Session C

Sunday, May 3, 2:00 – 5:00 pm, Exhibit Hall C

C1 Highway to the Danger Zone: Fatigue Assessment in a Flight Simulation

Gregory Gill, Centre for Biomedical Research, University of Victoria; Chad Williams, Centre for Biomedical Research, University of Victoria; Marielle Timmins, Centre for Biomedical Research, University of Victoria; Olave E. Krigolson, Centre for Biomedical Research, University of Victoria

Fatigue can pose a serious threat to individual safety as well as the safety of others, especially in aviation. With this in mind, it is imperative that both military and commercial aircraft personnel maintain alertness to ensure operational safety. Interestingly, a component of the human event-related brain potential (P300) has been demonstrated to be indicative of fatigue in experimental and real-world settings. While much of the existing literature suggests that task engagement is necessary in order to illicit the P300, prior work from our laboratory has shown that it can also be generated using unattended stimuli. In the current experiment, participants completed a challenging six-hour flight simulation in Microsoft Flight Simulator X during which EEG data was recorded. In a key manipulation, and unbeknownst to our participants, throughout the task a passive auditory oddball task was also occurring. An analysis of our data revealed that the passive auditory oddball task elicited a P300 response ? the aforementioned neural signal associated with fatigue and task engagement. Importantly, we found that the P300 response diminished with increasing fatigue in a non-linear manner. Further, we found contaminant changes in the EEG power spectra that were also indicative of increasing fatigue (i.e., an increase in frontal theta power). Our results show promise for the potential use of unattended, non-intrusive stimuli to probe various aspects of brain function during real world task performance as well as illustrating the practicality of utilizing portable devices in various settings to improve environmental validity of the research.

Topic Line: ATTENTION: Auditory

C2 Musical rhythm training improves temporal attention and working memory in aging

Theodore Zanto, University of California San Francisco; Vinith Johnson, University of California San Francisco; Avery Ostrand, University of California San Francisco; Tiffany Ford, University of California Berkeley; Adam Gazzaley, University of California San Francisco

Recent years have seen an increase in research indicating a positive effect of musical training on cognitive ability, particularly in attention and working memory. However, it is less clear whether the effects of musical training may help remediate age-related declines in attention and working memory. To address this, a double blinded, placebo controlled, musical rhythm training intervention was conducted in older adults (N=40) aged 60 – 80 years. Participants were randomly assigned to either a rhythm training or a word search training (control) group, and engaged in the intervention for 8 weeks. Both interventions were conducted at home on mobile tablets, however, only the rhythm training incorporated real-time closed-loop adaptivity. Measures of temporal attention (the ability to orient attention in time) and working memory were assessed pre- and post-intervention, while electroencephalography (EEG) data were recorded. Results indicate both temporal attention and working memory abilities were improved in the rhythm training, but not control, group. These results corroborate prior research indicating musical training has a positive effect on cognitive abilities, which may be used as a means to help remediate age-related declines in cognitive control.

Topic Line: ATTENTION: Development & aging

C3 Electrophysiological modulation of peripersonal space in the presence of threatening faces

Julia Fellrath, MySpaceLab, Department of Clinical Neurosciences; Silvia Serino, MySpaceLab, Department of Clinical Neurosciences; Giulia Ellena, Department of Psychology; Petr Grivaz, MySpaceLab, Department of Clinical Neurosciences; Andrea Serino, MySpaceLab, Department of Clinical Neurosciences

Peripersonal space (PPS) is a multimodal sensory-motor interface that mediates the interaction between the individual and the environment. Previous behavioral studies have shown that the valence of a stimulus moving in space has an impact on the sensorimotor mechanisms of the PPS. However, knowledge about temporal dynamics of PPS modulation with emotional information is lacking. Here, we recorded electrophysiological processing while administrating a multimodal interaction task with vibrotactile stimulation and concurrent looming faces. The vibrotactile stimulation was appearing when the looming face was either near or far from participant's body. An experimental group (N=13) was exposed to neutral and threatening faces, and a control group (N=13) was exposed to neutral faces only. We used cluster-based permutation statistics to identify clusters of electrodes showing a PPS effect â€' a multisensory response that is dependent on the distance of the visual information to the body (visuo-tactile near vs visuo-tactile far). In the experimental group, a PPS effect over central channels was observed around 200ms with neutral faces (p=0.02). However, there was no PPS effect with the sick faces. In the control group, a PPS effect was observed over central channels around 180ms (p=0.03). These results show that in contrast to neutral faces, threatening faces affect multisensory integration already at a distant position, probably for an appropriate defensive reaction: the difference between the near and the far space is blurred and a threatening face appears similarly relevant weather it appears in near of far space.

Topic Line: ATTENTION: Multisensory

C4 Rapid electrophysiological activations within anterior insula anticipate spontaneous pupil dilations

Aaron Kucyi, Northeastern University; Josef Parvizi, Stanford University

Spontaneous activation within neuronal populations is often of similar magnitude to activation evoked explicitly during cognitive performance. We hypothesized that spontaneous 'task-like' activations in the dorsal anterior insular cortex (daIC) signify self-generated cognitive processes that can be indexed by non-luminance-mediated pupil dilation, a marker of internal mental state. Using human intracranial electroencephalography in three subjects with electrodes implanted in the insular cortex, simultaneous pupillometry was recorded during multiple sessions of continuous task performance and wakeful rest (visual fixation). We found that within each subject, task-evoked pupil dilations scaled with the magnitude of preceding high-frequency broadband (70-170 Hz) activations in the daIC. Critically, during wakeful rest, spontaneous pupil dilations were anticipated by rapid daIC activations that emerged less frequently but that were of similar magnitude and form to task-evoked activations. Thus, daIC activations- in coordination with a distributed network and large-scale

neuromodulatory systems- may signify the emergence of self-generated cognitive processes with similar attributes to explicitly evoked cognition.

Topic Line: ATTENTION: Nonspatial

C5 Targeting Neural Correlates of State- and Trait-Boredom

Ofir Yakobi, University of Waterloo; James Danckert, University of Waterloo

Boredom is frequently associated with risk-taking, attention deficits, and more recently â€' with distinct modes of self-regulation. These results are primarily derived from behavioral and self-reported data, leaving the neurophysiology of boredom underexplored. The present work aims to investigate the oscillatory brain activity involved in trait- and state-boredom, namely â€' resting state EEG and event-related potentials (ERP).

Fifty undergraduates completed a boredom proneness (BPS) questionnaire, a go/no-go task and the Balloon Analogue Risk Task (BART), while their brain activity was recorded using EEG. State boredom ratings were taken before and after each task.

We compared Frontal Alpha Asymmetry (FAA) before and after the two tasks were completed. High boredom prone individuals showed a rightward drift in brain activity, reflecting a shift from approach to avoidance motivation. Low BPS individuals, in contrast, showed a non-significant trend toward a reversal of this pattern.

Trait boredom was correlated positively with risk-taking in the BART, and to the latency of the feedback-related negativityâ€' an ERP reflecting feedback processing. State boredom was associated with poorer accuracy in the go/no-go task and smaller magnitude of the error-related negativity and the stimulus locked P3. Trait boredom proneness was also correlated with decision-time in the BART, such that high-BP individuals exhibited shorter decision times.

These findings provide neural-level evidence for alterations in activity in the bored brain. The difference in spontaneous EEG asymmetry between high- and low-BP individuals, along with the negative correlation between the P3, ERN and state-boredom, map onto recent studies linking boredom, self-regulation and attention.

Topic Line: ATTENTION: Other

C6 Two dominant brain states reflect optimal and suboptimal attention

Ayumu Yamashita, Boston University School of Medicine; David Rothlein, Boston University School of Medicine; Aaron Kucyi, Northeastern University; Eve Valera, Harvard Medical School; Michael Esterman, VA Boston Healthcare System

Attention is not constant but fluctuates from moment to moment. Previous studies dichotomized these fluctuations into optimal and suboptimal behavioral states based on performance and investigated the difference in brain activity between these states. Although these studies implicitly assume there are two states, this assumption is not guaranteed. Here, we reversed the logic of these previous studies and identified unique states of brain activity during a sustained attention task and provided evidence for behaviorally optimal and suboptimal attentional states based on this dynamic functionally different brain systems' activities constrained by brain network. In this study, we demonstrate a systematic relationship between dynamic brain activity patterns and behavioral underpinnings of sustained attention by explaining behavior from two dominantly observed brain states. A brain state characterized by default mode network activity was behaviorally optimal and a brain state characterized by dorsal attention network activity was suboptimal. These results converge with the results of previous studies where states were defined behaviorally. We validated our results by using an independent validation dataset. We further demonstrated how these brain states were impacted by motivation, mind wandering, and ADHD. Our study not only provides evidence for behaviorally optimal and suboptimal attentional states from the viewpoint of brain activity but also provides the functional linkage of the mechanisms coordinating between functionally different brain systems related to sustained attention through the intermediary of their brain activity.

Topic Line: ATTENTION: Other

C7 Global integration of intrinsic brain activity is related to attention and ADHD

Agnieszka Zuberer, Boston Learning and Attention Laboratory, Boston University; Aaron Kucyi, Department of Neurology & Neurological Sciences, Stanford; Eve Valera, Department of Psychiatry, Harvard Medical School; Michael Esterman, Boston Learning and Attention Laboratory, Boston University

Most of our brain activity unfolds in an intrinsic manner and is unrelated to effects due to immediate external stimuli. The dissociation of this intrinsic (stimulus-unrelated) from extrinsic (stimulus-related) brain activity has been a major challenge to investigate how those two differential effects give rise to behavior. We present a unique gradual continuous performance task to map fluctuations of sustained attention which are self-emergent/not task-evoked and thus constitute an ideal candidate to study behavior relationships with fluctuations of the intrinsic network account. Behavioral correlates of suboptimal attention, defined both objectively and subjectively (higher reaction time variability and lower self-rated attention focus), are related to a connectivity state of global integrated neural processing, a brain state more akin to resting state. Subjects with ADHD showed a baseline task state perpetually more rest-like, accompanied by higher variability and lower task focus. In contrast, rare behavioral errors were followed by a transient reduction of global integration of the global connectivity state. ADHD subjects displayed stronger post-error reductions of this integrative property. The results suggest that the magnitude of these effects on intra-brain communication across network communities are uniform and not restricted to specific putative cortical systems suggesting that global integration of brain activity reflects a truly global measure of cross-talk in the brain, which is sensitive to within-subject attentional fluctuations and clinical abnormalities of attention.

Topic Line: ATTENTION: Other

C8 Gamma band activity acts as a trigger for long-range apparent motion. Towards an integrative theory of apparent motion

Yasuhiro Sakamoto, Max Planck Institute for Empirical Aesthetics; Hideyuki Hoshi, Max Planck Institute for Empirical Aesthetics; Yoshihito Shigihara, Hokuto Hospital; Winfried Menninghaus, Max Planck Institute for Empirical Aesthetics; David Poeppel, MPI for Empirical Aesthetics and New York University

Apparent motion is one fundamental perceptual attribute in the internal construction of visual world. Previous studies have examined the conditions in which apparent motion can be perceived. However, the implementational question of the neural mechanisms involved in apparent motion has not been investigated extensively. This MEG study characterizes how the visual cortex classifies and processes identical stimuli that elicit apparent motion or not, employing a range of inter stimulus intervals (ISI). In some of these, over multiple trials, perceptual uncertainty arises such that a participant perceives physically identical stimuli sometimes as apparent motion and sometimes not. Event related fields (ERF) in the occipital region for both response-types showed no

significant differences prior to ~200 ms. This is presumably due to the fact that the stimuli are always identical; only participants' responses differed. In contrast to the ERF results, spectral-temporal analyses revealed a significant difference in the low gamma-band on the right parietal sensors. This finding correlates with the source of the ERF peak roughly in in visual regions V3a and V3d (~140 ms). This suggests that apparent motion is not classified passively based on visual processing; rather, sensitivity to apparent motion - a kind of Gestalt perception - is influenced by the low-gamma state during stimulus presentation. Our findings give rise to further questions, including how the low gamma-band (de)synchronization on stimulus onset influences the low-level visual perception that makes for a rational interaction between perception and real world.

Topic Line: ATTENTION: Spatial

C9 Inhibitory rTMS over the right parietal cortex modulates functional connectivity

Selene Schintu, NINDS - NIH; Catherine A. Cunningham, NINDS - NIH; Michael Freedberg, NINDS - NIH; Stephen J. Gotts, NIMH - NIH; Sarah Shomstein, George Washington University; Eric M. Wassermann, NINDS - NIH

Hemispatial neglect is thought to result from hyper-activation of the left (intact) frontoparietal network, via its release from inhibition by the right hemisphere. Inhibitory rTMS over the left posterior parietal cortex (PPC) improves neglect and normalizes hyper-active left frontoparietal functional connectivity (FC). Delivered over the right PPC in healthy individuals, rTMS shifts midline judgment rightward, mimicking neglect, possibly by changing frontoparietal FC. We investigated whether inhibitory rTMS over the right PPC produces neglect-like behavior and changes frontoparietal FC.

Seventeen participants received 40 sec of continuous theta-burst rTMS at 80% of active motor threshold, to the right PPC or vertex (control) in sessions separated by ≥ 5 days. We targeted area 1 of the intraparietal sulcus, where TMS affects visuospatial behavior. Before and after rTMS, participants underwent 10-minute resting state fMRI and performed line bisection tasks. Diffusion tensor imaging data were acquired separately.

As expected, rTMS caused a rightward shift in line bisection judgment. A whole brain, seed-based, analysis found increased FC between the PPC target and the left superior temporal gyrus (STG). Follow-up exploratory analysis showed that the left STG increased FC with the right medial frontal gyrus and right precuneus, both nodes of the frontoparietal network. Furthermore, the fractional anisotropy (FA) of PPC to PPC white matter predicted the change in FC between the right PPC and left STG for PPC, but not vertex, rTMS.

Local inhibition of the right PPC reshapes the attentional network via an interhemispheric pathway and the FA between the PPCs predicts such change.

Topic Line: ATTENTION: Spatial

C10 Anatomical correlates of line-bisection peformance: what can be learnt from a game theoretical analysis?

Monica Toba, ; Monica Toba, Brain and Spine Institute, ICM, Paris and UPJV Amiens; Melissa Zavaglia, Institute of Computational Neuroscience, UKE; Caroline Malherbe, Institute of Computational Neuroscience, UKE; Tristan Moreau, Brain and Spine Institute, ICM; Federica Rastelli, Brain and Spine Institute, ICM; Anna Kaglik, Brain and Spine Institute, ICM; Romain Valabregue, Brain and Spine Institute, ICM; Pascale Pradat, APHP Paris; Claus Hilgetag, Institute of Computational Neuroscience, UKE; Antoni Valero-Cabré, Brain and Spine Institute, ICM

Line bisection is among the most used clinical tests to assess right brain-damaged patients with neglect, a neurological condition involving a rightward attentional bias. This test involves perceptual (line length estimation), motor (manual bisection) and attentional components. Here, we used the Multi-perturbation Shapley value Analysis (MSA) based on coalitional game theory to infer from 25 neglect patients, causal contributions for gray and white matter regions of interest (ROI) to visuospatial attention, on the basis of lesion location and line bisection outcomes. Analyses revealed positive contributions (i.e., regions facilitating performance) for the frontal eye fields (FEF), the intraparietal sulcus (IPS), the temporo-parietal junction (TPJ), the inferior occipital gyrus (IOG) and for the optic radiations (OR), inferior fronto-occipital fasciculus (IFOF), superior longitudinal fasciculus (SLF) and the posterior cingulum (CP). Negative contributions (i.e., regions hindering performance) were found for the inferior frontal gyrus (IFG) and the anterior cingulum (CA). Interactions between grey matter areas mirrored the trajectory of the white matter bundles involved. Our approach provides a picture of visuospatial attention systems and functions, which is overall compatible with existing accounts. Additionally, it characterizes a substantial number of interactions between regions, which should be tested with brain stimulation approaches. Our contribution maps should be used to design rehabilitation approaches based on transcranial magnetic/electrical stimulations. Such methods could contribute to individualize interventions, according to patient behavioral (i.e., double dissociations between performance in line bisection vs. other tests) and anatomical (i.e., presence/absence of lesions of positive/negative ROI contributors) profiles.

Topic Line: ATTENTION: Spatial

C11 Age differences in vmPFC functional connectivity during the processing of socioemotional information

Ryan T. Daley, Boston College; Holly J. Bowen, Southern Methodist University; Eric C. Fields, Boston College & Brandeis University; Katelyn R. Parisi, Boston College; Angela Gutchess, Brandeis University; Elizabeth A. Kensinger, Boston College

Socioemotional information processing may be partially supported by activity in the ventromedial prefrontal cortex (vmPFC) in older adults (OAs) and younger adults (YAs; Gutchess & Kensinger, 2018). It is unclear how age relates to vmPFC functional connectivity (FC) with other regions during socioemotional information processing. Here we ask two questions: Does the vmPFC show age-invariant processing of socioemotional compared to neutral information? And, are there age differences in vmPFC FC during socioemotional information processing? During fMRI scanning, OA and YA participants viewed images of positive, negative, and neutral objects, and were asked to imagine placing those objects in their own home or a stranger's home. Analyses revealed greater activity in the vmPFC during socioemotional compared to neutral information processing in both groups. OAs showed stronger FC between the vmPFC and regions associated with the anterior-temporal (AT) memory subsystem during emotional processing (Ritchey, Libby & Ranganath, 2015), for both emotional other person-relevant conditions compared with neutral: Positive-Stranger compared to Neutral-Stranger and Negative-Stranger compared to Neutral-Stranger conditions. For emotional self-relevant information, both groups showed effects of valence on vmPFC FC, although the direction of those effects differed: regions associated with the posterior-medial (PM) subsystem showed stronger FC with the vmPFC for Positive-Self compared to Negative-Self conditions in OAs and for Negative-Self compared to Positive-Self conditions in YAs. These results demonstrate that although both YAs and OAs recruit the vmPFC during socioemotional information processing, there are age reversals in the effects of valence on FC.

Topic Line: EMOTION & SOCIAL: Development & aging

C12 Impact of persistent depression on telomere length, cognitive decline and white matter alteration in aging adult

Hyeon Min Ahn, Korea University; Regina Ey Kim, Korea University; Soriul Kim, Korea University; Inkyung Baik, Kookmin University; Chol Shin, Korea University

Depression is associated with an acceleration of the cognitive decline in aging adults. The acceleration of aging in depression can affect telomere length shortening. However, recent studies about the relationship between telomere length and depression have shown inconsistent results. This study aimed to investigate the association of persistent depression symptoms with telomere length in aging adults and whether this is related to cognitive decline and possible cerebral modification of white matter integrity using diffusion tensor imaging (DTI). A cohort study of 2213 cognitively normal elderly adults from the Korean Genome Epidemiology Study was evaluated. All participants underwent a brain MRI scanning, a comprehensive neuropsychological test battery that included memory and executive function measures. Participants were also asked to answer questions on the Beck Depression Inventory (BDI) to measure levels of depressive symptoms. A linear regression analysis showed that persistently depressive participant had significantly shorter telomere length than control groups ($p = 0.002$). There is a significant relationship between persistent depression and memory tests ($p = 0.013$). The white matter results also showed a significant difference between persistent depressed group and control group in multiple areas such as frontal part of the right Inferior fronto-occipital fasciculus, bilateral superior longitudinal fasciculus, and right corticospinal tract regions ($p < 0.05$). We found a negative association between depressive symptoms and telomere length. We also found synergetic interaction between persistent depression symptom and telomere length on memory tests ($p = 0.013$). These findings provide biological evidence for the acceleration of cognitive decline in persistently depressed adults.

Topic Line: EMOTION & SOCIAL: Development & aging

C13 Characterizing cortical responses to faces and scenes in infant ventral temporal cortex.

Heather L Kosakowski, MIT; Michael Cohen, Amherst College; Lyneé Alvez, University of Denver; Atsushi Takahashi, MIT; Nancy Kanwisher, MIT; Rebecca Saxe, MIT

Adults have a variety of well-established category-selective regions in the ventral temporal cortex (VTC). For example, the fusiform face area (FFA) responds selectively to faces and the parahippocampal place area (PPA) responds selectively to scenes. Two studies in awake infant humans and non-human primates using functional magnetic resonance imaging (fMRI) demonstrated that infants have face- and scene-responsive regions that are not yet category specific (Deen et al., 2017; Livingstone et al., 2017). To determine if these results are replicable in a larger group of infants, we recruited 46 infants (2.5-11 months; 26 female). Infants watched videos of faces, objects, bodies, and scenes. In a group random effects analysis (n=26 had at least 5 minutes of low-motion data) we found face, object, and scene responses in infants that are in similar anatomical locations as those found in adults. In the fROI analysis (n=16), we replicated previous findings that infants have face- and scene-responses in VTC that are not yet category selective. Furthermore, we found a robust response to faces in the infant medial prefrontal cortex (MPFC) that was category-specific. These data suggest that awake infant fMRI produces reliable, replicable results.

Topic Line: EMOTION & SOCIAL: Development & aging

C14 Representations of the visual world in the dog brain

Raul Hernandez-Perez, Institute of Biology, Eotvos Lorand University; Laura Cuaya, Institute of Biology, Eotvos Lorand University; Eduardo Rojas-Hortelano, Instituto de Neurobiologia, UNAM; Eszter Farkas, Institute of Biology, Eotvos Lorand University; Attila Andics, Institute of Biology, Eotvos Lorand University

Sensory systems gather and process information to create representations of the world. These processes occur in different stages, from low-level visual processing, to object recognition. In primates, the occipital lobe performs the first feature detection steps, while computations required for object recognition take place in the inferior temporal cortex. In dogs, conflicting evidence points towards an organization similar to that in primates. Our aim was to describe regions in the dog cortex that process visual stimuli similarly to primate brain regions, by testing two visual processing models, one for low-level feature detection (V1 model) and another for high-level semantic organization (Category model). We acquired functional magnetic resonance images while the participants (13 humans, 10 dogs) observed the videos of cars, cats, dogs, and humans. Using representational similarity analysis, we compared the activity patterns of different regions of the human and dog cortex with the two models. We found a significant correlation between the V1 model and the patterns of activity of a bilateral cluster with peak in the left parahippocampal gyrus in dogs and a bilateral cluster with peak in the right intracalcarine cortex in humans. In turn, the Category model correlated with the patterns of activity of a cluster involving the left suprasylvian gyrus in dogs, and a bilateral cluster involving the lateral occipital complex in humans. The finding of comparable cluster locations in the cortex of the two species suggests a similar functional organization for visual object recognition in the human and the dog brain.

Topic Line: PERCEPTION & ACTION: Vision

C15 Assessing the tradeoff between ecological validity and EEG signal quality in an aesthetic rating task

Dominik Welke, Max-Planck-Institute for Empirical Aesthetics; Edward A. Vessel, Max-Planck-Institute for Empirical Aesthetics

'Real-world' visual aesthetic experiences involve open-ended exploration of highly variable artistic objects. Yet uncontrolled gaze and stimulus variability are typically avoided in electroencephalographical (EEG) experiments due to potential generation of artifacts and noise. We aimed to quantify the effect of relaxing such experimental constraints on EEG signal quality and behavioral measures recorded during an aesthetic rating task. 34 participants observed 40 'artistic' video clips depicting dynamic natural environments or dance performances plus 40 still frames drawn from these clips, while either maintaining fixation or being allowed to shift their gaze freely. Observers rated each stimulus for subjective aesthetic appeal and state of boredom while watching. Eye-tracking and 64-channel wet EEG was recorded. A task-unrelated frequency-tagged auditory stimulus (amplitude modulated pink noise) accompanied each trial, allowing to quantify Signal-to-Noise Ratio (SNR) to proxy overall signal quality. Data acquisition is continuing; here we report results from an initial analysis of N=5 participants. In our stimulus set, motion affects behavioral ratings (dynamic stimuli rated more aesthetic and less boring than static), while domain differences are present (landscape stimuli rated more aesthetic and less boring than dance). In the EEG we find only marginally lower SNR for dynamic than for static, and for dance than for landscape stimuli. These initial results suggest that it is possible to increase ecological validity without significantly disrupting the quality of EEG recordings or losing many trials to conservative cleaning, and that observers's subjective experiences will benefit from doing so.

