Session E

Monday, May 4, 2:00 – 5:00 pm, Exhibit Hall C

E1 Neural networks supporting memory-guided and cued attention in children: Mechanisms explaining the achievement gap

Maya Rosen, Harvard University, Lucy Lurie, Harvard University, Kelly Sambrook, University of Washington, Andrew Meltzoff, University of Washington, Katie McLaughlin, Harvard University

Academic activities engage complex sets of cognitive processes including perceptual processing, attention, and memory. Variation in socioeconomic status (SES) may impact development of the neural systems that support these processes which in turn may contribute to the income-achievement gap. Cued attention is the ability to use an external visual cue (e.g. an arrow) to direct attention to an important location in the environment while memory-guided attention is the ability to use past experience to direct attention. In the present study, we use functional MRI to investigate the neural networks that support these two critical aspects of healthy cognitive function and the relation of these systems to SES and academic achievement in school-aged children (n = 63, aged 6-8 years). Results revealed that like adults, children demonstrated greater activation in the lateral occipital cortex and other regions of the ventral visual stream (VVS) during cued attention compared to memory-guided attention. Children also demonstrated greater activation in the precuneus, a key node of the default mode network, for memory-guided attention compared to cued attention. Moreover, results revealed SES-related differences in recruitment of the anterior insula during the cued attention, but not memory-guided attention. Critically, recruitment of the VVS during both cued and memory-guided attention was associated with academic achievement and activation in this region explained SES-related differences in academic achievement. These findings extend previous work by highlighting the role of visual processing regions in complex cognitive functions to support children as they make the transition to school.

Topic Line: ATTENTION: Development & aging

E2 Relationships between age-related changes in attention span and anticipatory neural activity

Alexander Simon, UCSF, Joaquin Anguera, UCSF, Courtney Gallen, UCSF, David Ziegler, UCSF, Adam Gazzaley, UCSF

Sustained attention is the ability to maintain attention over time. Previous research has characterized how performance on such tasks changes with age, as measured by response time (RT), response time variability (RTV), and accuracy (e.g., D'). However, age-related changes in the duration that someone is able to maintain a stable focus of attention (attention span) remains unknown. Here, we sought to 1) develop a metric for characterizing attention span, 2) uncover how it changes during normal aging, and 3) uncover the neural correlates that facilitate maintaining an attention span, and how those change with aging. Here, 90 healthy young adults (age range: 18-35 years) and 93 healthy older adults (age range: 55-80 years) performed a go/no-go task while EEG was recorded. Attention span was computed by calculating the amount of time that a participant was able to keep RTs within 1 standard deviation from their mean RT without making an error. We found that while attention span declined with age, RTV, RT, and D' did not. Trial-wise time-frequency analysis of the EEG revealed that attention span is related to the ability to consistently reduce posterior alpha power during the pre-stimulus period in both younger and older adults. Additionally, these age-related changes in attention span are related to changes in anticipatory neural activity. Future work will involve relating attention span metrics to populations with sustained attention deficits, such as in kids with ADHD and older adults with mild cognitive impairment.

Topic Line: ATTENTION: Development & aging

E3 Neural oscillatory dynamics in directed and divided attention

Marie McCusker, , Marie McCusker, University of Nebraska Medical Center, Alex Wiesman, University of Nebraska Medical Center, Tony Wilson, University of Nebraska Medical Center

The spatial location of cortical regions serving directed and divided attention has been extensively studied using a myriad of methods, including functional neuroimaging. However, research on the dynamic patterns of neural activity underlying attention is relatively sparse. An enhanced understanding of this topic is important since spectrally-distinct patterns of neural oscillatory activity are thought to underlie numerous cognitive and behavioral processes, including attention. Using high-density magnetoencephalography (MEG) and a visual-somatosensory oddball task, we investigated the oscillatory dynamics of both directed (Experiment 1; N = 26) and divided (Experiment 2; N = 32) visual attention. All sensor-level MEG data were first analyzed in the time-frequency domain, and significant neural responses relative to baseline were imaged via beamforming for whole-brain analyses. Generally, we found that multi-spectral neural oscillatory responses were stronger when visual attention was sustained relative to when it was directed away or divided between sensory modalities. More specifically, we found stronger frontal theta (4 - 8 Hz), frontal and occipital alpha (8 - 14 Hz), occipital beta (16 - 22 Hz), and frontal gamma (74 - 84 Hz) responses when visual attention was sustained than when it was directed away from the visual domain. Similarly, in divided attention, we observed stronger frontoparietal theta activity and occipitoparietal alpha and beta oscillations when visual attention was sustained toward the visual stimuli than divided between the visual and somatosensory domains. Quantifying neural oscillatory activity in humans is essential for better understanding how attention is implemented in the brain and becomes dysfunctional in disease.

Topic Line: ATTENTION: Multisensory

E4 Prestimulus alpha modulation during a semantic judgement task

Lisa Payne, Rutgers University, Many Jiwjinda, Swarthmore College, Chad Dubé, University of South Florida

Cortical alpha band oscillations (8 - 14 Hz) have been used as a marker of attentional control for sensory stimuli. Increase in alpha oscillations over auditory, visual and somatosensory brain regions is believed to represent suppression of task irrelevant information. The purpose of this study was to examine electroencephalogram (EEG) alpha modulation during selective attention to visual, verbal information. On each trial of the task, two words were briefly presented in sequence. A green or red fixation cross preceding each word cued whether that word should be remembered or ignored, respectively. Following this sequence presentation, participants judged whether a probe word was related to the to-be-remembered word. Consistent with visual selective suppression, ignoring words also led to increased alpha activity over parietal and occipital regions. However, when ignoring the first word was compared with attending the first word, increased alpha emerged over left-lateralized parietal and temporal regions involved in word recognition. These results indicate that there might be more to suppressing printed words than just visual sensory inhibition and that mechanisms reflected by alpha oscillations might play a role in selective attention for verbal information.

Topic Line: ATTENTION: Nonspatial

E5 Attentional control as a potential mechanism linking worry and error monitoring: An event-related potential study

Anthony Cruz, Ohio University, Kevin Saulnier, Ohio University, Annmarie Huet, Ohio University, Nicholas Allan, Ohio University

Error-related negativity (ERN) is an event-related potential (ERP) indicative of error monitoring. Individuals with elevated worry demonstrate heightened ERN, reflecting a stronger reaction following the commission of an error. Worry also negatively impacts an individual's ability to regulate attention (i.e., attentional control [AC]). Occipital alpha activity, an EEG measurement typically derived from a resting state task, has been used as a neurophysiological measure of AC. However, the joint relation among worry, AC, and the ERN is unclear. Given worry impairs AC, it may be that reductions in AC explain the relations between worry and the ERN. Analyses were conducted in a sample of 68 community adults (M age 29.55, 67.7% female) to determine if the relation between worry and the ERN was explained through AC. Participants completed self-report measures of worry and AC, occipital alpha was captured during a resting state task, and the ERN was derived during a flanker task. Separate path analytic models were then conducted to test whether worry was related to the ERN through AC (both self-reported and occipital alpha). There was a marginally significant indirect effect of worry on the ERN through self-reported AC (B = .38, 90% CI: [.04,.75]). However, there was no indirect effect of worry on the ERN through occipital alpha (B = -.01, 95% CI: [-.15,.12]). These results indicate that the relation between worry and error monitoring may be mediated by self-reported AC. Finally, more research is needed to establish convergence across self-report and neurophysiological indicators of AC.

Topic Line: ATTENTION: Other

E6 Perceptual distraction disrupts the filter that gates visual working memory access

Blaire Dube, The Ohio State University, Julie Golomb, The Ohio State University

Given the complexity of our visual environments, a number of mechanisms help us prioritize goal-consistent information. When searching for a friend in a crowd, for instance, visual working memory (VWM) maintains a representation of your target (i.e., your friend's blue shirt) so that attention can be subsequently constrained to elements of the environment sharing its features. When distracting (i.e., unexpected/salient) information appears, however, attention is captured, increasing search time. Although the effect of distraction on search times is heavily studied, we know little about its consequences for the mechanisms that support behavior and the filters that underlie their efficient use. Does distraction also disrupt the VWM filter that restricts storage of irrelevant information? On each trial, participants performed two consecutive visual searches. In the first (S1), they located a target (T) among non-targets (Ls), all presented within colored squares. On 40% of trials, a distracting white border flashed briefly surrounding a non-target square-we asked whether the (task-irrelevant) color associated with this S1 distractor would be encoded into memory. In the second search (S2), participants located a uniquely oriented landolt stimulus among homogeneously colored non-targets. One item was uniquely colored and, critically, its color sometimes matched the S1 distractor. We observed memory-driven capture in this critical S2 condition-that is, response times increased relative to when this unique item matched a non-target, non-distractor S1 color. We suggest that distraction disrupts the filter that regulates VWM encoding, resulting in the encoding of irrelevant inputs at the time of capture.

Topic Line: ATTENTION: Other

E7 Trait anxiety modulates event-related potentials to alcohol images in social drinkers

Alyse Finch, , Allison Zborowski, Texas State University, Scott Oettli, Texas State University, Natalie Ceballos, Texas State University, Reiko Graham, Texas State University

The transition to college is a stressful time accompanied by exposure to alcohol, increasing the risk for problem drinking. Reactivity to alcohol is thought to play a role in problem drinking, resulting in cravings and alcohol-seeking. However, individuals differ in the cue reactivity that they exhibit and less is known about these differences. This study examined the role of trait anxiety in event-related potentials (ERPs) to images of alcoholic and non-alcoholic beverages using a Go/No-Go paradigm. ERPs were recorded in 23 social drinkers (5 males, 18 females; mean age = 22.0 years), who completed a Go/No-Go task using images of preferred alcoholic and non-alcoholic (control) beverages. Self-

report measures included state and trait anxiety, alcohol consumption, impulsivity and reward sensitivity. A median split was used to create high- (n = 11) and low-anxiety (n = 12) groups. N2 latency was not affected by target type (alcohol vs. control) or Go/No-Go status, whereas the P3 peaked earlier for alcohol Go trials relative to alcohol No-Go trials. P3 latency was also modulated by stimulus type and state anxiety, such that individuals with high state anxiety had shorter P3 latencies and low-anxiety participants had shorter P3 latencies to alcohol. Analysis of N2 amplitudes revealed that the N2 was larger for No-Go trials. P3 amplitudes were larger for non-alcoholic images and for No-Go trials. Our results suggest that the N2 is sensitive to behavioral inhibition, while the P3 component is sensitive to individual differences in trait anxiety, stimulus type, and response status.

Topic Line: ATTENTION: Other

E8 Withdrawn

E9 Withdrawn

E10 Are attention-related modulations of alpha-band dynamics local or global?

Mattia Pietrelli, UW Madison, Jason Samaha, UC Santa Cruz, Bradley Postle, UW Madison

Research on endogenous attention has shown that predictive cues about the location and timing of forthcoming visual stimuli can influence behavior and several stages of neural processing. One proposed neural mechanism is that spatial and temporal predictions are influence the processing of visual stimuli by hijacking ongoing alpha-band oscillatory activity in brain areas involved in visual perception. However, it is not known if this top-down modulation of alpha oscillatory activity is selective for the circuits that represent target locations, or if it more broadly influences the physiological tone of the representation of the entire visual field. To answer this question, we manipulated spatial and temporal predictability during a Posner-style visual discrimination task, in which, within a block, stimuli could only appear in two of the four cardinal locations (i.e., either left-right or top-bottom). Consequently, in each block, two locations were task-relevant while the other two were task-irrelevant. Inverted encoding modeling (IEM) was used to isolate patterns of alpha-band activity specific to each of the four locations. Results showed that top-down expectations biased alpha-band power in a target location-specific manner, suggesting that alpha-band oscillatory activity can be controlled within discrete, local networks in order to optimize visual perception. Furthermore, periodic waxing waning of IEM reconstructions between cued and uncued location, consistent with the idea that alpha oscillatory activity sampled the two task-related locations rhythmically.

Topic Line: ATTENTION: Spatial

E11 Age-related differences in the statistical regularity of emotional faces

Yi-Wen Kao, National Taiwan University, Taiwan, Hsing-Hao Lee, National Taiwan University, Taiwan, Joshua Oon Soo Goh, National Taiwan University, Taiwan, Su-Ling Yeh, National Taiwan University, Taiwan

Greater prior experience increases the contribution of statistical regularity on neurocognitive processing. We hypothesized that older adults have more experience and exposure to facial emotional expressions than younger adults and thus tend to make farther facial expression predictions. In a functional magnetic resonance imaging (fMRI) experiment, 19 young adults (mean±SD=22.6±3.01 years old) and 19 older adults (mean±SD=66.3±3.74 years old) viewed picture quartets of a sequence of facial expressions that changed in 10% intervals (i.e., 0%, 10%, 20%, 30%) from neutral to either a happy or disgusted face. A fifth target face was then presented that was either a 49% or 99% morph of the same or different emotion. Participants then responded whether the target met their expectation for the face that would immediately follow the quartet. Discrimination between 49% and 99% morphs was lower in older than younger adults when target emotions were congruent with quartets. Interestingly, target endorsement was generally higher in older than younger adults for happy than disgusted faces. Neural responses were higher for 49% than 99% morphs in younger than older adults in left inferior parietal areas but higher for 99% than 49% morphs in older than younger adults in left precentral areas. Generally, supportive of our hypothesis, our findings suggest that older adults make less distinctions between minute degrees of emotional expression levels. Furthermore, older adults prefer positive emotions to negative emotions, consistent with socioemotional selectivity theory. Such a behavioral effect of age might involve lower contributions from perceptual processing and more dominant top-down processing.

Topic Line: EMOTION & SOCIAL: Development & aging

E12 Different oscillatory networks underlie reward processing of novel and familiar music

Alberto Ara, University of Barcelona, Josep Marco-Pallarés, University of Barcelona

Recent accounts have unveiled the brain interactions underlying music-reward processing. These include functional connectivity between right frontal and temporal areas, as well as the striatum. Until very recently, however, the temporal dynamics of these interactions had remained unexplored. In a recent study, we pinpointed that phase synchronization between right frontal and temporal nodes increases with greater music-evoked pleasantness in the theta oscillatory band. Nonetheless, the interaction of this effect with familiarity has not been accounted for. In the present EEG experiment we studied phase synchronization with temporal electrodes in the theta band as a function of music-evoked pleasantness moderated by familiarity. Twenty-two participants listened to and rated 30 novel and 30 familiar music excerpts 24 h after an exposure session. We replicated the effect of increased synchronization between right frontal and temporal nodes in the theta band with music-evoked pleasantness only in the case of novel music. With familiar music, instead, we found greater synchronization between right temporal and left parietal nodes. Importantly, similar connections exhibited the opposite effect when music was novel. Overall, we conclude that different brain

mechanisms underlie music-reward processing depending on familiarity. We theorize that when music is novel, predictive coding mechanisms come into play when assigning value to music, whereas memory retrieval takes over when listening to familiar music.

Topic Line: EMOTION & SOCIAL: Emotional responding

E13 Deep and surface feature representations of affective dimensions in the human brain

Saeedeh Sadeghi, Cornell University, Xinyi Li, Cornell University, Junichi Chikazoe, Japan National Institute for Physiological Sciences, Eve DeRosa, Cornell University, Adam Anderson, Cornell University

Interpreting semantic content of visual emotional stimuli is computationally demanding and requires high-level cortical processing. However, recent evidence shows that basic visual features such as the frequency spectra of images, have above chance power to predict affective value. Here we ask if there are distinct representations in the brain for shallow features from deep content analysis in deriving affective value. In an fMRI experiment, Images (n=128) selected from the International Affective Picture System (IAPS) database were displayed to participants (n=20) during BOLD imaging. Following each trial, participants rated their positivity and negativity on two separate scales. Subjective arousal was defined as positivity + negativity. From each image we extracted eighty visual features derived from spatial frequency amplitudes. In a first set of analysis, all images in the IAPS database were used as training data for a random forest regression model that estimated arousal values. This model was then used to predict arousal of the experimental images ($p < 0.001$). ROI analysis revealed that the medial Prefrontal Cortex, and Orbitofrontal Cortex were specific to rated arousal, the amygdala and inferior Lateral Occipital Complex were correlated with both arousal and visual arousal, whereas the occipital pole was only related to visual arousal. These results support representations of affect both as a deep subjective experience but also separately as shallow perceptual visual features.

Topic Line: EMOTION & SOCIAL: Emotional responding

E14 Alterations in the Sympathetic Nervous System Reflecting Challenge and Threat When Confronted with Failure or Success

Viktoriya Babenko, University of California, Santa Barbara, Neil M. Dundon, University of California, Santa Barbara, Evan Layher, University of California, Santa Barbara, Scott T. Grafton, University of California, Santa Barbara

The biopsychosocial (BPS) model of challenge and threat states that a change in perception of a situation and of a person's capabilities can lead to one of two physiological states, either 'challenge' or 'threat'. These differing states, previously explained by individual differences and shown to alter with task difficulty, have been associated with task performance, anticipatory worry, and mindfulness. This study incorporates a false feedback manipulation to examine whether participants' sympathetic nervous system (SNS) response can be altered as a function of trial by trial performance feedback rather than reward or task difficulty. A modular math calculation task required participants to respond as quickly and accurately as possible while undergoing cardiovascular monitoring. A combination of electrocardiogram and impedance cardiography data estimated pre-ejection period (PEP) to define quantitative changes in SNS along with total peripheral resistance (TPR) to characterize trialwise stress responses as either 'challenge' or 'threat'. As positive feedback began to decline in an otherwise bountiful interval, significant decreases in PEP ($p < 0.01$) reflecting increased SNS activity were observed, suggesting declining fortunes in what was a positive state activates the SNS. In contrast, when receiving persistent negative feedback participants showed a response characteristic of 'threat' with high TPR ($p<0.01$) and when presented with exceptionally positive feedback they had a 'challenge' response, characterized by low TPR ($p<0.01$). With these results, we demonstrate, on a remarkably rapid time scale, that individuals can alter between states of challenge and threat on a trial by trial basis in relationship to perceived performance.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

E15 Effects of stress-related changes in pre-encoding intrinsic connectivity on subsequent emotional memory biases

Jaclyn Ford, Boston College, Sara Y. Kim, University of Notre Dame, Sarah Kark, UC Irvine, Ryan Daley, Boston College, Jessica Payne, University of Notre Dame, Elizabeth Kensinger, Boston College

Exposure to a stressor immediately before experiencing an event can influence how that event is later remembered. In the current study, we examined the hypothesis that acute stress affects memory by altering the underlying brain state of individuals prior to encoding. Specifically, we examined whether stress-related changes in intrinsic functional connectivity are related to subsequent emotional memory performance and valence biases. The reported data are from 25 participants (age 18-27; 15 female) who underwent a psychosocial stressor before an incidental emotional memory encoding task. Cortisol samples and resting state functional connectivity scans were obtained before and after the stressor to measure individual differences in stress-reactivity and to evaluate stress-related changes to intrinsic connectivity of the left and right amygdala. The primary analysis examined how stress-reactivity predicted change in amygdala connectivity and how such reactivity-related connectivity changes interact with memory bias (negative bias = greater effects for negative relative to positive memory; positive bias = greater effects for positive relative to negative memory). Although greater stress-reactivity was not associated with changes in amygdala connectivity patterns, there was a reactivity-by-memory bias interaction ($p < .005$). For participants exhibiting greater stress reactivity, negative memory bias was associated with increased connectivity between the amygdala and posterior visual regions whereas positive memory bias was associated with increased connectivity with a more widespread network including prefrontal, medial temporal, and parietal regions. The findings suggest that reactivity

to a stressor is associated with changes in intrinsic functional connectivity that have downstream effects on emotional

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

E16 Decoding semantic content from EEG

Zoa Glab, Loyola University Chicago, Laura Stockdale, Loyola University Chicago, Brigham Young University, Sylena Wilson, Loyola University Chicago, Marley Hornewer, University of Michigan, Sydney Samoska, Loyola University Chicago, Joseph Vukov, Loyola University Chicago, Rebecca Silton, Loyola University Chicago, Robert Morrison, Loyola University Chicago

Past studies from our lab have shown that short-term and chronic exposure to media violence can modulate the implicit processing of emotional faces (Stockdale et al., 2015, 2017). However, other research has shown that media violence can increase the speed and accuracy of identifying angry faces when participants are explicitly asked to attend to emotion. To investigate how media violence interacts with attention to emotional stimuli, we asked participants to complete a stop-signal task (SST) with happy and angry face stimuli, while they either categorized the gender (Implicit SST; n = 47) or the facial expression (Explicit SST; n = 40). Prior to completing the SST, participants watched a violent and non-violent film one-week apart in counterbalanced order. RT and SST accuracy did not differ based on film condition during the explicit version of the task. However, during the implicit task, exposure to the violent video eliminated differences in gender classification between happy and angry faces, once again showing the desensitizing effects of media violence on emotional face processing. A similar pattern emerged in N170 amplitudes, where violent film exposure eliminated differences between happy and angry faces when participants watched a non-violent clip. Media violence did not impact performance in the explicit task; however, processing angry faces received increased resources as measured by both increased angry face RT and increased amplitudes and delayed peak P100 and N170 latencies. These results suggest that short-term exposure to media violence differentially impacts emotional face processing depending on whether emotion processing receives focused attention.

