revealed activation in the posterior cingulate/precuneus (PC) and dorsomedial prefrontal cortex (dmPFC) for unreasonable - reasonable control statements. Using these regions for ROI analysis of all subject groups, we found that activation in the dmPFC for Israeli partisan - Arab partisan statements correlated strongly with both individual response differences in 'reasonableness' of partisan statements and performance on an Israeli-Arab Implicit Association (IAT) test. PC activation was also significantly correlated with the difference in 'reasonableness' of partisan statements. These results suggest that discrete brain regions are involved in the processing of emotionally laden statements, and that these regions are called upon more when emotionally salient partisan statements from an antagonistic out-group are being considered, relative to in-group partisan statements.

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HUMAN BRAIN DYNAMICS ACCOMPANYING THE USE OF EGOCENTRIC AND ALLOCENTRIC REFERENCE FRAMES DURING SPATIAL NAVIGATION Klaus Gramann¹, Julie Onton¹, Scott Makeig¹; ¹Swartz Center for Computational Neuroscience, UC San Diego – To maintain spatial orientation during navigation, spatial information encountered from a first-person perspective is integrated into an egocentric reference frame. Concurrent development of an allocentric or map-like reference frame requires translation of this egocentric spatial information into a viewpoint-independent representation. We recorded high-density electroencephalographic (EEG) data during a virtual tunnel passage task in which near-equal numbers of subjects respond to a subsequent homing challenge in ways compatible with their predominant use of an egocentric or allocentric reference frame. Approaching and during tunnel turns, brain dynamics in temporal, parietal, and occipital cortex exhibited alpha band power decreases, while upper alpha and beta band power increased in somatomotor and theta band power increased in medial frontal cortex. Subjects responding in a way compatible with adoption of an egocentric reference frame exhibited stronger alpha blocking in or near right primary visual cortex, while subjects whose responses were compatible with maintenance of an allocentric reference frame exhibited stronger alpha blocking, implying more intense activation, in occipitotemporal, parietal, and retrosplenial cortical areas known to support visuospatial orienting. Differences in EEG dynamics associated with the use of distinct reference frames during path integration thus include early visual, visual motion, and parietal areas, with additional activation in or near retrosplenial cortex associated with translating egocentric and allocentric information into complementary reference frames. The results confirm and extend results of functional brain imaging studies and demonstrate use of EEG imaging to track brain dynamics during navigation.

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EEG DYNAMICS OF LEARNING IN SOCIAL CONTEXT Ying Wu¹, Scott Makeig; ¹Swartz Center for Computational Neuroscience, UCSD – Learning is both an individual and social process. This study investigates distributed EEG brain dynamics associated with the effects of social interaction on cognitive processes that are critical for learning. High density EEG (133 channels per subject) was recorded simultaneously from pairs of healthy adults as they played a computerized version of the card game, "Concentration," which involves finding matching pairs of hidden values by touching a card image in a grid displayed on a touch-sensitive screen. Players participated in four types of games: competitive, collaborative (versus the computer), and solo (playing or observing). Artifact-free EEG data were submitted to independent component analysis (ICA). Epochs were extracted from component activations time-locked to critical events, such as the appearance of a hidden card value. Event-related spectral perturbation (ERSP) transforms of each epoch were computed. In addition, a context vector was defined for each epoch to characterize socially and cognitively relevant features of the trial context, such as

whether an uncovered hidden value yielded a matched or non-matching pair, whether it was selected by the player or partner, or whether it was selected in a competitive or collaborative game. Single-trial ERSPs and context vectors were combined, then concatenated, and then further decomposed by ICA into a set of independent context factors. We will discuss effects of social context (collaborative, competitive, and solo) on EEG dynamics accompanying performance and performance feedback during working memory and spatial learning.

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CAN IMAGINING OBSERVED BODY MOVEMENTS ENHANCE A NEUROMARKER OF SOCIAL COORDINATION: THE PHI COMPLEX? Stanley Lunde¹, Anthony Carnevale Bonilla², Chloe Boyle³, Mayra Estrada³, Zachary Bogorad³, Jennifer Torres³, Raphael Bernier⁴; ¹Lanterman Developmental Center, Pomona, ²University of California, Irvine, ³California State Polytechnic University, Pomona, ⁴University of Washington – There is increasing evidence for a shared neural substrate (mirror neuron system) involving observed, imagined and executed motor activity. The "phi complex", a possible neural marker of human social coordination (Tognoli et al, 2007), purportedly interacts with the mirror neuron system and has been identified as two narrowband components oscillating in the 9-12 Hz range. This EEG study aimed to determine whether observing body movements can induce phi oscillations, whether imagining while observing might enhance phi, and the relation of phi with alpha and mu. Participants were presented forty 30s video clips of gross motor (swimming) and fine motor (piano playing) body movements as well as control video clips during 10 ~six minute blocks. They were instructed to imagine performing the movements during half of the trials. High-resolution spectral analysis (0.1 Hz steps) of electrical brain activity was necessary to detect the different spectral peaks of alpha, mu and phi. Phi is a lateralized centro-parietal component and thus was analyzed as the power difference between electrode pairs. As expected, both alpha and mu amplitudes decreased during the clips with body movements. Phi tended to increase. It was difficult to detect phi in a number of participants. Participants that played piano exhibited the largest phi, which was enhanced during their imagine condition. Elaborating the roles of mu and phi as components of the mirror neuron system may increase our understanding of social behavior and of neurodevelopmental disorders such as autism.