Topic Line: EMOTION & SOCIAL: Emotional responding

C16 Associations between Risky Drinking, Suicidality and Network Activation During Emotional Response Inhibition

Julia Cohen-Gilbert, McLean Hospital/Harvard Medical School; Anna Seraikas, McLean Hospital; Eleanor Schuttenberg, McLean Hospital; Emily Oot, McLean Hospital/Boston University School of Medicine; Jennifer Sneider, McLean Hospital/Harvard Medical School; Lisa Nickerson, McLean Hospital/Harvard Medical School; Marisa Silveri, McLean Hospital/Harvard Medical School

Among young adults, suicidal ideation (SI) is strongly associated with dangerous patterns of alcohol use highly prevalent in this group, including binge drinking. The relationship between SI and drinking may be mediated by common neurocognitive factors, including dysregulated emotional impulsivity. Functional magnetic resonance imaging data were acquired during performance of an inhibitory control task (Go-NoGo) requiring participants to ignore emotionally negative or neutral background images. Subjects were 49 college freshmen (18-20yrs) who engaged in a broad range of drinking behavior (Alcohol Use Disorders Identification Test (AUDIT) scores=0-17). Seventeen subjects endorsed SI at baseline or within one year. Network template spatial activation maps, derived from HCP data, were projected onto brain activation for negative>neutral inhibitory (NoGo) trials, deriving a subject-series of activation strengths for each brain network for each participant. Multiple linear regression showed a significant interaction of AUDIT at 1-year follow-up and SI ($p=.01$); in the SI group only, AUDIT scores were associated with activation of a network comprising positive connectivity between regions involved in emotion (amygdala) and regulating attention (e.g., fusiform, precuneus), and negative connectivity within cingulo-opercular network nodes. These results may reflect altered shifting of cognitive resources between processing emotionally salient stimuli and maintenance of stable task performance. Accordingly, activation of this network was associated with slowed reaction times on negative versus neutral Go trials, with a particularly strong association observed in the SI group. This network activation profile may therefore serve as a potential risk marker for problematic alcohol use among youth endorsing SI.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

C17 Adults vs. neonates: Differentiation of functional connectivity between amygdala subnuclei and occipitotemporal cortex

Heather Hansen, The Ohio State University; Jin Li, The Ohio State University; Zeynep Saygin, The Ohio State University

The amygdala, a subcortical structure known for social and emotional processing, consists of multiple subnuclei with unique functions and connectivity patterns. Tracer studies in adult macaques have shown that the lateral and basal subnuclei differentially connect to visual cortical areas, with stronger connections to anterior regions and weaker connections to posterior regions; infant macaques show robust connectivity even with posterior visual regions. Do these developmental differences also exist in the human amygdala, and what is the possible functional role of this prolonged development of connectivity? To address these questions, we explored lateral and basal functional connectivity (from resting-state fMRI data) to occipitotemporal cortex in 40 adult subjects and 36 neonates scanned within one week of life. We calculated amygdala connectivity to anterior-posterior gradients of the anatomically-defined occipitotemporal cortex, and also to putative occipitotemporal functional parcels, including primary and high-level visual and auditory cortices (V1, A1, face, scene, object, body, and temporal speech regions). Results showed a decreasing gradient of functional connectivity to the occipitotemporal cortex in adults ? similar to the gradient seen in macaque tracer studies ? but no gradient in neonates. Further, adults had stronger connections to higher level functional regions associated with face, body, and object processing, and weaker connections to primary sensory regions (i.e., A1, V1), whereas neonates showed the same amount of connectivity to primary and higher-level sensory regions. Overall, these results show that functional connectivity between the amygdala and occipitotemporal cortex is not yet differentiated in neonates, possibly facilitating experience-dependent specialization of cortex.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

C18 How Depressive Symptomology Affects Emotional Regulation Across the Lifespan

Taylor James, Georgia Institute of Technology; Brittany Corbett, Georgia Institute of Technology; Audrey Duarte, Georgia Institute of Technology

Emerging evidence suggests that older adults spontaneously engage in downregulation of emotional affect during anticipation of negative events. Depression is known to interfere with the processing of emotional material; however, it is not known how depressive symptomology, even in the absence of a clinical diagnosis, affects anticipatory emotional processing and how this relationship may change with age. We have currently tested 15 young adults with a range of CES-D scores on an fMRI task where they view positive, negative, and neutral images preceded by auditory cues which indicate the valence of the upcoming stimulus. Participants rated the emotional intensity of the images while undergoing scanning, then, outside of the scanner, they completed a recognition task. Regardless of symptom severity, participants did not show valence differences in memory performance. Consistent with previous findings, young adults did not downregulate negative affect, as amygdala activity did not differ between negative and neutral image anticipation. Interestingly, those with lower CES-D scores showed more engagement of amygdala during anticipation of positive relative to negative and neutral images, possibly reflecting upregulation of positive affect. These preliminary results suggest that depressive symptomology impacts anticipatory processing of positive but not negative emotional images in young adults. Further analyses will be conducted as we collect data from more individuals to determine how the relationship between depressive symptoms and emotional regulation changes across the lifespan.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

C19 The neural correlates of aversive to appetitive counterconditioning

Nicole E. Keller, Institute for Neuroscience, University of Texas at Austin; Emily Leiker, Department of Psychiatry, University of Texas at Austin; Mason McClay, Department of Psychiatry, University of Texas at Austin; Augustin C. Hennings, Institute for Neuroscience, University of Texas at Austin; Jarrod A. Lewis-Peacock, Department of Psychology, University of Texas at Austin; Joseph E. Dunsmoor, Department of Psychiatry, University of Texas at Austin

Fear extinction, the basis for exposure based therapy, is often followed by the re-emergence of extinguished fear behaviors. Therefore, strengthening extinction memories to effectively inhibit the return of fear is critical in designing improved treatment for fear related disorders. Counterconditioning is an alternative technique to extinction, by which behavior is modified through a new association with a stimulus of an opposite valence. In the present within-subject neuroimaging study, we compared the neural correlates of counterconditioning, where an aversive shock was replaced by an appetitive stimulus, to the well-delineated neural circuitry of extinction, where an aversive shock was merely omitted. Results showed that in a whole-brain within-group contrast for items encoded during extinction, subjects exhibited higher BOLD activity in the amygdala and the striatum to counter-conditioned stimuli relative to extinguished items. Similarly, at a renewal test 24-h later, subjects displayed higher BOLD activity in the amygdala to new items from the counter-conditioned category relative to the extinguished category. One month later, in a long-term memory test, participants showed enhanced explicit memory for counter-conditioned items encoded during extinction in comparison to extinguished items. In line with

previous research, these results suggest mechanisms by which safe memories can be enhanced in the long term: (1) through increased engagement of the striatum during extinction learning, and (2) through increased engagement of the amygdala during both extinction learning and consolidation (Correia et al. 2016). This has implications for boosting exposure therapy efficacy by incorporating appetitive stimuli that enhance reward system engagement.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

C20 Heat environment increases mental workload even if learning efficiency is enhanced

Tsukasa Kimura, ISIR, Osaka University; Noriko Takemura, Institute for Datability Science, Osaka University; Yuta Nakashima, Institute for Datability Science, Osaka University; Hirokazu Kobori, Daikin Industries, Ltd.; Hajime Nagahara, Institute for Datability Science, Osaka University; Masayuki Numao, ISIR, Osaka University; Kazumitsu Shinohara, Graduate School of Human Sciences, Osaka University

Climate change is one of the most important issues for humanity. To defuse this problem, it is considered necessary to improve energy efficiency, make energy sources cleaner, and reduce energy consumption in urban areas. Japanese government recommended a setting of air conditioner to 28 ℃ in summer and 20 ℃ in winter. The aim of this setting was to save the energy by keeping the room temperature constant. However, it is unclear whether this setting is an appropriate temperature for workers and students. This study examined whether thermal environment influences the task performance varied with time. In addition, to examine whether the relationship between task performance and thermal environment influence psychological states of participants, we recorded subjective rating for mental workload, working memory score, electroencephalogram (EEG), heart rate variability (HRV), skin conductance level (SCL), and tympanum temperature during the task and compared among conditions. In this experiment, participants were asked to read some texts, after that, they were required to answer the questions related to the texts. The room temperatures were manipulated during the task (18, 22, 25 or 29 ℃) and participants performed the task at these temperatures. The results of this study showed that temporal cost of task and theta power of EEG decreased over time. However, subjective mental workload increased with time. Moreover, LF/HF and SCL increased at the heat environment (25 and 29 ℃). These results suggest that mental workload, especially implicit mental workload, increases at the heat environment, even if learning efficacy facilitates.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

C21 Using optical flow to capture movement in response to emotional stimuli among people with schizophrenia: a pilot study

Lisa Lin, University of Rochester; Michelle Matvey, San Francisco VA Medical Center; Ellen Bradley, San Francisco VA Medical Center; Chenwei Wu, University of Rochester; David Dodell-Feder, University of Rochester; Josh Woolley, San Francisco VA Medical Center

People with schizophrenia (SZ) demonstrate deficits in nonverbal expressivity that have important implications for social functioning. Previous work has typically relied on clinician- or observer-based ratings to measure symptoms associated with SZ. Recent advances in computer vision techniques have led to increases in automated measures to examine nonverbal behavior. In this pilot study, we assessed the relationship between automatically quantified evoked movement and clinician-rated symptoms of SZ. Men with schizophrenia (n=19) and neurotypical controls (n=17) viewed emotionally evocative videos while being video recorded. We estimated participants' movement using optical flow-a technique that estimates the pattern of apparent motion of an object between consecutive frames-from these recordings using the Farneback method. The Farneback algorithm produces estimates of the spatial-temporal changes resulting from motion and allows for the calculation of movement intensity (i.e. motion energy). We examined differences in motion energy in neurotypicals and SZ and ran correlations between motion energy and SZ symptoms. We found no differences in motion energy between SZ and controls in response to stimuli with either positive or negative valence (p's >0.05). Motion was inversely correlated with negative symptom severity for both positively ($r = -0.51$, $p=0.03$) and negatively ($r= -0.46$, $p=0.05$) valenced stimuli. Motion was correlated with positive symptom severity for negative ($r=0.66$, $p =0.002$) and for positively valenced stimuli ($r = 0.41$, $p = 0.09$). Although these preliminary findings should be interpreted with caution, they suggest that automated methods of measuring movement are potentially valuable tools that may efficiently capture meaningful differences in nonverbal expressivity.

Topic Line: EMOTION & SOCIAL: Other

C22 Interaction of Age- and Stroke-related Declines in Thalamus Volume

Lisa Krishnamurthy, Atlanta VA; Gabriell Champion, Atlanta VA; Keith McGregor, Emory University; Venkatagiri Krishnamurthy, Emory University; Aaminah Turabi, Atlanta VA; Joe Nocera, Emory University; Michael Borich, Emory University; Amy Rodriguez, Emory University; Rachael Harrington, Georgia State University; Bruce Crosson, Emory University

Purpose: It has previously been shown that the whole thalamus volume declines with age and stroke. In this study, we investigate the age-by-disease interaction of thalamus volume decline. We hypothesize that the thalamus volume will decrease linearly with age and non-linearly with stroke. Methods: This cross-sectional study quantified the left and right thalamus volume from anatomical MRI data processed with a refined set of imaging pipelines developed specifically for aging and stroke. In total, 337 subjects were used to relate thalamus volume to age and lesion volume. Results: We identified an aging-related reduction in thalamus volume ($p <0.0001$) and stroke-related reduction in ipsilesional thalamus ($p<0.0001$) but not contralesional thalamus. Further, aging-related changes in contralesional thalamus were evident ($p<0.0005$). Stroke-related changes layered on top of aging-related changes for ipsilesional thalamus were revealed when lesion volume was incorporated in the model ($p<0.0001$) resulting in a significant aging-by-disease interaction ($p<0.0001$).

Conclusion: We have presented evidence of an aging-by-disease interaction in thalamus volume decline. Additional research is warranted to understand changes in the neural circuitry due to aging and aging-related neurodegeneration."

Topic Line: NEUROANATOMY

C23 Sexual objectification beyond the metaphor: an EEG investigation

Carlotta Cogoni, IBEB (Instituto de Biofísica e Engenharia Biomédica); Jeroen Vaes, University of Trento; Giulia Cristoforetti, University of Ghent; daniela ruzzante, University of Trento; Veronica mazza, University of Trento

Objectification refers to the focus on the individual's physical appearance over his/her mental state. Women are often the victim of this phenomenon, that occur whenever a woman is reduced to her body or certain body parts losing out on her inner mental life and moral standing. However the extent to which a woman becomes an object when objectified is still unclear. Does she actually become similar to a real object or is the object reference a mere metaphor? In a set of three experiments, male and female participants' neural activity was measured while they analyzed pictures of men and women and comparable doll-like objects. Using the well-known oddball paradigm, gender matched doll-like objects appeared infrequently among frequently presented human stimuli.

Analyses were focused on a late event-related neurophysiological response (P300), which is triggered by the infrequent doll-like objects according to how different they were perceived from the repeated, human stimuli (i.e., the oddball effect). Results showed a significantly smaller oddball effect for objectified women compared to objectified men (Experiment 1). This difference did not occur for non-objectified depictions of men and women (Experiment 2). When no semantic references to the human-object divide were provided, objectified women were still perceived more similar to real objects (Experiment 3). The results are the first to demonstrate that the perception of women, when objectified, changes in essence beyond the metaphor making them more similar to objects than men.

Topic Line: EMOTION & SOCIAL: Person perception

C24 Neural correlates of affective and non-affective social interactions processing from point-light displays.

Lukasz Okruszek, Institute of Psychology, Polish Academy of Sciences; Justyna Gula, Department of Psychology, Goldsmiths, University of London

Ability to interpret social interactions (SI) is one of the crucial skills enabling functioning in social world and has been linked to the increased activity of social brain networks, even if actions of agents are visually degraded to point-light displays (PLD). The main aim of the project was to examine the patterns of neural activity associated with processing of affective and neutral SI from PLD. During the motion-capture session, two pairs of actors were asked to perform a range of dyadic 3-second actions, including: neutral communicative interactions (COM); emotional exchanges (EMO) and independent actions (IND). Stimuli was transformed into PLD, animations with scrambled motion of agents (SCR) were also created. Fifty healthy individuals (30M; 33+/-8 yrs) were asked to categorize vignettes during a neuroimaging session. SI elicited widespread activity in bilateral superior temporal sulci (STS) and the right precentral gyrus (PG), which could have been distinguished from the pattern of activation elicited by biological motion per se (bilateral posterior STS, fusiform gyrus and precuneus). COM>EMO elicited higher activity in bilateral superior parietal lobule and left PG, while the reverse contrast was associated with left medial prefrontal cortex and right amygdala activation. Furthermore, increased connectivity between the right posterior STS and dorsomedial prefrontal and limbic regions was observed for EMO>COM. These results suggest that, regardless of their type, SI processing elicit widespread activity of the social brain networks, specific patterns of action observation and mentalizing networks activity may additionally be linked to the processing of specific types of interactions.

Topic Line: EMOTION & SOCIAL: Person perception

C25 EEG frequency-tagging of apparent biological motion dissociates action and body perception

Guido Orgs, Department of Psychology, Goldsmiths, University of London; Emiel Cracco, Department of Experimental Psychology, Ghent University; Goedele van Belle, Institute of Research in Psychological Science, UCL; Lisa Quenon, Institute of Research in Psychological Science, UCL; Patrick Haggard, Institute of Cognitive Neuroscience, UCL; Bruno Rossion, Université de Lorraine, CNRS, CRAN

Language and music are hierarchically organized with clearly identifiable components such as phonemes or notes that are combined to produce sentences or rhythms. The structure of human action, on the other hand, is less clear. Based on dance choreography, we propose that action sequences can be broken down into a series of movements from one body posture to another. By frequency-tagging fluent, non-fluent and random apparent biological motion sequences, we show that brain activity entrains not only to the presentation rate of individual body stimuli, but also to the repetition of specific body postures within the stimulus stream, and to the rhythm of whole-body movements. Entrainment to individual body postures were strongest for non-fluent sequences and across bilateral occipitotemporal electrodes, consistent with processing of static body postures in extrastriate visual cortex. In contrast, neural responses to the rhythm of movement were strongest for fluent sequences and across occipito-temporal and fronto-central electrodes. Body- and movement-related neural responses were absent for random posture sequences without compositional structure. Instead, these sequences evoked brain activity only at the visual presentation frequency. Frequency tagging of apparent biological motion thus reveals multiple brain representations for observed actions, driven by change in visual surface form, by repetition of static body postures, and by rhythm of movement. Our results are consistent with a hierarchical process of action perception that builds complex rhythmical action sequences by connecting fluent trajectories between static body postures.

Topic Line: EMOTION & SOCIAL: Person perception

C26 Neuromodulation of the Theory of Mind Neural Network with Real-Time fMRI Neurofeedback

Abhishek Saxena, University of Rochester; Emily Dudek, University of Rochester; J. Steven Lamberti, University of Rochester; David Dodell-Feder, University of Rochester

Theory of mind (ToM)-the ability to attribute and reason about the beliefs, intentions, and emotions of others-is a vital component to successful social interaction. Deficits in ToM are a hallmark of some of the most debilitating mental disorders, including autism and schizophrenia. A large body of research has demonstrated that these behavioral deficits are sub-served by impairments to a network of brain regions including dorsal medial prefrontal cortex (dmPFC) and tempo-parietal junction (TPJ). For individuals with impairments in ToM, the ability to volitionally modulate these brain regions, and bring them online during social interaction, may alleviate deficits in ToM and concomitant social difficulties. Thus, here, we present a proof-of-concept study to evaluate the efficacy of using real-time fMRI towards training volitional control of the ToM network. Participants underwent four separate scan sessions. In the first session, we localized TPJ using validated ToM tasks. In sessions two through four, we provided feedback to participants from TPJ during which participants were instructed to up- and down-regulate neural activity (percent signal change). Preliminary results suggest that with neurofeedback, participants are able to modulate neural activity in the TPJ as well as other ToM-related brain regions (dmPFC) that participants did not receive feedback on. Further, participants were able to volitionally modulate the network during a transfer scan in which no feedback was provided. Together, these data highlight the potential utility of real-time fMRI for improving social deficits in psychiatric illness.

Topic Line: EMOTION & SOCIAL: Person perception

C27 Withdrawn

C28 The Developmental Trajectory of the Domain General Cortex

Athena Howell, The Ohio State University; Zeynep Saygin, The Ohio State University; David Osher, The Ohio State University; Jin Li, The Ohio State University

The human cortex is not fully mature at birth. In particular, the frontoparietal regions take the longest to mature, and take longer to mature in humans than in other primates. The behavioral consequence of this maturational delay for humans remains unknown. In human adults, parts of frontal and parietal cortices are engaged in 'domain general' mental functions (i.e. required for tasks that involve extra mental effort, working memory, and attention, regardless of task or mental domain). Consequently, in adults, these areas show greater activation

during difficult tasks vs. easy tasks; further, these areas are more connected to each other than to other networks (e.g. more intra-network connectivity vs. internetwork connectivity). It remains to be seen, however, whether these areas in neonates and children show a more prolonged development than adjacent areas engaged in other mental processes in either i) functional activation to task difficulty and/or ii) connectivity within and between functional networks. In this study, we assessed both the functional activation and connectivity of frontoparietal cortical areas in adults vs kids; and connectivity of these regions in adults vs neonates. Results indicate children exhibit generally weaker activation in domain-general areas as compared to adults. Further, neonates and children show similar intra- and inter-network connectivity whereas adults exhibit higher intra- vs inter-network connectivity for domain general regions. Ongoing and future longitudinal work will relate individual immaturity of function and connectivity to behavioral assessments and developmental milestones.

Topic Line: EXECUTIVE PROCESSES: Development &aging

C29 ERP P3 during visual 3-stimulus oddball task and intelligence at school aged children: the Hokkaido Study

Keiko Yamazaki, Hokkaido University; Atsuko Araki, Hokkaido University; Chihiro Miyashita, Hokkaido University; Sachiko Itoh, Hokkaido University; Sonomi Nakajima, Sapporo Medical University; Reiko Kishi, Hokkaido University

P3 is one of the most extensively studied event-related brain potential (ERP), whose characteristics change from children to adult. We investigated correlation between P3 and scores of the WISC-III (Wechsler Intelligence Scale for Children-third edition), which is consist of the tasks to need variable ability. The basic information of participants was obtained from a prospective birth cohort study, the Hokkaido Study on Environment and Children's Health. We enrolled pregnant women from 2002 to 2005 in Japan (n=514). The WISC-III was implemented when the children were at 7 years old, and ERP data was recorded at 13 years old. We analyzed data from 33 children who had both WISC-III and ERP data. The task was 3-stimulus visual oddball paradigm (standard, 70%; target, 15%; non-target, 15%), in which the stimuli were once every 2 s, with two condition for discrimination of the stimulus (easy/difficult condition). Mean age of children was 12.1 years old (SD 0.8). We observed P3a for non-target over the central electrodes, and P3b for target over the parietal electrodes from 300 to 500 ms. We found no significant correlation between P3a and any task score in WISC-III. Only P3b amplitude was decreased as increasing of Vocabulary score in difficult condition, and as increasing of picture arrangement score in the both conditions. These results are inconsistent to previous study, which reported correlation between P3b during auditory oddball task and digit span score (Boucher, 2010). This inconsistency might be due to visual modality task employed in this study.

Topic Line: EXECUTIVE PROCESSES: Development &aging

C30 The striatal feedback response reflects goal updating

Ian Ballard, University of California, Berkeley; Mark D'Esposito, University of California, Berkeley

Decades of neuropsychology and neuroanatomical research has converged on the theory that the striatum is a gate: it selects between potential action or goal representations in cortex. In contrast, fMRI investigations often characterizes the striatal BOLD response as a reward prediction error signal arising from midbrain dopaminergic inputs. However, prediction error is confounded with updating: if you discover that your decision resulted in a disappointing outcome, you must both represent that disappointment and update your behavior. We test whether apparent reward prediction error BOLD responses in the striatum are better described as goal updating responses, and reflective of gating functions rather than the activity of dopaminergic inputs. Subjects performed two tasks: a standard 2-arm bandit task (in which prediction error and updating are confounded), and a variant of the 2-arm bandit that dissociates goal updating from reward prediction error. We accomplish this by introducing conditions where losing money indicates the need to change goals. We find that in the traditional 2-arm bandit where goal updating and reward prediction error are confounded, the striatal BOLD response is consistent with both interpretations. However, in the same subjects performing the task where they are de-confounded, the striatal BOLD response tracks goal updating and not reward prediction error. Specifically, the accumbens and putamen respond more strongly to losing than winning money when losing money is more informative for goal selection. These results suggest that the striatal feedback response reflects updating of cortical goal representations, consistent with the gating theory of striatal function.

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

C31 Using a Memory Game to Enhance Frontal Activation: An fNIRS Study

Bhoomika Nikam, University of Tennessee, Knoxville; Meagan Smith, University of Tennessee, Knoxville; Sammy Perone, Washington State University; Aaron Buss, University of Tennessee, Knoxville

The dimensional change card sort task (DCCS) is a standard measure of executive function used in early development. The task requires children to sort cards by one dimension (e.g. shape) and then switch to sort by another dimension (e.g. color). Typically, 3-year-olds perseverate and continue to use the pre-switch dimension, while 4-year-olds are able to switch rules when prompted. Previous research suggests that prior exposure to the post-switch dimension in the form of a memory game facilitates better performance for 3-year-olds in the post-switch phase of this task (Perone et al., 2015; 2019). The goal of this study was to explore the neural basis of this effect with 3.5-year-olds. We used functional near-infrared spectroscopy (fNIRS) to measure activation from left frontal, left temporal, and right parietal regions previously implicated in dimensional attention (Morton et al., 2009; Buss & Spencer, 2018). Children participated in either a standard tic-tac-toe (control task) or color memory game prior to the DCCS. Although no performance differences were observed between groups, which has been reported in previous studies, neural activation differences between groups were observed in the left frontal cortex ($F(1,30)=7.129$, $p=.012$). Children with prior exposure to the post-switch (color) dimension showed stronger activation compared to children in the tic-tac-toe group. Our results support predictions of a dynamic neural field model (Buss & Spencer, 2014; Perone et al. 2015), which demonstrates how experience with perceptual dimensions can enhance activation of frontal cortex.