Topic Line: LANGUAGE: Semantic

E17 *Brain-Behavior Connections in ASD: Making Sense of Neural Activity in Emotion Recognition and ToM*

Yu Han, University of Vermont, Patricia Prelock, University of Vermont, Emily Coderre, University of Vermont

Children with Autism Spectrum Disorder (ASD) often struggle with social interactions and connecting with others due to deficits in theory of mind (ToM). In this study, we will collect behavioral and neuroimaging data for children with and without ASD, particularly in the areas of emotion recognition and understanding which are key skills required for meaningful social interaction. The research will use these measures to determine which brain systems contribute to behavioral functions associated with ToM. Insights derived from clarifying the neural systems involved in ToM surrounding desire-based emotion and more complex emotions (i.e., surprise and embarrassment) are expected to facilitate improvement in the diagnosis, design and target of intervention methods for the population. The study will include 40 children (7 to 14 years of age), 20 children with ASD and 20 neurotypycal children (NT). We will use two novel fMRI paradigms. The first is an fMRI Emotion Recognition task to assess recognition of less well studied basic and complex emotions (i.e., surprise, embarrassment) requiring ToM using a series of visually presented faces. The second is an fMRI ToM task developed to assess desired-based emotions, in which participants are required to infer the reaction of a cartoon character to a gift using knowledge provided about the preferences of that character. Results showed that the two novel fMRI tasks elicited brain activations in ToM related brain areas (e.g. anterior cingulate, prefrontal cortex), and ASD and NT groups demonstrated different brain activation patterns.

Topic Line: EMOTION & SOCIAL: Emotion-cognition

E18 The Emotional Regulation Effect of Cognitive Reappraisal and Psychological Anticipation on Behavior Inhibition

Xiaoli He, NingXia University, Lichen Zhou, NingXia University, Sha Xu, NingXia University, Jiaxu Gu, NingXia University

Conflict, a common social interaction behavior, plays an essential role in the development of human society. Negative emotions such as anger result from social conflicts have great impacts on individual behavior, which may lead to serious consequences. Regulation of negative emotions can promote behavioral inhibitions and avoid social conflicts. The influence of emotional regulation strategies on behavioral inhibition in specific conflict scenarios, however, has been relatively understudied. 101 participants, who were activated separately to be urban inspector group (51s) and vendor group (50s) by group identity materials, were recruited from NingXia University. The effects of emotional regulation strategies on anger for each group were acquired by MP150 and subjective emotional reports. Influences of emotional regulation strategies on behavior inhibition in the conflict between urban inspectors and vendors were explored by double-choice Oddball paradigm and the advantage of high time resolution of Event-Relatedâ€‚PotentialS (ERP). Participants using different emotional regulation strategies had lower level of anger emotion, skin electricity, and heart rate, compare to those with no emotional regulation strategies, which showed effective regulation of anger emotion in the conflict between urban inspectors and vendors. Participants using emotional regulation strategies showed higher emotional regulation ability and shorter response time to biased stimuli than the free-watch group. The N2 and P3 components in the bias-standard difference wave of behavioral inhibition control process were significant with the participants using emotional regulation strategies, compared to the free-watch group. Compared to psychological anticipation, cognitive reappraisal can reduce anger emotion and inhibit behavior effectively.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

E19 Brain's sensitivity to other's stimuli processing, a potential factor for the similarity of percepts across individuals.

matthieu lenne, Department of Neurology and Neurosurgery, McGill University Department of Psychiatry, McGill University, Amanda Tardif, Department of Neurology and Neurosurgery, McGill University, Bruno J. Debruille, Department of Psychiatry, McGill University

Our perceptual world, the 3D film (Chalmers) created by our brain from information from our receptors, must have its physics, like everything else. A sensitivity to this physics must also exist to account for our reactions to our percepts. Moreover, the others should also be sensitive to this physics, otherwise their brain could not produce percepts similar to ours. Indeed, percepts do not depend closely on brain structures. The visual cortex, for instance, can produce auditory percepts. To test this view of consciousness, we used the fact that, to create similar percepts, this sensitivity of others must be used only for the processing of the same stimulus. We therefore tested whether the event-related potentials (ERPs) evoked by images in simple memorization task depend on a) differences between the stimulus presented to a close other and the one presented to the participant and b) an announcement of these differences that was made just before each block of trials. For each participant to be sensitive only to the percepts created by his partner, and not to his partner's real stimulus or behavioral reactions to it, the two partners were separated by a double glass and a curtain. ERPs were found to depend on the match between the announcement and the actual differences between the stimuli, despite the impossibility for a participant to see the image of his partner. We therefore conclude that a person's brain could be used to detect the physics of the perceptual world of his close others.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

E20 Individual differences in personality traits and meta-traits are associated with features of intrinsic brain networks

Matthew Moore, University of Illinois at Urbana-Champaign, Grace Goodwin, University of Illinois at Urbana-Champaign, Evan Anderson, University of Illinois at Urbana-Champaign, Chris Zwilling, University of Illinois at Urbana-Champaign, Tanveer Talukdar, University of Illinois at Urbana-Champaign, Charles Hillman, Northeastern University, Neal Cohen, University of Illinois at Urbana-Champaign, Arthur Kramer, Northeastern University, Aron Barbey, University of Illinois at Urbana-Champaign

Despite recent progress targeting specific personality traits and the function of particular brain regions, it remains unclear what features of individual differences are associated with large-scale intrinsic networks observed in resting state functional connectivity. Clarifying these associations has important implications for identifying factors that influence cognitive function and socio-emotional well-being. Given that higher-order personality dimensions, or meta-traits, have received relatively little attention, we sought to examine their association with intrinsic connectivity networks. In the present study, the Big Five personality traits and two meta-traits (i.e., plasticity and stability) were examined in relation to the mean participation coefficient (measuring how well distributed the links of a node are among modules) of seven intrinsic connectivity networks, in a sample of 289 healthy adults (18?43 years old, 148 females). Plasticity (meta-trait super-ordinate to extraversion and openness) was negatively associated with the mean participation coefficient in the dorsal and ventral attention networks, suggesting that participants high in plasticity had attention networks with more within-module connections. Further examination at the trait level showed that extraversion and openness were negatively associated with the dorsal and ventral networks, respectively, suggesting that the associations with plasticity were differentially linked to specific traits. These results support the idea that there are associations between individual differences in personality and features of intrinsic connectivity networks, which can provide novel insights with valuable implications for understanding the interaction of these factors in healthy and clinical groups. Future studies will explore the relationship of network?personality associations with specific cognitive abilities.

Topic Line: EMOTION & SOCIAL: Other

E21 Irritability in Adolescent ADHD: Relations with Functional Connectivity and Subsequent Degree of ADHD Symptoms

Julie Schweitzer, University of California, Davis, Veronika Vilgis, University of California, Davis, Sarah Kahle, University of California, Davis, Shawn Rhoads, University of California, Davis, Grant Shields, University of California, Davis, Prerona Mukherjee, University of California, Davis, Amanda Guyer, University of California, Davis, Julie Schweitzer, University of California, Davis

Irritability in adolescent attention deficit hyperactivity/disorder (ADHD) is increasingly recognized as an important symptom as it may escalate risk for social problems, comorbid psychiatric disorders and suicidality in ADHD. Study 1 examined whole-brain functional connectivity of amygdala and nucleus accumbens seeds in relation to irritability in ADHD (n=34) and typically developing (TD) (n=34) adolescents, matched on sex, age, head motion and IQ. In the ADHD versus TD group, irritability was associated positively with connectivity between bilateral amygdala and putamen/caudate and the right amygdala and medial PFC/frontal pole, in ADHD only. Irritability was associated positively with connectivity of left nucleus accumbens and left medial temporal gyrus but associated negatively with connectivity of both amygdala and nucleus accumbens connectivity with posterior parieto-occipital regions (e.g., precuneus, lateral occipital regions), only in the ADHD group. Study 2 used path analysis to examine multiple dependent variables in ADHD and TD adolescents (n=108; Mean age=14.21 years) with parent ratings of irritability at Time 1 and Time 2 (n=80), approximately 18 months later. Irritability ratings were significantly correlated with the two dimensions of ADHD (inattention and hyperactivity/impulsivity). Time 1 irritability predicted higher levels of Time 2 hyperactivity/impulsivity (?=.24; 95% CI .09-.39) differentially by gender, with higher relative hyperactivity/impulsivity for females only (females: ?=.50, 95% CI .25-.76; males: ?=.17, 95% CI -.02-.36). These analyses suggest irritability in ADHD is associated with alterations in reward/emotion neural systems and may also predict the course of future symptoms, particularly in females with ADHD.

Topic Line: EMOTION & SOCIAL: Other

E23 ***Political identity priming and own-race bias in Caucasian and Hispanic/Latino college students.***

Aspen Madrid, Texas State University, Crystal Oberle, Texas State University

Individuals' enhanced recognition for faces of one's own race or ethnic group as opposed to faces belonging to other racial or ethnic groups is known as own-race bias, or ORB. Recent models of face processing suggest that a perceiver's motives, individuation experience, and contextual cues can all play a role in an individual's automatic decision to selectively attend to a face. However, an emerging body of research suggests contextual cues priming individuals with meaningful aspects of their identity that are not inherently indicated by one's physical appearance may influence in-group recognition bias in such a way that ORB may be attenuated. To date very little has been published regarding how one's political identity may influence ORB. The purpose of this study was to assess whether ORB can be attenuated for faces belonging to members of one's political in-group. Researchers hypothesized that when target faces were labeled as endorsing the same political ideology as the participant as opposed to a different political ideology, participants would exhibit (a) greater hit rates (b) lower false alarm rates (c) greater response sensitivity, and (d) more conservative response biases for other-race faces. Four separate 2 (same race, other race) x 2 (same ideology, other ideology) ANOVAs were conducted to analyze data for the dependent variables used to assess recognition memory accuracy: hits, false alarms, response sensitivity, and response bias. There were no significant differences in measures of recognition memory between groups..

Topic Line: EMOTION & SOCIAL: Person perception

E24 **The dimensional structure of social relationship knowledge**

Haroon Popal, Temple University, Yin Wang, Beijing Normal University, Mark Thornton, Dartmouth University, Ingrid Olson, Temple University

When we interact with other people, we make inferences about them, and act accordingly based in part on our social relationship to them. Key older work on social relationships in social psychology and sociology explored the semantic space of social relational concepts and hypothesized that these concepts are represented dimensionally. However, these studies failed to reach agreement on the organizing dimensions of human relationships and no attempt was made to understand the neural foundations. The goal of this study was to understand the representational architecture of social relationship knowledge. We hypothesized that our concepts of social relationships are organized along multi-dimensional components, which are represented in portions of the 'social brain'. We conducted a survey on Amazon Mechanical Turk in which participants were asked to rate 159 social relationships on 30 dimensions derived from theories from the literature on social relationships. Next, we conducted Principal Component Analysis to find the overarching components that could account for the variance in social relationships. We found that four components - emotional proximity, exchange opportunity, valence, and monetary exchange - accounted for 77% of the variance in the dimensional ratings of social relationships. Finally, we used a subset of the social relationship concepts as stimuli in an fMRI study. Preliminary findings using RSA show that regions of the social brain, such as medial prefrontal cortex and the precuneus, are recruited to process information about social relationships. These findings suggest that the human brain uses a common neural code to represent social relationships.

Topic Line: EMOTION & SOCIAL: Person perception

E25 **Differential modulation of brain responses to face stimuli after exposure to urban versus forest environments**

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There is currently a number of epidemiological studies which suggest that an urban environment increases the risk for the development of Schizophrenia as well as mood disorders (Mortensen et a., 1999; Peen et al., 2010). In addition empirical studies have observed greater amygdala activation, a key region for emotional face processing and attention allocation as a function of an individual's urban upbringing during stress (Lederbogen et al., 2011). In the current 64 channel electroencephalogram (EEG) study we investigated whether transient exposure to videos of an urban versus natural environment impacted the visual evoked responses elicited by face stimuli in 24 healthy young adults. The volunteers watched 20 minute videos showing either a forest or a city walk, and subsequently performed an oddball paradigm with neutral and emotional faces as the standard and target stimuli respectively. We focused our analysis on the early visual evoked potentials locked to the onset of the face stimuli, and found significant differences depending on the videos preceding the oddball task. Specifically, we found that the P1 over the right hemisphere was larger after the city than the forest video. Furthermore, the N170 occurred earlier over the right than the left hemisphere after the forest, but not the city video. The P1 results suggest that people attend more to faces after an urban than nature exposure video. This increased attention, which may deplete resources very fast, might account for why city living has been reported to be related to greater mental fatigue (Lee et al., 2015).

Topic Line: EMOTION & SOCIAL: Person perception

E26 **Does combined decision-making training and tDCS produce generalizable cognitive benefits in healthy older adults?**

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Much excitement has been generated about the use of brain stimulation techniques to ameliorate age-related neurocognitive decline. Existing studies suggest that transcranial direct current stimulation (tDCS) might enhance cognitive training effects. It remains unclear, however, whether benefits 'transfer' to other

cognitive domains or persist over time. This study is the largest to date, and the first Registered Report (Stage 1 in-principal accepted at Nature Human Behaviour) to investigate the effects of a combined training and tDCS protocol on cognitive functions in older adults. We assigned 131 healthy participants, aged 60-75, to four demographically-matched groups. Each group received one of four protocols over five consecutive days: decision-making training and anodal tDCS over the left prefrontal cortex (PFC); decision-making training and sham tDCS (left PFC); training on a control task and anodal tDCS over the left PFC; or decision-making training and anodal tDCS over the visual cortex (control electrode location). Participants completed a comprehensive battery of eleven cognitive tasks and two ecologically valid questionnaires pre- and post-intervention and at one and three-month follow-up time-points. In contrast to young adults, anodal tDCS did not enhance training benefits in healthy older adults, perhaps reflecting structural and functional brain changes experienced in ageing. In addition, observed training gains did not transfer to other cognitive domains or everyday function at the group level. However, analysis of individual differences revealed that for individuals who received tDCS, magnitude of training benefits was associated with performance gains on several transfer tasks at follow-up time-points hinting the possibility of transfer.

Topic Line: EXECUTIVE PROCESSES: Development &aging

E27 Differences in Cognitive and Motor Inhibition of Aging Musicians and Non-Musicians

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Older adults experience declines in inhibitory control. These declines have been associated with declines in instrumental activities of daily living. Older adult musicians have behavioral and neurophysiological enhancements in various cognitive and motor domains as compared to non-musicians, suggesting that music training may delay the decline in cognitive and motor inhibition with aging. Yet, this has not been studied across the lifespan in currently practicing musicians and non-musicians. Thus, the aim of this study was to investigate the behavioral and neurophysiological differences in cognitive and motor inhibition in aging musicians and non-musicians. Twenty young adult musicians and non-musicians and twenty older adult musicians and non-musicians were recruited. To measure cognitive inhibition, the Stroop task was performed while electroencephalography (P300 amplitude and latency) was recorded. To measure motor inhibition, finger taps in sync and between auditory tones presented at 1 Hz were performed while transcranial magnetic stimulation short latency intracortical inhibition (SICI amplitude) was applied in between finger taps. 2 x 2 ANOVAs revealed main effects of age for inhibitory brain measures (decreased P300 amplitude over Fz, F3, F4 and increased SICI in older adults) and Stroop reaction time (increased for older adults). Interactions were revealed only for inhibitory brain measures (P300 amplitude over F3 and SICI). Post-hoc Bonferroni corrections showed significant differences only for the P300 amplitude over F3 between young musicians (increased amplitude) and non-musicians. Results demonstrate that practicing a musical instrument may alter neural correlates of cognitive inhibition in young adults and not older adults.

Topic Line: EXECUTIVE PROCESSES: Development &aging

E28 The distinct roles of prefrontal GABA and glutamate/glutamine in two types of cognitive control

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This study tested whether individual differences in neurotransmitter levels in lateral prefrontal cortex are associated with brain activation during a cognitive control task. More specifically, we tested the hypothesis that individual differences in levels of excitatory (glutamatergic) neurotransmitter in the dorsolateral prefrontal cortex (dlPFC) are associated with brain activation when maintaining a task goal in the presence of competing information (goal-maintenance), while inhibitory (GABAergic) neurotransmitter levels in ventrolateral prefrontal cortex (vlPFC) are associated with brain activation when selecting information from multiple task-relevant options to guide responding (goal-related selection). In a sample of 47 adult women, PRESS and MEGAPRESS sequences were used to determine resting GABA+ and Glutamate/Glutamine (GLX) concentrations (accounting for grey matter) in two separate voxels (dlPFC, vlPFC). Participants then underwent functional magnetic resonance imaging while performing a verb generation task with a 2-by-2 design that separately manipulated the difficulty (high, low) of goal-maintenance and goal-related selection. Concentration of GABA+ (controlling for GLX) in vlPFC was associated with differences in activation between the high and low goal-related selection conditions in occipital and temporal regions. In contrast, GLX concentration (controlling for GABA+) in dlPFC was associated with differences in activation between the high and low goal-maintenance conditions in parahippocampal and inferior temporal regions. These findings are the first to show that individual differences in GLX and GABA+ in lateral prefrontal cortex are associated with brain activation during a cognitive control task, and that these relationships differ by region (dlFPC, vlPFC) and type of control mechanism required (goal-maintenance vs. goal-related selection).

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

E29 Effects of Action Priming on Involuntary Imagery in the Reflexive Imagery Task

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Involuntary mental imagery has been elicited by several experimental manipulations. In one version of the Reflexive Imagery Task (RIT), for example, subjects are presented with two

line drawings of everyday objects (e.g., FLOWER and HAMMER) and instructed to not think of the name of any of the objects (Cho et al., 2018). For this 'Two-Object' RIT, involuntary subvocalizations occur on a substantive proportion of the trials. We investigated, in a Two-Object RIT, whether priming a goal-directed action increases the rate of occurrence of the subvocalization of the name of manipulable objects. In this RIT, a trial could consist of HAMMER (the Tool category) presented along with CLOUD (the Non-Tool category). Would action priming render the subvocalization of 'hammer' to be more likely than that of 'cloud'? Subjects (n = 19) were primed, before a block of 40 RIT trials, with a Cognitive-Motor task (involving weight estimation) or a Cognitive Task (the control condition, a digit-span task). A Wilcoxon signed-rank test, performed on the arcsine-transformed proportions, revealed no difference between the rates of RIT effects for tools (Mdn = 0.44) versus non-tools (Mdn = 0.56), p = 0.25. Effects were more likely for Non-Tool stimuli following the Cognitive Task (Mdn = 0.52) than the Cognitive-Motor Task (Mdn = 0.39), p = .007, r = .60. We also examined whether tool-related involuntary mental imagery is associated with fluctuations in mu frequency (9-13 Hz) power over motor cortex (electrode sites: C3, and C4).

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

E30 Exploring Developmental Changes In Functional Connectivity Associated With Cognitive Flexibility

Meagan Smith, The University of Tennessee, Anastasia Kerr-German, Boys Town National Research Hospital, Aaron Buss, The University of Tennessee

Previous research has shown that the frontal-parietal neural network (FPN) supports cognitive flexibility. This includes shifts of attention between stimulus dimensions or between response sets during a task. Functional connectivity (FC) of this network during these tasks increases from childhood to adulthood. Our goal was to explore this in later childhood when this skill rapidly develops. We used functional near-infrared spectroscopy (fNIRS) to compare FC of the FPN between children at age five, seven, and nine during the digital Trail-Making, DCCS, and Switcher tasks. Regression analyses indicate that three predictors accounted for 87.4% of the variance in switch costs (R^2= .91, $F(3,7)=24.086$, $p < 0.001$) and six predictors accounted for 99.7% of the variance in proportion scores (R^2= .99, $F(6,4)=498.715$, $p<0.001$) for five-year-olds on the trail-making task. Two predictors accounted for 54.5% of the variance in switch costs for seven-year-olds (R^2= .62, $F(2,11)=8.797$, $p=0.005$). For nine-year-olds, one predictor accounted for 74.9% of the variance in switch costs ($F(1,6)=21.938$, $p=0.003$) and 57.5% of the variance in proportion scores ($F(1,6)=10.456$, $p=0.02$). Over development, cognitive flexibility seems to be supported by an increasingly constrained neural network, with rostral areas of frontal cortex becoming more strongly connected and caudal regions becoming more dissociated. While connections between many nodes of the FPN influence flexibility at five years, frontal dynamics alone are better predictors of flexibility at nine years. These findings suggest that there are developmental differences in frontal-parietal connectivity that drives performance on these tasks.