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NEURAL CORRELATES OF INCONGRUITY-RESOLUTION AND NONSENSE HUMOR Andrea C. Samson¹, Christian F. Hempelmann², Oswald Huber¹, Stefan Zysetz³; ¹University of Fribourg, Psychology, ²Hakia, Inc., New York, NY, ³NordicNeuroLab AS, Bergen, Norway – Cognitive processes of humor comprehension and appreciation are influenced by stimulus characteristics. The resolvability of the incongruity is an important structural stimulus characteristic of humor as it correlates strongly with certain personality characteristics whether incongruity-resolution or nonsense humor is preferred. By means of functional magnetic resonance imaging the present paper analyzes the neural correlates of processing and appreciating incongruity-resolution and nonsense cartoons. In the processing of incongruity-resolution stimuli the incongruity of the joke is largely resolvable, whereas in nonsense stimuli it is only partially resolvable and more incongruity remains. 30 incongruity-resolution and 30 nonsense cartoons were presented to 17 participants in the scanner. The results revealed that the anterior medial prefrontal cortex, bilateral superior frontal gyrus and temporo-parietal junction (TPJ) show more activation during processing of incongruity-resolution than of nonsense cartoons. These differences indicate that processing of incongruity-resolution cartoons requires more integration of multi-sensory information and coherence building, as well as more mental manipulation and organization of information. In addition, less self-reference might be established in nonsense cartoons as it is more absurd and more often deals with impossible situations.

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POWER FUNCTIONS DESCRIBE DYSFUNCTIONS OF AN INTERNAL CLOCK Elaine Wencil^{1,2,3}, H. Branch Coslett^{1,2,4}, Anjan Chatterjee^{1,2,4}, ¹University of Pennsylvania, Center for Functional Neuroimaging, ²University of Pennsylvania, Center for Cognitive Neuroscience, ³University of Pennsylvania, Psychology, ⁴University of Pennsylvania, Neurology – Power function relationships describe normal psychophysical judgments of magnitude estimates, including duration judgments. Such functions can be used to quantify deficits precisely, exemplified by reduced exponents observed in neglect patients' judgments of spatial extent. Since similar networks have been implicated for spatial and temporal processing, we use power function analyses to test the hypothesis that damage to cortical regions such as posterior parietal cortex would impair temporal judgments. Changes in the pulse width within a putative clock mechanism would alter the constant and dysregulation of the accumulator would alter the exponent of these judgments. Sixteen patients with right middle cerebral artery distribution lesions performed a temporal production task. Each trial began with the presentation of a blue square containing a number ranging from 4-15. Participants indicated when the duration (in seconds) corresponding to that number had elapsed. Patients' performances were described by a range of functions; constants varied from 0.43-3.27 and exponents varied from 0.43-1.12. Voxel lesion symptom mapping revealed that changes in each component of these power functions had distinct anatomical correlates. Specifically, 1) a lesion in the posterior superior temporal gyrus correlated with increased constants; 2) lesions in posterior superior temporal and angular gyri correlated with decreased exponents and 3) lesions in posterior and anterior superior temporal, middle and inferior frontal and angular gyri correlated with increased variability. Damage to posterior superior temporal gyrus appears to disrupt the pulse width while damage to the posterior temporal and inferior parietal cortex appears to dysregulate the accumulator in interval timing.

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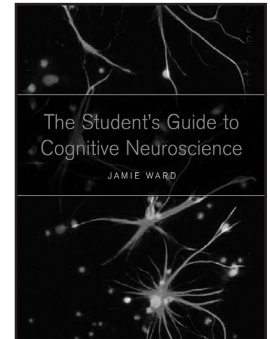
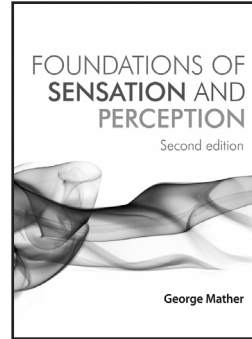
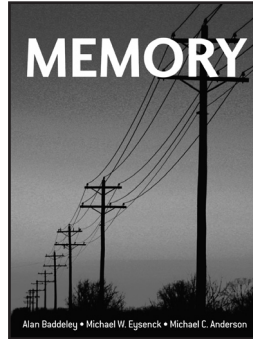
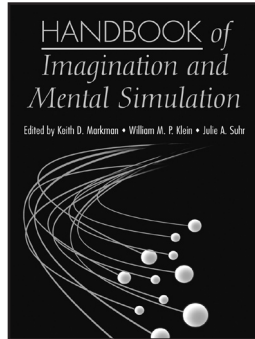
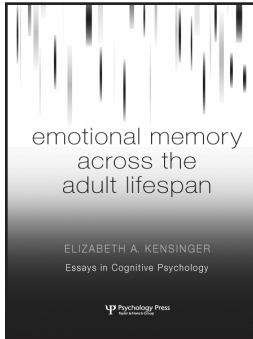
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