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

C32 Neural dynamics during dimensional label learning predicts dimensional attention performance in early childhood

Hollis Ratliff, University of Tennessee, Knoxville; Aaron Buss, University of Tennessee, Knoxville

Previous research suggests that children's ability to label visual features (e.g., 'green') and dimensions (e.g. 'color') can change aspects of their dimensional attention (Buss & Kerr-German, 2019). Based on this research, the goal of this project was to investigate whether children's dimensional attention can be predicted by the neural dynamics of dimensional label learning. Thirty-three preschool aged children (M=46.6mo.) performed dimensional label learning tasks assessing color production, comprehension, and matching. Dimensional attention was measured using the dimensional change card sort task (DCCS) which measures flexible dimensional attention, a dimensional attention priming task which measures attentional stability, and the triad classification (TC) task which measures children's selective attention. We used functional near-infrared

spectroscopy (fNIRS) to measure activation in frontal, parietal and temporal cortices previously implicated in dimensional attention (Buss & Spencer, 2018). Performance in the DCCS was positively correlated with activation in the frontal cortex during the comprehension task r(30)=0.375, p=0.041. Better performance on the TC task was associated with deactivation of the parietal lobe F(2,52)=3.96, p=0.025. Better performance on the priming task was positively correlated with activation in the temporal cortices during the comprehension task r(27)=0.407, p=0.035, and deactivation in temporal cortex, r(24)=-0.451, p=0.027. These results suggest that the neural dynamics elicited during the dimensional label tasks predicts performance across a range of tasks that measure dimensional attention.

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

C33 Effects of post-error arousal on cognitive control: Adaptive or maladaptive?

Rebecca Compton, Haverford College; Marc Jaskir, Haverford College; Jianing Mu, Haverford College

Neural reactions in the moments following a performance mistake may reflect heightened arousal that could either enhance or impair subsequent attention and performance. To investigate these alternative possibilities, 55 undergraduates completed a spatial cued Stroop task indexing several aspects of selective attention while EEG and pupil diameter were measured. Performance errors (~8% of trials) were followed by a set of physiological and behavioral changes, including increased pupil diameter ($F(5, 265) = 4.6$, $p = .012$) and EEG alpha suppression that extended into the next trial (during inter-trial interval, $F(1,53) = 13.9$, $p < .001$; following next-trial cue, $F(1,53) = 20.1$, $p < .001$); both of these measures likely reflect post-error arousal. Furthermore, next-trial performance was slower ($F(1,53) = 5.6$, $p < .03$) and less accurate ($F(1,53) = 3.9$, $p < .06$) following errors, a pattern that was unaltered by increasing the inter-trial interval to allow more time for adaptive control. Moreover, EEG and behavioral indices of attention involving Stroop congruency and spatial cue-validity effects were not affected by whether the prior trial was an error, counter to the prediction that post-error adaptive control sharpens attentional focus. Finally, within-participants correlations indicated that greater post-response pupil diameter, reflecting arousal, predicted slower next-trial reaction time, especially following errors (mean correlations for correct and error trials separately, $ps < .001$; error-correct contrast, $p < .02$). Together the results imply that errors are followed by increased arousal that predicts general slowing rather than enhanced attentional focus.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

C34 A cautionary tale about the importance of taking individual differences intoaccount when examining whether tDCS can enha

Sydney Darling, University of Connecticut; Keisha Alexander, University of Connecticut; Hannah Morrow, University of Connecticut; Eiling Yee, University of Connecticut

Can inhibitory cognitive control be enhanced via anodal tDCS over left prefrontal cortex? Evidence is mixed, with efficacy likely depending on factors including electrode position and size, stimulation intensity and duration, whether the task is performed during or after stimulation,and domain of cognitive control examined (for meta-analysis, see Imburgio & Orr, 2018). We examined the impact of anodal stimulation over left prefrontal cortex on inhibitory function, as measured via Flanker and Stroop, using an F3-RSO montage. Baseline performances on Flanker and Stroop were measured before stimulation. Afterward, anodal or sham stimulation began (between participants). After 3 minutes of stimulation (1.5mA with 5x7cm saline-soaked sponges), participants repeated the Flanker and Stroop tasks (each lasting 5 minutes) while stimulation continued. If anodal tDCS enhances inhibitory function, then when comparing repeated to baseline performance, there should be a smaller incongruency disadvantage (difference incongruent and congruent trials) for anodal compared to sham-reflecting greater ease inhibiting irrelevant/incongruent information. No differences in RT or accuracy were found in either task. However, if we had compared the incongruency disadvantage after stimulation in anodal vs. sham groups without accounting for baseline performance, we would have observed (contrary to our predictions) a significantly larger incongruency disadvantage in Flanker in the anodal group (because at baseline, the anodal group had a larger incongruency disadvantage). Results suggest that the F3-RSO montage with the simulation parameters we used may not impact inhibitory control, and highlight the importance of using designs that take into account individual differences in baseline inhibitory function.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

C35 The Effects of Bilingualism on Resistance to Proactive Interference and Brain Integrity Across the Adult Lifespan

Alessandra Macbeth, University of California, Riverside; Eve Higby, California State University, East Bay; Natsuki Atagi, California State University, Fullerton; Christine Chiarello, University of California, Riverside

Resistance to proactive interference (PI), or the ability to inhibit access to previously learned material that has become irrelevant, has not been examined before in the bilingualism literature. Seventy-four participants completed directed forgetting and proactive interference tasks and underwent a structural MRI scan. We hypothesized that behavioral differences would only be evident among the older adults (N=26, 13 bilingual), with bilinguals displaying greater resistance to PI than monolinguals. We also predicted brain structure would differ between monolinguals and bilinguals in both the young adults (N=48, 24 bilingual) and older adults, with bilinguals showing enhancement/preservation of cortical structures implicated in resistance to PI. Performance on directed forgetting revealed a significant age effect for to-be-remembered words: older adults remembered fewer. The proactive interference task yielded a significant age effect for both correct recall and intrusions; older adults recalled fewer words correctly and committed more intrusion errors. All groups showed release from PI. No language background effects were evident for either task, suggesting no differences in resistance to PI performance between bilinguals and monolinguals of either age group. When comparing brain structure, left and right pars triangularis cortical thickness was greater in monolinguals, contradictory to our hypothesis. However, correlations between behavioral and cortical measures showed that fewer intrusion errors among bilingual older adults were associated with greater cortical thickness in the left rostral and caudal middle frontal gyrus, with no comparable relationship for older monolinguals. These findings suggest the possibility of distinct neural correlates supporting inhibitory performance of bilingual versus monolingual older adults.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

C36 Best of both worlds: Integrating EEG and fMRI in the study of inhibition

M. Fiona Molloy, The Ohio State University; Brandon Turner, The Ohio State University

A task commonly used to measure response inhibition is the stop-signal task. Variations of this task have been studied using a wide range of populations and diverse methodologies, which makes it difficult to integrate these findings into a unifying theory. Here, we show how analyses from one modality, such as electroencephalography (EEG), can inform future analyses in a different modality, such as functional magnetic resonance imaging (fMRI). We use data from four previously published stop-signal tasks, with both auditory and visual

stop-signals requiring motor or verbal responses: two fMRI (Xue et al., 2008; Aron, et al., 2007) and two EEG (Castiglione, et al., 2018; Wagner et al., 2018). First, in the two EEG studies, we identified eight clusters of stopping, including bilateral inferior frontal areas, using temporal and spatial properties of individual's components. Then, probabilistic dipole maps from these EEG clusters were used to define the regions of interest (ROIs) for the fMRI datasets. Finally, hierarchical Bayesian analyses revealed larger pair-wise coactivation between these ROIs for successful and failed stopping than going. While the overall pattern was the same in the two datasets, successful and unsuccessful stopping had different signatures. Furthermore, in both datasets, the correlation between the left and right inferior frontal clusters increased for successful stopping. These analyses demonstrate how EEG data can inform analyses of fMRI data to aid in fully understanding response inhibition, but they lack mechanisms for causality. Further research using dynamical models is needed to determine causality and allow full integration of these modalities.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

C37 Activity Flow over Intrinsic Networks Explains Stimulation-Evoked Activations

JING JIANG, Stanford University; Manjari Narayan, Stanford University; Yu Zhang, Stanford University; Wei Wu, Stanford University; Colleen Mills-Finnerty, Stanford University; Carena Cornelssen, Stanford University; Rachael Wright, Stanford University; Michael Cole, Rutgers University; Amit Etkin, Stanford University

Human brain functions depend on complex activity flow between regions that constitute large-scale intrinsic networks, yet the principles governing causal activity flow throughout these networks remain unclear. We test two contrasting theories to reveal how stimulation-evoked local activity spreads in the brain, by empirically modulating local cortical activity in 11 cortical regions using noninvasive transcranial magnetic stimulation (TMS) and concurrently recording consequent whole brain activity through functional magnetic resonance imaging (fMRI) in 81 healthy participants. The resting-state fMRI data are also collected from these participants. Based on an activity flow mapping model, we find that TMS-evoked activation in a held-out region can be significantly better predicted via estimated activity flow over resting-state functional connectivity (RSFC) from all other regions collectively ('all-to-one') than that from the stimulated region exclusively ('one-to-one'). Furthermore, network features such as positive RSFC (versus negative or whole-brain RSFC) and within- (versus between-) network connectivity contribute significantly more to the prediction accuracy. Among all the 7 networks, the default mode network and frontoparietal control network provide the largest contributions to the activity flow prediction. Finally, the prediction is also robust via structural connectivity based on the diffusion tensor imaging data from Human Connectome Project. Together, these results demonstrate critical spatially-organized principles of intrinsic networks that shape causal global activity spreading in the brain and highlight the therapeutic potential of flow-based modulation.

Topic Line: EXECUTIVE PROCESSES: Other

C38 How does Feedback Processing Affect Learning in People with Traumatic Brain Injury?

Corina Mangione, MGH Institute of Health Professions; Gwendolyn Meredith, MGH Institute of Health Professions; Jessica Kenworthy, MGH Institute of Health Professions; Yael Arbel, MGH Institute of Health Professions; Lauryn Zipse, MGH Institute of Health Professions

Learning and memory deficits are often present in people who have experienced a traumatic brain injury (TBI). Errorless learning, which entails learning through repetition without opportunities to make mistakes, is one technique frequently used to teach people who have learning deficits secondary to TBI. However, errorless learning is not as functional or flexible as learning from feedback (i.e., errorful learning). The goal of this study was to examine how feedback processing affects learning in people with TBI. Nine individuals with TBI and 27 control participants completed a paired-associate word learning task under three conditions: Errorless, where participants practiced the correct response; Errorful, where participants learned from visual feedback; and Strategy, where participants learned from feedback but were taught a simple strategy for attending to and managing the feedback. EEG was recorded during learning in order to evaluate event-related potentials (ERPs) associated with feedback processing, namely the feedback-related negativity (FRN) and the fronto-central positivity (FCP). Behavioral learning outcomes were measured at three different time points after learning: immediately, at a short delay, and at a long delay (~one hour later). Results indicate that learning outcomes were best for both groups in the Errorless condition, and better for Strategy relative to Errorful at some testing time points. ERP data revealed different responses to feedback between the two groups. People with learning deficits secondary to TBI appear to be processing feedback differently than controls, and their learning outcomes in an errorful environment may be supported by applying metacognitive strategies.

Topic Line: EXECUTIVE PROCESSES: Other

C39 Memory and Metamemory Deficits in First-Episode Schizophrenia: Effects of Psychosis on Value-Directed Remembering

Tara Patterson, University of California, Los Angeles; Alan Castel, University of California, Los Angeles; Barbara Knowlton, University of California, Los Angeles; Kenneth Subotnik, University of California, Los Angeles; Keith Nuechterlein, University of California, Los Angeles

Memory deficits in individuals with schizophrenia are well established, but less is known about how psychosis affects metacognitive processes such as metamemory, which refers to awareness of and control over one's own memory. We investigated metamemory ability using the value-directed remembering task, which assesses the degree to which participants use value cues to guide their learning of a list of items (i.e., their memory selectivity). Successful performance of the task requires awareness that there are more items on the list than are likely to be remembered, necessitating direction of memory resources to the higher-value items. Participants were patients undergoing treatment following a recent first episode of schizophrenia and demographically comparable healthy controls. Participants viewed six lists of 24 words where each word was paired with either a low value (1-3 points) or a high value (10-12 points), and they were instructed to maximize their score on free recall tests given after each list. Consistent with previous research, individuals with schizophrenia showed reduced free recall. They also showed reduced memory selectivity, indicating impairment in the ability to preferentially encode higher-value items. This impairment may reflect diminished ability to recruit the frontal lobe resources required for successful metamemory awareness and control.

Topic Line: EXECUTIVE PROCESSES: Other

C40 Prefrontal tuning in mnemonic chunking in a spatial self-ordered search task

Feng-Kuei Chiang, Icahn School of Medicine at Mount Sinai; Erin Rich, Icahn School of Medicine at Mount Sinai

Working memory (WM) is a key feature of intelligence but has limited capacity. We rarely notice this constraint because we are able to implement mnemonic strategies, such as grouping items together into 'chunks', to overcome WM capacity limitations. My recent study found that spatial tuning in lateral prefrontal cortex (LPFC) neurons was modulated by self-generated sequencing strategies

(Chiang and Wallis, PNAS, 2018). However, it remains unclear how these neurons contribute to mnemonic chunking. To assess this, we trained two monkeys to perform a spatial self-ordered search task with six or eight identical visual targets. The subjects were required to saccade to each, one at a time in any order, returning their eyes to the center after each target. No reward delivered when monkeys revisited the targets. Therefore, the subjects had to use WM to keep track of which reward targets had been visited. We defined chunks as groups of targets that were frequently selected together and used graph theory approaches to quantify the degree of chunking in trial blocks. Preliminary data indicate that stronger chunking reduces error rates, consistent with the notion that chunking increases WM capacity. In brief, we found monkeys generated chunking strategy in self-ordered WM tasks. Using decoding approaches, we will reconstruct two-dimensional spatial locations of targets held in WM from populations of LPFC neurons which recorded simultaneously from two 8-by-8 Utah arrays. We hypothesize that, compared to the actual target configurations, chunking targets involves an efficient reorganization of location information represented in LPFC neurons.

Topic Line: EXECUTIVE PROCESSES: Working memory

C41 Using fNIRS to Probe the Effects of Response Type in a Visual Working Memory Task

Rachel Eddings, University of Tennessee; Aaron Buss, University of Tennessee

Visual working memory (VWM) allows us to hold visual information in mind to be manipulated for a task. Previous research shows that performance varies based on factors such as stimulus modality and number of distractors. This study aimed to explore the effect of response type on VWM performance in 4.5- and 5.5-year-olds. A single-item probe color change detection task and a cued recall with labeling task were administered. The tasks were identical in structure until the response phase of the trial. Neural data were collected using functional near-infrared spectroscopy. Both tasks used set-sizes 1-3 and six canonical colors (red, orange, yellow, green, blue, purple). All children were given the change detection task first. Behavioral analyses show that children's performance declined as set-size increased in both tasks ($F(2,11)=65.438$, $p=0.003$). Moreover, VWM capacity was estimated to be higher in the change detection task ($k=2.53$) compared to the cued recall task ($k=1.24$) ($p<0.001$). When we look at the neural data, both tasks activated bilateral temporal and parietal cortices. The change detection task also elicited activation in bilateral frontal cortex. Though both tasks required the same working memory processes, distinct neural regions were involved based on the response type. Lastly, increases in activation over set-size, a key signature of VWM, were only observed in the change detection task, suggesting that this pattern of activation may be an artifact of response type rather than an actual signature of working memory.

Topic Line: EXECUTIVE PROCESSES: Working memory

C42 Losing money and memory: The effect of loss incentives on working memory in young and older adults

Hyesue Jang, University of Michigan; Richard Lewis, University of Michigan; Cindy Lustig, University of Michigan

Older age is accompanied by an increasing threat of losses (e.g., of health, financial security, driving privileges), with the opportunity to avoid such losses often used to motivate older adults. However, previous studies in our lab show that loss-based incentives reduce older adults' motivation (Jang et al., submitted). In low-constraint tasks, it also reduces their performance (Lin et al., in revision). Here, we more directly examine the impact of task constraints by manipulating them within a single task. We randomly assigned young (age: 18-26; current n = 22) and older (age: 61-86; current n = 54) participants to a control or loss incentive condition and had them perform a Sternberg-type working memory task. Task constraint is manipulated within the task by using short (4 sec) versus long (16 sec) retention intervals, randomly intermixed. Preliminary results indicate that whereas the loss incentive has no effect or a small numerical benefit on young adults' performance (n.s.), it impairs working memory performance in older adults. Moreover, older adults under loss incentive tend to report lower motivation than the other groups in a post-task questionnaire. Retention interval has the expected effect on young adults in the control condition: Better performance after the shorter interval. However, young adults in the loss condition show no difference, whereas older adults show the opposite effect: Better performance after the longer retention interval. The results suggest that loss incentives reduce older adults' motivation and working memory performance, but they may still be more motivated than young adults.

Topic Line: EXECUTIVE PROCESSES: Working memory

C43 Cerebellar Contributions to Higher Order Cognition

Ted Maldonado, Texas A&M University; Jessica Bernard, Texas A&M University

Though the prefrontal cortex is highly involved in cognitive performance, the cerebellum, has an increasingly recognized role in higher order cognition as well. However, the necessity and contribution of the cerebellum to cognition remains relatively unknown. Transcranial direct current stimulation (tDCS) uses weak electrical current to modulate neural activity in an effort to alter behavior, allowing for temporary functional alteration in the cerebellum to investigate its role in cognitive functions. The current work employed a between-subjects design using a 2 pad tDCS system to apply anodal, cathodal, or sham stimulation to the cerebellum to examine the effect of stimulation on Sternberg task performance, which had low, medium, and high load conditions. We predicted performance decrements following cathodal stimulation and performance increases following anodal stimulation, compared to sham. We assessed reaction time (RT) and accuracy and found typical load effects for both outcome measures such that low, medium and high load were all significantly different from each other. We found a main effect of stimulation on RT. RT was significantly slower following cathodal stimulation, compared to sham, consistent with our predictions. Surprisingly, there was a similar trend following anodal simulation, relative to sham. Stimulation also affected accuracy, but only under low load, such that accuracy was worse following both anodal and cathodal stimulation. The current results suggest an effect of stimulation on cognition under low load, perhaps suggesting that the cerebellum is more critical when processing is automatic but becomes less involved under higher load when processing is more prefrontally-dependent.

Topic Line: EXECUTIVE PROCESSES: Working memory

C44 Creativity influences the visual perspective of autobiographical memories

Selen Kucuktas, University of Alberta; Daniel Schacter, Harvard University; Peggy St. Jacques, University of Alberta

Autobiographical memories (AMs) are retrieved from the visual perspective of one's own-eyes or from an observer-like perspective in which one sees oneself in the remembered event. The ability to adopt multiple visual perspectives reflects the constructive nature of memories, which allows us to flexibly recreate our personal past in novel ways. However, not all individuals report the ability to naturally retrieve memories from alternative visual perspectives and/or to shift perspective during remembering. In the current study, we examined how individual differences in convergent and divergent creativity contribute to visual perspective during AM retrieval and the neural mechanisms supporting these effects. Participants generated specific AMs from the last five years. One week later, they retrieved AMs during functional scanning while either maintaining an

own-eyes perspective or shifting to an observer-like perspective. We found that convergent creativity was related to naturally adopting an own-eyes perspective, whereas divergent creativity was related to naturally adopting an observer perspective. People with higher convergent creativity also had greater reductions in emotional intensity when shifting their perspective to an observer-like perspective coupled with increased difficulty in remembering from this alternative perspective. A region of interest approach in subregions of parietal cortex linked to visual perspective, revealed that the angular gyrus was positively correlated with individual differences in convergent creativity. These findings demonstrate that creativity impacts the visual perspective from which we remember the personal past, and that convergent creativity influences recruitment in angular gyrus that supports the ability to reconstruct the features of episodic memory.

Topic Line: LONG-TERM MEMORY: Episodic

C45 Training attractor dynamics in human visual working memory

Qing Yu, University of Wisconsin-Madison; Matthew Panichello, Princeton University; Bradley Postle, University of Wisconsin-Madison; Timothy Buschman, Princeton University

Humans have the ability to maintain substantial amount of information in working memory, yet their memory performance is imperfect. Previous behavioral studies have demonstrated that responses during a working memory task for colors can be strongly biased towards several stable attractors, even when memory samples were drawn from a uniform distribution. These attractors help to reduce the effect of internal noise, and are adaptive to environmental statistics (Panichello et al., 2019). Here we conducted a training study in combination with fMRI to explore the neural mechanism of attractors dynamics and their adaptive nature. Participants performed one-item delayed-recall-of-color across four separate scanning sessions. In the first session (baseline), the sample colors were drawn from a uniform distribution. In the second and third sessions (training), half of the colors were drawn from a biased distribution (four biased centers chosen randomly for each participant). In the fourth session (post-training), the stimulus distribution was again uniform. Consistent with previous work, all participants demonstrated biases toward 'endogenous' attractors in the baseline session, and, during training, these attractor dynamics flexibly adapted to the change in environmental statistics. Interestingly, participants' responses during post-training demonstrated a mixture of effects from both the baseline and trained attractors, suggesting a long-lasting influence of adapted context on behavior. Neurally, we observed attractor biases in patterns of responses in visual cortex. These results suggest the neural biases to attractors may be a stable attribute of the visual system, and that they can exert an influence on visual working memory.

Topic Line: EXECUTIVE PROCESSES: Working memory

C46 NSF Funding Opportunities for Cognitive Neuroscience

Kurt Thoroughman, NSF

C47 Withdrawn

C48 Phonological representations of their non-spoken language help Heritage speakers to learn new words: An ERP study

Beerelim Corona Dzul, Universidad Autónoma de Querétaro; Keila Nava-Báez, Universidad Autónoma de Querétaro; Eva Velásquez-Upegui, Universidad Autónoma de Querétaro; Haydée Carrasco-Ortiz, Universidad Autónoma de Querétaro

Event-related potentials (ERPs) served to investigate whether Heritage speakers of an endangered language (Hñähño) activate phonological representations while learning written words of that language. Participants were control Spanish monolinguals (n=20) and Heritage speakers of Hñähño (n=14) who were exposed to the oral form of the language in their early years but do not speak, read or write in Hñähño. All participants learned written words in Hñähño classified into high or low degree of phonological similarity with Spanish words. Phonological similarity was manipulated through the Levenshtein Distance (OLD 20). Two training sessions involved two paired-association tasks where images, auditory and written forms of the words were presented. During the third session ERPs to written words in Hñähño with high and low phonological similarity across languages were recorded while participants performed an image-word verification task. Results showed a reduction in N400 amplitude in response to Hñähño words with a high degree of phonological similarity compared to those with low degree of phonological similarity across languages. This N400 modulation was true only in Heritage speakers but not in monolingual Spanish speakers. These findings suggest that only Heritage speakers activated the phonological representation of Hñähño words and were influenced by phonological similarity with Spanish words. These results suggest that heritage speakers benefit from the early exposition to the oral language even for recently learned written words. These findings highlight the importance to uncover brain responses in heritage speakers on an endangered language.