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

E31 Atypical response inhibition in 22q11.2DS: diminished error registration and awareness

Ana Clara Alves Francisco, Albert Einstein College of Medicine, Douwe J Horsthuis, Albert Einstein College of Medicine, John J Foxe, Albert Einstein College of Medicine, University of Rochester, Sophie Molholm, Albert Einstein College of Medicine, University of Rochester

22q11.2 deletion syndrome (22q11.2DS; also known as DiGeorge syndrome or velo-cardio-facial syndrome) is characterized by increased vulnerability for neuropsychiatric symptoms, with approximately 30% of the individuals with the deletion developing schizophrenia. Clinically, deficits in executive function have been noted in this population, but the underlying neural processes are not well understood. Using high-density electrophysiology (EEG), we investigated the neural dynamics of inhibition of a prepotent response (a critical component of executive function) in individuals with 22q11.2DS with and without psychotic symptoms. Twenty-seven individuals with 22q11.2DS (14-35 years old, 14 with at least one psychotic symptom) and 27 age-matched neurotypical controls participated in a go/no-go task while EEG was recorded. Analyses were focused on the P3 go/no-go response and error-related positivity (Pe). Behaviorally, individuals with 22q11.2DS were slower and unable to inhibit prepotent responses as the controls, with significantly more false alarms. Atypical inhibitory processing was confirmed by significantly reduced P3 no-go responses in the 22q11.2DS group. Such reductions were particularly marked in those with psychotic symptomatology. Pe was likewise significantly decreased (regardless of the presence of psychotic symptoms), suggesting impaired ability to register errors (i.e., false alarms) in 22q11.2DS. Both Pe and P3 correlated with clinical measures of inhibition (DKEFS and CPT). P3 and Pe reductions, which have also been shown in schizophrenia, suggest diminished error registration and awareness in 22q11.2DS and, possibly, a consequent difficulty in adjusting response strategies.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

E32 Mobile brain/body imaging of cognitive-motor impairment in multiple sclerosis

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Individuals with multiple sclerosis (MS) often present with deficits in the cognitive and motor domains. The ability to perform tasks that rely on both domains may therefore be particularly impaired. Yet, behavioral studies designed to measure costs associated with performing two tasks at the same time such as dual-task walking have yielded mixed results. Individual variability to cope with brain

insult and to mobilize additional brain resources to sustain performance may contribute to mixed findings. To test this hypothesis, we acquired event-related potentials (ERP) in thirteen individuals with MS and fifteen healthy control (HC) participants performing a Go/NoGo response inhibition task while sitting or walking on a treadmill. Previously we showed that the nogo-N2 elicited by the cognitive task was reduced when healthy adults are also asked to walk, and that nogo-N2 reduction was accompanied by sustained dual-task performance. The HC group performed the Go/NoGo task more accurately while walking, thus showing a dual-task benefit, whereas the MS group showed a trend towards dual-task costs. The expected nogo-N2 reduction during dual-task walking was found in the HC group, but was not present at the group level in the MS group, suggesting that this group did not modulate the nogo-N2 process in response to higher task load. Further, we found a link between nogo-N2 reduction and better dual-task performance. We conclude that impaired nogo-N2 adaptation reflects a neurophysiological marker of cognitive-motor dysfunction in MS. Dual-task walking captures closely real-world issues and may improve assessment and treatment of MS.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

E33 Decoding semantic content from EEG

Timothy Trammel, UC Davis, Natalia Khodayari, UC Davis, Matthew J. Traxler, UC Davis, Tamara Y. Swaab, UC Davis

Traditional univariate analysis of EEG and ERP data have provided many insights in the dynamic neural computations that underlie visual word recognition (Grainger & Holcomb, 2009). However, it is difficult to infer the linguistic content of these computations using traditional analysis methods. Recent developments in machine-learning classification have provided a promising tool to provide insight into the content of computations in memory and attention paradigms (Bae & Luck, 2018, 2019; Hong et al., 2020), but little is known about their application to studies of word recognition. In the present study, EEG data from a visual ERP priming paradigm (Brothers et al, 2016) were used to examine if an adaptation of a Support Vector Machine (SVM)-based classification analysis method (Bae & Luck 2018) could reliable categorize the EEG signal according to the animacy of the prime and target words. The SVM method classified 500 time points across the -200 ms to 1600 ms stimulus-locked interval. Decoding accuracy was calculated for each participant and then a grand-average was taken for each time point. We found grand-average decoding accuracy was greater than chance (50%) in multiple clusters during the time interval. Several of these decodable clusters are within typical windows of interest in semantic processing. These results indicate the SVM-based method was able to reliably classify EEG data according to the animacy of words.

Topic Line: LANGUAGE: Semantic

E34 Withdrawn

E35 Withdrawn

E36 Neurophysiological markers of sensorimotor and cognitive-motor dysfunctions in autism

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Gross motor behavior in autism spectrum disorder (ASD) has been less emphasized in research, despite up to 80% of individuals with ASD exhibiting deficits including gait instability. The integrated processing of sensory, cognitive, and motor functions during ambulation has become recognized, but no studies have examined this in ASD using mobile-brain body imaging (MoBI). MoBI allows for the concurrent acquisition of EEG electrophysiological and 3D kinematic data to monitor brain dynamics and gait pattern during ambulation. We used a dual-task walking design to assess 17 ASD and 15 neurotypical (NT) individuals while they were exposed to sensory load (walking with and without being exposed to perturbed full-field optical flow stimulation) and motor load (performing a Go/NoGo task while standing or walking). Our aim was to determine sensitive brain measurements of sensorimotor and cognitive-motor dysfunction in ASD. No differences were seen in Go/NoGo performance between groups, or between standing and walking. However, mean stride width and stride length variability increased in the ASD compared to the NT group, and exposure to optical flow further increased these group differences. These data suggest a general deficit in motor behavior that is enhanced under conditions of increased sensory load (as evidence in reduced walking stability). In the electrophysiological data, P3 responses to NoGo trials were reduced for walking (dual-task) versus standing (single-task) conditions, and this reduction was much greater for the ASD group. Stronger reduction in P3 during walking in ASD may indicate increased effort in the ASD group to sustain.

Topic Line: EXECUTIVE PROCESSES: Other

E37 Withdrawn

E38 Cognitive and neural deficits associated with a history of mTBI

Hector Arciniega, University of Nevada, Reno, Marian Berryhill, University of Nevada, Reno

Head injury is a major public health issue. In the USA alone, traumatic brain injury (TBI) causes 235,000 hospital visits, each year. The bulk of these TBI are categorized as mild (mTBI). It is assumed that after a few months patients gradually return to their premorbid performance including the general assumption of full cognitive recovery. However, there is a fundamental gap in knowledge as to whether this is always true, or whether there are lasting cognitive consequences of mTBI. We have previously reported visual working memory deficits in undergraduates with a history of mTBI (~4 years post-injury). To begin to understand the extent of cognitive deficits and their neural underpinnings we further tested working memory for visually presented stimuli and

more broadly tested cognitive performance (RBANS) as well as collecting resting state electroencephalography (rs-EEG), and resting state functional magnetic resonance imaging (rs-fMRI) in undergraduates with a history of mTBI. Although there is no general cognitive deficit, there is a general visual working memory deficit in the empirical task and in the neuropsychological assessment. The resting state data reveal wide-ranging deficits in connectivity, particularly in those whose performance is most severely impaired. These data serve as a conservative indicator for executive disfunction in individuals with a history of mTBI.

Topic Line: EXECUTIVE PROCESSES: Working memory

E39 Functional organization of hippocampus is altered by associative encoding and retrieval

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The hippocampus is critical for learning and memory and can be separated into anatomically-defined hippocampal subfields (aHPSFs), including subiculum, CA1, CA2/3, CA4 and dentate gyrus. However, the assumptions of within-subfield functional homogeneity and across-subfield functional dissociation were not supported by clear evidence. The data-driven approaches offer an alternative means to investigate the hippocampal functional organization without a priori assumption. Nevertheless, the relatively low spatial resolutions employed in the previous studies precluded the examination of the functional specialization across aHPSFs. Hence, we developed a functional Magnetic Resonance Imaging (fMRI) sequence on a 7T MR scanner with 1-mm isotropic resolution, a TR of 2s and brain-wide coverage. Healthy young adults were scanned at rest and in associative memory task. We aim to investigate: 1) how the associative memory tasks alter the functional organization of hippocampus, and 2) how the functionally-defined hippocampal subfields (fHPSFs) connect with the rest of the brain. Using a spatially restricted hippocampal Independent Component Analysis (ICA) and k-means approaches, we observed that the fHPSFs were distinct from aHPSFs with the exception of CA1. Additionally, 30+ fHPSFs were identified at encoding phase while only 5 fHPSFs were identified at retrieval phase. More areas within hippocampus were relatively inactive at retrieval phase than at encoding phase. For the brain-wide functional networks, primary sensory networks connected with selective fHPSFs while high-level association networks connected with the hippocampus more uniformly. Our analyses of the fine-grained functional segmentation and the respective functional networks hold a great promise in the applications of neurodegenerative diseases.

Topic Line: EXECUTIVE PROCESSES: Working memory

E40 The Cerebellum Works Across Task-Positive and Task-Negative Networks

Magda L. Dumitru, University of Bergen, Laurens Van Calster, University of Liege, Steve Majerus, University of Liege, Kenneth Hugdahl, University of Bergen

The organization of neural activation in anti-correlated networks is a fundamental property of the human brain (Duncan et al. 2001; Fox 2005; Hugdahl et al. 2015; Raichle et al. 2001). However, the distinction between task-positive networks (e.g., the Dorsal Attention Network DAN and the fronto-parietal cortical network FPCN) and task-negative networks (i.e., the Default-Mode Network DMN) as well as the definition of their scope (e.g., exclude the cerebellum) are not clear. Here, we used structural, functional, and resting-state MRI to investigate the interplay of neural structures before, during, and after a working memory task involving maintenance and recognition of weak and strong visual Gestalts. We used SPM12 for analysing univariate task-based data, PRONTO for investigating multivariate task-based data, and CONN for exploring resting-state connectivity. Whole-brain task-related activation foci were stronger for weak compared to strong Gestalts, they extended over cortical regions typically associated with DAN including bilateral intraparietal sulcus IPS, superior parietal lobule SPL, and precentral gyrus, as well as with FPCN, and further involved cerebellar regions. Whole-brain multivoxel pattern analysis MVPA showed high classification accuracy of weak versus strong Gestalts. Seed-based functional connectivity analysis of post- versus pre-task resting-state sessions revealed deactivation of cortical networks driven primarily by the posterior cingulate cortex, i.e., from a DMN node, accompanied by increased connectivity within the cerebellum. We conclude that cortical network activity is involved in task processing, which prompts post-task downregulation, and that the cerebellum plays a singular role in both task- and post-task processes.

Topic Line: EXECUTIVE PROCESSES: Working memory

E41 Feedback Processing and Working Memory in Children with Typical and Atypical Language Development

Isabel Fitzpatrick, MGH Institute of Health Professions, Xinyi He, MGH Institute of Health Professions, Zoya Surani, Harvard University, Yael Arbel, MGH Institute of Health Professions

This research aimed to evaluate the relationship between working memory and feedback processing in children with typical language development (TD) and children with developmental language disorder (DLD) performing a declarative learning task. Thirty-five participants completed a declarative paired-associate learning task under two conditions. In the feedback-based condition (errorful), participants learned through trial and error guided by performance feedback. In the no-feedback (errorless) condition, participants learned through observation (i.e., repeated presentation of correct associations). Participants' electrophysiological data were recorded during the learning tasks, and their accuracy was evaluated at the end of each task through a test that was free of feedback. Participants completed two working memory (WM) subtests. An errorless advantage (EA) score was calculated for each participant as the accuracy difference between the errorless and the errorful conditions. EEG data were time-locked to the presentation of feedback, and two event related potentials (ERPs) were evaluated, the Feedback Related Negativity (FRN) and a Fronto-central Positivity (FCP). Regression analysis indicated that in the DLD group, scores on the familiar sequences subtest of WM predicted EA scores, such that lower WM scores were associated

with greater errorless advantage in the DLD group. The results of the mixed ANOVA of the FRN and FCP suggested that while differences between positive and negative feedback were observed in the TD group, they were absent in the DLD group. Group differences were also found in the amplitude of the FCP. FCP amplitude to negative feedback was found associated with EA scores in the TD group.

Topic Line: EXECUTIVE PROCESSES: Working memory

E42 Acute bouts of intense interval and moderate continuous exercise alter neural oscillation during working memory

Alvin Kao, Purdue University, Chun-Hao Wang, National Cheng Kung University, Keita Kamijo, University of Tsukuba, Chih-Chun Lin, National Cheng Kung University, Naiman Khan, University of Illinois at Urbana-Champaign, Charles Hillman, Northeastern University

Although research has demonstrated transient enhancements in working memory following moderate-intensity continuous exercise (MICE), it remains to be determined whether a single bout of high-intensity interval training (HIIT) generates similar benefits to behavioral performance and neural correlates of working memory. The purpose of this study was to investigate the acute effects of HIIT versus MICE on neuroelectric mechanisms underlying working memory processes by utilizing frontal alpha event-related desynchronization (ERD). Thirty-six healthy young adults were recruited to perform a 20-min bout of HIIT, MICE, and rest on separate days in counterbalanced order. At 25-min following each intervention condition, electroencephalogram was recorded while participants performed a modified Sternberg task requiring varying amounts of working memory (3-, 5-, 7-letter tasks). The behavioral results showed a condition effect, indicating a general improvement in response time following HIIT compared to rest. Analysis of frontal alpha ERD showed an interaction of condition and task, indicating no differences across tasks following rest but a task effect following the two exercise conditions, with frontal alpha ERD increasing in the 7-letter task compared with the 3-letter task. Further, this task-related contrast of frontal alpha ERD lasted longer on the time-frequency representation during working memory processes following HIIT, with such effects extending to the time period when memory retrieval occurred. After a delay following exercise cessation, HIIT induces a temporally wider alteration in frontal activation underlying working memory processes compared to MICE, along with improved behavioral performance. These findings provide support for potential applications of HIIT for enhancing working memory.

Topic Line: EXECUTIVE PROCESSES: Working memory

E43 Causal Evidence that Theta and Alpha Neural Oscillations Dynamically Coordinate Output-gating

Justin Riddle, University of North Carolina at Chapel Hill, Trevor McPherson, University of North Carolina at Chapel Hill, Flavio Frohlich, University of North Carolina at Chapel Hill

Cognitive control requires the manipulation of internal representations for goal-directed behavior, referred to as output-gating. Output-gating recruits two distinct processes: selection of relevant information, correlated with theta oscillations (4-7Hz) in prefrontal cortex (PFC), and suppression of irrelevant information, correlated with alpha oscillations (8-12Hz) in posterior parietal cortex (PPC). However, there is no study that examines the causal interactions between theta and alpha oscillations in output-gating; therefore, we designed a pre-registered (https://osf.io/37ey4/), crossover, randomized study using simultaneous EEG and rhythmic transcranial magnetic stimulation (TMS) (N=48). Using a retro-cue during the delay period of a working memory (WM) task, we elicited theta oscillations in PFC (100-500ms post-cue) as a function of selection (retro-cue relative to neutral-cue). Memory items were lateralized to the left and right visual hemifield. Using a retro-cue towards the left versus right hemifield, we elicited alpha oscillations in PPC (500-900ms) as a function of suppression (contralateral to the irrelevant memory items). Participants with the greatest lateralized PPC alpha activity, also showed the greatest benefit to WM capacity from the retro-cue. Additionally, theta frequency functional connectivity (weighted phase lag index) between PFC and PPC increased contralateral to relevant WM representations (500-900ms). Finally, online rhythmic TMS post-cue disrupted WM capacity (relative to arrhythmic TMS) only for alpha to PFC and theta to PPC, but had no effect on behavior for theta to PFC and alpha to PPC. Our findings suggest that frontal theta and parietal alpha oscillations play a causal role in output-gating.

Topic Line: EXECUTIVE PROCESSES: Working memory

E44 Withdrawn

E45 Withdrawn

E46 Sentence listening comprehension among Chinese bilinguals and English monolinguals: An fNIRS study

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The purpose of this study is to compare the mechanisms underlying the processing of canonical and noncanonical sentences and to examine whether monolinguals and bilinguals process structurally complex sentences via different cortical networks and whether Age of Acquisition (AoA) is an influential factor. Method: participants included 15 monolingual children,16 early-bilingual children and 12 late-bilingual adults. They completed an English listening comprehension task during fNIRS scans. Auditory stimuli included four sentence types: Subject-Verb-Object (SVO), Passive (PAS), Subject Relative (SR), and Object Relative (OR) clauses. The semantic plausibility of the sentences was controlled, so that word order was the only relevant linguistic cue. Participants were asked to select the agent of each sentence. Behavioral Results: Repeated-measure ANOVAs showed that all groups performed better on canonical sentences (SR, SVO) and no significant differences between groups. fNIRS results: Bilingual adults evidenced more brain activation in left and right dorsolateral prefrontal cortex [L/RDLPFC], middle pre-frontal cortex [MPFC] and left inferior parietal lobule [LIPL] than children groups. No

difference was found between children groups. OR sentences corresponded with more brain activation in L/RDLPFC, MPFC, LIPL, and left superior temporal gyrus [LSTG] than SVO and PAS. No difference was found between SR and OR. Conclusions: Findings of more activation in adults and no difference between children suggest that AoA is an influential factor. No difference between SR and OR indicated that participants performed relative clauses similarly. Further studies are needed to examine whether clauses rather than noncanonical sentences are more difficult to process.

Topic Line: LANGUAGE: Development & aging

E47 VWFA Functional Connectivity for Print and Speech Processing in Emerging Readers

Rebecca Marks, University of Michigan, Lynn Eickholt, University of Michigan, Yuuko Uchikoshi, University of California, Davis, Fumiko Hoeft, University of Connecticut, Ioulia Kovelman, University of Michigan

Learning to read requires children to develop an efficient neural network that connects the visual and language systems of the brain. Recent work suggests that specificity for print processing in the Visual Word Form Area (VWFA) emerges rapidly over the first year of schooling (Dehaene-Lambertz, Monzalvo & Dehaene, 2018). Furthermore, the VWFA has been found to be responsive to auditory stimuli in beginning readers, ages 5-6 (Wang, Joanisse & Booth, 2018). How is the VWFA functionally connected to language regions of the brain during word reading, and how does this connectivity differ between print and speech processing for emerging readers?

78 kindergarteners (mean age = 5.7) completed visual and auditory word processing tasks during fMRI. PPI analyses suggest that during print processing, beginning readers show functional connectivity between the VWFA and the left superior temporal gyrus, inferior parietal lobe, and bilateral frontal cortex. During auditory word processing, VWFA activity is significantly correlated with activation in the left superior temporal gyrus (STG), a critical region for language processing in speech and print. This suggests the emergence of a functional network connecting the VWFA and language regions during the early phases of literacy acquisition. Ongoing analyses will further examine connectivity between VWFA and key language regions. We hypothesize that more advanced readers will show greater VWFA activation in response to auditory stimuli, and that VWFA-STG connectivity will be associated with concurrent reading ability.

Topic Line: LANGUAGE: Development & aging

E48 Reading abilities of the right hemisphere in left- and right-handers

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The 'two orthographic lexicons' framework suggests that the advantage of the left hemisphere (LH) over the right (RH) for reading is due to lexical factors, suggesting the existence of one orthographic lexical store for each hemisphere. Accordingly, left-handers, i.e. subjects with a lesser degree of functional lateralization than healthy right-handers, should show a small hemisphere effect for words, since the LH lexicon is 'less dominant' over the right one. Conversely, a 'unique lexicon' view suggests the 'hemisphere effect' to depend on the length of the information that must be transferred from the RH to the LH, regardless of its lexical status. In line with the latter framework, performance in lateralized reading should not differ across different laterality groups. At most, any group differences should depend on factors preceding lexical access, and they should be evident for both words and non-words. We administered a tachistoscopic eye-tracking-controlled lateralized lexical decision task to 60 right-handed and 60 left-handed volunteers. We manipulated target hemisphere, stimuli length, lexicality and word frequency.â?¨We found that word frequency, rather than pre-lexical factors, best explained hemispheric differences. Left-handers showed better performance in the RH than right-handers for words only. Finally, while right-handers showed chance-level performance for low-frequency words presented to the RH, left-handers performed significantly better than chance level in this condition. Our findings show that each hemisphere contains an orthographic lexical store. In right-handers the LH lexicon is highly dominant over the RH one, in which low-frequency words are poorly represented. In left-handers, such dominance is less pronounced.

Topic Line: LANGUAGE: Lexicon

E49 When two vowels go walking: an ERP study of the vowel team rule

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The vowel team rule in American English ('when two vowels go walking, the first does the talking') teaches that two vowels together in a word are pronounced like the name of the first vowel, with the second vowel silent. In an ERP investigation of the vowel team rule, we used a lexical decision task to determine whether words that follow the rule (e.g., braid) elicit different lexicosemantic processing than well-matched, controlled words that do not follow the rule (e.g., cloud), and whether this extends to nonwords (e.g., braip, cloup). In 32 college students who recalled learning to read with phonics and/or learning reading and spelling rules, N400 amplitude did not distinguish between rule-following and rule-breaking words, with a similar pattern for nonwords. However, behavioral responses in the lexical decision task were sensitive to rule status: Participants were both more accurate with and faster to respond to rule-following words; this pattern was not observed with nonwords. The N400 findings indicate that vowel team rule adherence does not affect lexicosemantic processing of either words or nonwords in fluent readers. In contrast, findings from the behavioral measures suggest facilitation for familiar rule-following lexical items, perhaps at a late decision stage, but no extension of facilitation to unfamiliar nonwords. Overall, these results call into

question the utility of teaching the vowel team rule as a standard component of many phonics programs.

Topic Line: LANGUAGE: Lexicon

E50 Neural Correlates of Auditory Comprehension: Single-Word versus Sentence Comprehension

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Debate exists as to the neural correlates of auditory comprehension. Some discrepancy in the literature is likely due to the use of different types of comprehension tasks across studies. In the current study, we used lesion-symptom mapping to identify critical brain regions in the network underlying auditory comprehension in three distinct tasks: Yes/No sentence comprehension, comprehension of sequential commands, and single-word comprehension. This retrospective study included 168 chronic left hemisphere stroke patients who met strict inclusion/exclusion criteria and had a wide range of comprehension impairment from mild to severe. Both multivariate and univariate LSM analyses were run to ensure that findings were robust. Several nuisance variables were included as covariates, including lesion volume, age, months post-onset, and overall aphasia severity. For single-word auditory comprehension, significant voxels centered primarily in left mid- to posterior middle temporal gyrus, and also included smaller portions of the left angular gyrus, mid-posterior inferior temporal gyrus, and inferior-middle occipital gyri. Yes/No sentence comprehension was associated almost exclusively with the left mid-posterior middle temporal gyrus. For comprehension of sequential commands, significant voxels were located primarily in the left posterior middle temporal gyrus. There was only a small region of convergence between the three comprehension tasks, in the very posterior portion of the left middle temporal gyrus. These findings suggest that auditory comprehension is mediated by a network of regions in the left posterior temporo-parietal cortex with a core region in the posterior middle temporal gyrus and partially distinct subregions underlying different types of comprehension tasks.