Topic Line: LANGUAGE: Lexicon

C49 ERP evidence for flexibility in accessing representations associated with subject-verb agreement

Jane ARISTIA, Université de Lille; Angèle BRUNELLIERE, Université de Lille

Both based-statistical and abstract feature representations have been described as being involved in the computing of subject-verb agreement. This event-related potential (ERP) study investigated whether the access of representations involved in the subject-verb agreement processing is either flexible or automatic. Two ERP experiments were conducted wherein 990 pairs of primes (i.e., pronouns and articles) and targets (i.e., congruent and incongruent verbs, nouns, and pseudowords) were auditorily presented. ERPs were recorded after the processing of verbal targets preceded by pronominal subjects in French. Twenty-three participants did a lexical decision task on the target (i.e., whether it was a word or not) in Experiment 1; while twenty-four other participants performed a noun categorization task (i.e., whether it was a noun or not) in Experiment 2. Analyses were conducted on the main ERP components that we observed (N100, N400, late frontal negativity). The results showed a stronger negative amplitude in Experiment 1 than in Experiment 2 for the N100 ($p < 0.001$) and N400 ($p<0.001$). Statistical representations elicited an increased amplitude of the N100 and N400 and this effect was not dependent on the task. Abstract representations also modulated the N400 amplitude but their effect persisted later over a frontal negativity ($p<0.05$). Interestingly, the effect of abstract representations was task-related. Overall, the early processing of verbs at the auditory level and the access of abstract representations at later stages were shaped by the task. These findings highlighted automaticity for use of based-statistical representations and flexibility in accessing abstract representations in subject-verb agreement.

Topic Line: LANGUAGE: Other

C50 The neural bases of phonological acceptability judgements

David Gow, Massachusetts General Hospital; Enes Avcu, Massachusetts General Hospital; Olivia Newman, Massachusetts General Hospital; Seppo P. Ahlfors, Athinoula A. Martinos Center for Biomedical Imaging;

Linguistic theory must account for not only patterns of attested structure (observational adequacy), but also patterns of native speaker intuitions about the acceptability of novel structures (descriptive adequacy). While theorists believe that acceptability judgments reflect a combination of implicit structural

knowledge (competence) and general cognitive (performance) constraints, little is known about the processing dynamics that support acceptability judgements. To address this gap, we performed high spatiotemporal resolution Kalman-filter enabled effective connectivity analyses of MRI-constrained sourcespace reconstructions of simultaneous MEG and EEG data collected during an auditory nonword phonological acceptability task. Response-locked analyses traced patterns of effective connectivity backwards in time from the onset of right precentral gyrus activation associated with the left-handed button press speakers used to signal a judgement. Right precentral gyrus activation was primarily determined by right anterior middle temporal gyrus and frontal regions involved in motor planning and response inhibition. These in turn were influenced by the right angular gyrus, a region implicated in predictive coding mechanisms. Stimulus-locked analyses of earlier processing revealed reciprocal interactions between regions implicated in acoustic phonetic representation (posterior superior temporal gyrus) and lexical representation (supramarginal and posterior middle temporal gyrus) whose strength varied with judgements of phonological acceptability. Dynamic interactions between the early lexical network revealed by stimulus-locked analyses and the response formation network revealed by response-locked analyses suggest integration between the two. These results support the hypothesis that phonological acceptability judgements primarily reflect the degree to which input forms match overlapping forms stored in the lexicon.

Topic Line: LANGUAGE: Other

C51 The universal language network

Saima Malik-Moraleda, Harvard University; Dima Ayyash, Massachusetts Institute of Technology; Jeanne Gallée, Harvard University; Zach Mineroff, Massachusetts Institute of Technology; Olessia Jouravlev, Carleton University; Evelina Fedorenko, Massachusetts Institute of Technology

More than 7000 languages are spoken across the world, varying in their phonology, morphology, lexicon, and grammar (Ostler, 2005). Despite this linguistic diversity, most language research, especially in cognitive neuroscience, tends to be conducted in English and a few Western European languages (Bornkessel-Schlesewsky & Schlesewsky, 2016). Here, we investigate whether the functional architecture of the language network is similar in typologically varied languages across 10 language families (Afro-Asiatic, Austronesian, Dravidian, Indo-European, Japonic, Koreanic, Niger-Congo, Sino-Tibetan, Turkic, Uralic). Two native speakers of each of the 44 languages listened to passages of 'Alice in Wonderland' in their native language while in fMRI, along with acoustically degraded passages and passages in an unfamiliar language. Additionally, each participant completed two non-linguistic tasks (spatial working memory task and arithmetic), and two naturalistic conditions (resting state and a longer passage in their native language). The functional architecture of the language network was remarkably consistent across languages, replicating several key signatures previously discovered for English and related languages. The contrast of native passages and degraded or foreign passages elicited activations on the lateral surfaces of left frontal and temporal cortex. These language-responsive regions showed strong selectivity for language with no response to spatial working memory or arithmetic (Fedorenko et al., 2011). Finally, functional correlation analyses revealed that the language network is highly internally integrated during both naturalistic conditions but is strongly dissociated from the domain-general Multiple Demand network (Blank et al., 2014). Thus, the basic functional architecture of the language network is robust to cross-linguistic variation.

Topic Line: LANGUAGE: Other

C52 No country for old men: reducing age bias through virtual reality embodiment

Stefania La Rocca, University of Milano Bicocca; Andrea Brighenti, University of Milano Bicocca; Giorgia Tosi, University of Milano Bicocca; Roberta Daini, University of Milan Bicocca

The multisensory integration can be used to induce body ownership illusion and investigate whether it is possible to modify social representations of one's self. Previous studies have investigated the role of this paradigm on self and other's attitudes; however, few studies have considered age stereotypes and attitudes. By making participants embodying arms of the same age and older, we aimed to induce the illusion of ownership for the virtual body and tested whether we could reduce negative implicit bias toward older adults exclusively in the older body condition. We used a within-group design, including 24 adults participants. They completed four conditions by watching videos in virtual reality. Through a visuotactile synchrony stimulation between real and virtual condition, we elicited an illusion of body ownership. Participants looked at their 'virtual' arm while they were touched by the same wooden stick seen in the video, every second for two minutes. After each condition, we measured the implicit attitudes toward the elderly through an IAT paradigm. The main effect of age ($F(1,23)=9.013$, $p<0.01$, $\eta 2=0,282$) suggests a decrease of negative attitudes toward elderly people in the adult population only after the older body exposure. Although the study did not show any effect of embodiment in reducing ageism bias, it did substantiate a possible effect of exposure to avatar's features. These findings have important implication for strategies to reduce ageism, a negative attitude toward ageing and older adults, and provide new insights into both self-representation and social cognition through the virtual environment.

Topic Line: PERCEPTION & ACTION: Multisensory

C53 Acquisition context modulates affective perception of swear words

Katherine Sendek, Department of Psychology, The College of Wooster; Grit Herzmann, Department of Psychology, The College of Wooster; Stanley Donahoo, Department of Linguistics, University of Arizona; Valeria Pfeifer, Department of Psychology, University of Arizona; Vicky Lai, Department of Psychology, University of Arizona

People who learn multiple languages sequentially have reported that they feel expressed emotions more intensely when using their first language (L1), regardless of proficiency. They also prefer to swear in their L1. One explanation is that languages are affected by the context in which they are acquired. Specifically, swears in L1 are typically acquired directly in naturalistic and informal contexts, whereas swears in L2 or non-swear words are often learned indirectly through textbooks in a formal, academic setting. To test this, we presented American English speakers with American and British taboo words (AT and BT), assuming they learned AT directly, and BT, indirectly. Participants made word/non-word decision on taboo, negative, positive, neutral, and non-words, while EEG was recorded. Manipulations of word valence, arousal, and taboo-ness were verified via online ratings, and word length and frequency were matched between conditions. We examined the ERP components of early posterior negativity (EPN) between and late positive complex (LPC), based on literature on emotional words in L2 (Conrad, Recio, & Jacobs, 2011). We found that both AT and BT elicited similarly larger EPN (150-250ms) compared to the other categories. Differences between AT and BT were found in the LPC (550-750ms), with larger LPC for AT than BT. These results show that the social context in which language is acquired influences the later, social processing associated with swears. However, it does not impact early, attention of taboo words. In conclusion, the context in which a word is acquired influences affective perception.

Topic Line: LANGUAGE: Other

C54 The origin of the second language after-effect in bilingual language production: and ERP investigation.

Agata Wolna, Jagiellonian University; Jakub Szewczyk, University of Illinois, Urbana Champaign; Patrycja Kalamala, Jagiellonian University; Jonas Walther, Jagiellonian University; Zofia Wodniecka, Jagiellonian University

Naming pictures in L1 is considerably slowed-down after naming in L2, the phenomenon known as the L2 after-effect. However, the origins of the effect are unclear: it can be a consequence of language-specific mechanism resulting in increased interference between L1 and L2 or reflect the cognitive effort related to mere reconfiguration of the task-set. To adjudicate between the two possibilities we designed a Picture Naming experiment in which L1 naming was preceded by 3 different tasks: naming in L1 (L1-after-L1), naming in L2 (L1-after-L2) and performing a non-linguistic task (L1-after-NLT). L1-after-L2 was meant to replicate the L2 after-effect, whereas the L1-after-NLT was meant to test the effect of task-set reconfiguration. 33 Polish-English bilinguals participated in the experiment. On the behavioural level we failed to observe the slow-down of naming in neither L1-after-L2 nor L1-after-NLT. On the psychophysiological level (ERPs) we found a fronto-central modulation in the P2 time-window (150-250ms) for L1-after-L2 whereas no similar effect was found for L1-after-NLT. The P2 was previously shown to be sensitive to the difficulty of lexical access and accumulation of the semantic interference. Therefore, psychophysiological measurement indicate that the L2 after-effect is rather a language-specific effect. Additionally, we observed a trial effect causing a systematic increase of naming latencies and P2 amplitude throughout the experiment, possibly reflecting the uncontrolled accumulation of semantic interference. The effect might have obliterated the behavioural measurement of L2 after-effect which could explain the discrepancy between the naming latencies and ERPs results.

Topic Line: LANGUAGE: Other

C55 Dynamic connectivity of neural networks supporting incremental speech interpretation

Yuxing Fang, University of Cambridge; Bingjiang Lyu, University of Cambridge; Benedict Vassileiou, University of Cambridge; Kamen Tsvetanov, University of Cambridge; Lorraine Tyler, University of Cambridge; William Marslen-Wilson, University of Cambridge

An explanatory account of human speech comprehension, rooted in the real-time electrophysiological activity of the brain, must identify what is being computed, where and when in the brain, as speech unfolds over time. Recent research (Lyu et al, PNAS, 2019) combines computational semantic models and representational similarity analysis (RSA), operating in EMEG source space, to reveal a network of core left hemisphere regions supporting incremental semantic combination, and using a spatiotemporal pattern-based implementation of Granger Causal Analysis (GCA) to estimate the information flow between these regions. In current research we adopt two strategies to probe further the neurocomputational content both of the activity within each region and of the information that is being communicated between them over time. First, building on the earlier research, we expand the range of computational models being tested against brain activity to include the acoustic?phonetic input to the system, thereby critically augmenting the functional ROIs in terms of which the directional connectivity of the left hemisphere language network can be evaluated. Second, taking an ICA whole-brain data-driven approach, we decomposed the entire source-reconstructed neural activity of the brain during key epochs of the speech input into functional spatially-independent components. Using RSA-based measures, we filter this set of components to identify those which are significantly related to the computational semantic and acoustic?phonetic models established earlier. The interactivity between these model-sensitive components was then probed using the GCA technique to provide an integrated framework for defining and understanding the neural systems underpinning human speech interpretation.

Topic Line: LANGUAGE: Semantic

C56 Parafoveal Semantic Integration Eliminates the N400 of Foveal Semantic Violation

Chuchu Li, University of California, San Diego; Katherine Midgley, San Diego State University; Phillip Holcomb, San Diego State University

The current study used a visual hemi-field flanker RSVP paradigm with event-related potentials (ERPs) to investigate the parafoveal-foveal semantic integration in sentence comprehension. Twenty-one English monolinguals read sentences that were presented serially in triads, with the target word at central fixation (foveal target), the upcoming word on the right (parafoveal target), and the preceding word on the left. Each triad stayed for 400ms, without any interval between two trials, following the settings of reading process in real life (i.e., stimuli do not disappear before or when foveal fixation changes). A sentence may or may not contain a word that semantically violates the sentence context (e.g., Tom just broke up with his computer/girlfriend last month), and we compared the ERPs of the critical words (i.e., computer vs. girlfriend) when they served as parafoveal and then foveal targets. Results showed a significant parafoveal N400 effect for semantic violations (350ms to 550ms time window). However, when time-locked to the critical word in foveal position, there was no longer an N400 effect but instead a broadly distributed positivity, which may reflect a long-lasting cost of semantic anomaly. The results suggested that semantic integration of a word starts when it is in parafoveal vision in sentence comprehension in natural settings. In addition, although the processing of the same word continues when it moves to the foveal vision as evidenced by the extended duration of the N400, semantic integration has mostly been completed when readers fixate on the target word.

Topic Line: LANGUAGE: Semantic

C57 Preview effect of semantic integration in Chinese Sentence Reading

Nan Li, South China Normal University; Suiping Wang, South China Normal University; Hsuan-Chih Chen, The Chinese University of Hong Kong

Reading words in sentence starts once the word appearing in the parafoveal vision. While the parafoveal preview effect is widely studied in behavior, its brain-electric correlates have only recently been investigated. Recent studies with ERPs have consistently reported a congruency effect on the N400 component in ERPs time-locked to the parafoveal presentation of the target, indicating that words in parafovea can be integrated during reading. However, whether the contextual information obtained through preview can influence the processing of foveal word, and in which level such preview effect can reach is unclear. Using RSVP_flankers paradigm combined with the co-registration method of ERP and eye movement, the present study investigated the effect of preview word's congruence on the semantic integration of the foveal target word. In the experiment, we manipulated both the congruence of the preview word and the foveal target word to be either congruent or incongruent in the sentence. The sentence was presented with each fixated word flanked by the next word to its right, and the previous word to its left. Eye movements and EEG were simultaneously recorded during reading, and trials with participants' gaze left the central fixation area were excluded from the analysis. The results revealed an interaction between congruence of the preview word and the target word. Specifically, N400 effect time-locked to the foveal target word only appeared when the preview word was congruent. Results underline the importance of considering semantic preview effect in ERP studies on reading.

Topic Line: LANGUAGE: Semantic

C58 A systematic comparison between spatial similarity and evoked responses in EEG and MEG during language comprehension

Lin Wang, Department of Psychiatry, Harvard Medical School; Gina Kuperberg, Department of Psychology, Tufts University

EEG and MEG index the time-course of neural activity associated with incoming stimuli. Traditional event-related potentials/fields (ERPs/ERFs) are generally taken to reflect differences in the engaged neurocognitive processes evoked by different stimuli (e.g. the reduced N400 ERP/ERF to plausible versus anomalous words reflects easier semantic retrieval/access). More recently, it has been argued that Representational Similarity Analysis (RSA) can capture differences in the underlying representations associated with different stimuli (e.g. animate versus inanimate). Representation and process are, however, tightly linked, and so, to take full advantage of RSA, it is critical to understand where it converges and diverges from evoked responses. We therefore directly compared ERPs/ERFs and spatial similarity patterns in an EEG (n=72) and MEG (n=32) dataset, collected using a paradigm that crossed the plausibility (plausible vs. anomalous) and the animacy (animate vs. inanimate) of nouns in discourse contexts. The two measures converged in (a) their overall time-course (similarity values mirrored the peaks of the classic N1/P2/N400/P600 evoked responses), and (b) their sensitivity to plausibility (mirroring the ERPs/ERFs, spatial similarity was larger to anomalous than plausible words between 300-500ms and 600-1000ms). These findings underline the importance of considering evoked responses when interpreting differences in spatial similarity between stimuli. RSA diverged from evoked responses by revealing greater similarity to animate than inanimate plausible nouns where overall ERPs/ERFs were small. This suggests that spatial similarity can capture differences in representation, even when overall evoked activity is minimal.

Topic Line: LANGUAGE: Semantic

C59 Withdrawn

C60 Shared interpretation of an auditory narrative increases BOLD-synchrony between subjects

Maria Hakonen, Aalto University School of Science; Arsi Ikäheimonen, Aalto University School of Science; Annika Hulten, Aalto University School of Science; Janne Kauttonen, Haaga-Helia University of Applied Sciences; Miika Koskinen, Helsinki University; Fa-Hsuan Lin, University of Toronto; Anastasia Lowe, Aalto University School of Science; Mikko Sams, Aalto University School of Science; Iiro Jääskeläinen, Aalto University School of Science

The interpretation of an identical narrative varies between listeners. We studied whether similarity in the interpretation of the narrative corresponds to the similarity in the listeners' brain activity. 48 healthy volunteers listened to a 71-min narrative during ultra-fast fMRI. Afterward, the narrative was replayed in 101 segments, and the subjects were asked to produce associations related to each segment to describe what had been on their minds while they listened to the story during neuroimaging. The similarity in brain activity was estimated using inter-subject correlation analysis of the hemodynamic response, whereas similarity of the interpretation of the narrative was estimated by comparing the semantic relatedness of the associated words between each pair of subjects in semantic space (Word2Vec) generated from a large internet text corpus. An inter-subject representational similarity analysis (RSA) between the BOLD-similarities and the semantic similarities of the associated words across the subjects revealed that individuals that produced semantically similar association words were also more similar in their BOLD responses. Specifically, similarity increased in left in inferior frontal gyrus, bilateral superior temporal gyrus, precuneus, anterior cingulate cortex, and ventromedial prefrontal cortex. Our results support the notion that brain areas across different levels of narrative processing contribute to inter-individual differences in narrative interpretations, confirming and extending results from other similar studies.

Topic Line: LANGUAGE: Semantic

C61 Robust Neural Adaptation to Syntactic Structure

Jeanne Gallée, Harvard University; Hope Kean, Massachusetts Institute of Technology; Evelina Fedorenko, Massachusetts Institute of Technology

Humans are efficient information processors who quickly adapt to changes in the input statistics across domains. For example, during language production, we tend to re-use syntactic structures (Mahowald et al., 2016). However, whether or not structure repetition facilitates comprehension remains debated in both psycho- and neuro-linguistic literatures (e.g., Tooley & Traxler, 2010; Devauchelle et al., 2009). Across two fMRI experiments (n=13, n=23) we evaluated sensitivity to structure repetition under conditions that are most likely to reveal adaptation effects. In particular, participants processed sets of sentences where 80% of the sentences (n=240 sentences) used one structure (or similar structures, in Experiment 1), and 20% of the sentences used different (diverse) structures (n=60 sentences). In Experiment 1, the repeated structures were subject- and object-extracted relative clauses and clefts; and in Experiment 2, the repeated structure varied across participants and included six structure-types (relative clauses, pseudo-clefts, the-Xer-the-Yer construction, topicalization, sentential subjects, and X said that [clause]). The key prediction was a stronger response to the 20% of trials with diverse structures compared to the rest of the trials with the same/similar structures. To increase power (Nieto-Castanon & Fedorenko, 2012), we identified language-responsive areas in each participant using an independent 'localizer' task (Fedorenko et al., 2010). In both experiments, we observed reliable adaptation effects in the language-responsive areas. Furthermore, these effects were present across the frontal and temporal language areas, in line with other findings of distributed syntactic effects (e.g., Blank et al., 2016). This study establishes robust adaptation to syntactic structure during language

Topic Line: LANGUAGE: Syntax

C62 Structural Connectivity and Memory Systems Across the Lifespan: Is There a Common Network?

Susan L. Benear, Temple University; Zachary Heffernan, Temple University; Linda Hoffman, Temple University; Ingrid R. Olson, Temple University; Nora S. Newcombe, Temple University

Axonal tracts that connect disparate regions of the brain play an essential role in normal cognition. For instance, transection of the fornix, a small white matter tract connecting the hippocampus to the septal nuclei and mammillary bodies, results in dense anterograde amnesia. In neurologically normal adults, measurable variation in white matter tracts can provide information about the functional significance of various tracts and also provide information about how different brain regions interact to perform complex tasks. Here we compared and contrasted the structural brain networks involved in semantic memory and episodic memory. These memory systems have different developmental and senescence profiles, with episodic memory developing relatively later and failing relatively earlier than semantic memory. We predicted that individual differences in semantic memory would correlate with variation in a left lateralized network of tracts that include the inferior frontal occipital fasciculus and medial longitudinal fasciculus. In contrast, we predicted that episodic memory performance would correlate with variation in two limbic pathways: (bilateral) fornix and uncinate fasciculus. We tested a sample of young and older adults. Participants were required to learn new episodic and semantic information - they learned facts about animals and buildings (semantic), which were told to them by two different sources (episodic). Younger adults outperformed older adults on a delayed test

of episodic memory (t=2.46, p=.03), while immediate tests of both episodic and semantic memory showed no group differences. Results of high-resolution diffusion weighted imaging scans will be discussed.

Topic Line: LONG-TERM MEMORY: Development & aging

C63 The Effect of Hippocampal Integrity and Volume on Recall Memory in Healthy Aging

Kirolos Ibrahim, University of California, Riverside; Anu Venkatesh, University of California, Riverside; Ilana Bennett, University of California, Riverside

The ability to learn and subsequently recall information declines in healthy aging. Studies have separately attributed these age-related memory declines to integrity of white matter tracts connected to the hippocampus and hippocampal volume. A few studies, including our own, have also assessed the contribution of hippocampal gray matter integrity. But no studies have assessed the joint contribution of hippocampal integrity and volume to recall memory in aging, as was done here. Younger (n=45, 20.031.58 years) and older (n=47, 74.025.97 years) adults completed the Rey Auditory Verbal Learning Test (RAVLT) from which Total Recall scores were calculated. They also underwent structural magnetic resonance imaging to obtain measures of hippocampal gray matter integrity (free, hindered, restricted diffusion) and whole hippocampus volume. Results showed that increased age was related to declines in RAVLT Total Recall, hippocampal integrity (increases in all diffusion measures), and hippocampus volume. Independent of age, better RAVLT Total Recall scores were also related to higher hippocampal integrity (decreases in all diffusion measures except right hippocampus free and restricted diffusion). Finally, structural equation modeling revealed that age group differences in memory performance are more robustly explained by hippocampal volume alone rather than hippocampal volume and integrity together. These findings strengthen the notion that there are age-related differences in brain structure that contribute to individual- and age-related declines in memory.

Topic Line: LONG-TERM MEMORY: Development & aging

C64 Stronger structural connectivity in the default mode network is associated with youthful memory in superaging

Jiahe Zhang, Northeastern University; Lianne Scholtens, Vrije Universiteit Amsterdam; Martijn van den Heuvel, Vrije Universiteit Amsterdam; Brad Dickerson, Massachusetts General Hospital; Lisa Barrett, Northeastern University

'Superagers' are older adults who maintain youthful memory despite advanced age. Previous studies demonstrated that superagers have greater morphometric integrity and stronger functional connectivity in the default mode network (DMN) and salience network (SN), which contributes to their youthful memory performance. In this study, we used diffusion-weighted imaging to examine structural connectivity within the DMN and SN in 41 young adults (24 males, ages 18-35) and 40 older adults (24 males, ages 60-80). Superaging was defined as youthful performance (males: 13; females: 14) on the long delay free recall measure of the California Verbal Learning Test. We masked the DMN and SN, and their assessed the integrity of structural connectivity using fractional anisotropy. As predicted, within both DMN and SN, superagers had higher fractional anisotropy compared to typical older adults (DMN: $t = 2.51$, $p = 0.01$; SN: $t = 2.89$, $p = 0.01$). Compared to young adults, superagers had weaker DMN fractional anisotropy ($t = 2.53$, $p = 0.01$) and similar SN fractional anisotropy ($t = 0.11$, $p = 0.92$). Higher fractional anisotropy within the DMN predicted better performance on both recall ($r = 0.27$, $p = 0.07$) and recognition memory tasks (item recognition: $r = 0.48$, $p = 0.00$; associative recognition: $r = 0.43$, $p = 0.01$) in older adults. Completing a link between morphometry and functional connectivity, these structural connectivity results continue to extend the multimodal characterization of superaging.

Topic Line: LONG-TERM MEMORY: Development & aging

C65 Theta Networks of Memory in Traumatic Brain Injury

Richard Adamovich-Zeitlin, Department of Psychology, University of Pennsylvania; Paul Wanda, Department of Psychology, University of Pennsylvania; Ethan Solomon, Perelman School of Medicine, University of Pennsylvania; Tung Phan, Department of Psychology, University of Pennsylvania; Brad Lega, Department of Neurosurgery, University of Texas Southwestern; Kan Ding, Department of Neurology, University of Texas Southwestern; Ramon Diaz-Arrastia, Department of Neurology, University of Pennsylvania; Michael Kahana, Department of Psychology, University of Pennsylvania

Traumatic brain injury (TBI) is a leading cause of cognitive disability in young adults, with this disability resulting prominently in impaired episodic memory. In these patients, as in healthy controls, memory exhibits marked temporal variability. Using recordings from indwelling electrodes, we sought to characterize and compare the oscillatory biomarkers of mnemonic variability in two cohorts of epilepsy patients: those with a history of moderate-to-severe TBI (n=30) and a group of closely matched non-TBI controls (n=30). Analysis of these recordings demonstrated that theta-frequency connectivity marks periods of successful memory formation in both cohorts. Periods of successful memory encoding were further marked by increased gamma power and decreased theta power across a broad set of brain regions (frontal, lateral temporal, medial temporal, parietal), a pattern seen in both cohorts. These biomarkers of successful memory, common to both TBI and non-TBI cohorts, could guide new approaches to the treatment of disordered memory in diverse forms of neurological disease.

Topic Line: LONG-TERM MEMORY: Episodic

C66 REM sleep and inferior temporal lobe recapitulation support positive memory retrieval

Ryan Bottary, Boston College; Sarah Kark, University of California Irvine; Ryan Daley, Boston College; Jessica Payne, University of Notre Dame; Elizabeth Kensinger, Boston College

Emotional episodic memory retrieval is best when brain regions engaged during memory encoding become reactivated at retrieval, a phenomenon termed recapitulation. Additionally, slow wave sleep (SWS) is implicated in memory consolidation and rapid eye-movement (REM) sleep in emotional memory consolidation. Here, we investigate how individual differences in recapitulation and sleep affect emotional memory retrieval performance. Healthy adults (N = 22; 11F, 11M; age: 19-29 years) received fMRI scanning during an incidental encoding task and a surprise recognition memory task 24-hrs later. Overnight sleep was monitored with polysomnography. During encoding, participants viewed line drawings of negative, neutral and positive images, each followed by their full-colored photo. At recognition, participants distinguished new from encoded line drawings. Recapitulation for each valence was defined as the percentage of voxels activated at encoding that were re-activated during successful recognition (recap%); this metric was calculated within 3 ROIs (mPFC, amygdala and inferior temporal lobe (ITL)). Multiple linear regression was performed to predict valence-specific memory performance from ROI-based recapitulation and sleep. Positive memory performance was predicted by both ITL recap% and REM sleep percentage (%), but no interactive effects between recap% and REM% were observed. No effects of SWS% were observed, nor were the regression models significant in predicting negative or neutral memory. These findings support REM sleep's importance for emotional memory retrieval

and further suggest that it may be particularly important for positive memory retrieval. The results also suggest that ITL recapitulation supports positive memory retrieval.

Topic Line: LONG-TERM MEMORY: Episodic

C67 Evaluating the subsequent memory effect as predictive of memory

Sucheta Chakravarty, University of Alberta; Yvonne Chen, Baylor College of Medicine; Jeremy Caplan, University of Alberta

To isolate brain activity that reflects effective processes during the study phase of a memory task, cognitive neuroscientists commonly contrast brain activity during study of later-remembered versus later-forgotten items. This 'subsequent memory effect' method has been described as identifying brain activity 'predictive' of memory outcome. However, decades of behavioural research has told us that memory success depends not only on cognitive processes during study of an item, but on many processes that occur at other times (e.g., competition from other studied items, study-test compatibility, etc.). We show that conventional event-related potential 'subsequent memory effect' signals are predictive, but indeed, only to a small degree (N=60, 225 items/participant). This improves substantially when machine-learning classifier methods developed are applied, but the predictive effects are still modest. These findings suggest that the term 'predictive' is, at a minimum, overstating the standard subsequent memory effect. For an approach to study-related brain activity to be more predictive may require integrating the myriad and interesting other factors known to influence memory outcome, with standard univariate, as well as classifier-based approaches.

Topic Line: LONG-TERM MEMORY: Episodic

C68 The Retrieval of Context Variability in Episodic Memory: An ERP Study

SHIH-KUEN CHENG, National Central University

This experiment aimed to examine the retrievability of encoding context variability. This was achieved by presenting objects repeatedly presented in a single encoding context (low variability) or various different encoding contexts (high variability) during the study phase. In the subsequent test, participants engaged in an exclusion task that designated items from high or low variable encoding tasks as the targets to be identified. The retrievability of context variability was indexed by the recollection and familiarity scores derived from the process-dissociative procedure (PDP) developed by Jacoby (1991).The results suggested that when the targets of retrieval were the encoding context variability per se, participants indeed could retrieve their memories of encoding variability. However, it was only when the participants were prompted to search for items that were encoded in a constant condition that the retrieved variability information could be utilized. The encoding context variability information seems to be of little use if participants were prompted to retrieve items from varied contexts. Increasing the times of exposure could enhance the capacity to retrieve the memory of encoding context variability. However, the enhancement from repetition could only be observed when the retrieval targets were items that were paired with constant contexts. To conclude, the retrieval encoding variability might not be a spontaneous process. In addition, even when the information of encoding variability is deliberately retrieved, it could only be used in a certain circumstance, namely to confirm that the consistency of the encoding context.

Topic Line: LONG-TERM MEMORY: Episodic

C69 Repulsion of hippocampal representations is time-locked to resolution of memory interference

Wanjia Guo, University of Oregon; Robert Molitor, University of Oregon; Serra Favila, New York University; Brice Kuhl, University of Oregon

The hippocampus is believed to play a critical role in disambiguating memories for similar events (Yassa & Stark, 2011). Indeed, recent fMRI studies have found that event similarity triggers an active 'repulsion' of hippocampal activity patterns (Chanales et al., 2017), and this repulsion is associated with reduced memory interference (Favila et al., 2016; Hulbert and Norman, 2014). Here, we tracked hippocampal representations of similar events over the course of learning in order to test whether hippocampal repulsion is 'time locked' to interference resolution. Participants (N = 30), completed 6 runs of a learning task. Each run began with a study phase during which scene-object associations were encoded. Critically, the scenes were comprised of pairs of highly similar images (pairmates), but each scene was associated with a unique object. After each study phaseround, participants completed an associative memory test that required selecting the object associated with each scene while avoiding interference from similar (pairmate) associations. The same set of associations was studied and tested in each round, allowing for measurement of the point in time at which interference between pairmates was resolved. Pattern similarity analyses revealed that, within the CA23/dentate gyrus sub-region of the hippocampus, there was a repulsion of pairmate representations that selectively occurred precisely when memory interference was resolved. Strikingly, this repulsion effect was fully absent in sub-region CA1 and in visual cortical areas. Thus, our findings reveal an important relationship between the repulsion of CA23/dentate gyrus representations and the successful resolution of interference between competing memories.

Topic Line: LONG-TERM MEMORY: Episodic

C70 Withdrawn

C71 Inhibition of related items in long-term memory specificity depends on confidence

Brittany Jeye, Worcester State University; Scott Slotnick, Boston College

In the current investigation, we evaluated the specificity of long-term memory representations for faces. During each study phase, participants were presented with neutral Caucasian male and female faces. During the corresponding test phase, old faces, related faces, and new faces were presented and participants made 'old'?'new' recognition judgments followed by 'unsure', 'sure' and 'very sure' confidence judgements. Related faces were created by morphing along a continuum in steps of 20% (i.e., 20%, 40%, 60% and 80% morphs) between old and new faces. Memory representations were very specific as the 'old' response rate for old faces was significantly higher than closely related faces (i.e., 20% morphs) for both 'very sure' and 'sure' confidence responses (there was no difference for 'unsure' responses). Furthermore, there was evidence of memory inhibition, as the 'old' response rate for 20% morphs was significantly lower than 40% morphs for 'sure' responses (but not for 'very sure' or 'unsure' responses). These findings may reflect an evolutionary advantage for recognizing specific faces, which may require inhibition of closely related faces. These findings also suggest that inhibition of closely related faces may be flexibly directed depending on confidence level, and may be primarily associated with intermediate confident responses. Future research will utilize event-related potentials and functional magnetic resonance imaging to investigate the brain basis of this long-term memory inhibition.

Topic Line: LONG-TERM MEMORY: Episodic

C72 EEG biomarkers of immediate and delayed verbal recall

Connor Keane, University of Pennsylvania; Brandon Katerman, University of Pennsylvania; Michael Kahana, University of Pennsylvania; Li Yuxuan, Stanford University

Recordings of brain activity in the moments leading up to successful verbal recall provide a window into the cognitive processes underlying memory retrieval. But these same recordings also subsume neural signals unrelated to mnemonic retrieval, such as those associated with vocalization of the recalled item. Here we examined spectral EEG biomarkers of successful recall under conditions designed to vary the mnemonic demands of the retrieval process. In an immediate test, subjects recalled a single just-presented word after a brief delay. In a long-delayed test, subjects attempted to recall items learned across multiple days but not presented in the current session. This extreme manipulation of mnemonic demands helped to isolate components of EEG activity most related to the act of interest: namely, episodic retrieval of a previously encoded item. Comparisons between these conditions revealed a unique electrophysiological signature of long-term episodic memory retrieval in the period leading up to vocalization: increased high-frequency activity and decreased low-frequency activity across multiple cortical regions, and increased frontal theta activity.

Topic Line: LONG-TERM MEMORY: Episodic

C73 Image memorability is predicted by activity across stages of convolutional neural networks and the human ventral stream

Griffin E. Koch, University of Pittsburgh; Essang Akpan, University of Pittsburgh; Marc N. Coutanche, University of Pittsburgh

What makes some images memorable while others are forgettable? The features of an image can be represented at multiple levels, from low-level visual properties to high-level meaning. Across two behavioral studies and a neuroimaging study, we addressed the question of how image memorability is influenced by levels of the visual hierarchy. In a first behavioral study, we combined a convolutional neural network (CNN) with behavioral prospective assignment, by using one of four CNN layers to select the scene images that each of one hundred participants experience. We found that participants remembered more images when they were assigned to view stimuli that were identified as discriminable using low-level CNN layers, or identified as similar in high-level layers. A second study replicated the first experiment's results using images from a single semantic category (houses), but found that similarity predicted memorability at a slightly less high-level that holds representations of objects, suggesting this level is more important for remembering images from the same category. Finally, we analyzed neural activity collected through functional magnetic resonance imaging (fMRI) scans as independent participants viewed the same scene images. Pattern similarity analyses revealed an analogous relationship in the ventral stream between image discriminability/similarity and level of the visual hierarchy. Discriminability in early visual areas, and similarity later in the ventral stream, each predicted greater image memorability. Together, this research shows that discriminability at different visual levels can be used to predict image memorability through both CNN models and neural activity in the human ventral stream.

Topic Line: LONG-TERM MEMORY: Episodic

C74 The role of reward in encoding details of complex episodic memories for events

Azara Lalla, McGill University; Kevin Da Silva Castanheira, McGill University; A. Ross Otto, McGill University; Signy Sheldon, McGill University

Experimental evidence indicates that the presence of reward when encoding items and associations enhances memory performance. However, little is known about how reward affects the encoding and subsequent retrieval of episodic memories for complex events which contain different types of detailed information (e.g., what is happening, what objects are present, and where things are located). To investigate this question, we designed a within-subjects experiment in which young adult participants (N=45) studied a series video clips of complex, naturalistic events (e.g., a dinner party). They were informed that each video was associated with a high (25 cent) or low (1 cent) reward. The effect of this reward manipulation was tested with a recognition memory test for event, object, and spatial details within each of the videos. A mixed-effects logistic regression predicting memory accuracy from detail type and reward condition found that memory was better for event than object or spatial details (Ã?2=-0.113,SE=0.033,p<.0001) and that high reward predicted better memory (ÃŽÂ²=0.082,SE=0.027,p<.005), but there was no interaction between these factors (ÃŽÂ²=0.035,SE=0.033,p=.301). To assess whether this effect was due to a decision-making strategy or stronger encoding of the high reward videos, we used drift diffusion modelling, which revealed a higher drift rate for the high compared to low reward condition (mean difference=0.0646,95%CI=[0.0241,0.1075],p<.0001), but no effect of reward on decision thresholds or non-decision time. These results suggest that reward at encoding enhances memory for detailed information and that this effect is due to stronger encoding.

Topic Line: LONG-TERM MEMORY: Episodic

C75 Oscillatory Mechanisms for Hippocampal Memory Encoding Tested in Humans

Sarah Lurie, Northwestern University; Joel Voss, Northwestern University

Hippocampal ensemble activity shows prominent coherence in the theta frequency band, which may serve as a rhythm to orchestrate binding of various sensory inputs into memory. Although evidence in rodents suggests that encoding ability might vary with hippocampal theta phase, this has not been demonstrated in humans. We addressed this question by testing whether theta-patterned transcranial magnetic stimulation (TMS) of the hippocampal-cortical network causes theta-periodic fluctuations in the efficacy of memory encoding. We presented brief (<20ms) associative visual memoranda aligned to known phase angles of theta-patterned TMS. Our hypothesis was that TMS would phase-entrain the endogenous theta rhythm, in turn producing periodic variation in memory encoding performance as measured by subsequent recall accuracy. As hippocampus cannot be stimulated directly with noninvasive methods, we stimulated cortical network locations to indirectly influence hippocampal activity, as in other recent work from our laboratory. In N=15 adults, we found that memory varied periodically with entrained theta phase angle, with worse performance for items encoded during the 'rising' (trough + pi/2) stimulation phase angles relative to 'falling' (peak + pi/2) phase angles (P<0.01) following hippocampal network stimulation. Additionally, we found modulation of the electroencephalographic (EEG) event-related potential encoding signal for items encoded during the rising versus falling phase angles after hippocampal network stimulation. These findings suggest an influence of theta-patterned TMS on encoding-related theta signals and support the role of theta phase in encoding.

Topic Line: LONG-TERM MEMORY: Episodic

C76 Do metacognitive judgments impact environment learning?

Lauren Mason, Tufts University; Holly Taylor, Tufts University; Ayanna Thomas, Tufts University; Tad Brunyé, Center for Applied Brain & Cognitive Sciences

When navigating an environment for the first time, people frequently use navigational aids, such as maps on smart phones, to inform navigation choices leading to a destination. This notion that individuals seek out information when feeling unsure about where they are within the environment suggests a role of metacognition in environment learning. Although research examining the role of

metacognitive processes in EL is limited, recent findings from our lab suggest that people exercise control by switching between different map displays at predictable path locations, dependent on established learning goals. The present study examines the role of explicit metacognitive monitoring judgments during environment learning. We hypothesize that the act of making prospective judgments of learning may influence learners' objective performance when faced with navigating the same environment in the future or constructing a map of the environment from memory. Participants navigated a virtual environment to find a series of destinations; upon reaching each destination they made a JOL or generated a random number. We tested spatial memory by having participants re-navigate routes and construct a map. Results highlight the role of metacognitive monitoring on egocentric and allocentric environment learning. Furthermore, while modern technology has provided solutions to streamline the process of successfully navigating unknown territory, research shows that navigational aids impair spatial memory. Therefore, alternative strategies that encourage user-based monitoring and self-initiated control to optimize environment learning should be considered. This project is an early step in building a body of research that would support the development of such tools.

Topic Line: LONG-TERM MEMORY: Episodic

C77 Transfer of negative emotion in episodic memory

Daniela J. Palombo, University of British Columbia; Leor Elizur, University of British Columbia; Christian L. Esposito, University of British Columbia; Christopher R. Madan, University of Nottingham

Among the myriad of effects of emotion on memory, one consistently observed finding is that negative emotion weakens memory binding: Memory for associations between the elements that comprise an episode is attenuated in the presence of emotional information. This effect is typically observed in laboratory studies in which emotional and neutral items are experienced in pairs. Moreover, recent work suggests that the presence of a negative item can also disrupt subsequent encoding of novel items when an overlapping neutral item is presented again in the presence of novel information (i.e., second-order associations). This leads to the intriguing hypothesis that the effects of negative emotion on binding are not uniform. It is possible that when associations are formed, negative context gets bound 'on the fly' to adjacent neutral information to hinder subsequent associative memory. Here, we tested and demonstrate preliminary support for this hypothesis: Using a preference judgement task, we show that neutral information 'inherits' the emotional valence of negative adjacent items, and that this effect occurs vis-à-vis poor associative binding. Contrary to our hypothesis, we did not observe carry-over effects for second-order pairs (wherein a neutral co-pair is encoded with yet another neutral item). Preliminary individual-difference data suggests that the transfer-of-emotion phenomenon at the first-order may be a relevant phenotype for understanding trait anxiety. Consistent with some theoretical models of memory, we suggest that these co-occurring processes may contribute to the decontextualization of emotional memories.

Topic Line: LONG-TERM MEMORY: Episodic

C78 The role of autobiographical memory processes in planning and problem solving

Sarah Peters, McGill University; Signy Sheldon, McGill University

Neuroimaging research proposes a common core neural network underlying autobiographical memory and future-oriented tasks that rely upon the construction of complex mental representations, such as planning and problem solving. However, behavioural research indicates that planning and problem solving may have distinct cognitive processing requirements such that planning involves implementing an established script whereas problem solving involves generating options before simulating how to implement the selected solution. Prior work has not considered planning and problem solving simultaneously, leaving it unclear how and when autobiographical processes support complex future-oriented thinking. To address this, we tested neural overlap between autobiographical memory, and future thinking across two distinct retrieval forms. In an MRI scanner, young adults viewed three cue types, memory, problem solving and planning. To each cue, participants generated multiple exemplars of memories, plans, or solutions (generation retrieval) and then selected one example to think about in detail (elaboration retrieval). Multivariate analysis revealed distinct patterns of neural activity as a function of retrieval form with generation recruiting anterior cortical regions and elaboration posterior regions. Within retrieval form, neural activity additionally dissociated as a function of task. For generation, there was common neural activity among future-oriented tasks that was distinct from autobiographical memory. During elaboration, neural overlap was observed between problem solving and memory that was distinct from planning. These dissociations were reflected in patterns of hippocampal-cortical connectivity. Together, results provide insight into the neural mechanisms of planning and problem solving and suggest that retrieval demand mediates the recruitment of autobiographical processes during

Topic Line: LONG-TERM MEMORY: Episodic

C79 MR elastography of hippocampal subfield viscoelasticity is related to relational memory outcomes across the lifespan

Hillary Schwarb, University of Illinois Urbana-Champaign; Peyton L Delgorio, University of Delaware; Lucy V Hiscox, University of Delaware; Ana M Daugherty, Wayne State University; Matthew DM McGarry, Dartmouth College; Neal J Cohen, University of Illinois Urbana-Champaign; Curtis L Johnson, University of Delaware

Magnetic resonance elastography (MRE) is an emerging technique that provides quantitative measures of viscoelastic mechanical properties indicative of underlying neural tissue health. Previous work from our group has demonstrated that MRE is a sensitive technique for assessing hippocampal integrity that is related to relational memory outcomes. The hippocampus, however, is not a homogenous structure and each of its subfields has a unique cellular organization and unique relationship with episodic memory. Furthermore, volumetric analyses demonstrate that hippocampal subfields may decline at different rates as we age, and even more so with neurodegenerative disorders like Alzheimer's disease. While whole brain viscoelastic changes have been assessed across the lifespan, hippocampal subfield viscoelasticity has yet to be considered. Therefore, to assess viscoelasticity in the hippocampal subfields we have developed, for the first time, a high-resolution (1.25 mm) MRE protocol specific for analyzing the subfields and their relationship with memory across the lifespan. Here we demonstrate that 1) this protocol provides reliable damping ratio measurements from each of the subfields, 2) that damping ratio differs significantly between the subfields (i.e., DG/CA3, CA1/2, and subiculum), and 3) that individual subfields show distinct patterns of age-related viscoelastic differences across the lifespan. Participants also completed a short-delay relational memory task. On each trial participants studied a three-featured stimulus and were then asked to identify the learned stimulus among several test-stimuli that share zero, one, or two of overlapping features. Performance on this task correlated with DG/CA3 viscoelasticity such that participants with poorer DG/CA3 integrity performed worse.

Topic Line: LONG-TERM MEMORY: Episodic

C80 Sleep-dependent consolidation enhances episodic memory for a real-life event

Stephanie Simpson, University of Toronto; Rotman Research Institute at Baycrest; Nick Diamond, University of Pennsylvania; Laryssa Levesque,

Rotman Research Institute at Baycrest Health Sciences Centre; Yushu Wang, Rotman Research Institute at Baycrest Health Sciences Centre; Catherine Le, Rotman Research Institute at Baycrest Health Sciences Centre; Brian Levine, Rotman Research Institute at Baycrest Health Sciences Centre

Consolidation during a period of sleep, compared to wakefulness, has been shown to reliably improve episodic memory retrieval. However, it is still debated whether sleep equally benefits all aspects of episodic memory given that spatiotemporal (sequence) information appears to profit more from sleep than perceptual (item) details. Moreover, most of this prior work applied oversimplified, lab-based stimuli in one experimental session. The primary goal of this study was therefore to determine whether these results generalized to memory for more complex real-life events. Here, we examined memory for an encoded staged event in which 60 healthy adults participated in the Baycrest Tour, a museum-style, audio-guided, staged-event followed by independent assessments of sequence and item memory for items encountered during the tour. These validated online tests were serially administered at 30 minutes, 12 hours, 1 week, and 1 month after encoding. Participants were randomized to either an awake or sleep (polysomnography) condition during the 12-hour delay, allowing us to extract sleep spindle and slow-wave oscillation measures. Extending previous research, we found that sleep, particularly N2 and N3 (slow wave sleep), boosts memory performance at the 12-hour test interval, with group effects observed for both sequence and item memory. This suggests that sleep-dependent memory processing may facilitate a widespread mnemonic advantage. These results shed light on the mnemonic benefit of sleep-dependent consolidation for both the items and sequences that compose recent real-world experiences.

Topic Line: LONG-TERM MEMORY: Episodic

C81 Medial Temporal Network Representations of Conceptual Information During Naturalistic Events

Alyssa Sinclair, Duke University; Jia-Hou Poh, Duke University; R. Alison Adcock, Duke University; Morgan Barense, University of Toronto

How does the brain represent conceptual information during continuous experience? To investigate the conceptual representation of naturalistic episodes, we used fMRI to analyze patterns of neural activity. Participants (N=24) viewed 70 multimodal videos, each featuring distinct narratives, characters, and contexts. To analyze the conceptual information in these complex episodes, we submitted participants' descriptions of the videos to a text-based analysis of word meanings and frequency. We used these analyses to construct three separate conceptual similarity models for information about narrative, characters, and context. We then related these conceptual similarity models to neural activity by using representational similarity analysis and linear mixed-effects regression. Within the left hippocampus, activity patterns in the anterior hippocampus corresponded to information about both narratives ($p=.014$) and characters ($p=.014$). In the posterior hippocampus, activity patterns only corresponded to the character model ($p=.005$). Medial temporal lobe neocortical regions surrounding the hippocampus represented information about context ($p=.026$) and characters ($p=.049$), but not narratives. The angular gyrus and areas of the default mode network also represented information about narratives ($p<.001$) and characters ($p<.001$). These findings link narrative comprehension of naturalistic episodes to the posterior-medial memory system. Our results further offer a novel demonstration of representational specialization along the anterior-posterior axis of the hippocampus, casting light on how cortical and hippocam pal regions work together to represent and extract meaning from continuous experience.