Topic Line: LANGUAGE: Other

E51 Cerebral Perfusion and Brain Activity Related to Reading Aloud in Subacute-to-Chronic Stroke Recovery

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We report preliminary results from a study investigating the neural mechanisms of recovery from stroke-induced reading impairments. Four survivors (3 women, M age = 60.75, SD = 14.45) of first-ever left-hemisphere stroke (brainstem, putamen, thalamus, superior parietal lobule) completed behavioral testing and MRI 3 months post-stroke (chronic). Participants completed touch-screen orthography, phonology, and semantics tasks and in-scanner reading aloud (words and pseudowords). Brain activity was recorded using fMRI and cerebral perfusion was measured with ASL. Reading aloud accuracy improved from 66% (SD=14%) to 86% correct (SD=5%) for words and from 24% (SD=14%) to 41% correct (SD=22%) for pseudowords. Minimal changes were observed on the touch-screen tasks.

Subacute word reading (vs fixation) produced activity in areas typically recruited in healthy readers (e.g. left occipito-temporal fusiform gyrus, left anterior middle temporal gyrus (MTG), temporal pole, insula).

Subacute pseudoword reading activated bilateral pre- and postcentral gyri, primary auditory cortex, and left supramarginal gyrus, likely due to increased reliance on sound processing and spelling-to-sound mapping. Chronic word and pseudoword reading showed increased reliance on bilateral auditory cortex, anterior cingulate cortex (implicated in conflict resolution and attention), frontal operculum, IFG pars triangularis and posterior MTG (thought to support semantic processing). This indicates adaptive post-stroke plasticity in the domain of reading with increased reliance on fronto-temporal, rather than occipito-temporal and parietal regions. Areas of increased activation in the bilateral auditory cortex, anterior cingulate, and the operculum overlapped with areas where resting cerebral perfusion increased from subacute to chronic period.

Topic Line: LANGUAGE: Other

E52 Withdrawn

E53 Third person perspective impedes comprehension in patients with lesions in right temporo-parietal junction

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Right temporoparietal junction has been shown to be (causally) involved when people take a third person perspective. First person perspective taking on the other hand is hypothesized to have processing benefits in terms of lower working memory load. In two case studies we show that lesions in right temporoparietal junction resulting from stroke show comprehension deficits for stories written in third person perspective. Participants listened to six short stories - half of which were written in a first-person perspective and the other half in a third person perspective. Each paragraph contained a probe sentence that was either metaphorical or literal, which was tested for comprehension right after the paragraph. In addition, we tested reading habits, general working memory performance on discourse level, perspective taking, as well as appreciation of and immersion into the stories. While there was no difference in comprehension between metaphorical and literal probe sentences, both patients had difficulty understanding probe sentences in third person stories, while performing at ceiling for probe sentences in first person stories. Both patients preferred narratives in first person perspective. Our results suggest a role for the right temporo-parietal junction for processing language in third person narrative perspective, without affecting a first person perspective, when listening to narratives.

Topic Line: LANGUAGE: Other

E54 Neural Activation for Lexical Sign and Pantomimic Gestures in Deaf Signers.

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There is debate about the degree to which motor systems are involved in language comprehension. Some accounts suggest that speech comprehension relies on motor systems similarly to comprehension of observed actions. Signed languages provide an interesting test case, having the linguistic properties of spoken languages but sharing a modality with actions. American Sign Language (ASL) makes use of a variety of manual and body actions to convey meaning. These include conventional lexical signs as well as pantomimic enactments (aka constructed actions). In this fMRI study we examined neural requirements for the production and processing of lexical signs and pantomimic actions in deaf signers. Sixteen deaf signers observed and produced lexical signs for, and pantomimes of object-oriented actions (e.g. ASL: SWEEP, pantomime: using a broom). Image and statistical ROI analysis (SPM12, REX) revealed a graded activation of anatomically similar bilateral visual cortical and posterior temporal activation (pantomime > ASL), suggesting commonality in the neural regions for the perception of complex manual actions. In production, we observe an expected pattern of bilateral Rolandic motor-sensory and inferior frontal gyrus activation, but increased medial and selected inferior frontal activation for pantomime relative to ASL production (MFG-1 $p < .008$, MFG-2 $p < .05$ and IFGop $p < .04$), and no differences in IFGtr and IFGorb $p > .1$).These patterns of activation suggest differential metabolic demands reflecting a cognitive efficiency for linguistic processing and increasing demands for the on-line construction of pantomimic gestures and that co-engagement of action-perception systems varies with task demands.

Topic Line: LANGUAGE: Other

E55 Early signed language exposure does not harm phonemic discrimination for individuals with cochlear implants (CIs)

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We tested two competing hypotheses about age of signed language exposure (age-ASL) with CIs. Geers et al. (2017) have claimed that signed language exposure harms spoken language development, while others suggest the contrary -- early signed language exposure supports language development by offsetting the negative effects of language deprivation prior to implantation (Davidson et al., 2014; Jasinska & Petitto, 2013; Petitto et al., 2016). Hypotheses tested: (1) only early-life spoken language exposure through CI- or, (2) early-life simultaneous signed and spoken language exposure- supports neural systems underlying phonemic discrimination. Eighteen adults with CIs exposed to signed language between age 1-22 years completed an auditory phoneme discrimination task while undergoing fNIRS neuroimaging. Phonemic discrimination showed no significant effect of age-ASL, and was only marginally better for individuals implanted earlier ($b=-.019$, $t(16)=-1.777$, $p=.094$). There was significant age-ASL and age-CI interaction in LIFG and LSTG. As age-CI increased, adults with earlier age-ASL showed increased activation in LIFG ($b=2.345$, $t(23)=3.034$, $p<.0001$) and STG ($b=2.027$, $t(23)=3.938$, $p=.0006$), and adults with later age-ASL showed reduced activation in LIFG ($b=-.827$, $t(23)=-3.207$, $p=.003$) and angular and supramarginal gyrii ($b=-1.450$, $t(23)=-4.085$, $p=.0004$). Taken together, these findings suggest no negative impact of sign language exposure on phonemic discrimination. Earlier versus later sign-exposed individuals with early implantation showed greater activation in language areas (LSTG, LIFG), supporting Hypothesis 2. Early-life language exposure, irrespective of modality, supports neurodevelopment underlying phonemic discrimination.

Topic Line: LANGUAGE: Other

E56 Interplay of episodic and semantic memory in repeat object reference

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Language comprehension involves an interaction between episodic information about particular object tokens and semantic information about object types: 'The man will chop the tomato' activates information about how tomatoes typically look/taste, and the episodic trajectory of the tomato's states as it changes from intact to chopped. The Intersecting Object Histories account of event representation claims that understanding an event ('chopping a tomato') entails the activation of both the pre-chopped and chopped states of the tomato. fMRI studies show that reference to a changed object ('The man will chop the tomato. Then, he will taste the tomato') elicits a 'competition effect' in Stroop-sensitive voxels in Left Inferior Frontal Gyrus (LIFG), arising from a need to select one of these two object-states (compared to events which do not change object states). However, these studies contained potentially infelicitous repetitions of the full noun phrase. Competition could arise not from competition between two episodic states, but between the current episodic state and bottom-up activation of semantic information associated with reading 'the tomato.' The current study includes the contrast above, as well as conditions using pronouns ('â?| then he will taste it') which must refer to the episodic entity. We show a competition effect in LIFG for the pronoun conditions, although not in Stroop-sensitive voxels. We found no competition for repeated noun phrases (their infelicity being heightened by the pronoun conditions). This suggests that the competition effect for state-change events reflects cognitive control mechanisms within LIFG that select between episodic states of an object.

Topic Line: LANGUAGE: Semantic

E57 The Time Course of Meaning Construction with Varying Expectations

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Mechanistic theories of the N400 event-related potential-a neural correlate indexing semantic processing in the brain-implicate the roles of prediction, priming, and bottom-up sensory integration in language comprehension; however, mechanisms explaining volitional aspects of semantic meaning construction are not fully understood. To explore this, participants were visually shown sentences, with words presented one at a time, and evaluated whether the final words of sentences formed sensible (SC) or unconnected completions (UCs). Participant expectancies were modulated using colored boxes that surrounded the words of each sentence cueing the participants to either expect a SC (green) or UC (orange). A neutral cue (purple) did not indicate the completion type and served as a baseline condition. Expectancies were factorially crossed with completion type forming valid, invalid, and neutral conditions. Trial presentations were weighted such that sentences were validly, invalidly, and neutrally cued 60/20/20% of the time, respectively, incentivizing participants to utilize the colored cues. Cues successfully modulated participant expectations such that participants were more accurate when evaluating validly than invalidly cued sentences and selectively faster when solving validly cued sentences that were semantically congruent. The N400, as measured following the presentation of the final word, was modulated by completion type such that UCs elicited more negative deflections than SCs. However, expectations generated via colored cues did not modulate N400 mean amplitudes. These results suggest that volitionally generated expectancies do not dramatically affect neural signatures of semantic access, but ultimately lead to additional processing responsible for resolving discrepancies between semantic congruency and expectancy.

Topic Line: LANGUAGE: Semantic

E58 Jumping to conclusions: Levy flights characterize younger but not older adults during fast binary decisions

Aalim Makani, Ryerson University, E.Marie Weischen, Heidelberg University, Andreas Voss, Heidelberg University, Julia Spaniol, Ryerson University

Over the past 20 years, applications of the drift-diffusion model (DDM) have advanced cognitive-aging research by identifying age differences in component processes of perceptual and memory-based decisions. The classic DDM assumes that fast binary decisions are based on an evidence-accumulation process with Gaussian noise. However, recent research suggests that young-adult data are sometimes better characterized by Levy-flight models with heavy-tailed noise distributions, which produce occasional extreme jumps in the accumulation process (Voss et al., 2019). Jumpy information accumulation causes fast errors, but may be adaptive in contexts that reward exploration. In the current study, we examined age differences in decision processes in the context of a letter-number discrimination task. Healthy younger and older adults completed easy and hard versions of the task. Accuracy and RT analyses showed expected effects of age and difficulty. In the difficult task, younger and older adults' performance was best described by the standard DDM. In the easy task, older adults' data were also well captured by the standard DDM, whereas younger adults showed the Levy pattern. Furthermore, in younger adults, 'jumpiness' was negatively associated with mean drift and boundary separation. The easy task also produced age differences in other parameters. Compared to younger adults, older adults showed longer nondecision times, wider boundary separation, and - surprisingly - higher drift rates. The current findings are the first to show that Levy flights are more characteristic of decision making in younger than in older adults, and they constrain hypotheses about physiological and psychological correlates of jumpy decisions.

Topic Line: PERCEPTION & ACTION: Development & aging

E59 Responsiveness to cues as a measure of emerging language ability in aphasia

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Two million people in the United States are living with aphasia, which is an acquired communication impairment most frequently caused by stroke. Prior research suggests that initial aphasia severity, lesion size and lesion location are the most salient factors in predicting recovery outcomes. While these factors provide important prognostic information, information that is individualized and readily available to clinicians is limited. Deficits in naming, a skill central to effective communication, is common to all aphasia types and is routinely targeted in aphasia assessment and treatment, with cues provided to facilitate lexical retrieval (naming). Meaning cues and sound cues tap into levels of lexical processing that are essential to effective naming-semantic cues activate the underlying concept of the word, while phonological cues provide information about the word form. In this longitudinal study, I propose that a person's ability to improve naming with cues will be predictive of future word retrieval and provide insights into the integrity of the lexical processing system. At four timepoints over the course of one year, we evaluated naming ability in individuals with aphasia and measured the proportion of successful lexical retrieval with the presentation of feature, sentence, and phonemic cues. Data have been collected from six participants at two or more timepoints, with three participants reaching study completion. Analyses suggest that cue responsiveness may differentiate individual recovery patterns, with individuals who responded best to sentence-based cues at 6 weeks post-stroke demonstrating greater improvements in naming ability without cues at 3 months post-stroke.

Topic Line: LANGUAGE: Semantic

E60 P600 and dispositional affect

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Affective state is known to influence cognitive processing (Loftus et al., 1987). Here we investigated whether this relation extended to sentence processing. In an event-related potential (ERP) study, we examined whether individual differences in dispositional affect

interacted with syntactic processing. We used stimuli from Osterhout and Holcomb's seminal paper on the P600 effect, a marker of syntactic anomaly (Osterhout & Holcomb, 1992). To this end, 20 participants read sentences (critical words are underlined) such as (i) The broker planned to conceal the transaction *was sent to jail vs. (ii) The broker persuaded *to conceal the transaction was sent to jail. We expected to replicate findings from the original work, where P600 effects were expected at 'to' in (ii) vs. (i) and at 'was' in (i) vs. (ii). We did not replicate the P600 effect at 'to', however, the P600 effect downstream at 'was' did replicate. Regarding affect, we hypothesized that individuals who reported more positive affect would show larger P600 effects at was. Chwilla and colleagues (2010) conducted an induced mood study and found that positive participants produced larger P600 effects for syntactically anomalous sentences, vs. negative participants, who did not. Our results showed a significant positive correlation between positive affect scores and P600 amplitude. Results are discussed in terms of 'family of P600' components and affect.

Topic Line: LANGUAGE: Syntax

E61 Listeners' experience with face-accent (in)congruencies modulates speaker identity effects in native- and foreign-accent

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Comprehending foreign-accented speech is more effortful than native-accented speech, but few studies examined how speakers' facial features affect listeners' speech comprehension. In two ERP experiments, we presented American and Chinese-accented English sentences preceded by White or Asian faces (creating 4 face-accent (in)congruent conditions). Sentences contained semantic anomalies or pronoun violations, or no errors. To examine how listeners' experience with face-accent (in)congruencies affects processing, sentences were presented to White-American (Expt.1) or Asian-American (Expt.2) listeners. Overall, White-Americans demonstrated strong sensitivity to (in)congruency of face-accent pairings. Specifically, semantic anomalies in American-accented sentences yielded a larger N400 for incongruent (Asian face/American accent) than for congruent (White face/American accent) face-accent pairings. Semantic anomalies in Chinese-accented English elicited an N400 only for congruent but not for incongruent face-accent pairings, and pronoun errors in American-accented English elicited an Nref for congruent, but not for incongruent pairings. In contrast, Asian-Americans (American-English accented speakers with extensive experience with face-accent incongruencies) showed little sensitivity to (in)congruency of face-accent pairings. Semantic anomalies elicited N400s in American- and Chinese-accented English, of similar magnitude for congruent and incongruent face-accent pairings. Likewise, Asian-Americans' sensitivity to pronoun violations in American- and Chinese-accented English was largely comparable for congruent and incongruent pairings. White-Americans are thus more sensitive to face-accent incongruencies than Asian-Americans, which indicates that listener experience modulates the effects of facial cues on native- and foreign-accented speech processing, thereby providing a more in-depth understanding of the role visual cues play in language processing.

Topic Line: LANGUAGE: Syntax

E62 The impact of altered sleep on memory consolidation in Parkinson's disease patients

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Healthy sleep is crucial to memory consolidation. Sleep impairments are common in Parkinson's patients and have been associated with worse cognitive outcomes. Research has mostly focused on the link between REM sleep behaviour disorder and cognitive impairment but abnormalities in non-REM sleep structure are also common and have been associated with worse cognitive performance. Whether this is due to a direct impact of impaired sleep on sleep-dependent cognitive processes is not known. The goal of this study was to determine if alterations in sleep structure are associated with deficits in overnight memory consolidation.

We recorded overnight sleep with polysomnography in twenty-one Parkinson's patients and measured memory consolidation with a word pair association task. Patients first learned 50 word pairs. Memory for the word pairs was tested twice: once before sleep and again in the morning. Consolidation was measured as the relative difference in recall between the morning and the night tests. We restricted our preliminary analysis to patients without REM sleep behaviour disorder (n=16).

We found no relationship between total sleep time or sleep efficiency and memory consolidation. We did find that greater severity of obstructive sleep apnea (as measured with the apnea-hypopnea index) was associated with worse overnight memory consolidation. Ongoing analyses are focused on the relationship between obstructive sleep apnea, sleep structure and memory consolidation, with a particular focus on sleep spindles and slow oscillations. These results suggest that targeting sleep could have direct benefits on cognition in Parkinson's patients.

Topic Line: LONG-TERM MEMORY: Development & aging

E63 Naturalistic auditory narratives synchronize 'visual' cortices of congenitally but not late blind or sighted people

Elizabeth Musz, Johns Hopkins University, Rita Loiotile, Johns Hopkins University, Janice Chen, Johns Hopkins University, Marina Bedny, Johns Hopkins University

In individuals who are born blind, 'visual' cortices are activated during auditory and tactile tasks such as judging sound location (e.g. Sadato et al., 1996; Collignon et al., 2011). 'Cross-modal' activity during these tasks is reduced or absent in people who lose vision as adults. Do adult-onset blind individuals recruit 'visual' cortices for different cognitive processes? Alternatively, is there a sensitive period in cortical development? To gain insight, we used naturalistic auditory movies and narratives that engage many varied cognitive processes. Congenitally blind (CB, n=18), adult-

onset blind (vision loss >18 years-of-age, LB, n=12) and sighted (n=18) participants listed to six-minute auditory excerpts from movies; a spoken narrative; and matched degraded auditory stimuli (i.e., shuffled sentences, backwards speech) during fMRI scanning. We correlated the voxel-wise timecourses of different participants within and across groups. Both within and across all groups, all conditions drove synchrony in auditory cortex, while only narrative stimuli synchronized activity in higher-cognitive fronto-parietal and temporal regions. Inter-subject synchrony in visual cortices only emerged for the CB group, and only for narrative stimuli. Synchrony was low in 'visual' cortices of the LB group, both among LB participants and between LB and CB and LB and sighted participants. Unlike in the CB group, 'visual' cortex synchrony of the LB group did not vary systematically as a function of stimulus cognitive complexity. In sum, these results suggest that visual cortices are consistently reorganized across congenitally but not adult-onset blind people, and provide support for sensitive periods in functional reorganization of 'visual' cortex.

Topic Line: LONG-TERM MEMORY: Development & aging

E64 Neural mechanisms underlying the use of learned value to guide memory across development

Kate Nussenbaum, New York University, Daphne Valencia, New York University, Jamie Greer, Vassar College, Nora Keathley, Emory University, Catherine A. Hartley, New York University

Previous work has revealed that the ability to strategically encode high-value information may improve gradually over development, as the systems supporting cognitive control processes mature. However, studies of value-directed memory have relied on explicit cues that signal the importance of information, which are rarely present in real-world contexts. Here, using a novel fMRI paradigm, we examined whether individuals across a wide age range (N = 90; ages 8 - 25 years) could learn the relative frequency of items in their environment and prioritize memory for information associated with higher frequency items, which would ultimately enable them to earn more reward. We found that from childhood to early adulthood, individuals improved both at transforming their experiential learning into explicit representations of information value and at using these value estimates to strategically modulate encoding. Memory for high-value information was supported by increased engagement at encoding of the left caudate, putamen and lateral prefrontal cortex -- regions that have been implicated in value processing and the implementation of cognitive control mechanisms. We also observed increased recruitment of the thalamus and occipital and parietal cortices during encoding of high- vs. low-value information. Our results suggest that over development, the ability to dynamically adjust memory based on the statistics of the environment engages a wide network of brain regions that support both the recognition and use of information value to implement strategic control over encoding.

Topic Line: LONG-TERM MEMORY: Development & aging

E65 Reinstatement of Item-Specific Contextual Details During Retrieval Supports Recombination-Related False Memories

Alexis Carpenter, Harvard University, Preston Thakral, Harvard University, Alison Preston, University of Texas at Austin, Daniel Schacter, Harvard University

Flexible retrieval mechanisms that allow us to link together related memories, infer novel relationships across event boundaries, and recombine experiences into possible future events may also leave memory prone to error or distortion when details of one event are misremembered as having come from the related or overlapping event. To determine how flexible retrieval and cross-episode binding mechanisms affect the reinstatement of related contextual details and subsequent false memories, we developed a modified version of an associative inference paradigm in which participants viewed each event context during a pre-exposure phase prior to encoding overlapping events (AB, BC) that may later be linked to support successful associative inference (AC). During the retrieval phase, we correlated neural patterns when participants were asked to retrieve the currently cued context (AB) with neural patterns when participants viewed the overlapping, yet incorrect context (BC) during the pre-exposure phase. Results revealed that after successful inference, when participants were asked to retrieve contextual details of the currently cued event, neural patterns in the anterior hippocampus, posterior medial prefrontal cortex, and content-reinstatement regions were more similar to the overlapping, yet incorrect context compared to pattern similarity after unsuccessful inference. Further, the degree of 'false' contextual reinstatement evident in our content-reinstatement region correlated with the strength of participants' false memory effects. Results suggest that retrieval-mediated recombination mechanisms support not only successful associative inference but play a role in the misattribution of contextual details and that these misattributed details are reinstated during subsequent retrieval attempts, resulting in false memories.

Topic Line: LONG-TERM MEMORY: Episodic

E66 Does reset of hippocampal theta predict dynamics of memory encoding?