Topic Line: LONG-TERM MEMORY: Episodic

C82 Functional Connectivity Differs across Cultures

Wanbing Zhang, ; Xin Zhang, Brandeis University; Jessica Andrews-Hanna, University of Arizona; Angela Gutchess, Brandeis University

People from different cultural backgrounds have been found to differ in their memory specificity and their patterns of neural activation during encoding. However, little is known about how the brain areas associated to cultural differences in memory specificity behave when at rest especially after the memory task. The current study investigates how functional connectivity differs across cultures. 20 Americans and 20 East Asians completed an eyes-open resting state scan after incidentally encoding pictures of objects. Regions selected to compare resting state connectivity during rest included two cortical regions (left parahippocampal gyrus, and left hippocampus) previously identified as being more active in East Asian vs. American participants when encoding items that would later be correctly recognized as being the same or similar as items presented during encoding. Our results revealed that the left parahippocampal gyrus showed a significantly greater connection to the striatum (including bilateral caudate, left pallidum, and left putamen) in East Asian compared to American participants. The activations overlapped with striatal parcellations typically thought to project to the frontoparietal control network. This may suggest that consolidating specific information about details of items is more effortful for East Asian participants and thus requires more cognitive coordination.

Topic Line: LONG-TERM MEMORY: Episodic

C83 The effects of a moderate dose of alcohol on prospective memory: A pilot study

Xiao Liu, University of Southern California; Marie Brown, University College London (UCL); Emily Thomas, University College London (UCL); Sunjeev Kamboj, University College London (UCL); Valerie H. Curran, University College London (UCL)

Prospective memory (PM) involves planning and carrying out tasks during future events. Research suggests that excessive alcohol consumption negatively impacts prospective memory. However, alcohol's effects on PM mechanisms are not fully understood, and evidence for the efficacy of memory strategies to reverse impairment remains mixed. We completed a pilot study to investigate the acute effects of alcohol on PM and whether implementation intentions (IIs) could be used to combat these effects. We used Virtual Week as an objective measure of PM, which is a computerized board game that simulates typical events during a week and generates PM tasks for the subject to complete. 20 participants were randomly allocated to receive alcohol or placebo in a double-blind independent group design. They played 4 experimental rounds of Virtual Week and used IIs in the final 2 rounds. There was a significant main effect of alcohol on irregular PM task scores ($p = 0.012$). Furthermore, we observed a significant interaction of memory strategy and group ($p = 0.002$), where use of IIs improved scores in the alcohol group more than in the placebo group. Pairwise Bonferroni adjusted comparisons showed significant improvement of scores while using IIs in the alcohol group ($p = 0.007$). This provides initial evidence supporting the use of IIs to help bypass pathways in PM that are impaired under acute alcohol use, which may have important clinical and theoretical implications.

Topic Line: LONG-TERM MEMORY: Other

C84 Matisse or Degas? Using paintings to investigate the relevance of sleep in memory for specific details vs generalization

Sarah (Sadie) J. Witkowski, Northwestern University; Sharon M. Noh, University of Texas at Austin; Victoria Lee, Northwestern University; Alison R. Preston, University of Texas at Austin; Ken A. Paller, Northwestern University

Sleep is important for memory, but does it favor consolidation of specific details or extraction of generalized information? Both may occur together, or generalization may be facilitated by a loss of memory details. To examine these issues, we studied participants who viewed cropped landscape paintings by six artists (six paintings per artist). Paintings were cropped to show only part of each original scene. Each painting was presented with the artist's name and a sound cue to be associated with that artist in a learning-with-feedback phase. In a test of detailed memory, participants were shown an array of six images, all by the same artist, and asked to select which had been seen previously. Some of the foils were different parts of paintings from the learning phase. Generalization was tested by asking participants to select the correct artist for new paintings by the same six artists. Initial performance was similar on both tests (specificity: 59%; generalization: 54%). After testing, participants had a 90-minute sleep opportunity with polysomnographic monitoring. When slow-wave sleep was detected, three of the sound cues were presented unobtrusively. Upon waking, participants were again tested for memory specificity and generalization. Performance declined for specificity (46%), as expected due to episodic forgetting, but generalization performance was largely maintained (52%). A further analysis related time spent in different sleep stages to changes in these two forms of memory. Additional information was provided by considering sleep physiology in conjunction with whether cues reactivated specific or general memories during sleep.

Topic Line: LONG-TERM MEMORY: Other

C85 Integrating MVPA and Connectivity in a Multiple Constraint Network to Bootstrap Brain Models

Chris McNorgan, University at Buffalo; Greg Smith, University at Buffalo; Erica Edwards, University at Buffalo; Jennifer Mosley, University at Buffalo

Brain-based cognitive models draw on traditional general linear model fMRI analyses, which have been more recently complemented by multivariate pattern analyses (MVPA) and by connectivity analyses to identify regions supporting cognitive processes and the interactions between them. We describe a machine-learning approach that represents an explicit union of MVPA and functional connectivity, aiming to facilitate the integration of evidence afforded by these two analytic methods. Multilayer neural networks learned the real-world categories associated with macro-scale cortical BOLD activity patterns generated during a multisensory imagery task, while simultaneously encoding interregional functional connectivity in an embedded autoencoder. Our technique permits the MVPA and functional connectivity solutions to mutually constrain one another, and we argue that these Multiple Constraint Networks naturally generate models that best fit all available data. We find that functional connectivity encoding significantly improved MVPA classifier accuracy, and used the resulting models to simulate lesion-site appropriate category-specific impairments and identify semantic category-relevant brain regions. We conclude that data-driven Multiple Constraint Network analyses encourage parsimonious models that may benefit from improved biological plausibility and facilitate discovery.

Topic Line: LONG-TERM MEMORY: Semantic

C86 Language learning can withstand one night of total sleep deprivation

Jakke Tamminen, Royal Holloway, University of London; Chloe Newbury, Royal Holloway, University of London; Rebecca Crowley, Royal Holloway, University of London; Kathleen Rastle, Royal Holloway, University of London

Sleep is thought to consolidate new memories. We tested the impact of total sleep deprivation on adults' memory for newly-learned words and on their ability to generalise knowledge to untrained words. We trained participants to read fictitious words printed in a novel artificial orthography, while depriving them of sleep the night after learning (Experiment 1, N = 47) or the night before learning (Experiment 2, N = 46). Following two nights of recovery sleep, and 10 days later, participants were tested on trained words and untrained words, and performance was compared to controls who slept normally throughout. In both experiments, participants showed a high degree of accuracy in learning the trained words and in generalising their knowledge to untrained words. There was little evidence of impact of sleep deprivation on generalisation. Given this unexpected lack of effect, we assessed the robustness of the literature on sleep deprivation and memory. We conducted a meta-analysis of studies published between 1970 and 2018. We found 27 studies looking at sleep deprivation before encoding. These showed that sleep deprivation impairs encoding with a medium effect size (g = -0.55). We found 35 studies looking at sleep deprivation after learning. These showed a small effect (g = -0.34) of sleep deprivation impairing consolidation. No statistically significant evidence of publication bias was found. Taken together, our data and the meta-analysis suggest that lack of sleep before or after encoding may have a small-to-medium size effect on episodic memory, but this effect does not extend to generalisation.

Topic Line: LONG-TERM MEMORY: Semantic

C87 Observational and Rule-based Artificial Grammar Learning in Individuals with Aphasia

Carla Tierney-Hendricks, MGH Institute of Health Professions; Sofia Vallila-Rohter, MGH Institute of Health Professions; Natasha De Novi, MGH Institute of Health Professions

Learning is often characterized within frameworks of implicit and explicit learning. Implicit or observational learning is thought to operate below conscious awareness. In contrast, explicit or rule-based learning involves conscious awareness and often relies on verbally-mediated processes. In the current study, we examined observational and rule-based learning in people with aphasia, a language deficit that arises subsequent to brain injury or stroke. We hypothesized that observational learning, which does not rely on language would be intact in people with aphasia (PWA), regardless of stimulus modality, whereas rule-based learning would be impaired due to its reliance on language. Data have been collected from seven PWA and eight age-matched controls. All participants completed 3 artificial grammar learning tasks: observational visual, observational auditory, and rule-based visual. Data analyses compared performance following 1) observational training with visual (shape sequence) versus auditory (nonword sequence) stimuli and 2) observational versus rule-based visual training conditions. Results revealed that controls and PWA performed similarly on both observational tasks, supporting the hypothesis that observational learning remains relatively unaffected by neurological injury to language. In the rule-based learning condition, control participants had higher accuracy than PWA. Findings support the hypothesis that language mediates rule-based learning. This research has implications for understanding learning mechanisms for a range of neurological populations with disordered language networks.

Topic Line: LONG-TERM MEMORY: Skill Learning

C88 Correspondence between Electroencephalography Analysis Techniques in Early Childhood: Evidence from a Passive Oddball Ta

Caroline Hoyniak, Washington University School of Medicine; Rebecca Hailperin-Lausch, Indiana University; Lauren Wade, Indiana University; Elizabeth daSilva, Indiana University-Purdue University - Columbus; John Bates, Indiana University; Bennett Bertenthal, Indiana University

There are a number of techniques that can be used to analyze electroencephalography (EEG) data, but little research has examined correspondence among these techniques in data collected from young children.

Participants included 67 42-month-olds (29 female) who participated in a Passive Auditory Oddball task while EEG data were collected using a 128-electrode sensor EGI system. These data were analyzed using three techniques: 1) traditional Event-Related Potential (ERP) identification across P3, Pz, and P4 electrodes (10-20 system), 2) ERP component identification using temporospatial Principal Components Analysis (tsPCA), and 3) time-frequency analysis measuring Event-Related Desynchronization (ERD) within the alpha frequency band, 7 ? 10 Hz, over central sites. Differences between the Frequent and Target condition occurred in the traditional ERP analysis at Pz (cohen's d = .27), and during the 200 ? 399 ms, 600 ? 799 ms, and 800 ? 999 ms bins in the ERD analysis (cohen's d = .47, .41, and .40, respectively). No significant differences emerged between conditions in the tsPCA analysis. Pearson correlations suggested correspondence between P3 amplitudes as calculated using traditional ERP analysis and as calculated using tsPCA, such that, in the target condition, the P3 component examined at Pz was significantly associated the temporospatial factor chosen to represent the P3 (r =.39). However, across time bins, alpha ERD was not associated with P3 amplitudes in either condition as calculated using either ERP processing technique. The current study is the first, to our knowledge, to compare the common EEG/ERP analytic approaches in data collected from young children.

Topic Line: METHODS: Electrophysiology

C89 A Gaussian process model of human electrocorticographic data

Lucy Owen, Dartmouth College; Tudor Muntianu, Dartmouth College; Andrew Heusser, Dartmouth College; Patrick Daly, University of California San Francisco; Katherine Scangos, University of California San Francisco; Jeremy Manning, Dartmouth College

There is increasing evidence from human and animal studies that memory encoding and retrieval is supported by fast timescale network dynamics involving the coordinated activities of widespread brain structures. However, measuring these network dynamics directly in the human brain poses a substantial methodological challenge. In prior work, we developed a method for inferring high spatiotemporal resolution activity patterns throughout the brain, using recordings taken at only a small number of ECoG electrodes (Owen and Manning, 2017). The method, SuperEEG, builds a covariance model that describes how activity patterns throughout the brain are related as a function of their spatial location. We train the covariance model by stitching together recordings taken from a large number of patients and electrode locations. Once the covariance model has been fit, we can apply the model to ECoG recordings from a small number of locations to estimate activity patterns throughout the rest of the brain. In our prior work, we showed that the activity patterns estimated at held-out (unobserved) electrode locations were reliably correlated with the true (observed) activity recorded from those electrodes. Here we apply this same approach to two new large ECoG datasets. We first replicate our prior results, reliably estimating activity patterns from held-out electrodes across both patients and experimental tasks. In other words, the properties our approach leverages appear to be person-general and task-general. Then, we assess reconstruction quality across six frequency bands and broadband power; while quality remains stable across frequencies, highest quality reconstructions come from broadband power activity patterns.

Topic Line: METHODS: Electrophysiology

C90 Gaussian Process Joint Models for Estimating Latent Dynamics of Brain and Behavior

Giwon Bahg, The Ohio State University; Daniel Evans, The Ohio State University; Matthew Galdo, The Ohio State University; Brandon Turner, The Ohio State University

For bridging implementational and algorithmic levels of analysis (Marr, 1982), Bayesian joint modeling (Turner et al., 2013) was proposed as a statistical framework for investigating shared constraints between neural activities and cognitive model parameters. However, previous joint modeling approaches have assumed linearity in estimating a covariance matrix between neural and behavioral measures, which might not always be ideal dealing with complex brain dynamics. Also, joint models based on covariance estimation often ended up sacrificing the temporal dynamics of cognitive activities. To address these limitations, we propose a Gaussian process joint model (GPJM), a data-driven and nonparametric joint modeling framework based on hierarchical Gaussian process latent variable models (Lawrence & Moore, 2007). The GPJM aims to estimate complex temporal dynamics embedded in neural and behavioral data using Gaussian processes as a linking function across modalities. The GPJM can incorporate spatiotemporal covariance structures as its constraints and evaluate the relevance of each latent dimension to data generation processes. To verify the utility of the GPJM, we tested the model performance with simulation and an application to real data. The simulation results demonstrated that the GPJM estimates cognitive dynamics while exploiting spatiotemporal constraints. In an fMRI experiment based on a continuous motion-tracking task, the GPJM could fit neural and behavioral data appropriately, and estimate non-trivial underlying dynamics governing data generation processes. Moreover, out-of-sample validation analyses showed that the latent dynamics trained with complete neural data and selected behavioral data could predict test data reasonably.

Topic Line: METHODS: Neuroimaging

C91 Military Blast Exposure and PTSD are Associated with Aging White Matter Integrity and Functioning

Emma Brown, VA Boston Healthcare System; Anna Etchin, VA Boston Healthcare System; William Milberg, VA Boston Healthcare System; Regina McGlinchey, VA Boston Healthcare System; David Salat, VA Boston Healthcare System

Emerging evidence has demonstrated independent risks that history of military blast exposure (MBE) and PTSD pose for adverse health outcomes including changes to brain microstructure and function. Given these findings, we evaluated (a) the association of MBE and diagnosed PTSD with white matter integrity indexed by diffusion tensor imaging; (b) the relationship between MBE and PSTD with neurocognitive function; and (c) if neurocognitive function is associated with white matter alterations in a large veteran cohort. The sample consisted of OEF/OIF/OND veterans, aged 19 to 62 years (n = 191 MBE with PTSD; 106 MBE-only; 34 PTSD-only; 43 no MBE or PTSD). Delayed recall was measured by the Brief Visuospatial Memory Test (BVMT-R). PTSD diagnosis was determined by the Clinician-Administered PTSD Scale (CAPS-4). Voxelwise cluster-based statistics revealed a significant MBE and PTSD x age interaction on diffusion parameters with the MBE and diagnosed PTSD group exhibiting a more rapid cross-sectional age trajectory towards reduced white matter integrity. We identified distinct regions of lower fractional anisotropy in those with MBE and PTSD than other groups ($p < 0.05$). MBE and PTSD demonstrated indirect influence on delayed memory recall performance ($p < 0.01$). Delayed recall performance was associated with altered white matter integrity. We found that MBE and PTSD are associated with altered cross-sectional aging at the microstructural level and may confer risk for cognitive decline. Additional work examining neurobiological underpinnings of PTSD and longitudinal changes of brain tissue integrity after blast exposure will be important in developing effective interventions for returning veterans.

Topic Line: METHODS: Neuroimaging

C92 Cross-site multiband fMRI signal validation and calibration for cross-cultural neurocognitive studies

Chi-Chuan Chen, National Taiwan University; Chun-Yih Lee, National Taiwan University; Ross Mair, Harvard University; Angela Gutchess, Brandeis University; Joshua Oon Soo Goh, National Taiwan University

Comparisons of functional magnetic resonance imaging (fMRI) cognitive brain response data across different sites is becoming critical in the field, such as in cross- cultural studies. This present study comprehensively evaluated functional brain imaging data comparability between two sites (Taiwan, US) using identical multiband MRI base systems and settings. Four subjects (1 male, 3 females; 2 Caucasians, 2 East Asians) each completed 12 independent fMRI runs of both visual (flashing checkerboard) and motor (finger tapping) tasks at both sites using Siemens PRISMA 3T MRI scanners with closely matched experimental environments. Planned contrasts between the visual and motor tasks and ANOVA analysis evaluated the effects of subject, task (visual and motor task), site (Taiwan and the U.S.) and their interactions on the fMRI data. Replicating past work (Sutton et al., 2008, J. Magn. Resonance. Imaging), visual and motor tasks evoked higher brain responses in visual and motor areas, respectively, as expected. Also, main and interactive effects of subject and task were dominant across frontal, parietal, temporal and occipital areas. Main and interactive effects of site were present but largely restricted to the visual area. Overall, cross-site comparisons of functional neural responses are feasible, particularly for tasks that do not focus on low-level visual processing areas. We also suggest that site-specific fMRI signal scaling might improve comparisons. To this end, standardized procedures for between-site calibration of human brain responses, such as in this present study, is strongly recommended in future studies examining fMRI data across data acquisition sites and systems.

Topic Line: METHODS: Neuroimaging

C93 Predictable brain: Using machine learning to predict brain signals of subjects during social interaction

Candida Da Silva Ferreira Barreto, 1. Federal Universty of ABC/ 2. Drexel University; Guilherme Bruneri, UNIFESP (Federal University of Sao Paulo); José Guilherme Oliveira Brockington, Federal University of ABC (UFABC); Joao Sato, Federal University of ABC (UFABC)

Brain synchronization is fundamental to successful communication between dyads in social interactions, such as teacher-student. Hyperscanning is a neuroimaging acquisition approach that consists of simultaneously measuring the brain activity of two or more individuals interacting. Combining that possibility with the fact that interbrain synchronizations (IBS) are present in social interactions lead us to an ambitious question. In a situation of teacher-student interaction, would it be possible to predict brain signals of a student using the brain signals of a teacher as predictors? To address this question, we propose this proof-of-concept study where we performed an fNIRS hyperscanning to collect brain signals from the prefrontal cortex and temporoparietal junction of eight healthy pairs of teacher-student playing a space race game. Three pairs of subjects were excluded due to poor quality of data. We used a machine learning (ML) algorithm named support vector regression (SVR) to predict the student's brain signals using the teacher's data as a predictor. As a result, the algorithm was able to predict the student's brain based on the teacher's brain for all five pairs of subjects. The predictions were related to different positions located in the TPJ. All dyads had at least two predicted signals from this region. However, only two pairs of subjects had predictions of signals from the prefrontal. Thus, pairwise brain predictions during teacher-student interactions were performed. This preliminary result is promising, therefore to move forward, we intend to increase the number of pairs, test more controlled tasks, and different ML models.

Topic Line: METHODS: Neuroimaging

C94 Reconstructing Mechanistic Models of Cognition via Simultaneous MINDy Modeling for Resting-State and Task fMRI

Matthew Singh, Washington University in St. Louis; Anxu Wang, Washington University in St. Louis; ShiNung Ching, Washington University in St. Louis; Todd Braver, Washington University in St. Louis

Cognitive operations are widely believed to result from a combination of long-distance signaling between brain regions as well as anatomically-local computations. Thus, mechanistic accounts of cognitive neuroscience must consider information processing at both the nodal and network scale. However, producing such mechanistic accounts remains a key challenge for task-fMRI. Current approaches have emphasized traditional statistical modeling (e.g. Granger Causality) to extrapolate causal mechanisms. However, spatial-variability in the neurovascular coupling, low sampling rates, and the high-dimensionality of brain data have proven significant barriers in adapting these approaches to task-fMRI. By contrast, generative models such as Dynamic Causal Modeling, provide inherently mechanistic descriptions. Unfortunately, current generative have been limited in the number of regions that can be considered without compromising model detail (e.g. removing hemodynamic modeling). In the current work, we aim to produce generative, large-scale models of task-induced brain activity using simultaneous Mesoscale Individualized NeuroDynamic (MINDy) Modeling of resting-state and task-fMRI. In this approach neural-mass type models are simultaneously fit to the fMRI BOLD time-series for resting-state data and task-data. Task-induced changes in the effective coupling, local time-constants/recurrent connectivity are modeled using a block-design, whereas changes in steady-state activity follow a full fMRI glm model (block and event regressors, etc.). At the same time, separate hemodynamic models are fit for each brain region. We demonstrate the approach's validity and demonstrate its superior statistical power in identifying local activity over statistical fMRI models in a variety of Cognitive Control tasks.

Topic Line: METHODS: Neuroimaging

C95 Investigating the intensity-dependent modulatory effect of TMS on functional connectivity during motion perception

Lifu Deng, Duke University; Olga Lucia Gamboa Arana, Duke University; Moritz Dannhauer, Duke University; Anshu Jonnalagadda, Duke University; Rena Hamdan, Duke University; Fang Wang, Duke University; Marc Sommer, Duke University; Angel Peterchev, Duke University; Greg Appelbaum, Duke University; Roberto Cabeza, Duke University; Simon W Davis, Duke University

Transcranial magnetic stimulation (TMS) is a powerful technique in both scientific and clinical practices, and yet our understanding of how the brain responds to TMS is still limited. Concurrent TMS-neuroimaging research may bridge this gap, and emerging evidence suggests widespread neurophysiological and psychological effects of TMS beyond stimulated location. This indicates that modulatory effects of TMS may be captured though changes in functional connectivity in addition to BOLD responses. However, the relationship between stimulation parameters and functional connectivity is unknown. In this study, healthy volunteers received concurrent TMS-fMRI while performing a dot-motion discrimination task presented in their right visual field. A figure-of-8, MR-compatible coil was used to apply bursts of 3 pulses at 10Hz over the primary visual cortex (V1) at the onset of the dot stimuli with four levels of stimulation intensity (20/40/80/120% resting motor threshold), randomized across trials. TMS-induced artefacts were repaired using ArtRepair and independent component analysis (ICA), and univariate activation and functional connectivity were subsequently estimated from the data. The results yielded two findings. First, the activation in middle temporal visual area (MT) contralateral to the visual stimuli showed a significant effect of stimulation intensity. Such effect was absent in the MT region ipsilateral to the visual stimuli. Second, functional connectivity between left V1 and MT was significantly modulated by TMS

intensity, and such intensity effect was found only in the hemisphere contralateral to the visual stimuli. These findings provide evidence that TMS can modulate the activity and connectivity beyond stimulated location in an intensity-dependent manner.

Topic Line: METHODS: Other

C96 Direct electrical stimulation evidence for a dorsal laryngeal motor cortex area

Raouf Belkhir, Carnegie Mellon University; Frank Garcea, Moss Rehabilitation Center; Ben Chernoff, Carnegie Mellon University; Max Sims, Carnegie Mellon University; Sam Haber, University of Rochester Medical Center; Eduard Navarrete, University of Padova; David Paul, University of Rochester Medical Center; Susan Smith, University of Rochester Medical Center; Webster Pilcher, University of Rochester Medical Center; Brad Mahon, Carnegie Mellon University

Proximate control of the laryngeal muscles during language production in humans is supported by the ventral laryngeal motor cortex (vLMC), and controversially, by the dorsal laryngeal motor cortex (dLMC). Here we present causal evidence using direct electrical stimulation (DES) in a patient undergoing language mapping during removal of a right frontal lobe tumor. Direct electrical stimulation of dLMC caused guttural involuntary vocalizations and transient 'laryngeal speech arrest'. Characteristics of the patients' errors suggest that stimulation disrupted speech at a 'late' or 'peripheral' stage of processing, because on several trials the patient resumed speaking within 200ms of removal of the stimulating probe from the brain. That short refractory time from stimulation offset to speech onset is consistent with the inference that dorsal laryngeal motor cortex supports direct control of laryngeal muscles. Stimulation of adjacent regions in the right hemisphere did not noticeably interfere with speech production.

Topic Line: NEUROANATOMY

C97 Cerebellar Dentate Connectivity Across Adulthood: A Large-Scale Resting State Functional Connectivity Investigation

Jessica Bernard, Texas A&M University; Hannah Ballard, Texas A&M University; Bryan Jackson, Texas A&M University

Cerebellar contributions to behavior in advanced age are of great interest and importance, given its role in both motor and cognitive performance. Including cerebellar perspectives in models of motor and cognitive aging is critical for a more complete picture of the aging mind and brain. There are differences and declines in cerebellar structure in advanced age, and cerebellar resting state connectivity is decreased in older adults. However, the work on this area to date has focused on the cerebellar cortex. From a connectivity perspective, the deep cerebellar nuclei provide the primary cerebellar inputs and outputs linking it to the cortex (via the thalamus), as well as the spinal and vestibular systems. In both human and non-human primate models, networks of the dorsal and ventral dentate can be dissociated such that dorsal regions are associated with the motor cortex, while the more ventral aspect is associated with the prefrontal cortex. However, whether or not dentato-thalamo-cortical networks differ across adulthood remains unknown. Here, using a large representative adult sample (n=591) from the Cambridge Center for Ageing and Neuroscience (Cam-CAN), we investigated dentate connectivity across adulthood. First, we replicated past work showing dissociable resting state networks in the dorsal and ventral aspects of the dentate. Second, in both seeds, we demonstrated connectivity decreases with age, in network specific regions, indicating that connectivity differences extend beyond the cerebellar cortex. Together this expands our understanding of cerebellar circuitry in advanced age, and further underscores the potential importance of this structure in age-related performance differences.

Topic Line: NEUROANATOMY

C98 Oscillation-based connectivity is dominated by an intrinsic spatial organization, not mental state or frequency

Parham Mostame, university of illinois at Urbana-Champaign; abbas babajani-feremi, university of tennessee; sepideh sadaghiani, university of illinois at urbana champaign

Coupling of oscillations across distant brain areas is thought of as a mechanism facilitating neural information exchange. Such oscillation-based functional connectivity (FC) is often considered to reflect rapidly formatting and dissolving neural ensembles. On the other hand, neuroimaging studies have shown that spatial organization of fMRI-based FC is largely stable across mental states such as resting wakefulness and cognitive tasks. Given the rapid and malleable nature of oscillation-based FC, does its spatial organization likewise contain a component that remains stable across mental states? We investigated potential state-dependency of oscillation-based FC in electrocorticography (ECoG) signals of 10 patients undergoing presurgical evaluation. FC was measured as phase coupling and alternatively as amplitude coupling in five canonical frequency bands compared across six different mental states (Resting state, pre- & post-stimulus of word recognition (Listening), pre- & post-stimulus of object viewing (Viewing), and naming of object (Naming)). We found a state-invariant spatial organization of phase coupling in all frequency bands. We further tested for frequency-dependency of phase coupling and found that the observed state-invariant FC has also a universal spatial organization over frequency bands, indicating its frequency-invariance. Dynamic FC analysis revealed that multiple frequency-specific time-varying coupling processes rather than a single set of broadband events underly the state- and frequency-invariant FC. Replicating the results with amplitude coupling, we showed that the state- and frequency-invariant FC is governed by two distinct modes of neural connectivity: phase- and amplitude coupling.

Topic Line: OTHER

C99 Educational experiences connect symbolic fractions to parietofrontal nonsymbolic ratio processing systems

Isabella Starling Alves, University of Wisconsin-Madison; Yunji Park, University of Wisconsin-Madison; Priya Kalra, University of Wisconsin-Madison; John Binzak, University of Wisconsin-Madison; Percival Matthews, University of Wisconsin-Madison; Edward Hubbard, University of Wisconsin-Madison

Recent studies have suggested that humans have a neurocognitive architecture dedicated to processing nonsymbolic ratios, the Ratio Processing System (RPS), which might function as a foundation for fraction knowledge (Lewis, Matthews & Hubbard, 2015). Nonsymbolic and symbolic fractions processing have been associated with activity of frontoparietal networks in adults, but these studies leave unresolved the origins of these neural systems. We investigated the development of frontoparietal regions for symbolic and nonsymbolic fractions processing in an accelerated longitudinal design testing children prior to and after extensive fractions instruction. We collected fMRI data from 44 2nd and 39 5th graders while they performed a comparison task in three notations: nonsymbolic ratios, symbolic fractions, and mixed nonsymbolic/symbolic ratios. We are currently following up with these same participants as 3rd and 6th graders (n = 19 and 24, respectively). For nonsymbolic comparisons, we observed robust activation of the intraparietal sulcus (IPS) in all grades, which increased across development. For symbolic fractions, we observed little activation of the IPS in 2nd graders, which increased significantly when they returned one year later. We consistently observed robust IPS activation in 5th graders and 6th graders. For mixed comparisons, IPS activation was similar to nonsymbolic comparisons in 5th graders, but similar to symbolic comparisons in 6th graders. Overall, these data are consistent with three predictions of the RPS

theory: nonsymbolic ratio processing develops prior to formal instruction with fractions, symbolic fractions processing builds on preexisting frontoparietal networks for nonsymbolic ratio processing, and continued education/development refines these representations.

Topic Line: OTHER

C100 Frequency of resting-state BOLD signal in 2-month-old Bangladeshi infants growing up in poverty

Ted Turesky, Boston Children's Hospital; Nadine Gaab, Boston Childrens Hospital/Harvard Medical School; Charles Nelson, Boston Childrens Hospital/Harvard Medical School; Shahria Hafiz Kakon, The International Centre for Diarrhoeal Disease Research, Dh; Nazrul Islam, National Institute of Neurosciences & Hospital, Dhaka, Bangl

Previous studies have shown that frequency characteristics of the blood-oxygen-level-dependent (BOLD) signal change from early to late infancy, with peak average (across voxels) spectral power shifting from lower to relatively higher frequencies. BOLD spectral power may be an important measure as it has been associated with cognitive performance in infancy and also developmental disorder status. However, the link between BOLD spectral power and early developmental factors that may affect it have not been investigated. Importantly, risk factors associated with childhood poverty have been shown to impact other measures of brain function and we hypothesized that they may also affect BOLD spectral power. To test this, we acquired resting-state fMRI data in 32 infants (77.8 Ã‚Â± 9.1 days) from families with low income-to-needs (5110 Ã‚Â± 3100 Tk) and low maternal education (5.69 Ã‚Â± 3.5 years) in Dhaka, Bangladesh. Power density spectra were computed voxel-wise, then averaged across all gray matter voxels and subjects to identify the frequency corresponding to peak average spectral power (i.e., 'peak frequency'). Spectral power at this peak frequency negatively correlated with maternal education ($r = -.42$; $p < .05$). Also, qualitatively higher spectral power estimates were localized to primary visual and anterior frontal brain regions upon visual inspection of surface topography. These findings demonstrate the first link between measures of poverty and BOLD frequency characteristics.

Topic Line: OTHER

C101 Transitional knowledge within counting sequences is processed across multiple levels of cortical hierarchy

Eli Zaleznik, University of Massachusetts Amherst; Joonkoo Park, University of Massachusetts Amherst

Learning the count list (one, two, three, ...) is a critical stepping-stone for the acquisition of number concepts. Most research about counting, however, is done in the behavioral domain, and little is known about the neural representations underlying counting sequences. Here, we test the hypothesis that transitional knowledge within a counting sequence exist both at sensory and conceptual (ordinal and magnitude) levels. To test this hypothesis, we employed a passive-listening violation-to-expectation fMRI paradigm where adult participants heard auditory count sequences that were correct (4 5 6 7) or violated at the end (4 5 6 8; consecutiveness) and, orthogonally, that were ordered or unordered (orderedness). Another orthogonal dimension was the manipulation of sensory sequence violation where the voice speaking the numbers was consistent throughout the trial or could change on the last number (voice identity). This 2x2x2 factorial design was analyzed using univariate and multivariate pattern analyses. Three clusters in the right fronto-parietal network (BA44, BA46, and IPS) showed greater neural response to violations to orderedness. Of the three clusters, the anterior IFG (BA46) demonstrated the encoding of consecutiveness. Interestingly, the bilateral STS, which showed a robust effect to violations in voice identity, also demonstrated the encoding of consecutiveness. These results indicate that a right-lateralized fronto-parietal network activity can differentiate between a count list and random numbers, while BA46 and bilateral STS respond specifically to violations of the count sequence, suggesting specific mechanisms in the brain for processing consecutive numbers in both the perceptual and cognitive levels.

Topic Line: OTHER

C102 Mind the gap: Differences in sensory memory throughout development in individuals with Cystinosis

Alaina S. Berruti, Albert Einstein College of Medicine; Ana A. 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

Cystinosis, a genetic rare disease characterized by cystine accumulation and crystallization, results in significant damage in a multitude of tissues and organs. While Cystinosis' impact on brain function is relatively mild compared to its effects on other organs, the increased lifespan of this population and thus potential for productive societal contributions have led to increased interest in the effects on brain function. Nevertheless, and despite some evidence of structural differences, the neural impact of the mutation is still not well characterized. We tested basic auditory processing in a group of 36 individuals with Cystinosis (6-38 years old) and in neurotypical age-matched controls (n=39). High-density electrophysiology was recorded while participants were presented with a passive duration oddball paradigm using three different presentation rates (stimulus onset asynchrony: SOAs). We examined whether the N1 (basic auditory processing) and mismatch negativity (MMN; sensory memory) significantly differed between groups, and characterized the developmental trajectory of these processes in Cystinosis. Individuals with Cystinosis presented similar N1 responses to their age-matched peers, indicating typical basic auditory processing in this population. The MMN response, however, was clearly reduced in the longer SOAs in the children and adolescents, whereas the adults presented similar responses to the neurotypical controls. These findings suggest shorter lasting auditory sensory memory traces, and thus a sensory memory impairment in younger patients, which seems to be resolved by adulthood. Future work addressing other aspects of sensory and working memory is needed to understand the bases of the differences described here and their implications.

Topic Line: PERCEPTION & ACTION: Audition

C103 Do you hear that? Individual Differences in Alpha-Frequency Connectivity Predict Hyperacusis in Anxiety

Jessica Simon, Florida State University; Nika Kartvelishvili, Florida State University; Kevin Clancy, Florida State University; Wen Li, Florida State University

Alpha oscillations (8-12 Hz range) act as an inhibitory mechanism of sensory activity, mediating sensory gating and sensory cortical inhibition. Attenuated alpha oscillations have been implicated in key anxiety symptoms such as hypervigilance. In parallel, impaired sensory gating and heightened sensory responses, especially in the auditory modality, have been reliably observed in anxiety. Relatedly, symptoms of auditory hypersensitivity (aka, hyperacusis) are disproportionately represented in individuals with anxiety. Here, we tested the hypothesis that attenuated alpha oscillations can contribute to hyperacusis in anxiety. Participants (N = 94) underwent a 3-minute resting-state electroencephalogram (EEG) recording, followed by an anxiety induction manipulation. Before and after anxiety induction, participants also performed intensity ratings to a set of sounds varying in Valence (Fear, Disgust, Neutral)

and Loudness (Loud, Medium, Quiet). In support of anxiety-induced hyperacusis, we observed an increase in perceived intensity of loud sounds after anxiety induction [Meanpost-pre(SD)= 2.68 (9.8), p = .01], which was marginally correlated with the magnitude of anxiety induction (r = .182, p = .085). Baseline alpha-frequency connectivity (posterior ï? frontal) marginally correlated with baseline perceived intensity of loud sounds (r = -.177, p = .095). Critically, baseline alpha connectivity predicted the increase in sound intensity following anxiety induction (r = -.264, p = .012) such that individuals with weaker alpha connectivity demonstrated greater levels of anxiety-induced hyperacusis. These results thus implicate an alpha oscillatory mechanism underlying hyperacusis in anxiety where alpha activity attenuation heightens hyperacusis, facilitating and perpetuating sensory hypervigilance in anxiety.

Topic Line: PERCEPTION & ACTION: Audition

C104 Non-specific impact of Transcranial Magnetic Stimulation sound patterns on cortical oscillations and visual detection

Chloé Stengel, Institut du Cerveau de la Moelle epiniere (ICM),Paris,France; Adrien Martel, Institut du Cerveau de la Moelle epiniere (ICM),Paris,France; Julian Amengual, Institut des Sciences Cognitives Marc Jeannerod,Lyon, France; Antoni Valero-Cabre, Institut du Cerveau de la Moelle epiniere (ICM),Paris,France

The delivery of active pulses of Transcranial Magnetic Stimulation (TMS) generates a brief but loud clicking sound. To cancel the influence of this auditory stimulation, experimental designs contrast active TMS with a sham control condition that mimics this sound. But what is the impact of auditory stimulation associated to sham TMS on brain activity and behavioral performance, and may this impact interact with the effect of active TMS pulses? Here we recorded EEG activity from healthy participants performing a near-threshold visual detection task while they received, pre-target onset, either single pulses or short rhythmic or random bursts of sham TMS. We show that the delivery of sham TMS did not significantly modulate visual sensitivity (d'). However, sham stimulation, either in single pulses or in bursts, modulated the decision criterion of participants, leading them to show a more liberal decision making. In parallel, we found no signs of oscillatory entrainment following the delivery of rhythmic bursts of sham TMS. Nonetheless, single pulses or bursts of sham stimulation induced broadband phase-locking in the auditory cortex. These results strengthen the use of sham control designs in TMS entrainment experiments. Moreover, here we bring evidence that sham TMS does not induce states of neural activity (namely increased fronto-parietal high-beta oscillatory activity) reported elsewhere as contributing to the facilitation of visual perception. Nonetheless, the non-specific effects on perceptual decision-making processes and oscillatory phase-locking here reported call for a better understanding of the effects of sham TMS on brain activity.

Topic Line: PERCEPTION & ACTION: Audition

C105 Withdrawn

C106 Withdrawn

C107 Color and Intensity of flickering light to enhance gamma entrainment and networking

Kanghee Lee, Dept. of Neuropsychiatry, Seoul Nat'l Univ. Bundang Hosp.; Yeseung Park, Dept. of Brain & Cognitive Science, Seoul National Univ.; Seung Wan Suh, Dept. of Neuropsychiatry, Seoul Nat'l Univ. Bundang Hosp.; Ji Won Han, Dept. of Neuropsychiatry, Seoul Nat'l Univ. Bundang Hosp.; Jaeho Lee, School of Electrical Engineering, KAIST; Jaehyeok Park, School of Electrical Engineering, KAIST; Seunghyup Yoo, School of Electrical Engineering, KAIST; Ki Woong Kim, Dept. of Neuropsychiatry, Seoul Nat'l Univ. Bundang Hosp.

Sensory stimulation with 40Hz flickering light could entrain gamma oscillations leading to decreased amyloid ? burden. However, the optimum parameters of a light source to promote brain gamma activity in humans have not suggested yet. For developing a standardized protocol to enhance the synchronization of brain gamma activities in humans, we performed the study to investigate the optimal intensity and frequency of the flickering light stimulus (FLS) in healthy young adults. We measured electroencephalography (EEG) during the FLS presented. In experiment 1, we applied 10 cd/m2 light with four different colors (white, red, green, and blue). In experiment 2, we applied white light with four different light intensities (10, 100, 400, and 700 cd/m2). Each FLS condition consists of 10 different flickering frequencies from 32Hz to 50Hz with an interval of 2Hz in both experiments. We configured each frequency condition with ten repetitions of 2-sec FLS. Entrained gamma activity started after the FLS onset, lasted during the FLS, and diminished after the FLS offset, which was observed profoundly at the parietal area and steadily decreased from the parietal to the frontal area. Red or white entrains gamma entrainment more effectively than green or blue. The stronger FLS of 400 and 700 cd/m2 entrained higher event-related synchronization (ERS) with stronger functional connectivity. FLS with the lower frequencies than 40Hz entrained significantly higher ERS than the others. Applying the optimal parameters of the FLS validated in this study could accelerate the development of Alzheimer's disease therapies.

Topic Line: PERCEPTION & ACTION: Development & aging

C108 Positive expectation improves perception of mental and physical fatigue in a sequence learning task

Mirta Fiorio, University of Verona; Mehran Emadi Andani, University of Verona; Paola Cesari, University of Verona; Bernardo Villa-Sanchez, University of Verona

Learning to perform precise movement sequences underlies many daily-life functions. As many other processes, sequence learning goes through repeated practice sessions until automation is achieved. Intensive repetition induces mental and physical fatigue that in turn cause individuals to give up the training sessions. In this study, we investigated the effects of positive expectations, induced through placebo procedures, in influencing implicit sequence learning and perception of mental and physical fatigue. Ninety healthy volunteers performed a serial reaction time task in three sessions (baseline, training, final). Two placebo procedures were applied in two different experimental groups: a motor placebo procedure consisted in the application of transcutaneous electrical nerve stimulation, TENS (inert), over the hand executing the task; a cognitive placebo procedure consisted in the application of sham transcranial direct current stimulation, tDCS (inert), over the supraorbital area. In both cases, participants received specific verbal information about the positive effects of the treatment (i.e., TENS in increasing muscle activity or tDCS in increasing attention). A control group performed the same task without treatment. Reaction times were measured as index of performance and perception of mental and physical fatigue was measured by means of visual analogue scales. While performance improved independently of the adopted placebo procedure, perception of fatigue was differently modulated by the type of placebo: placebo-TENS reduced only perception of physical fatigue, whereas placebo-tDCS reduced perception of both mental and physical fatigue. Positive expectation can reduce the perception of mental and physical fatigue, with potential implications to foster sequence skill learning.

Topic Line: PERCEPTION & ACTION: Motor control

C109 Prior Exposure Enhances Cortical Entrainment to Unheard Speech during Silent Lip-reading

Zhewei Cao, Dept of Brain and Cog Sci, Univ Rochester; Aisling O'Sullivan, Trinity Center for Bioengineering,Trinity College Dublin; Lauren Szymula, Dept of Biomedical Engineering, Univ Rochester; Aaron Nidiffer, Dept of Biomedical Engineering, Univ Rochester; Edmund Lalor, Dept of Biomedical Engineering,Univ Rochester

Neuroimaging research has demonstrated that observing visual speech in the absence of auditory speech activates primary auditory cortex. However, it remains unclear what this activation precisely reflects. It is established that, during continuous auditory speech, neural activity in auditory cortex tracks the temporal envelope of the speech signal. Recently, it has been suggested that this process may reflect a synthesis of the speech stream rather than the encoding of the envelope. In the current study, we look into whether silent lip-reading can elicit a similar 'entrainment' to the envelope in the absence of auditory speech. We trained subjects on 5 audiovisual videos of a speaker, and then asked them to perform a target word detection task to the silent version of the trained videos, as well as 5 novel silent videos of the same speaker. We tracked both behavioral performance and recorded electroencephalography (EEG) data during testing. Results showed that subjects exhibited higher accuracy in trained over novel ones in the target word detection task. Additionally, by reconstructing an estimate of the silent audio speech envelope from the EEG signal, we find that when the speech could be accurately lip-read, the speech envelope can be more accurately reconstructed. Preliminary analysis suggests that this improved envelope tracking was driven by greater encoding of phonetic features of the unheard speech in the case of the trained videos. With these results, we show supporting evidence that silent lip-reading does activate auditory cortex in a way that is meaningfully related to the speech stimulus.

Topic Line: PERCEPTION & ACTION: Multisensory

C110 Assessing and Predicting Efficacy of Dance Intervention for Parkinson's Disease

Anna Krotinger, Wesleyan University, Harvard Medical School; Psyche Loui, Northeastern University, Wesleyan University

Parkinson's disease (PD) is associated with a loss of internal cueing systems, affecting rhythmic motor tasks such as walking and entrainment. Music and dance encourage spontaneous rhythmic coupling between sensory and motor systems; this has inspired the development of dance programs for PD. Here we assessed the therapeutic outcome of dance classes for PD, as measured by neuropsychological assessments of disease severity as well as quantitative assessments of sensorimotor experience. We assessed prior music and dance experience, beat perception (Beat Alignment Test), sensorimotor coupling (tapping to high- and low-groove songs), and disease severity (Unified Parkinson's Disease Rating Scale in PD individuals) before and after four months of weekly dance classes. PD individuals performed better on UPDRS after four months of weekly dance classes, suggesting efficacy of dance therapy. Greater post-intervention improvements in UPDRS were associated with the presence of prior dance experience and with more accurate sensorimotor coupling, especially as assessed by tapping to low-groove songs. Prior dance experience was additionally associated with enhanced sensorimotor coupling during tapping to both high-groove and low-groove songs. These data suggest that dance classes for PD improve both qualitative and quantitative assessments of disease symptomology. The association between these improvements and dance experience suggests that rhythmic motor training, a mechanism underlying dance training, impacts the therapeutic outcome of dance classes for PD.

Topic Line: PERCEPTION & ACTION: Multisensory

C111 The relationship between sign language fluency and mental rotation: An EEG study

Emily Kubicek, Gallaudet University; David Thornton, Gallaudet University; Lorna Quandt, Gallaudet University

Past work investigating spatial cognition suggests better mental rotation abilities for those who are fluent in a signed language. However, no prior work has investigated if fluency is needed to achieve this performance benefit and what it may look like on the neurobiological level. We used EEG to examine deaf fluent signers (n=18), hearing fluent signers (n=16), hearing non-fluent signers (n=17), and hearing non-signers' (n=15) performance on a classic mental rotation task. We hypothesized that mental rotation abilities are enhanced only when sign language fluency is attained, most notably for deaf fluent signers. In line with our behavioral prediction, deaf fluent signers and hearing fluent signers scored significantly better than hearing non-fluent signers and hearing non-signers ($p=.02$), suggesting a high level of sign language comprehension is needed for significant performance enhancements in mental rotation abilities. In a correlation analysis, we discovered that as sign language skills increase, mental rotation improves, regardless of hearing status ($p=.001$). We further hypothesized that this behavioral enhancement can be seen through differential responses of sensorimotor system EEG activity. Time-frequency activity in alpha and beta ranges were computed for each condition at frontal and central sites overlying the sensorimotor cortex. Contrary to our prediction, results show similar activity across groups in response to stimuli, suggesting similar strategies are being used regardless of sign language knowledge or mental rotation abilities. We also conducted multiple exploratory analyses on mental rotation abilities, sign language knowledge, and past spatial experiences.

Topic Line: PERCEPTION & ACTION: Other

C112 Formation of face-related predictions: An interplay of prestimulus α/β enhancement and peristimulus N170 diminution

Marlen Roehe, ; Marlen A. Roehe, University of Muenster; Daniel S. Kluger, University of Muenster; Svea C. Y. Schroeder, University of Muenster; Lena M. Schliephake, University of Muenster; Jens Bölte, University of Muenster; Axel Kohler, University of Frankfurt; Ricarda I. Schubotz, University of Muenster

Our environment confronts us with a highly dynamic nature, veiling a cascade of statistical regularities. Explicitly, these regularities often go unnoticed whilst traces of implicit learning are evident in neural activity. Recent perspectives have offered convincing evidence that both prestimulus oscillations and peristimulus event-related potentials are reliable biomarkers of implicit anticipation during statistical learning. What remains ambiguous, however, are temporal aspects underlying the genesis of predictions. To address this issue and determine a timeframe confining the formation of predictions, prestimulus increases in alpha and beta power were examined in relation to a reduction of the early N170 face-sensitive component. EEG was acquired from naive participants (n=35) who engaged in a 'cover-up' gender discrimination task. Participants were unaware, however, that eight face images were sorted into four reoccurring pairs - the first image invariably preceded the second image - and were pseudorandomly hidden amongst sequences of arbitrary face images. As hypothesized, we found a reduced N170 amplitude for anticipated compared to unanticipated images over temporal and temporo-parietal electrodes. Furthermore, enhanced alpha and beta power was evident prestimulus for anticipated in comparison to unanticipated faces. Of particular interest, however, was the early onset of alpha/beta power enhancement which commenced as early as -1.75 seconds prior to onset of the anticipated faces. Our findings thus provide evidence of a systematic correspondence between prestimulus alpha/beta enhancement and peristimulus N170 diminution, suggesting an approximate timeframe in which the formation of face-related predictions can be observed.