Ryan Colyer, University of Pennsylvania, Michael Kahana, University of Pennsylvania

Both human and animal studies have implicated hippocampal theta oscillations in learning and memory function. Furthermore, theta oscillations reset following the appearance of a behaviorally relevant stimulus. Here we asked whether reset of hippocampal theta oscillations predict the dynamics of memory encoding for subsequently recalled and forgotten items. Our dataset comprised 42 neurosurgical patients who studied lists of common words for a subsequent delayed free recall test. We observed significant phase reset in the 125-375ms interval following stimulus presentation for both subsequently recalled and forgotten items. This effect, which appeared most prominently at frequencies 5-16Hz, distinguished between the encoding of subsequently recalled and forgotten items. These findings lend support to the view that hippocampal theta oscillations serve an important role in the encoding of new episodic associations.

Topic Line: LONG-TERM MEMORY: Episodic

E67 Manipulating associative encoding strategy impacts neural discriminability at encoding and retrieval

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Recent studies of associative memory in young adults have found that manipulating the strategy
used to encode item-item or item-context associations can lead to unitization of the stimulus pair (Overman & Stephens, 2013). While unitization leads to improved memory performance compared to associative encoding (e.g., Hertzog et al., 1998; Naveh-Benjamin et al., 2007; Rogers et al., 2000), the neural mechanisms underlying this strategy have not been fully examined. The current study examined the effect of manipulating encoding strategy on neural activation using a low-association condition and a high-association condition that promotes unitization. In line with previous studies, participants were significantly better at recollecting associative pairs in the high-association condition than the low-association condition. To investigate whether these behavioral differences were underscored by neural differences, we used multivoxel pattern analyses to examine whether patterns of activation between our strategic manipulation conditions were discriminable within regions known to support associative memory at encoding and retrieval. At encoding, a classifier was marginally able to distinguish between encoding conditions in the perirhinal cortex. Whereas, at retrieval, these conditions were significantly distinguishable in the inferior occipital cortex and perirhinal cortex, and marginally distinguishable in the angular gyrus/ BA5/ BA7. Results suggest that inducing unitization leads to better memory, and the benefit may lie in differences at retrieval associated with how the pair are retrieved.

Topic Line: LONG-TERM MEMORY: Episodic

E68 From episodic to semantic memory: A computational model

Denis Alevi, The Pennsylvania State University, Richard Kempter, Humboldt University of Berlin, Henning Sprekeler, Berlin Institute of Technology

Systems memory consolidation describes the process of transferring and transforming initially hippocampus-dependent declarative memories into stable representations in the neocortex. Experimental evidence indicates that neural replay is linked to this process. While multiple phenomenological theories of systems consolidation have been proposed, a mechanistic theory on the level of neurons and synapses is missing. Here, we study how episodic memories change over time in a recently suggested computational model for the neuronal basis of systems memory consolidation. The model suggests that consolidation could arise from Hebbian synaptic plasticity in networks with parallel synaptic pathways. We implement the proposed mechanism in artificial neural networks to study how episodic memories change over time. We conceptualize the formation of an episodic memory as overfitting to a single event -- thereby learning all of its details. We show that memory transfer in the model facilitates the forgetting of episodic detail in memories and enhances the extraction of semantic generalizations. Moreover, we show that neural replay enhances the speed of consolidation and can in certain situations be necessary for the extraction of semantic memories. The latter appears to be the case specifically for the extraction of semantic content from a rapidly learning hippocampal system. Finally, we hypothesize that a hierarchical iteration of the mechanism may provide a mechanistic model for the spatial and temporal gradients of episodic and semantic memories observed in lesion studies, which suggest that episodic memory content decreases and semantic memory content increases with distance from the hippocampus.

Topic Line: LONG-TERM MEMORY: Semantic

E69 Hippocampal-targeted noninvasive stimulation alters objective memory for naturalistic episodes

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Episodic memory depends on a widespread network of regions including the hippocampus and posterior parietal lobes. Two previous studies have shown that single-session theta-burst transcranial magnetic stimulation (TBS) of lateral parietal regions showing high functional connectivity with the hippocampus can alter episodic memory and its neural correlates. These studies reported stimulation-induced improvements in word-list and spatial precision tests of episodic memory. However, it is currently unclear whether the effects of hippocampal-targeted stimulation generalize to more naturalistic forms of episodic memory, which likely involve distinct neural mechanisms. The current study therefore investigated the effects of hippocampal-targeted parietal stimulation on memory for naturalistic video-clip episodes, which afford high experimental control while more closely approximating memory for life events. Participants (N=20) received TBS to a lateral parietal target demonstrating high functional connectivity with the hippocampus, or to a control stimulation site, on separate days. Immediately following stimulation, participants viewed short video clips depicting everyday activities. At retrieval, participants answered true/false questions to test their accuracy for the videos and rated their subjective vividness of the memory. Compared to control stimulation, parietal stimulation enhanced memory accuracy for the videos, but had no effect on memory vividness. These findings demonstrate that hippocampal-targeted parietal stimulation alters objective memory for naturalistic episodic events. Potential differences between the effects of stimulation on distinct forms of episodic memory and their neural correlates will be discussed.

Topic Line: LONG-TERM MEMORY: Episodic

E70 Dissociable neural reinstatement of emotional memories in human PFC

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Neurophysiological research in rodents using activity-dependent neural tagging shows separate neural ensembles in the hippocampus, amygdala, and medial PFC activate at encoding and retrieval of threat memories and extinction memories (Frankland et al., 2019). Detailing this level of neuronal organization is not currently possible using human neuroimaging, but multivariate analysis of fMRI data can quantify reinstatement of encoding-related activity patterns during memory retrieval (Ritchey et al., 2013). Here, we developed a hybrid threat conditioning-episodic memory paradigm that allowed us to localize distinct patterns of threat versus safety memories using multivariate representational similarity analysis in healthy adults (N=24) and patients with PTSD (N = 24). Subjects first learned to associate non-repeating exemplars from a semantic category with a shock (CS+) or no shock (CS-), immediately followed by extinction. Then 24 hours later participants completed a surprise recognition memory test for all CS stimuli previously encoded during both conditioning and extinction. Encoding-retrieval overlap was analyzed by stimulus type (CS+/-), encoding phase (baseline, acquisition, extinction), and group (healthy, PTSD). Healthy controls showed dissociable reinstatement patterns for CS+ items relative to CS- items in the dACC for items encountered during conditioning, and in the vmPFC for items encoded during extinction. PTSD displayed significant reinstatement for both threat and safety memories in the dACC, but no reinstatement in the vmPFC, consistent with an extinction deficit associated with the disorder. These results provide evidence for the neural reinstatement of emotional memories in human PFC, and show dysregulation of extinction memory processing in PTSD.

Topic Line: LONG-TERM MEMORY: Episodic

E71 Mismatch negativity (MMN) predicts mnemonic specificity: A new metric for auditory pattern separation

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Humans are very good at differentiating highly similar inputs belonging to separate, yet overlapping events into discrete episodes at encoding, a process known as 'pattern separation.' This process likely depends on our ability to automatically encode similar sensory input into distinct memory representations. In this study, we combine a behavioral paradigm with the brain's perceptual discrimination index known as mismatch negativity (MMN) to determine the neural substrates enabling pattern separation. We hypothesized that the MMN -- mainly considered a measure of sensory memory -- would predict participants' ability to discriminate incidentally learned items from highly similar lures and from relatively dissimilar foils. We measured ERPs of young adults as they passively listened to 700 standard and 300 deviant micropatterns presented in a random order. These micropatterns were 500 ms long and consisted of a sequence of five 100 ms tones rising and falling in frequency. After exposure, all participants completed a surprise memory test in which they were presented with old micropatterns, highly similar lures, and relatively dissimilar foils. At test, participants were better at remembering the standard compared to the deviant micropatterns, and better at identifying foils as new compared to lures. Importantly, we also found a significant correlation ($p < .05$) between the MMN amplitude and recognition accuracy for old versus new, and for old versus lures. These findings suggest that the MMN translates to behavioral pattern separation. Our investigation is the first to show that our capacity to discriminate auditory inputs, as measured by MMN, translates into unique memories.

Topic Line: LONG-TERM MEMORY: Episodic

E72 Neural reactivation of mnemonic interference during associative memory

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Episodic reinstatement is predicted to play an important role in recollection memory. However, it remains unknown how neural reinstatement is affected by mnemonic interference arising during new learning or memory retrieval. The purpose of the present study was to use representational similarity analyses to measure the extent of neural reactivation of interfering memory representations and its impact on associative memory performance in young and older adults. Younger and older participants completed an associative memory task in which objects were paired repeatedly with either faces or scenes. Participants were asked to memorize the most recent pairing for each object under different levels of proactive interference during the encoding session. The level of interference was manipulated by increasing the number of presentations for the other, least recent, face or scene. In the retrieval session, participants made a decision whether a face or scene was the most recently paired with the object. EEG was recorded over the encoding and retrieval sessions. Across interference levels, greater episodic reinstatement supported better associative memory accuracy. Emerging results suggest that proactive interference reduces the degree of episodic reinstatement between encoding and retrieval of the target (recent) associated face or scene, suggesting that mnemonic interference of the associated lure in turn contributed to worse memory performance across age groups.

Topic Line: LONG-TERM MEMORY: Episodic

E73 Coarse-grained event segmentation induces false memory

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Humans segment continuous streams of experience into fine-grained events (e.g., eating breakfast, commuting to work, meetings), simultaneously grouping these events into coarse-

grained summaries (e.g., the typical Monday morning). The granularity of event boundaries not only influences the types of details we can access in memory, but may also influence false memory of details that never happened. Here, we manipulate the granularity of event boundaries through task instructions and examine false memory in young adults. In the fine-grained condition, participants were asked to remember picture-word pairings in each block, with a displayed trial number denoting the current temporal position within the experiment. In the coarse-grained condition, participants were instead asked to remember picture-word pairings across all trials, with no knowledge of temporal position within the experiment. Critically, all picture-word pairings were trial unique, with the number of stimuli and timings identical in both groups. The only difference between groups was the wording of instructions, which biased participants into segmenting experience in a fine-grained ('each block') or coarse-grained ('all trials') manner. Participants in the coarse-grained condition not only made twice as many false alarms to recombined picture-word pairings, but made false alarms to pictures and words presented further apart in temporal distance. We replicate this effect in Experiment 2 after controlling for potential confounds, suggesting that the wording of instructions can robustly influence false memory through the granularity of event segmentation. The manner in which we segment experiences alters the veridicality of memory, providing new insight into age-related susceptibility to interference.

Topic Line: LONG-TERM MEMORY: Episodic

E74 How basic emotion categories and emotional congruency with context interacts to influence memory

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Information congruent with prior knowledge is remembered better than incongruent information. At the same time, emotionally charged items are often remembered better, but emotional associations -worse. We investigated how emotional congruency and basic emotions influence associative memory for words in communicative context of faces.

18 subjects (females, age 22-29) took part in fMRI study. Stimuli included emotional words and faces (disgusting/fearful/neutral) from standardized datasets. During encoding sessions, words were presented with faces, emotionally congruent or incongruent. Subjects were instructed to memorize these pairs and imagine as messages and senders. During retrieval sessions, old and new words were shown, and participants indicated what was the emotion of accompanying faces.

Behavioural analyses showed interaction between emotion and congruency â?' disgust was remembered better than fear when congruent, but not incongruent. During correct encoding, we observed that left parahippocampal gyrus was more active for incongruent than congruent pairs, while right hippocampus was more active for disgust than fear. Correct encoding of congruent disgust was specifically related to activation of right amygdala and hippocampus. During correct retrieval, right parahippocampal gyrus was more active for congruent than incongruent pairs and also for disgust than fear. Retrieval of congruent disgust activated specifically left hippocampus and medial prefrontal cortex.

Here we provided behavioral and neuroimaging evidence that encoding and retrieval of verbal stimuli depends on basic emotions and emotional congruency between item and communicative context. Emotionally congruent information might be unitized more easily and only encoding and retrieval of incongruent emotional information was related to the hippocampal

Topic Line: LONG-TERM MEMORY: Episodic

E75 The primacy of processing speed on episodic memory maintenance: A single-blind randomized trial assessing the effects of

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Episodic memory (EM) is defined as the recollection of autobiographical events. Behavioral studies investigating memory maintenance have suggested a central role for processing speed (PS). The extent to which episodic memory maintenance (EMM) depends on PS remains unknown. Furthermore, studies assessing caffeine's influence on EMM are limited. We conducted a participant-blind, two-part study to investigate caffeine's effects on EMM. Participants completed two sessions, about a week apart, during which they were administered a pill containing either caffeine (250mg) or placebo before performing an EM task during each session. The task required participants to learn 70 face-name pairs. Each pair was presented for 5s. The same pairs were shown during both sessions. EM performance was assessed by the recall-accuracy of the face-name pairs following each session. PS was measured as the average time to retrieve face-name pairs. The participants were randomly assigned to one of three groups, namely: 'caffeine-placebo', 'placebo-caffeine', and 'placebo-placebo', indicative of the pill they received for sessions 1 and 2. We found no significant group-differences in recall-accuracy or PS in either session. These results suggest caffeine has no effect on encoding or retrieval of EM. We observed significant between-session increases in task accuracy and processing speed across all three groups (all $p's<0.05$). There were no significant between-session increases in task accuracy when controlling for PS as a

covariate, suggesting a central role for PS in EMM following rehearsal.

Topic Line: LONG-TERM MEMORY: Episodic

E76 Human MTL Neurons are Phase-locked to Hippocampal Theta

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Functional interactions between the hippocampus and surrounding medial temporal lobe (MTL) regions are critical for episodic memory integrity. Animal studies have proposed a role for neural oscillations in coordinating brain activity between regions, and in rodents, phase-locked firing of cortical neurons to hippocampal theta oscillations facilitates information transfer to the hippocampus and supports memory-guided behavior. In this work, we explored a role for hippocampal phase-locking in the human brain. We recorded 1348 MTL and neocortical neurons and simultaneous hippocampal local field potentials from intracranial microwires implanted in 18 epilepsy patients who played a virtual navigation game. For each neuron, we calculated the mean resultant length across spike-coincident hippocampal LFP phases for frequencies from 0.5 to 90.5 Hz. We compared these values to null distributions drawn from circularly shifted spike trains and applied false discovery rate correction (alpha=0.05) across comparisons to determine significance. We identified 419 neurons (31.1%) that phase-locked to hippocampal oscillations, almost exclusively within the delta (1-4Hz) and theta (4-8 Hz) bands. Phase-locking occurred robustly across patients and most prominently among entorhinal cortex and amygdala neurons. Highly phase-locked firing, but not firing rate, coincided with greater hippocampal delta and theta power and with elevated functional coupling (correlated LFP power across frequencies) between a neuron's region-of-origin and the hippocampus. Our results reveal that spike-time coordination between MTL neurons and hippocampal low frequency oscillations is a defining feature of their functional interactions. We propose that hippocampal phase-locking could mediate flexible interregional communication to guide the encoding and retrieval of episodic memories.

Topic Line: LONG-TERM MEMORY: Episodic

E77 Spatial memory activation patterns classify females but not males

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In a previous fMRI investigation, we identified sex differences during spatial long-term memory. During study, abstract shapes were presented to the left or right of fixation. During test, old shapes were presented at fixation and participants classified each shape as previously on the 'left' or 'right'. We selected eighteen female participants (from forty) to match the behavioral accuracy and standard error of the eighteen male participants. Despite equivalent behavioral performance, females and males activated widely different brain regions. In the current investigation, we used the same dataset to classify sex using multi-voxel pattern correlation analysis. For each pair of left-out participants (1 female, 1 male), an independent functional ROI was defined from the remaining participants as the union of activity produced from the contrasts of female hits versus misses and male spatial hits versus misses (thresholded such that each contrast produced the same number of activated voxels). A female template and a male template were created from the remaining participants by averaging the response magnitude for each sex within the functional ROI. The sex of each left-out participant was classified depending on whether their activation pattern was more highly correlated with the female or the male template (this was repeated for all participant combinations). Sex classification accuracy was significantly above chance for females but not males, which suggests spatial memory activation patterns are more consistent between females than between males. More broadly, these results contribute to the growing body of evidence supporting sex differences in the field of cognitive neuroscience.

Topic Line: LONG-TERM MEMORY: Episodic

E78 Spatiotemporal analysis of a neural contiguity effect in episodic memory retrieval

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An important neural correlate of episodic memory is the increased activity of the posterior cortex during successful retrieval. In the old/new paradigm for recognition memory, Hit trials elicit greater activity than Correct Rejection trials in electroencephalography (EEG) recordings. However, the neural processing underlying this increased activity and how it supports memory retrieval remain poorly understood. In this study, we tested whether this neural activity reinstates the temporal order in which the item was encoded -- a contiguity effect that serves as the basis for encoding temporal context into memory. Twelve subjects underwent simultaneous EEG/MEG when performing an old/new recognition memory task, and completed the same task in functional magnetic resonance imaging (fMRI) scans. A feature vector of EEG amplitude across 64 channels was used to compare the neural representations between items. Feature vector similarity across items during retreival reflected the order in which items were presented during encoding. The similarity was significant in the 26-30 Hz range, 600 ms post-stimulus, and decreased as the lag between items increased. The decreasing similarity suggested the reinstatement of a gradually changing signal that was present during item encoding -- a neural contiguity effect. Joint EEG/MEG source localization found strongest 26-30 Hz activity in the posterior cingulate cortex, and this region was consistently located by an old-new contrast in the fMRI analysis. In sum, these results provide further insights into the neural dynamics underlying the reinstatement of temporal context in episodic memory.

Topic Line: LONG-TERM MEMORY: Episodic

E79 Word problems: An event-related potential study on remembering semantically related and unrelated words

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Dual process models of recognition memory distinguish between familiarity, a feeling of 'oldness' and recollection, the remembering of contextual details. Event-related potential (ERP) studies identified the P300 at encoding as a reliable predictor of subsequent recollection-based recognition (subsequent memory effect, SME). However, previous research was equivocal on whether facilitation of or increased demands on semantic processing are beneficial for familiarity-based remembering. Thus, the present research investigated whether increases or decreases in the N400, a component associated with semantic processing, predict subsequent familiarity-based recognition. In an incidental study phase, participants saw three prime words followed by a target word. In order to contrast facilitated and demanding semantic processing, three conditions were realized: The primes were either semantically related with each other and the target (coherent condition), only related with each other but not the target (deviant condition), or unrelated with each other and the target (incoherent condition serving as a control condition). Despite an increased N400 in the deviant and incoherent condition as compared to the coherent condition, memory was poor and no reliable SME emerged in these conditions. In contrast, in the coherent condition, where recollection and familiarity estimates were highest, a frontocentral positive SME in the N400 time window differentiated between remembered or known words and forgotten words and was followed by a centroparietal P300 SME. These results suggest that both, subsequent familiarity- and recollection-based remembering profit from facilitated, but not from demanding semantic processing.

Topic Line: LONG-TERM MEMORY: Episodic

E80 An ERP study of the beneficial effects of gesture on associative memory formation

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Co-speech gestures benefit language comprehension and memory. In the present study, we examined whether the memory benefits of gesture also extend to novel associations, such as pre-experimentally unrelated word pairs. EEG was recorded while participants watched videos of an actor reciting sentences that ended in unrelated verb-noun pairs (e.g., 'She thought about the driving apple'). Each verb was accompanied by either a matching iconic gesture (i.e., the steering of an imaginary wheel for 'driving'), a beat gesture (small, spontaneous hand movement), or no gesture. To examine the role of imagery in mediating effects of gesture on memory, participants were asked to provide trial-by-trial ratings of word pair imageability in addition to trying to commit the word pairs to memory. Memory was assessed via free recall. Relative to pairs presented with no gestures, pairs presented with iconic gestures were perceived as more imageable and better recalled. Moreover, ERPs elicited by the second words (nouns) of each pair differed according to whether or not a gesture had been paired with the preceding verb. In particular, nouns paired with iconic-gestured verbs elicited greater (more negative) amplitudes of the N700, a late frontal potential previously linked to mental imagery. Beat gestures also enhanced imageability ratings and modulated ERPs to the nouns, but these ERP effects were more posteriorly distributed and were not accompanied by an increase in pair recall. Overall, these data suggest that iconic, but not beat gestures facilitate memory for novel associations, and that these benefits may involve mental imagery.

Topic Line: LONG-TERM MEMORY: Episodic

E81 Withdrawn

E82 Time cell population from various delays show similar structures

Rui Cao, Boston University, Stephen Charczynsk, Boston University, Marc Howard, Boston University

The sequential firing of 'time cells' after the presentation of a salient event can be used to decode the passage of time (Eichenbaum, 2014). Many studies have found time cells across a variety of brain regions and species. Strong empirical evidence from those studies suggests that time is not encoded at a constant rate but compressed as the delay increases. The goal of this study is to quantitatively describe the form of this compression by studying populations of time cells using datasets of extracellular recordings of single units in different brain regions from multiple species. Here we applied Hierarchical Bayesian modeling techniques to characterize the distribution of time field centers and the relationship between each time field center and its time field width. The model fitting results turned out to be similar across those data sets despite their heterogeneousness, especially in terms of the delay length. These preliminary results suggest the possibility of a unified model for time encoding in brain.

Topic Line: LONG-TERM MEMORY: Episodic

E83 Path integration using eye and hand movements

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Although there is neuroimaging evidence suggesting that the entorhinal cortex performs similar computations on whole-body in navigable space and eye movements in two-dimensional space, behavioral evidence of the same is sparse. Humans track their current position in reference to the starting point of a journey using information from whole-body movements through the process of path integration. We tested if path integration, a process dependent on the entorhinal cortex, reflects how gaze and hand movements are integrated to update current position. We used novel eye tracking and tablet tasks in which participants followed a route guided by minimal visual or auditory cues. At the end of each route, participants were asked to revisit the starting point or another en route location. Consistent with previous studies of spatial path

integration using whole-body movements, we found that participants used different strategies to update gaze or hand location depending on task demands. They either continuously updated their current position (continuous updating) or retroactively updated position using a map representation of the route (configural updating) as evidenced by the reinstatement of gaze or hand movement patterns from encoding. Due to higher working memory demands, participants made more errors and took longer to respond during continuous than configural updating. The use of comparable strategies to integrate whole-body, eye, and hand movements suggests that they rely on similar underlying processes. Our results align with recent work which demonstrates that visual space and navigable space are coded through analogous processes in the entorhinal cortex.

Topic Line: LONG-TERM MEMORY: Other

E84 Distinct event-related potential and EEG oscillatory mechanisms of memory dysfunction in Mild Cognitive Impairment

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Reliable biomarkers of memory decline are critical for the early detection of Alzheimer's disease. Previous work has found three EEG measures, namely the event-related potential P600, suppression of oscillatory activity in the alpha frequency range (~10 Hz), and cross-frequency coupling between theta and alpha/beta activity, each to correlate strongly with verbal learning and memory abilities in healthy elderly and patients with Mild Cognitive Impairment or prodromal Alzheimer's disease (Olichney et al., 2008; Mazaheri et al., 2018). In the present study, we investigated whether these measures are complementary predictors of verbal memory. Single-trial correlation analyses showed that despite a similarity in their time-course and sensitivities to word repetition, the P600 and the alpha suppression components are minimally correlated with each other on trial-by-trial basis(generally $|rs| < .10$). This suggests that they are unlikely to stem from the same neural mechanism. Furthermore, event-related potentials constructed from bandpass filtered (delta, theta, alpha, beta, or gamma bands) single-trial data indicated that only delta band activity (1-4 Hz) was strongly correlated ($r = .94$, $P < .001$) with the traditional P600 repetition effect; event-related potentials in higher frequency bands were not. Importantly, stepwise multiple regression analyses revealed that the three event-related potential/oscillatory measures are complementary in predicting California Verbal Learning Test scores (overall R2's in 0.45-0.63 range). The present study highlights the importance of combining EEG event-related potential and oscillatory measures to better characterize the multiple mechanisms of memory failure in patients with Mild Cognitive Impairment or prodromal Alzheimer's disease.

Topic Line: LONG-TERM MEMORY: Other

E85 The different contribution of different associations to visual predictions

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Numerous studies testify to the predictive account of visual perception, showing that learned associations are utilized to generate predictions regarding upcoming events. However, associations can vary in characteristics. Some activate one and some activate multiple associations, some trigger a single context and some multiple contexts, and the corresponding contribution to predictions is not fully explored.

Addressing this gap, we examined how the number of associations an object triggers (i.e. associative specificity) and how the range of contextual schemes these associations construe (i.e. contextual specificity) guide predictions. Resource availability was also manipulated, to test how situational factors influence predictions.

Study one employed an associative version of the 'n-back' task. Results show that associative specificity uniquely facilitates visual predictions. Contextual specificity both enhanced predictions but also triggered conservative associativity criterions. Resource availability contributed only to sensitivity performance, and not the criterion, suggesting that maintaining predictions over time requires resources.

Study two employed a contextual priming paradigm under different load conditions. Findings revealed that associative specificity facilitated object recognition and hindered non-object recognition in a correlative manner. Resource availability did not influence object-recognition accuracy, but a reaction-time priming effect emerged only under low load.

While associative specificity facilitated object recognition here, contextual specificity may possibly enhance predictions during contextual scene processing. Our results also call to explore how selection or inhibition impact predictions when multiple associations are involved.

To sum, we suggest that different associative characteristics differentially guide predictions, and that resource availability influences the way predictions are attended and maintained.

Topic Line: LONG-TERM MEMORY: Priming

E86 Neural evidence for a tradeoff between visuospatial working memory capacity & sensitivity to task irrelevant information

Jacob Momsen, SDSU/UCSD, Seana Coulson, UCSD

Variability in working memory capacity (WMC) is related to the ability to suppress irrelevant information while prioritizing task goals, but less is known about the neural mechanisms that underlie these differences. This study presents EEG data from a dual task paradigm to test how differences in the neural response to task irrelevant stimulus processing manifest as a function of visuospatial WMC. EEG was recorded as adults (n=46) performed a visuospatial free-recall WM task that involved encoding sequences of dot locations under low (one dot) and high (four dots) load conditions. During the maintenance interval, participants watched video clips of speakers describing objects or scenes using semantically congruent or incongruent iconic gestures. A picture probe followed videos used to assess participants' sensitivity to the

discourse content. ERSPs elicited by videos revealed distributional differences in alpha band suppression as a function of WMC-disproportionately enhanced occipital alpha suppression in those with low WMC suggests maladaptive control over exogenous visual activation ($p<0.001$). These results suggest that WMC is characterized both by differences in the degree of attentional capture elicited by task-irrelevant stimuli as well as differences in the management of online inhibitory control under conditions of increased cognitive load.

Topic Line: EXECUTIVE PROCESSES: Working memory

E86 Semantic Memory in Preclinical Alzheimer's disease

Nathaniel Klooster, University of Pennsylvania, David Wolk, University of Pennsylvania, Anjan Chatterjee, University of Pennsylvania

People with preclinical Alzheimer's disease (AD) display evidence of cerebral amyloid, but perform normally on neuropsychological assessment. Cognitive measures sensitive to subtle cognitive change during this stage of disease are needed and would have significant impact for screening and measuring outcomes in intervention studies.

We tested the hypothesis that semantic richness changes early in the AD trajectory. Here, we assess productive and receptive semantic richness, using tests adapted from the psycholinguistic and language-learning literatures in older adults and relate performance to structural imaging and molecular PET imaging.

The number of senses a word can take (e.g. pen: a writing instrument, to write a letter, an enclosure for animals, the University of Pennsylvania) is a measure of semantic richness used widely in psycholinguistic studies. In the Senses-listing task, participants are given one minute to list as many senses as possible for target words chosen from normed databases.

The Word Associates Test (WAT) measures depth of vocabulary used in first and second-language learning research. Participants choose four correctly matching synonyms or collocates from among eight possibilities for each target word.

Performance across tasks differentiates MCI patients from healthy participants. In healthy participants, integrity of MTL subregions vulnerable to early AD pathology, including perirhinal and entorhinal cortices predicts performance, and amyloid status in cognitively 'normal' adults shows a trend in predicting performance. These preliminary results highlight the necessity of the MTL for rich semantic knowledge and suggest that probing semantic memory shows promise in differentiating healthy aging from preclinical AD.

Topic Line: LONG-TERM MEMORY: Semantic

E87 NSF Funding Opportunities for Cognitive Neuroscience

Kurt Thoroughman, NSF, Kurt Thoroughman, NSF

E88 Targeted Memory Reactivation for Multiplication Problems During an Afternoon Nap

Adrianna M. Bassard, Northwestern University, Ken A. Paller, Northwestern University

Learning new facts is a valuable memory ability relevant in many educational contexts. When one learns to multiply, for example, fact learning and skill learning are likely intertwined. Sleep, especially slow-wave sleep (SWS), can facilitate memory consolidation for many types of memory. After pairing sensory stimuli with newly learned information, Targeted Memory Reactivation (TMR) can influence which memories are strengthened over a period of sleep. Here we examined memory reactivation during an afternoon nap using a multiplication task. Twenty-one young adults trained on 30 multiplication problems from six classes (13s, 14s, 16s, 17s, 18s, and 19s) while hearing six different, corresponding sounds. At Test 1 (after ~20 min of training), accuracy averaged 88% (±11) correct, with a mean response time (RT) of 6.3 s (±1.5) on correct trials. During a nap, three of the sounds were softly presented during SWS. At Test 2 (after sleep), mean accuracy and RT were unchanged, with no difference in either between cued and uncued problems. Although the expected cueing benefit was not observed, delta power over the nap marginally correlated across subjects with the cueing benefit for accuracy [$r(19) = 0.38$]. As a secondary analysis, we compared these results with results from participants who stayed awake for 2 hrs between Tests 1 and 2. Although TMR did not produce behavioral changes in multiplication problem-solving, sleep physiology may have affected memory reactivation. Future research is needed with multiple types of memory to clarify which factors influence memory reactivation during sleep and its consequences.

Topic Line: LONG-TERM MEMORY: Skill Learning

E89 Data-driven classification of spectral profiles reveals brain region-specific plasticity

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The human brain exhibits rhythms that are characteristic for anatomical areas and presumably involved in diverse perceptual and cognitive processes. Visual deprivation results in behavioral adaptation and cortical reorganization. Whether plasticity-related changes are accompanied by altered spectral properties of neural signals and whether certain brain areas are particularly targeted is unknown. With a recently introduced approach, we analyzed magnetoencephalography resting state data of congenitally blind and matched sighted individuals. First, using clustering procedures (k-means and Gaussian Mixture Models) we identified brain region-specific spectral clusters. Second, a classifier was employed testing the specificity of the spectral profiles within and the differences between groups. We replicated the previously reported finding of area-specific spectral profiles, indicated by high classification performance in the sighted. Additionally, we found high classification performance in the blind, suggesting that after deprivation-related restructuring, area-specific spectral profiles can

be consistently identified. Crucially, in the cross-group classification (sighted vs. blind), several sensory (visual and auditory) and right frontal brain areas were classified worse compared to the control (within sighted classification) condition. Overall the spectral profiles of those brain areas showed increased neuronal power in higher frequency bands, possibly reflecting acceleration of the regionally prevalent brain rhythms in the blind compared to the sighted. We provide evidence that visual deprivation-related plasticity selectively alters the spectral profiles of right frontal and sensory brain areas, possibly reflecting increased temporal processing capabilities (auditory, frontal cortices) and changes in the visual inhibitory-excitatory circuits in the blind.

Topic Line: METHODS: Electrophysiology

E90 Applying multivariate empirical mode decomposition to the analysis of broad-band EEG microstates

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EEG microstates models spontaneous resting-state EEG as continuous transitions among a few quasi-stable scalp topographies that remain unchanged for 60-120ms. The microstates are extracted from band-passed EEG signals of 2-20Hz or 1-40Hz. Microstates are typically described as broad-band phenomena. A single microstate could model temporal dynamics of a broad range of time scales. The present study investigates a novel method of microstates extraction to examine the broad-band perspective. The data-driven noise-assisted multivariate empirical mode decomposition (NA-MEMD) was applied to decompose time-domain EEG into a set of intrinsic mode functions (IMFs). Each IMF carries information of the original signal at different time scales (~2-150Hz). IMFs can be combined to reconstruct the original signal.

EEG microstates were extracted from healthy young (age 20.7 (1.56), n=22) and older adults (age 72.3 (3.34), n=24) utilizing 2-20Hz band-passed signals or reconstructed signals from different IMFs combinations. The proposed approach could recover the four traditional microstate classes from both subject groups while the existing method failed in the elderly group, recovering only two of four classes. Microstates extracted from IMFs of frequency range (~2-15Hz) explained 54% and 59% of total variances of young and old group respectively, which are higher than using existing method (53% and 56%). It is found that microstate classes A and B were more consistent across frequency ranges, while classes C and D were more frequency-specific. The proposed approach provides new insights on the frequency composition of EEG microstates.

Topic Line: METHODS: Electrophysiology

E91 Hybrid structure-function connectome predicts crystallised and fluid cognition

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Functional connectivity (FC) represents temporal dependency patterns between regional blood-oxygenation-level dependent activity in functional magnetic resonance imaging (MRI) time series, and structural connectivity (SC) represents the inter-regional white matter pathways estimated from diffusion-weighted MRI. SC and FC can be independently used to predict cognition, and show distinct patterns of variance in relation to cognition. No work identified has yet investigated whether SC and FC can be combined to better predict cognitive abilities. In this work, we use data from 785 healthy young adults to:

1) predict crystallised and fluid cognition using SC, FC, and a hybrid structure-function connectome, and

2) quantify the most important pairwise structural and functional connections for cognitive prediction.

FC explains 11.3%, 6.5%, 7.5%, and 12.0% of the variance in crystallised, early childhood, fluid, and total cognition, respectively, while SC explains 5.3%, 3.0%, 2.3%, and 7.1%, respectively. The hybrid connectome explains 12.5%, 8.2%, 8.3%, and 15.0% of the variance in crystallised, early childhood, fluid, and total cognition, respectively, and outperforms the independent use of SC for cognitive prediction. The most important FC features for cognitive prediction are primarily long-range inter-hemispheric cortico-cortical connections, while the most important SC features are primarily short-range inter-hemispheric cortico-subcortical and subcortical-subcortical connections. There is no correlation between the feature importance for FC and SC features, suggesting that while a given region-pair's FC might be important for cognitive prediction, the same region-pair's SC may not be important. Taken together, this suggests that the integration of multi-modal data is crucial to understanding the neurophysiological correlates of cognitive function.

Topic Line: METHODS: Neuroimaging

E92 Assessing brain-wide TMS-evoked responses depending on ocular and oscillatory state: a simultaneous TMS-EEG-fMRI project

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Complex cognitive functions rely on communication in/between widespread brain networks. Brain-wide signal propagation can be studied by using transcranial magnetic stimulation (TMS) as a system probe, and concurrent functional magnetic resonance imaging (fMRI) to measure local and network responses. Network responses depend on neurocognitive state, and moreover on momentary neuronal oscillations measured with electroencephalography (EEG). We applied an innovative simultaneous TMS-EEG-fMRI setup, in six participants, to study these mechanisms across two neurocognitive states: eyes open and closed. We applied TMS to right posterior parietal cortex, a strongly interconnected network hub and high-level association area. We used an MRI-compatible TMS coil and holder, along with two 4-channel MRI flex coils to create sufficient space for the TMS-

EEG equipment. Supra- versus sub-threshold 15Hz TMS triplets were administered during fMRI acquisition gaps. Ocular state (eye closure) was cued by auditory tone, in complete darkness. We measured fluctuations in neuronal oscillations prior to TMS with EEG, within and between the two ocular states which were previously associated with different brain-wide connectivity patterns. As expected, supra- compared to sub-threshold TMS induced higher fMRI activation in bilateral auditory and sensorimotor areas, due to louder noise and stronger sensation of TMS. Ocular state modulated fMRI responses in motor and sub-cortical areas (such as thalamus). Future analyses will evaluate whether/how such effects depend on EEG-indexed oscillatory state at the time of TMS. These preliminary findings confirm the potential of our new simultaneous TMS-EEG-fMRI setup and open the door to the investigation of state-dependent brain-wide signal propagation.

Topic Line: METHODS: Neuroimaging

E93 Age-related differences in white matter: Comparing fixel-based and tensor-based analyses

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Older adults tend to perform worse on cognitive and behavioral tasks, and age-related changes in white matter (WM) may play a role. Most prior studies of age differences in WM have used diffusion tensor imaging (DTI), but typical DTI metrics can reflect multiple different biological factors, making interpretation challenging. New fixel-based analysis (FBA) techniques have been developed to address some of these concerns, but have not yet been applied in the domain of aging. Here, we used both DTI and FBA to analyze age differences in WM in a large sample of healthy older (n=45) and younger (n=25) adults, both at the whole brain level and in specific WM tracts. While the two methods provided partially consistent results, FBA more clearly delineated a (fronto-)limbic locus of age-related effects and provided additional insights into structural changes underlying them. DTI analysis provided less specific results, potentially reflecting decreased biological specificity of tensor-based metrics. These results demonstrate the power of FBA and provide novel insights into major WM differences associated with aging.

Topic Line: METHODS: Neuroimaging

E94 Using mobile EEG to assess brain health and performance

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In recent years it has become possible to use mobile electroencephalographic (mEEG) technology to collect research grade data (Krigolson et al., 2017). The recent advances in mEEG data quality and the ease of use have opened the doors for a wide range of real-world applications for human neuroimaging in addition to allowing large scale data collection. Here, we present the results from a large sample size study (n = 1000) wherein we used a combination of event-related potentials (ERPs), time-frequency analysis (FFTs), and machine learning classifiers to examine relationships between neural data and cognitive fatigue. In this study, participants played two simple games on an Apple iPad using PEER research software ? a visual oddball task and a two-choice gambling task while mEEG data was recorded from a MUSE headband. In line with previous research, our results demonstrate that diminished ERP responses (P300, reward positivity) are associated with increased cognitive fatigue. Further, using a combination of multivariate regression and machine learning classifiers we were able to greatly increase the explained variance in our results (Discriminant Analysis Classifier with Bayesian Optimization, 91.6% accuracy) and come up with a more accurate prediction of cognitive fatigue level. Importantly, we demonstrate two key things here. One, we provide further evidence for the use and validity of mEEG in research. Two, we provide an important building block for cognitive fatigue detection capability ? something that obviously could have huge impact in a variety of real-world applications.

Topic Line: METHODS: Neuroimaging

E95 Brainstem Structural Alterations Correlates with Sleep Difficulty and Pain in Gulf War Illness Veterans

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Background: Gulf War illness (GWI) in veterans who served in the 1990-91 Persian Gulf War is manifested by multiple chronic symptoms, including pain, sleep problems, neuropsychiatric disorders, autonomic, gastrointestinal, and skin problems. Major reticular nuclei and circuits of the brainstem play key roles in regulating sleep-awake circle and pain control. The aim of this study was to find the brainstem neuro-correlates of the chronic sleep and pain syndromes in GWI veterans.

Methods: We enrolled 26 GWI patients who meet both Fukuda/CDC and Kansas criteria for chronic multi-symptom illness (Age=51±5, 88% Male). Sleep quality was evaluated using the global Pittsburgh Sleep Quality Index (PSQI). Pain intensities were obtained with the Brief Pain Inventory (BPI). Structural and diffusion tensor MRI scans for all participants were post-processed to measure the white matter integrity of three dorsal brainstem circuits, as well as the volumes of the periaqueductal gray matter (PAG) and locus coeruleus (LC).

Results: There was a significant correlation (R=-0.45, P=0.02) between worsening of the global PSQI and the integrity of the dorsal longitudinal fasciculi (DLF), a brainstem tract that interconnects hypothalamus, PAG, LC, and medial medulla. There was also a significant correlation (R=-0.40, P=0.04) between increasing pain levels, measured by the 'Pain-right-now' item from BPI, and the integrity of the DLF.

Conclusion: These preliminary findings of the brainstem neuroanatomical correlates of chronic sleep disturbances and pain may improve the understanding of the brainstem neurotransmitter

regularization system and its pathophysiological basis underlying the chronic multi-symptoms in GWI.

Topic Line: METHODS: Neuroimaging

E96 Default Mode Network Connectivity Response to Transcranial Magnetic Stimulation in Smokers: A Preliminary Evaluation

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Repetitive transcranial magnetic stimulation (rTMS) has been hailed as a promising therapy for a range of psychiatric disorders, including Tobacco Use Disorder (TUD). High frequency rTMS to the dorsolateral prefrontal cortex (dlPFC) has been the predominant therapeutic approach investigated for TUD, but advances in brain imaging have suggested other targets, such as the superior frontal gyrus (SFG) or posterior parietal cortex (PPC) may be equally or more efficacious. Therefore, 13 daily smokers received up to four sessions of neuronavigated 10Hz rTMS directed at the SFG, dlPFC, PPC, or visual area 5 (V5). Stimulation targets were selected based on individual intrinsic network connectivity, and stimulation sessions were separated by ?24 hours. Before and after rTMS, participants completed esting-state functional connectivity (RSFC) scans and self-reports of craving symptoms. The effect of rTMS on default mode network (DMN) connectivity depended on stimulation site, with dlPFC rTMS producing its maximum change in PCC-DMN connectivity, SFG and PPC rTMS both producing their maximum changes in precentral gyrus-DMN connectivity, and V5 rTMS producing its maximum change in amygdala-DMN connectivity. The magnitude of change in PCC-DMN connectivity corresponded to the magnitude of change in self-reported craving measured with both the Urge to Smoke (interaction $p = 0.0036$) and Shiffman-Jarvik Withdrawal Scales (interaction $p = 0.0214$). These findings suggest that high frequency rTMS to the dlPFC produces the largest changes to PPC-DMN connectivity, that these connectivity changes correspond to rTMS-induced craving relief, and that PPC-DMN connectivity changes may underlie the therapeutic action of dlPFC rTMS in smokers.

Topic Line: METHODS: Other

E97 Longitudinal structural effects of electroconvulsive therapy in major depressive disorder

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Major depressive disorder (MDD) affects around 10-15% of the worldwide population. Electroconvulsive therapy (ECT) can be used to treat MDD patients that have not responded to standard treatments. Despite ECT remarkable efficacy, we still have a restricted comprehension of its mechanisms of action and the way it relates to changes in clinical symptoms.

We performed a longitudinal structural neuroimaging study in 17 MDD patients to compare whole-brain volumetric changes before and after ECT. We also explored the relationship between volumetric changes and changes in depression severity (categorical syndrome) and dimensional measures of positive and negative affect and suicide risk (QIDS, PANAS and CHRT).

We found ECT-related bilateral increase volume for all subcortical regions. We reported ECT-related volume increase in parietal, temporal, occipital and insular cortices; and decrease in inferior frontal cortex, subparietal cortex and premotor regions. We found significance linear regressions between difference in clinical scores and difference in volume for several regions: right putamen with QIDS, superior occipital gyrus with PANAS-POS, parahippocampal gyrus with PANAS-NEG, superior occipital sulcus with PANAS-NEG, posterior-dorsal part of the cingulate gyrus with PANAS-POS, middle occipital gyrus with PANAS-POS, occipital pole with PANAS-NEG, superior segment of the insula circular sulcus with PANAS-POS and middle temporal gyrus with QIDS, PANAS-NEG and CHRT.

These results indicate compelling and potentially specific clinical associations. Clarification of these correlations is required to gain a deeper and more granular understanding of MDD pathophysiology, the mechanisms of action of ECT and to use this information towards novel treatment development.

Topic Line: NEUROANATOMY

E98 Differences in left fusiform gyrus morphometry in adults with dyslexia: Voxel- and surface-based analyses

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Dyslexia is a neurological disorder that specifically impairs the development of fluent and accurate reading skills. However, structural neuroimaging research has not converged on reliable neuroanatomical signatures of reading impairment. In a large sample of adults with dyslexia ($n = 55$) or typical reading skills ($n = 52$), we tested for whole-brain group differences in three neuroanatomical metrics: gray matter density, cortical thickness, and cortical surface area. We also performed whole-brain correlations in the dyslexia group between these metrics and standard neuropsychological assessments of phonological awareness, phonological working memory, reading accuracy, and reading fluency. No significant group differences were observed for gray matter density or cortical surface area. Cortical thickness significantly differed between adults with dyslexia and typical readers in a cluster in left fusiform gyrus (FDR $p < 0.05$) when controlling for age and sex. No continuous relationships between brain morphometry and reading skills were found. These results raise the possibility that prior reports of morphometry differences in dyslexia-particularly those outside of a core reading center in left fusiform gyrus-may not generalize to larger samples or disorder heterogeneity. Our observation of cortical thickness differences in left fusiform gyrus suggest this region may mature differently during reading development in adults with dyslexia, though whether this is a cause or consequence of the disorder is unclear. This is a

preliminary report from a sample of more than 1000 brains of adults and children with and without dyslexia, where we are investigating neuroanatomical differences associated with dyslexia across the lifespan.

Topic Line: NEUROANATOMY

E99 The influence of reproductive stage on cerebellar network connectivity across adulthood

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Resting state networks impacted in aging, particularly those involving the cerebellum, show sex-specific differences. As females are disproportionately affected by aging, a biological component may help explain sex differences in the trajectories of brain changes across adulthood. Specifically, hormone changes with menopause may play a critical role in aging. We were interested in evaluating the influence of reproductive stage, as well as age and sex more broadly, on cerebellar network connectivity. The data used for this investigation (n = 591 adults) was acquired from the Cambridge Centre for Ageing and Neuroscience (Cam-CAN) repository. We used raw data from structural and resting state magnetic resonance imaging (MRI), as well information regarding age, sex, and menopause-related variables. Crus I and II and Lobules V and VI were our cerebellar seeds. Reproductive stage of females was characterized using the STRAW+10 criteria. Results show that postmenopausal females (n = 123) have reduced cerebello-striatal and cerebello-cortical connectivity, particularly in frontal regions, as well as greater connectivity within the cerebellum, compared to reproductive females (n = 107). These differences begin to emerge across transitional stages of menopause. Further, results reveal sex-specific differences in connectivity between female reproductive groups and age-matched male control groups. This suggests that menopause, and associated hormonal fluctuations, may influence cerebellar network differences within aging females. Further, sex-specific differences in the aging brain may be related to these biological characteristics. Thus, differences in reproductive stage and the menopausal transition are important factors to consider when evaluating differences in cerebellar network connectivity across adulthood.

Topic Line: OTHER

E100 Two-way communication between dreamers and experimenters

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Dreams are emblematic of human sleep, but they have yet to be adequately explained. In part, this is due to the limited options available for peering into dream experiences. Mapping neural measures onto dreams is problematic when those dreams are recounted after waking. Retrospective dream reports are subject to distortion and rapid forgetting. Here, we describe a method to overcome these obstacles through two-way communication between dreamers and experimenters. To demonstrate proof-of-concept, we presented softly spoken math problems to participants during lucid REM sleep, and they provided answers using covert physiological signals such as eye movements. We confirmed REM sleep using standard polysomnographic methods. Thus far, 3 out of 8 participants who had lucid dreams correctly answered problems during REM sleep. Results document that sleeping individuals can have sufficient abilities for veridical perceptual analysis, maintaining information, computing simple answers using working memory, and expressing volitional replies. Dreamers can thus be capable of interacting and exchanging information with other individuals. In this way, the mental content experienced by the dreamer can be interrogated to characterize the phenomenological experiences and cognitive abilities of dreaming.

Topic Line: OTHER

E101 A Possible Effect of the PICMOR Intervention Program on Regional Brain Volume in Older Adults

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Photo-Integrated Conversation Moderated by Robots (PICMOR) is a social activity-based intervention program for older adults that has been developed to enhance their cognitive functions. PICMOR offers a moderated group conversation with robotic supports, in which participants are prompted by a robot to talk about their daily life using photos they prepared beforehand, and answer questions about the topic asked by others; alternatively, they are required to listen carefully to others and ask them questions. To investigate the effect of PICMOR on cognitive functions in older adults, we previously conducted a randomized controlled trial. Here we conducted a voxel-based morphometric analysis for structural magnetic resonance imaging (MRI) data from the participants and examined a possible difference in brain structures between the intervention group (INT) and the control group (CONT). Although the possible differences cannot be fully attributed to the effect of PICMOR because we lack comparable MRI data from before the intervention, we aimed to provide directions for future research examining the intervention effects. We found larger volume in INT than in CONT in several regions, such as the right parahippocampal gyrus/ hippocampus, superior frontal gyrus, postcentral gyrus, and left posterior middle temporal gyrus. In contrast, no regions showed greater volume in CONT than in INT. The present findings suggest that PICMOR has a beneficial effect on regional brain volume. Further investigation will be needed to confirm this possible effect in future research by collecting longitudinal data through the intervention period and making comparisons with the data from the two groups.

Topic Line: OTHER

E102 Directional brain-to-brain oscillation coupling reflects music ensemble leadership

Andrew Chang, McMaster University, Philip Chrapka, McMaster University, Dan Bosnyak, McMaster University, Laurel Trainor, McMaster University

Coordinating with others is essential for humans during many daily activities, ranging from working on the same task to performing music in an ensemble. However, the neural oscillatory representations of interpersonal coordination are unclear, and past research suffers from two major limitations. First, studies on isolated individuals makes it unclear whether the findings generalize to interpersonal settings. Second, most hyperscanning studies have only examined similarity across coactors' brains, which cannot exclude the confound that both brains receive similar sensory input during coordination, or assess directional coordination among coactors. The current study aimed to overcome these limitations. We measured EEG in two professional string quartets in the LIVELab concert hall as a real-world example of interpersonal coordination. We experimentally manipulated leadership, assigning a different musician as leader on each short performance, and here we report EEG analyses. We focused on the source signals generated from four regions of interest, specifically, auditory cortex, visual cortex, dorsal and ventral lateral prefrontal cortex (lateral PFC), and supplementary motor area (SMA). Preliminary analyses using partial directed coherence showed that followers influenced leader more than leader influenced followers or followers influenced each other, especially the couplings involving SMA, lateral PFC and auditory cortex. These couplings might reflect interpersonal sensorimotor predictions and adaptations. Together, we have shown that interpersonal coordination can be represented in EEG activities and that it reflects directional influences between coactors.

Topic Line: PERCEPTION & ACTION: Audition

E103 Hemispheric Specialization in Auditory Rhythm Processing

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Previous research suggests the cerebral hemispheres may have specialized roles in processing rhythms, with the left hemisphere specializing in faster rhythms and the right hemisphere specializing in slower rhythms. Evidence for hemispheric specialization includes the findings that synchronized tapping with the right hand is more precise than with the left to faster rhythms (Repp, 2005; Ivry, 1998), while the left hand is more precise with slower rhythms (Pflug et al. 2017). More recently, amplitude modulation in the beta band was shown to preferentially represent faster rhythms in the left auditory cortex while engaged in a synchronized tapping task, while slower rhythms are represented in the right auditory cortex (Pflug et al. 2019). To further tease out the role of rhythm processing in sensorimotor synchronization with regards to hemispheric differences, we recorded EEG while subjects listened to 3 different rhythms (fast, slow, metered) while either tapping with their left hand, tapping with their right hand, or listening without tapping. Initial analyses in the non-tapping condition reveal greater gamma and beta suppression in the left hemisphere for each of the 3 rhythms in the time/frequency domain, and greater mu suppression in the spectral domain in the left hemisphere for the faster rhythm. While the hemispheric differences seen in our initial analysis in the gamma and beta bands do not show a preference between faster and slower rhythms, the mu suppression in the left hemisphere aligns with the hypothesis of hemispheric specialization for rhythms of different tempos.

Topic Line: PERCEPTION & ACTION: Audition

E104 The effect of aperiodic but predictable temporal regularity on pitch discrimination

Jesse Pazdera, McMaster University, Andrew Chang, McMaster University, Elger Baraku, McMaster University, Dan Bosnyak, McMaster University, Laurel Trainor, McMaster University

Temporal regularities are common in many auditory signals, including speech and music. It has been shown that periodic or isochronous temporal regularities enable temporal prediction, which facilitates perceptual performance. However, auditory tempo often accelerates or decelerates in a predictable way in music and speech, creating an aperiodic yet still predictable temporal pattern. A few previous studies have investigated this effect with accelerating and/or decelerating sequences, but as the tempo changed in a fixed regular fashion for all trials, an effect of temporal prediction might be confounded with a memory effect. The present study investigates whether aperiodic-predictable temporal regularity facilitates auditory perception as does periodic regularity. Participants were presented with a tone sequence composed of six tones of the same pitch followed by a seventh (target) tone that differed in pitch. The tone sequence was either linearly accelerating or decelerating, or steady. To control for the memory effect, the final target onset time was either matched or mismatched to the trajectory of the sequence with equal likelihood. Participants were asked to tap along with the sequence, and then judge whether the target was higher or lower in pitch. Preliminary analyses using signal detection theory showed a trend for perceptual improvement, in that discrimination sensitivity was higher when the target onset time matched with the regularity of the tone sequence, most prominently in accelerating sequences. Further analyses will examine associations between perceptual performance, temporal precision of tapping, and neural oscillatory activities.

Topic Line: PERCEPTION & ACTION: Audition

E105 What's next? Timing-based anticipation in children with Autism Spectrum disorder

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Music-based interventions have become increasingly adopted for Alzheimer's Disease (AD) and Mild Cognitive Impairment (MCI). Previous research shows that music engages reward-related regions through functional connectivity with the auditory system. Here we characterize intrinsic connectivity of the auditory and reward systems at different stages of dementia. Using resting-state fMRI data from Alzheimer's Database Neuroimaging Initiative, we tested functional connectivity within and between auditory and

reward systems in older adults with AD, MCI, and age-matched controls (N=108). Seed-based correlations were assessed from regions of interest (ROIs) in the auditory network (aSTG, pSTG, Heschl's Gyrus) and reward network (nucleus accumbens, caudate, vmPFC). MCI and AD individuals showed lower functional connectivity in the auditory network compared to controls. In contrast, MCI individuals showed higher functional connectivity than controls and AD individuals in the reward network. Furthermore, graph theory analyses showed that MCI individuals had consistently high between-network connections as well as within-network clustering within the reward network relative to controls and AD individuals. AD individuals had significant between-network connections and clustering within the reward network; however functional connectivity, degrees, and betweenness centrality were all lower in AD than in controls or MCI. Together, the auditory and reward systems show preserved between-network connectivity in MCI relative to AD. These results suggest a potential for music listening as an intervention to make an early difference in MCI individuals due to the preservation of functional connectivity in reward-related regions and between auditory and reward networks at that early stage of neurodegeneration.

Topic Line: PERCEPTION & ACTION: Development & aging

E106 What's next? Timing-based anticipation in children with Autism Spectrum disorder

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Information in the sensory environment tends to be highly predictive of upcoming events, allowing for online planning and decision-making. The neural processing of expected stimuli is significantly facilitated compared to that of non-expected stimuli.

In individuals with autism spectrum disorder (ASD), reduced behavioral flexibility, insistence on sameness and rigidity of routines are prevalent symptoms. In recent years, data from behavioral, physiological and computational modeling suggest that children and adults with ASD have diminished capacity to form expectations about upcoming stimuli based on prior events, while the neural mechanisms are still unknown. Here, we test the integrity and flexibility of neural oscillations when sensory stimuli are presented, through entrainment and contingent negative variation (CNV), which are critical for preparing for upcoming, temporally predictable, events. We record high-density electroencephalography and measure behavioral responses from children with ASD (n=31) and Typically Developing (TD) age- and sex-matched controls (n=20), while presented with to a train of isochronous events. Results show that while both groups showed highly comparable evoked responses to the sensory stimuli, children with ASD had reduced neural entrainment to the rhythm of the cues, and altered anticipation to their occurrence.

Our results outline neural processes that may underlie impaired event anticipation in children with autism, and support the notion that perception of external events in autism is influenced more by their mere sensory appearance, as measured by evoked responses, and less by their temporal predictability, as measured by later electrophysiological components. ââ?¬Æ'

Topic Line: PERCEPTION & ACTION: Development & aging

E107 The Effect of Context on Human Mirror System Integration in Action Understanding

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The accurate perception of complex motor actions is believed to be dependent on sensorimotor integration with visual and prefrontal areas, and the context of the action. In action intention understanding, the mirror system is involved in the perception?action matching process while the mentalizing system is purported to underlie higher-level intention inference. The current study used electroencephalography to assess how sensorimotor neural processing is affected by different levels of context during interactive gameplay in 43 HC. Sequential brain microstates were extracted during which we analyzed sensorimotor mu (8?13 Hz) suppression, an index of neural mirror system activation, and the multiscale entropy (MSE) of that same signal to capture the information content, and indirectly, the functional connectivity, within the region and band. We found significantly differing levels of mu suppression across levels of participant involvement in gameplay, with a linear increase over time windows, while actively playing RPS, only ($F(5.98, 297.54)=4.115$, $p<0.001$, partial eta^2=0.23). These findings suggest that action intention understanding may involve an integration between the sensorimotor and prefrontal areas that is dependent on situational context. The increasing levels of mu suppression and complexity with the context of action observation, suggests the need for assessing the underlying systems of action understanding with the observation of actions with higher-order goals.

Topic Line: PERCEPTION & ACTION: Motor control

E108 Withdrawn

E109 Intracranial stereotactic EEG study of crossmodal influences in human auditory cortex

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Crossmodal visual influences occur already at early stages of human auditory cortex (AC) processing. The mechanisms and role of these effects are still unclear. A more conservative hypothesis is that crossmodal visual influences modulate sound processing, without directly activating human AC neurons. However, single-unit studies in other mammals report visually triggered AC firing patterns, which may even carry information of the non-auditory

stimulus. Here, we examined crossmodal influences on human AC processing by using intracranial stereotactic EEG (SEEG). Simple auditory (300-ms noise burst), visual (checkerboard), and audiovisual (noise burst + checkerboard) stimuli were presented to ten patients who had depth electrodes implanted in or near ACs for presurgical monitoring. These depth electrode locations were determined by clinical criteria only: one patient was implanted with bilateral, five with left-hemispheric, and four with right-hemispheric SEEG electrodes. Hypotheses were tested based on 50-200 Hz high broadband gamma (HBG) activity, a putative correlate of local firing activity. In addition to conventional signal analyses, we employed inverse modeling of the intracranial source currents to facilitate anatomically normalized group analyses. HBG activity was very robust after unimodal auditory but weak after unimodal visual stimuli in superior temporal AC areas. However, HBG activity was significantly increased to auditory stimuli that were coupled with a visual stimulus. Evidence for visually induced HBG was found only beyond ACs. Our results suggest that visual inputs modulate coinciding sound processing but do not trigger robust suprathreshold activation patterns in human ACs.

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Topic Line: PERCEPTION & ACTION: Multisensory

E110 How action modulates the body model

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The knowledge of where bodies are in space is referred to as position sense. Recently, it has been found that the representation of the body that underlies this ability (the body model) is distorted. Adult humans overestimate hand width and underestimate finger length. How is it possible for us to interact with our surroundings using a distorted representation of the hand? One possibility is that haptic information modulates the body model. A study from our lab found that when participants relied on haptic information alone, they had more accurate representations. However, when we navigate in our environments we typically rely on visual information. Therefore, we investigated if increased haptic information reduced the distortions of the body model. We asked participants to place their hands underneath a covered tabletop (no vision of the hands) and to estimate where they believed ten landmarks (the tips and knuckles of each finger) were located. Prior to every estimation the participant tapped the target finger five times to the beat of a metronome. The results depict that the participants who tapped their fingers made significantly more accurate estimates of hand width, but not of finger length. It appears thus, that increased haptic information modulates the body model and this modulation is specific to the effector involved in the action. We discuss these results in relation to how somatosensory information influences body representation. Specifically, it appears that haptic information is most relevant for the body model.

Topic Line: PERCEPTION & ACTION: Multisensory

E111 Hebbian associative plasticity shapes the motor resonance properties of the Mirror Neuron System

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Hebbian associative plasticity has been implied in the formation of the association between sensory and motor representations of actions in the Mirror Neuron System (MNS); however, such an inductor role still needs empirical support. To address this issue, we have assessed whether a novel non-invasive paired associative stimulation (PAS) protocol can induce the formation of atypical (i.e., absent in normal conditions), visuo-motor associations, in turn reshaping motor resonance following Hebbian learning.

Twenty healthy participants underwent our novel mirror-PAS protocol (m-PAS) during which they were exposed to repeated pairings of transcranial magnetic stimulation (TMS) pulses, applied over the right primary motor cortex (M1), time-locked with the view of index-finger movements of the right (ipsilateral) hand. In two different sessions, the inter-stimulus interval (ISI) between the onset of the visual action stimulus and TMS pulse was varied following the chronometry of motor control (25 ms) or that of MNS activation (250 ms). Before and after each m-PAS session, motor resonance was assessed by recording Motor Evoked Potentials (MEPs) induced by single-pulse TMS applied to the right M1, during the observation of both contralateral and ipsilateral index-finger movements or static hands.

m-PAS successfully induced new ipsilateral motor resonance responses, indexed by an atypical facilitation of cortico-spinal excitability by the view of ipsilateral (i.e., right) hand movements. Crucially, this effect occurred only if the associative stimulation followed the chronometry of motor control (ISI of 25 ms). The present findings provide empirical evidence that Hebbian associative plasticity shapes the visual-motor matching properties of the MNS.

Topic Line: PERCEPTION & ACTION: Other

E112 Formalizing Medial Temporal Lobe involvement in perception: From psychological constructs to function approximation

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The Medial Temporal Lobe (MTL) is well recognized for its role supporting memory-related behaviors. Yet there is an enduring debate surrounding the involvement of the MTL in perception. Unfortunately, synthesizing results across studies has been stymied by informal, descriptive accounts of stimulus properties (e.g. 'feature ambiguity'). Here we adopt a combination of meta-analytic, computational, and behavioral approaches in order to formalize the involvement of the MTL in perception. We focus exclusively on, perirhinal cortex (PRC), substructure within the MTL, and it's role in concurrent visual discrimination ('oddity') tasks. After a meta-analytic review, we collect stimuli presented to PRC-lesioned subjects from all relevant and available published studies. In these experiments, we expect PRC-lesioned behaviors to reflect the pattern of performance supported by a linear readout of the Ventral Visual System (VVS). We parametrize this null model of

perirhinal function with a computational proxy for the VVS: a task-optimized convolutional neural network, validated on multielectrode array data from macaque inferior temporal cortex. With this model, we identify experiments within the literature that may not be diagnostic of PRC's involvement in perception: a linear readout of the VVS should be sufficient to enable ceiling performance on these tasks. With the remaining experiments, we observe a striking correspondence between model and PRC-lesioned behaviors (r>.9). Critically, there is a divergence between PRC-intact and PRC-lesioned behavior (p<.005). This biologically plausible null model for perirhinal function offers a formal, unifying account of the experimental literature as well as tool for future experimentation.

Topic Line: PERCEPTION & ACTION: Vision

E113 Cardiac phase modulates endogenous and exogenous ERPs and HEP predicts awareness at the visual threshold

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We can investigate neural correlates of consciousness by experimentally dissociating sensation and perception (e.g., sensory threshold stimuli are consciously perceived in 50% of trials) and by measuring the response of the brain to different perceptual outcomes of the same stimulus. Such differences in perceptual awareness can arise from i) evoked brain responses for different perceptual outcomes and ii) from the pre-stimulus differences in brain activity. The brain is inextricably connected with the body, and cyclic variations of bodily signals like e.g. the cardiac phase and the response of the brain to the heartbeat (HEP) before stimulus onset can influence perceptual awareness: baroreceptor activity during the systolic phase interferes with sensory stimulus processing, and the HEP differs for stimuli subsequently seen or not. We presented subjects with stimuli (Gabors overlaid with random-dot-noise) at the sensory threshold and compared i) the ERPs and ii) the HEP for the same stimuli when consciously seen and not. We found that ERPs for seen and unseen differed as a function of cardiac phase: the P1 reflecting early sensory processes was modulated during systole and the VAN reflecting cognitive processes was modulated during diastole. The HEP also differed between the conditions: amplitude, topographic and source space differences indicated that the default-mode-network is recruited in response to the heartbeat for subsequently unseen stimuli and that the saliency-network is recruited for subsequently seen stimuli. Taken together, we can show that the cardiac cycle and the HEP can influence conscious awareness at the visual threshold.

Topic Line: PERCEPTION & ACTION: Vision

E114 Uncovering a scene-defining feature using converging stimuli-based, behavioral and neural approaches

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Our ability to recognize places, or 'scenes', is remarkable. Not surprisingly, there are cortical processes specialized for scene recognition. However, it remains unknown how humans recognize scenes from non-scene stimuli, such as faces and objects. Here, we hypothesize that, just like faces always have two eyes above a nose, above a mouth, there also exists some scene-defining visual features that enable the human brain to recognize scenes. To identify a potential scene-defining feature, we analyzed thousands of naturalistic scene images and found that, across most scenes, there is a vertical asymmetry in luminance, with the upper half brighter than the lower half. Next, we asked if this vertical luminance asymmetry is not only a common scene feature, but also necessary for engaging human visual scene processing. We predicted that if vertical luminance asymmetry is necessary to engage scene processing, then a 90-degree image rotation that disrupts the vertical luminance asymmetry of a scene will impair scene recognition. Consistent with our hypothesis, we found people are worse at recognizing scenes that are rotated away from their upright, canonical orientations (90-degree, 180-degree, 270-degree rotation), while object recognition is unaffected by image rotation. Similarly, using functional magnetic resonance (fMRI), we found that the cortical scene processing system shows a diminished response to rotated scene images, whereas the cortical object processing system does not differentiate objects across different orientations. Taken together, these results provide converging stimuli-based, behavioral, and neural evidence that vertical luminance asymmetry is a scene-defining feature that enables human visual scene processing.

Topic Line: PERCEPTION & ACTION: Vision

E115 Opposite lateralization for face recognition and gender perception

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The perception of boundaries between stimuli existing along a graded continuum of physical properties is referred to as categorical perception (CP). Divided field studies of color and shape perception suggest a relationship between left-lateralized CP in these cases, and cerebral laterality for language. Unlike color and shape processing, face recognition is associated with right-lateralized circuits in the visual cortex and beyond. We used a divided field method to study two different kinds of face perception: (1) gender discrimination and (2) identity recognition. In four experiments, observers performed a visual search task on arrays of faces split between the left visual field (LVF) and the right visual field (RVF). The search required visual discrimination of faces by virtue of their identity, gender, or both. Our results showed categorical face perception effects in all three types of tasks. Crucially, however, hemifield biases for categorical perception of gender were different from the categorical perception of identity. We found that the well-known LVF advantage for face recognition showed modulation by categorical versus non-categorical face perception when the change was happening across gender. While for identity categories, we found that the CP effect was stronger in the RVF. Our findings show that categorical effects on face

recognition may depend on opponent cerebral laterality for language and the visual processing of faces.

Topic Line: PERCEPTION & ACTION: Vision

E116 Unimpaired novel object recognition in developmental prosopagnosia

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The classic debate over the face specificity of prosopagnosia was recently revived by a meta-analysis that found 42-80% of developmental prosopagnosics (DPs) to have mild to major object recognition deficits (Geskin and Behrmann, 2017). However, nearly all studies used real-world objects (e.g., cars) where recognition depends on object-specific expertise, raising the question of whether impairment in a single object category is representative of general object abilities. Recently, recognition tests using novel objects have shown to correlate highly with general object abilities. No studies to our knowledge have tested DPs using novel object memory tests (NOMTs), and the majority of studies have tested fewer than 20 DPs. In the current study, we tested 30 DPs and 30 age- and gender-matched controls (TD) on a NOMT ('Ziggerins') and the Cambridge Face Memory Test (CFMT). DPs were impaired on the CFMT (DP:38.3, TD:59.4, $p<0.01$) but performed normally on the NOMT (DP:58.2, TD:57.5, $p=0.75$). We also compared DP NOMT performance to a matched sample of 275 web-based controls and found no difference in reaction time (DP:4.2, TD:4.1, $p=0.58$) and only a trend in accuracy difference (DP:58.2, TD:61.1, $p=0.06$). Individual analyses show 13.3% of our DPs reached impairment (2SD below average) in object recognition, which did not significantly differ from the impairment rate in our control group (10%, $p=0.69$) or the web controls (5%, $p=0.09$). Together, these results suggest that DPs are essentially normal at novel object recognition. Future investigations would be useful to determine whether DPs have specific impairments with acquiring longer-term object expertise.

Topic Line: PERCEPTION & ACTION: Vision

E117 Patients with hemispherectomies evince intact visual recognition behaviors

Michael C. Granovetter, Carnegie Mellon University, Leah Ettensohn, Carnegie Mellon University, Marlene Behrmann, Carnegie Mellon University

Cortical resection is an efficacious treatment for pharmacoresistant epilepsy. For markedly intractable epilepsy, a hemispherectomy--resection or disconnection of an entire cerebral hemisphere--may be performed to alleviate a patient's seizures. Prior studies have reported moderate maintenance or recovery of post-operative cognitive behaviors in resection patients. However, to date, visual recognition abilities of patients with full hemispherectomies have not been systematically investigated. Here, 16 hemispherectomy patients aged 8- to 38-years-old (5 right, 11 left) performed a visual discrimination task. Pairs of stimuli (words in one block, faces in another) were consecutively presented for brief intervals, and participants reported whether images were identical or different. Stimuli were presented at central fixation for patients (who were all hemianopic) and in the left or right visual fields for controls (such that images would likely be most immediately registered in a single hemisphere). Remarkably, accuracy for 15 of 16 patients with left and right hemispherectomies were comparable to age-matched controls viewing stimuli in their left and right visual fields, respectively, as determined by the Crawford & Howell individual subject analysis method. This was verified with a mixed effects analysis showing no effects of stimulus category (words versus faces) or group (patients versus controls) on accuracy. A mixed effects analysis did reveal longer reaction times for the right resection patients than controls viewing words in the right visual field, but only among participants less than 15-years-old. Altogether, these findings suggest that patients with complete hemispherectomies are able to maintain or recover critical visual recognition behaviors.

Topic Line: PERCEPTION & ACTION: Vision

E118 Division of Labor and Coordination of the Face Network in Developmental Prosopagnosia and Controls

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Successful face recognition relies on the coordination between face-selective regions (e.g., fusiform face area-FFA, occipital face area-OFA), though the computations performed and interactions between these regions is debated. To further characterize these regions and their interactions, we examined 23 developmental prosopagnosics (DPs, 9 with mild/major face perception impairment-mFPI vs. 14 non-impaired) and 23 controls. Using a faces/scenes/objects/bodies dynamic localizer, we defined individual's bilateral FFAs and OFAs and examined their face-selectivity (differential activation for faces vs. scene) during the localizer, as well as functional connectivity (FC) during resting-state. In the dynamic localizer, while DPs with mFPI showed reduced selectivity in OFA, perceptually-normal DPs showed FFA reduction. Across all subjects, OFA face-selectivity correlated with both face perception and face memory abilities, while FFA only correlated with face memory. Moreover, FFA, but not OFA, was associated with holistic processing. Together, these selectivity results suggest that the OFA is important for earlier perceptual processing whereas the FFA is involved more in integration of face parts. On the other hand, when examining resting-state fMRI, face network FCs were found predictive of both face perception and face memory across all subjects, and was reduced in DPs, but no difference was found between the DP subgroups. Notably, face network FCs were not associated with the face-selectivity during task. Overall, this study indicates that while face-selective area activation can reflect the division of labor in hierarchical facial processing, the face network FC at rest may reflect more general coordination of these regions for effective information transfer.

Topic Line: PERCEPTION & ACTION: Vision

E119 Dissociable Systems for Recognizing Places and Navigating through them: Causal and Developmental Evidence.

Stephanie Wahab, Medical College of Georgia, Frederik Kamps, Emory University, Sama Radwan, Emory University, Daniel Dilks, Emory University

Humans recognize a place or 'scene' in a fraction of a second and almost simultaneously navigate that scene flawlessly and effortlessly. Functional MRI evidence suggests that human visual scene processing is supported by at least two functionally distinct systems; visually-guided navigation, including the occipital place area (OPA), and scene categorization, including the parahippocampal place area. It is unknown, however, whether these systems arise along differential timelines in typical development and whether they are causally dissociable ? possibilities that would greatly strengthen the claim that these systems are distinct. Here we tested navigation and categorization abilities in typically developing children and adults with Williams syndrome (WS), a genetic disorder involving cortical thinning of the OPA. During the categorization task, participants were shown rooms and indicated whether they were in a bedroom, kitchen, or living room. During the navigation task, participants imagined walking through the room and indicated whether they could leave through a door on the left, center, or right by following a path on the floor that only connects to one of the three doors. We found that i) navigation and categorization develop along differential timelines in typical development, with navigation maturing more slowly across childhood than categorization; and ii) that WS adults are selectively impaired in navigation relative to mental-age matched controls (i.e., typical developing 7 year olds). Taken together, our results provide the first developmental and causal evidence for dissociable visually-guided navigation and scene categorization systems, and further suggest that this distinction may have a genetic basis.

Topic Line: PERCEPTION & ACTION: Vision

E120 The Primacy of Color in Visual Perception

Brian Zhang, Marjan Persuh, Mentor

The phenomenon of change blindness suggests that visual experience is sparse and limited by attention and working memory capacity. Iconic memory experiments, however, suggest that our visual experience is rich and that we are aware of many details of our environment. To circumvent the involvement of memory, we developed a methodology that directly measures the richness of visual experience without reliance on memory. A circular array of either color patches, geometric objects or different orientations, with set sizes of two, five or eight, was briefly displayed to participants. On half of the trials, one of the randomly selected items was present twice and participants were asked to report repetition. Because the repeated item was not known in advance, the task estimated the content of perceptual experience. With a set size of two, performance was at ceiling for all features; however, with a set size of five, accuracy for color was significantly different from both orientation and shape. With a set size of eight, accuracy for color still remained high, whereas accuracies for other features dropped to chance levels. We further explored perception of color in a second experiment by increasing the number of simultaneously presented items to sixteen. Accuracy was above chance even for a set size of twelve and only dropped to chancel level when sixteen colors were displayed. Our results demonstrate that the richness of visual experience depends on specific features and that our perception of color is superior to our perception of orientation and shape.

Topic Line: PERCEPTION & ACTION: Vision

E121 Resolving the credit assignment problem in cortico-basal ganglia pathways

Matthew Clapp, Carnegie Mellon University, Catalina Vich, Universitat de les Illes Balears, Kendra Noneman, Boise State University, Jonathan Rubin, University of Pittsburgh, Timothy Verstynen, Carnegie Mellon University

When selecting actions within a volatile or noisy context, mammals are capable of flexibly modifying their decision policy to efficiently balance explorative and exploitative behavior. The cortico-basal ganglia-thalamic (CBGT) pathways, organized into parallel action channels, are ideal for the feedback-driven management of this behavioral trade-off via dopaminergic (DA) plasticity. DA error signals modulate the balance of direct (D) and indirect (I) pathways, with rewarding outcomes favoring the D pathway and aversive outcomes favoring the I pathway. Action selection is driven via cross-channel competition influenced by the within-channel balance of D and I pathway weights. Previous models have shown how DA can alter the D/I pathway balance to learn action-value contingencies using simplified cortico-striatal networks with simple, local selection rules. Selection in real CBGT networks, however, happens downstream and temporally distant from striatal dynamics. It is unclear how DA plasticity in the striatum manages this credit assignment problem. Here, we imbued a fully-spiking model of the CBGT network with a biologically-plausible DA spike timing dependent plasticity rule, with DA signals produced in accordance with the network's selected actions. This network was simulated in the context of a 2-choice value-based decision task with varying levels of environmental volatility and noise. Our model was found capable of quickly learning the most rewarding action in a stable environment by sustaining activity in the selected channel until movement execution, as observed in motor planning circuits. The network appropriately alters its behavior when the most rewarding action changes identity, dynamically learning new action-outcome contingencies.

Topic Line: THINKING: Decision making

E122 Bifocal tDCS stimulation of the right and left DLPFC leads to asymmetrical effects on judgment and decision-making

Michael Lundie, The University of Texas at Dallas, Lauren Kim, The University of Texas at Dallas, Harshith Dasara, The University of Texas at Dallas, Daniel Krawczyk, The University of Texas at Dallas

Investigations of the neural correlates of reflective judgement and decision-making have revealed the importance of the dorsolateral prefrontal cortex (DLPFC) in attentional control and regulating

impulsivity. Edgecumbe et al. (2019) determined that bifocal transcranial direct current stimulation (tDCS) of the right DLPFC facilitated performance on the cognitive reflection test (CRT), a common indicator of reflective processing. Building upon these findings in the present study, we collected data from a series of randomized, within-subjects trials measuring the behavioral effects of anodal tDCS stimulation on judgment and decision-making across the following three conditions: left DLPFC, right DLPFC, and sham stimulation. Each stimulation condition was counterbalanced and spaced at least one week apart to attenuate residual effects of tDCS. We determined that stimulation of the left DLPFC significantly reduced accuracy on the CRT in comparison to right DLPFC and sham stimulation conditions. On measures of inhibition indexed by a visual stop-signal task, no significant effect of stimulation was observed. On a financial framing task, however, we identified that the right DLPFC stimulation condition significantly reduced susceptibility to the framing effect compared to left DLPFC and sham conditions. These findings provide evidence for both the potential benefits and hinderances of using tDCS to enhance reflective processing by modulating activity in the DLPFC.

Topic Line: THINKING: Decision making

E123 Similarity-based episodic sampling processes in decision-making: A role of the hippocampus in memory-guided decisions

Seokyoung Min, Yonsei University, Sanghoon Han, Yonsei University

Our decisions are often guided by past experiences. Recently, several researchers have begun to focus on the role of episodic memory in value-based decision-making to address the limitations of the reinforcement learning framework. Although these studies have investigated how the values of single past episodes contribute to decisions, it is unclear whether and how they contribute to the valuation of novel stimuli that never repeats. Using a novel experimental paradigm combined with model-based fMRI, we investigated whether episodic memory could guide novel decisions based on similarity between the present and past experiences. Participants viewed a trial-unique image and made decisions on whether to accept or reject each novel gamble. Of importance, we assigned reward probabilities for all stimuli to be unique while similar images had similar values, and the same images were never repeated. We found that the outcome values of the five most similar past stimuli had a significant effect on the choice, and the effects were higher for the more similar stimuli. Next, we fit a computational model from the case-based decision theory to the behavioral data. Model-based fMRI analysis revealed that trial-by-trial expected values were associated with the activity of the ventromedial prefrontal cortex and the hippocampus, and the reward prediction errors were correlated with the activity of the ventral striatum and the hippocampus. Our findings provided empirical evidence that similarity plays a key role in enabling episodic memory to guide value-based decision-making and the hippocampus plays a critical role in this memory-guided decision process.

Topic Line: THINKING: Decision making

E124 Withdrawn

E125 Flexibility and Predictions in Autism: Findings from EEG, pupillometry, behavior, and computational modeling

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In stable and predictable environments, the brain generates expectations with high confidence; whereas this confidence is lowered in volatile and unstable environments. Thus, the brain not only makes predictions but also assigns an expected error rate according to environmental volatility. Individuals with autism resist even trivial changes in everyday life, leading us to hypothesize impaired ability in flexibly tuning the confidence of predictions based on changes in volatility. To assess the use of environmental statistics in making and adjusting predictions, adults with (N=21) and without (N=20) autism performed a task in which they responded to the completion of a pattern of three sequentially presented shapes. Across blocks of ~120 pattern initiations, the probability of pattern completion varied between 100%, 86%, 66%, and 33%. The ability to infer a change in the probability of pattern completion was assessed with electroencephalography (P3 and CNV responses), reaction time, and pupil size. Modulation of P3 and CNV by volatility was significantly diminished in the autism group. Further, Bayesian modeling of subject belief trajectories discriminated between the groups. We also presented a passive auditory oddball paradigm in which the probability of a deviant tone was 4%, 8%, or 16% in different blocks. In contrast to our findings above, preliminary analyses of the mismatch negativity (MMN) suggest that the brain is able to calculate stimulus statistics in autism. Taken together, these data suggest that the specific problem with predictive processing in autism is not in registering environmental statistics, but in applying the statistics to making predictions.

Topic Line: THINKING: Decision making

E126 Visualizations of God: Differences in strength of religious belief influence representations of God.

Emily Dyke, Georgetown University, Adam Weinberger, Georgetown University, Kathryn Johnson, Arizona State University, Thomas Dameris, Georgetown University, Ariana Mastrogiannis, Georgetown University, Adam Green, Georgetown University

Is God represented similarly in the brains of believers and nonbelievers (i.e., do believers and nonbelievers hold consistent sets of representations in mind, but believe differently in the reality of what they are representing), or are differences in belief associated with fundamentally different God representations? In order to study neural representational similarity of God visualizations, this pilot study collected data in a large, online sample concerning participants' religious beliefs. Participants completed a number of self report questionnaires, which indicated the type and strength of their religious beliefs. Participants were also provided with an open-ended prompt in which they were asked

to describe how they visualize God. Responses were coded to indicate the extent to which visualizations were abstract, anthropomorphic, or impersonal. Results indicated that participants with stronger religious belief held more anthropomorphic representations of God relative to both moderate and non-believers, who were more likely to describe God as being abstract or impersonal. This study is the first to our knowledge to identify differences in deistic representation based on strength of religious belief. It provides the empirical framework for an ongoing investigation of the neural basis of God representation. In particular, this research utilizes representational similarity analysis to measure the similarity of God representations both within and between groups of believers. Based on this pilot research, we are testing the hypothesis that believers' representations are a) more similar to each other than to representations of nonbelievers, and b) more similar to representations of anthropomorphic entities than to abstract representations.

Topic Line: THINKING: Other

E127 The relationship between creativity and individual semantic network properties

Marcela Paola Ovando Tellez, Institut du Cerveau et de la Moelle épinière, Sorbonne Uni, Yoed Kenett, Department of Psychology, University of Pennsylvania, Mathias Benedek, Institute of Psychology, University of Graz, Emmanuelle Volle, Sorbonne University

The associative theory of creativity suggests that creative abilities rely, at least in part, on the organization of semantic associations in memory. Recent research has demonstrated that semantic network methods allow exploring the properties and organization of semantic associations and testing this hypothesis. The aim of the current study was to investigate the properties of semantic networks and relate them to creative abilities at the individual level, using graph theory. Individual semantic networks were estimated using relatedness judgments of pairs of words. Thirty-five words were selected based on French association norms and controlled for the theoretical semantic distance between them and for linguistic properties. Topological properties of the estimated individual semantic networks were measured by several graph metrics which were correlated with individual creativity scores. The theoretical semantic distance between words correlated with the relatedness ratings given by the participants, indicating the validity of our approach. Importantly, we observed a significant correlation between semantic network metrics and creativity as measured by creative achievement and creative task performance. These findings replicate and extend previous similar results and suggest that exploring semantic network properties is a valuable approach to study creativity.

Topic Line: THINKING: Other

E128 Overlapping neural responses to symbolic math and formal logic in the intra-parietal sulcus

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Symbolic math (e.g. 17 ? 3) and formal logical thinking (e.g. if X then Y) depend on distinct neural mechanism from natural language and both recruit the intraparietal sulci (IPS) (Monti et al., 2009, PNAS; Amalric and Dehaene, 2018, Phil. Trans. R. Soc. B). Do these culturally derived symbol manipulation systems depend on overlapping neural resources? While undergoing fMRI, participants (n=12) performed matched language, logic and math tasks. On language trials, participants reported whether two sentences, one in active and one in passive voice, have the same meaning (e.g. 'The child that the babysitter chased ate the apple' vs 'The apple was eaten by the babysitter that the child chased'). On symbolic math trials, participants reported whether X has the same value across two equations (e.g. 'X minus twenty-five equals forty-one' vs 'X minus fifty-four equals twelve'). On formal logic trials, participants reported whether two logical statements are consistent (whether one statement being true implies the other also being true) (e.g. 'If either not Z or not Y then X' vs 'If not X then both Z and Y') Consistent with prior findings, language activated left-lateralized perisylvian networks. By contrast, math and logic activated left-lateralized IPS and dorsolateral frontal areas more so than the language task. Responses to math and logic were highly overlapping, both in the IPS and in prefrontal cortex. These findings suggest that part of the IPS response to symbolic math is related to formal symbol manipulation.

Topic Line: THINKING: Problem solving

E129 A meta-analysis study on the process of deductive and inductive reasoning using Log-Gaussian Cox Processes

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Reasoning is a cognitive process of inferring conclusions from a given situation. Two different kinds of reasoning, deductive and inductive reasoning, were usually studied separately to examine brain regions essential to each reasoning process. Previous studies lacked a consensus on brain regions in charge, including a debate on whether inferior frontal gyrus is a core region of deductive reasoning or not. Researchers conducted coordinate-based meta-analyses to resolve the issue of inconsistent activation patterns and to compensate for low statistical power from a small sample size. However, they focused on limited types of reasoning and used conventional kernel-based methods like Activation Likelihood Estimation which make no explicit assumption on the model structure. Alternatively, we conducted a coordinate-based meta-analysis study using coordinates from 53 studies, applying an explicit spatial model called Log-Gaussian Cox Process to estimate predictive intensity maps of reasoning processes. This approach enabled us to investigate core regions of each type of reasoning and similarity of their activation pattern. From estimated posterior predictive maps of reasoning processes, we found that prefrontal cortex and posterior parietal cortex are mostly engaged in both deductive and inductive reasoning, but with different activation patterns such as higher activations in left inferior frontal gyrus during deductive reasoning process compared to inductive reasoning. Therefore, we suggest that the two types of reasoning are supported via distinct neural mechanisms.

Topic Line: THINKING: Reasoning