Topic Line: PERCEPTION & ACTION: Other

C113 Male Observers use Facial Sexual Dimorphism to make Physical Dominance Assessments Following Brief Exposure

Graham Albert, Boston University; Erika Wells, Boston University; Steven A., Arnocky, Nipissing University; Changhong Liu, Bournemouth University; Carolyn R., Hodges-Simeon, Boston University

Research on facial dominance perceptions has consistently demonstrated the faces manipulated to appear more masculine (i.e., masculinized) are rated as more dominant than those manipulated to appear more feminine (feminized). However, these studies have relied on forced-choice paradigms, which are susceptible to demand characteristics. To circumvent these problems, we test if manipulating the sexual dimorphism of faces effects men's dominance perceptions when these faces are presented individually, and for one-hundred milliseconds, reducing the time available to assess facial features. We predicted that men would assign higher dominance ratings to masculinized faces, and that they would remember these faces better in a follow up recognition memory test. In two experiments 46 men were presented with masculinized and feminized facial photographs and rated physical dominance. In Experiment 2, the facial photographs were set to an oval shape, to control for the effects that face outline may have had on dominance ratings. Men assigned significantly higher dominance ratings to masculinized faces, suggesting that they can appraise differences in facial sexual dimorphism following brief exposure. This effect occurred regardless of whether men were presented with complete facial photographs or photographs set to an oval, suggesting that observers were relying on internal facial features. The rating phase was followed by a surprise recognition memory test where participants classified faces as either old or new. Men correctly classified more masculinized men's faces as old, providing evidence that facial sexual dimorphism is a salient feature that men attend to during dominance assessments.

Topic Line: PERCEPTION & ACTION: Vision

C114 MRI structural analysis of cortical thickness and tissue integrity in developmental prosopagnosia

Joseph DeGutis, VA Boston Healthcare System/Harvard Medical School; Jirapat Likitlersuang, VA Boston Healthcare System/Harvard Medical School; David Salat, VA Boston Healthcare System

Face recognition is crucial to social functioning and is severely impaired in developmental prosopagnosics (DPs), individuals with lifelong face recognition deficits. DPs have shown to have reduced face-selective responses in the fusiform face area (FFA), a key face processing node in the ventral temporal cortex, as well as decreased white matter integrity in tracts originating from the FFA. However, studies have yet to investigate cortical thickness and macromolecular tissue differences in the FFA between DPs and controls. In this study, we examined the T1-weighted magnetic resonance imaging (MRI) scans as well as collected T1 quantitative MRI scans of 25 developmental prosopagnosics and 24 healthy controls. The statistical group difference of the cortical thickness were computed using General Linear Model (Freesurfer's mri_glmfit) followed by permutation clusterwise analysis (mri_glmfit-sim).The region of interest generated within the right FFA was selected for mean cortical thickness calculation. The result revealed a significantly thicker cerebral cortex among individual with DP compared to control in the FFA sub-region. Furthermore, a preliminary quantitative MRI results also showed shorter proton relaxation time (T1) in controls compared to DPs within FFA, indicative of reduced macromolecular tissue integrity in DPs. These results reinforce that structural integrity and functioning of the right FFA is crucial for successful face recognition and suggests that DPs' thicker and less marcomolecularly rich FFA is consistent with poor or incomplete development of this region.

Topic Line: PERCEPTION & ACTION: Vision

C115 Mugs and Plants: Objects' Action Associations Bias Perception

Dick Dubbelde, The George Washington University; Sarah Shomstein, The George Washington University

Neuroimaging studies of object recognition have revealed that object processing is largely a result of computations within the dorsal and ventral visual streams. Each stream is differentially recruited depending on object identity. Objects with strong action associations (e.g., tools) recruit dorsal regions more than non-tool objects, which are more reliant on ventral processing. We hypothesized that if this differential functional recruitment is indeed meaningful, it should have behavioral consequences. Due to the relative proportions of magno- and parvo-cellular input to each stream, processing along the dorsal stream, such as when a tool is seen, should have higher temporal sensitivity, while processing along the ventral stream, such as when a non-tool is seen, should have higher spatial sensitivity. We test this hypothesis using two tasks: gap detection, testing the spatial resolution of the ventral parvocellular processing, and object flicker discrimination, testing the temporal resolution of the dorsal magnocellular processing. Across four experiments we show (1) a non-tool advantage in spatial resolution, (2) a tool advantage in temporal discrimination, (3) that this advantage is reduced by impeding object recognition through inversion, and (4) that this advantage diminishes when suppressing magnocellular processing with red light. These results demonstrate perceptual differences in object processing arising from differential recruitment of the two processing streams, such that tools, which recruit the more magnocellular dorsal stream regions have higher temporal resolution, and non-tools, which are reliant on the more parvocellular ventral stream regions, have higher spatial resolution.

Topic Line: PERCEPTION & ACTION: Vision

C116 Representation of visual information for rapid motor responses

Rajendran Pottayil, Borough of Manhattan Community College; Marjan Persuh, Borough of Manhattan Community College

Visual perception has limited capacity. We can attend only to a limited amount of information and we can track only few objects at a time. It is conceivable that visual information is represented differently for different tasks; however, capacity limitations might affect all visual pathways at the encoding stage of the visual system. We tested our prediction in a paradigm that differs substantially from attentional and object tracking tasks and requires rapid motor responses: a response priming, in which a preceding prime activates or inhibits response to a target. In a set of three experiments, participants responded to stimuli of different orientations, shapes, or colors. A single prime together with a varying number of distractors was presented in a circular arrangement while targets were presented at the center. Participants made speeded responses to the targets. Our results show that priming decreased as the number of distractors increased, suggesting that capacity for simultaneous representation of visual information is limited for rapid motor responses. However, all features were not represented with equal efficiency. We found that as the number of distractors increased, priming dropped faster for orientation and for a set size of six was practically eliminated. Priming for shape and orientation was stronger and still detectable at the highest set sizes. Our results demonstrate that visual information representation is limited in capacity even for response priming, suggesting a general limitation for all visual pathways. Furthermore, capacity limitations are feature specific and color, in particular, shows higher representational capacity than other features.

Topic Line: PERCEPTION & ACTION: Vision

C117 A brief period of postnatal visual deprivation permanently alters visual motion processing in early visual regions.

Mohamed Rezk, Université Catholique de Louvain (UCLouvain); Stefania Mattioni, Université Catholique de Louvain (UCLouvain); Junghyun Nam,

University of Toronto; Zhong-Xu Liu, University of Michigan-Dearborn; Xiaoqing Gao, Zhejiang University; Terri Lewis, McMaster University; Daphne Maurer, McMaster University; Olivier Collignon, Université Catholique de Louvain (UCLouvain)

How does early visual experience shape the development of the visual motion network? To address this question, we used functional magnetic resonance imaging to characterize the brain response elicited by visual motion in adults born with dense bilateral cataract that was treated early in life. Our results suggest that early cataract patients showed reduced recruitment of the early visual areas while processing motion information when compared to matched controls with typical visual development. Interestingly, no alterations were observed in the higher-order visual motion area hMT+/V5. Psychophysiological interaction analyses demonstrated reduced interhemispheric connectivity in V1, and reduced connectivity between bilateral hMT+/V5 and V1 during visual motion processing. The altered connectivity profile of V1, but not hMT+/V5, in cataract-reversal patients was confirmed using independent data collected without the subjects being involved in a specific task (resting-state). Altogether these results suggest that a brief and transient period of visual deprivation early in life has a region-specific impact on the visual motion network with V1 being permanently affected while hMT+/V5 shows resilience to deprivation.

Topic Line: PERCEPTION & ACTION: Vision

C118 Fast periodic visual stimulation marker of face identity impairment in developmental prosopagnosia

Kevin Spencer, ; Elyana Saad, Harvard Medical School; Maruti Mishra, Harvard Medical School; Joseph DeGutis, Harvard Medical School

Developmental prosopagnosia (DP) is characterized by severe lifelong face recognition deficits. Researchers have sought to identify an objective neural marker to better understand and diagnose DP. Fast periodic visual stimulation (FPVS) EEG is one potentially efficient method to reliably identify dysfunctional face processing. Here we used FPVS in 30 individuals with DP and 25 matched control participants to determine which aspects of face processing might be dysfunctional in DP. In our FPVS paradigms, participants performed a color change-detection task at fixation while in the background, an image category was repeated at 6 Hz while an oddball image was presented every 5th image (1.2 Hz). The signal-to-noise ratio (SNRs) of the oddball frequency and its harmonics were computed in the frequency domain at occipito-temporal electrodes sensitive to face processing (PO7/8, P9/10). The tasks were upright face identity (novel face oddball amongst presentations of the same repeated face), inverted face identity (inverted novel face amongst same inverted face), face vs. object (face oddball amongst objects), famous face identity (famous face oddball amongst non-famous faces). We found a significant reduction of SNR for the oddball frequency and harmonics in DPs compared to controls in the upright face identity task. No significant differences between DPs and controls were found in the other tasks. These FPVS results are consistent with DPs' pronounced difficulties in matching novel face identities and recognizing newly learning faces. The FSVP method may be useful as a rapid means to test face perception mechanisms in DP.

Topic Line: PERCEPTION & ACTION: Vision

C119 Putting visual object recognition in context

Mengmi Zhang, Boston children's hospital, harvard medical school; Claire Tseng, Harvard College; Gabriel Kreiman, Harvard

Context plays an important role in visual recognition. Recent studies have shown that visual recognition networks can be fooled by placing objects in inconsistent contexts (e.g. a cow in the ocean). To understand and model the role of contextual information in visual recognition, we systematically and quantitatively investigated ten critical properties of where, when, and how context modulates recognition including amount of context, context and object resolution, geometrical structure of context, context congruence, time required to incorporate contextual information, and temporal dynamics of contextual modulation. The tasks involve recognizing a target object surrounded with context in a natural image. As an essential benchmark, we first describe a series of psychophysics experiments, where we alter one aspect of context at a time, and quantify human recognition accuracy. To computationally assess performance on the same tasks, we propose a biologically inspired context aware object recognition model consisting of a two-stream architecture. The model processes visual information at the fovea and periphery in parallel, dynamically incorporates both object and contextual information, and sequentially reasons about the class label for the target object. Across a wide range of behavioural tasks, the model approximates human level performance without retraining for each task, captures the dependence of context enhancement on image properties, and provides initial steps towards integrating scene and object information for visual recognition.

Topic Line: PERCEPTION & ACTION: Vision

C120 Catching the Visual System in Action: A Modified Event-Related Potential Paradigm for Dynamic Stimuli

Shan Zhang, University of California, San Diego; Ayse P. Saygin, University of California, San Diego

Perceiving biological motion (BM), the movements and actions of other living entities, is critical for human behavior and social interaction. Despite the inherently dynamic nature of these stimuli, much remains to be understood about the temporal aspects of BM processing. The event-related potential (ERP) technique provides excellent temporal resolution, but typically involves time-locking to overall stimulus onset, which can make it difficult to explore subtler and ongoing aspects of processing for dynamic stimuli. We developed a variant of the ERP method, to apply sparse visual events onto continuously presented, dynamic stimuli. Subjects viewed point-light walkers (PLWs) depicting BM with black dots corresponding to the joints of a moving body. A contrast reversal (i.e., change to white dots), aimed to induce a feed-forward wave of processing, was applied to individual frames at an average rate of 3/s, without disturbing the continuity of motion. Each trial featured either an intact or a spatially-scrambled PLW matched for local motion and motion energy. Responses to the contrast-reversal frames showed the expected visual ERP componentry and distribution, indicating the feasibility of our approach. Furthermore, the occipital P1 (90-110ms) and parietooccipital N1 (150-170ms) components were enhanced for intact vs. scrambled PLWs. Further frame-level analyses showed that while the response to the stimulus onset can dominate evoked potentials to dynamic stimuli, our ERP paradigm provides a promising approach to study the temporal aspects of BM processing by acting as a probe to 'catch the visual system in action'.

Topic Line: PERCEPTION & ACTION: Vision

C121 Clarifying the Role of the Medial Prefrontal Cortex During Metacognition: Revelations from a 'Maybe' Judgment

Hillary Erwin, The University of Alabama; Tasnuva Enam, The University of Alabama; Deborah Eakin, Mississippi State University; Ian McDonough, The University of Alabama

Metacognition refers to an awareness of one's knowledge and ability to understand, control, and manipulate their own cognitive processes. A common way to measure metacognition is to directly ask people to predict their current learning state via judgments of learning (JOLs), which are subjective ratings concerning whether information will be remembered later. Prior research

suggests that brain regions within the Default Mode Network (DMN), especially the medial prefrontal cortex (mPFC), are involved in making JOLs, but its computational role has yet to be identified. In a preregistered study (https://osf.io/sp5hn), we attempted to adjudicate between three theoretical perspectives about the bases of JOLs: Somatic Marker (emotionally guided), Feeling of Rightness (contextually appropriate), and Task Engagement (self-referential processing) Hypotheses. Twenty participants made JOLs on a 1-3 scale (Likely, Maybe, Unlikely) after viewing picture pairs during fMRI scanning. All hypotheses predicted that mPFC activity would be greater for Likely than Unlikely judgments, which was found. Each hypothesis made different predictions regarding the Maybe judgment, either higher than both Likely and Unlikely or mid-way between the two; however, brain activity was lowest for Maybe judgments. Rather than create emotional sensation or elicit more self-referential processing, the uncertainty of Maybe judgments might shut down pathways associated with ongoing decision making. Only the Feeling of Rightness hypothesis predicted higher mPFC activation for Likely over Maybe judgments. The unexpected decrease in mPFC activity relative to Unlikely judgments might then be due to the continuing unresolved uncertainty relative to the other two judgments.

Topic Line: THINKING: Decision making

C122 Differential Striatal Responses During Moral and Economic Value-Based Decision-Making

Yu-Hsuan Kao, National Taiwan University, Taipei, Taiwan; Chi-Chuan Chen, National Taiwan University, Taipei, Taiwan; Yu-Shiang Su, National Taiwan University, Taipei, Taiwan; Chien-Te Wu, National Taiwan University, Taipei, Taiwan; Joshua Oon Soo Goh, National Taiwan University, Taipei, Taiwan

In this study, we investigated neurobehavioral processes underlying value-based decisions over variable amounts of money or human lives. We hypothesized that decisions involving monetary and human life forfeiture would reflect utilitarian and non-utilitarian strategies, respectively. We scanned 29 participants (mean age(SD)= 24.1(3.1) years; 16 females) in a functional magnetic resonance imaging (fMRI) moral choice task (MCT) experiment. Participants underwent four blocked conditions each consisting first of text describing a hypothetical scenario followed by 10 associated choice trials. In Cash-Cash blocks, scenarios described cash stakes. For each following choice trial, participants saw different initial cash expected values (EV), defined by varying probabilities and amounts, as well as an alternative cash EVs. Participants either accepted the initial EV or forfeited NT$10 million in exchange for the alternative, which could yield better or worse overall outcomes. Cash-Life blocks involved saving or sacrificing human lives with cash forfeit option to alter expected number of lives. Life-Cash blocks involved money with option to forfeit one life to alter cash EVs. Life-Life blocks involved human lives with one-life forfeit option to alter expected number of lives. Forfeiture rates over expected loss to gains and reaction time remained low for Life-Cash. For all other conditions, forfeiture rates were low for expected losses and switched to high for expected gains, reflecting utilitarian behavior. Critically, neural responses in the striatal areas were higher for Life-Cash and Life-Life than Cash-Life and Cash-Cash conditions. Our findings reveal differential involvement of striatal processes when deliberating moral and economic values in decision behavior.

Topic Line: THINKING: Decision making

C123 Classifying individuals into 'info types' based on information-seeking motives

Christopher Kelly, UCL; Tali Sharot, UCL

The human pursuit for information drives intellectual development and social engagement. Here, we test whether individuals can be categorized into 'info-types' according to their motives for seeking knowledge expressed in information-seeking decisions. We further test if this classification provides clues about latent psychiatric conditions. Participants indicated whether they wanted to receive 40 different pieces of information related to themselves. They also rated (i) how useful each piece of information will be, (ii) its likely impact on their affective state, and (iii) how often they think about it. Cluster analysis revealed three well-defined 'info-types'. The first type included participants that made information-seeking decisions based predominately on whether information was useful ('Action Group'). The second included participants who primarily took into account the expected influence of information on their affect ('Affect Group'). The third type consisted of participants who predominately made information-seeking decisions based on the frequency in which they think about the information in question ('Cognitive Group'). The 'Affect group' reported the most trans-diagnostic psychopathology symptoms and the 'Cognitive group' the least. The data suggests that information-seeking behavior can be indicative of mental health. Thus, the research may inform the development of new screening tools based on information-seeking patterns.

Topic Line: THINKING: Decision making

C124 Disentangling the influences of positive and negative incentives on cognitive effort

Xiamin Leng, Brown University; Debbie Yee, Brown University; Amitai Shenhav, Brown University

When deciding how much effort to invest in a given task, people weigh both potential positive outcomes that one would accrue (e.g., praise) as well as potential negative outcomes such efforts would avoid (e.g., admonishment). Yet research into the basis of cognitive effort has largely focused on how people respond to positive incentives. Here, we sought to distinguish adjustments of cognitive effort motivated by positive versus negative incentives, and to further dissociate between different kinds of effort adjustments that can result under threat of a negative outcome -- namely, the choice to work more vigorously or more cautiously. To quantify these incentive effects, we developed a novel Incentivized Cognitive Effort Task, in which participants are given fixed time intervals to complete as many trials as they want of a Stroop task. We vary the positive incentives for performance (monetary gain for each correct response; Studies 1-3) and two forms of negative incentives: monetary loss avoidance for responding correctly (negative reinforcement; Study 2) vs. penalty for responding incorrectly (punishment; Study 3). Participants correctly completed more trials with increasing reinforcement, and even more so under negative vs. positive reinforcement, whereas they completed fewer trials (but were more accurate) with increasing potential punishment. Drift diffusion models revealed that this dissociation between cognitive effort strategies could be accounted for by reinforcement vs. punishment differentially increasing evidence accumulation (drift rates) vs. response thresholds. These findings provide an important foundation for a better understanding of the mechanisms driving individual differences in real-world cognitive effort investment.

Topic Line: THINKING: Decision making

C125 Navigational Agency Modulates Neural Representations of Spatial Environments

Yi-Chaung Lin, National Taiwan University, Taipei, Taiwan; Ya-Ting Chang, National Taiwan University, Taipei, Taiwan; Charlotte Maschke, Technical University Dresden, Dresden, Germany; Joshua Oon Soo Goh, National Taiwan University, Taipei, Taiwan

Spatial navigation (SN) involves forming accurate neural representations of the environment usually with movement actions that involve making navigational decisions. However, how navigational agency in SN modulates neural spatial

representations remains unclear. We evaluated the effects of navigational decision-making on SN-related neural responses under conditions of internally (Free) vs. externally (Tour) generated navigational steps. 17 participants (23.7±2.5 yrs old, 7 females) underwent a SN functional magnetic resonance imaging (fMRI) experiment in virtual mazes consisting of 12 landmarks. In the Free condition, participants first freely navigated a maze in the first person to learn landmark locations. During testing, participants started at various locations, and determined distances then navigated to target landmarks. In the Tour condition, participants viewed first-person videos guiding them through the landmarks and then did the same spatial retrieval test. All participants underwent both learning conditions in different mazes in counterbalanced order. Direction judgement errors were greater ($t(16) = 2.29$, $p < .05$) and navigational time to targets were longer ($t(16) = 2.36$, $p < .05$) for the Tour than Free condition. During maze learning, brain responses were generally higher for Free than Tour in anterior cingulate cortex (ACC) and thalamus, but higher for Tour than Free in orbitofrontal cortex. Comparing maze junction to traversing periods, brain responses were higher for Free than Tour in hippocampus and thalamus during maze learning, but in ACC during retrieval navigation. Our findings demonstrate more accurate spatial representations under navigational agency that implicate neural processes in the ACC, thalamus, and hippocampal areas.

Topic Line: THINKING: Decision making

C126 The Effect of Phasic Arousal on Risky Choice in Younger and Older Adults

Margot Sullivan, Ryerson University; Ringo Huang, Davis School of Gerontology, USC; Joseph Rovetti, Ryerson University; Erika Sparrow, Ryerson University; Julia Spaniol, Ryerson University

Anecdotal evidence suggests that choices we make 'in the heat of the moment' are often different from those we make while 'cool and collected'. In younger adults, arousal has been shown to promote simple decision strategies and preference for low-risk options, but little is known about the influence of arousal on decision making in older adults. In light of recent evidence of age-related declines in the locus coeruleus-norepinephrine system, we predicted a reduced influence of arousal on risky choice in older adults. Healthy younger and older participants made a series of choices between smaller-safer and larger-riskier financial gains. Each choice was preceded by a high-arousal or a low-arousal sound clip. Three conditions were compared within subjects: low-arousal baseline trials, low-arousal trials embedded in mixed blocks, and high-arousal trials embedded in mixed blocks. Pupil dilation was continuously recorded as an index of task-evoked arousal. Both age groups showed significant modulation of pupil dilation as a function of the arousal manipulation, but behavioral results offered only partial support for the hypothesized effects of arousal on choice. Arousal produced shorter decision times in both age groups, consistent with an effect of arousal on decision thresholds. Furthermore, younger adults were more risk-averse, and showed greater sensitivity to expected value, compared with older adults. However, these patterns were not significantly modulated by arousal. Jointly, these findings help inform current theories of the effects of arousal on information processing in younger and older adults.

Topic Line: THINKING: Decision making

C127 Understanding brain pattern complexity and interactivity in naturalistic processing

Lucy L. Owen, Dartmouth College; Jeremy Manning, Dartmouth College

Naturalistic processing requires coordinated activity patterns across our brain. In order to understand the dimensionality of neural activity patterns, and changes in the complexity of brain activity patterns over time, we used an fMRI dataset collected by Simony et al. (2016) in which cognitive richness was manipulated. Specifically, participants listened to an audio recording of a story, as well as scrambled versions of the same story (where the scrambling was applied at different temporal scales). We applied dimensionality reduction algorithms to the activity patterns in each experimental condition. We sought to understand the 'dimensionality' of the neural patterns that were sufficient to decode participants' listening times (or approach was similar to that of Mack et al. 2017). We trained classifiers with the same neuroimaging dataset using more and more principle components to decode the precise time when a given neural patterns was recorded. We found that even low-dimensional embeddings of the data were sufficient to accurately decode listening times from the intact story recording, whereas finer temporal scramblings of the story required higher-dimensional embeddings of the data to reach peak decoding accuracy.

Topic Line: THINKING: Other

C128 Computer code comprehension shares neural resources with formal logic and math

Yun-Fei Liu, Johns Hopkins University; Marina Bedny, Johns Hopkins University; Colin Wilson, Johns Hopkins University

Computer programming is a recent cultural invention that makes use of neural circuits evolved for other cognitive domains. We investigated which neural mechanisms are 'recycled' to support code comprehension. While undergoing fMRI, eleven expert-programmers (>5 years of experience) performed a code comprehension task and four non-programming tasks previously hypothesized to share neural resources with coding: language comprehension ('The lawyer that the banker irritated ...'), symbolic math (e.g., 17-3=X), formal logic (If X and Y, then Zâ?|), and executive control (multisource interference task MSIT) (Monti et al., 2009, PNAS & Kanjlia et al., 2016, PNAS). In the code-comprehension task, participant saw trials with real or fake code. Real code trials began with a Python function implementing character manipulations (24 seconds), followed by an input string (6 seconds), and then a possible output (6 seconds). Participants judged whether the output was correct. On analogous fake code trials, participants saw a word-level scrambled version of a Python function, followed by a fake input and fake output. They judged whether the fake output string had appeared in the fake function. The real vs. fake code contrast revealed a consistent left-lateralized network of regions across individuals: dorsal and ventral lateral frontal cortex, intra-parietal sulcus, and posterior temporal cortex. A high degree of overlap was observed among neural responses to code comprehension, formal logic, and math. However, there was little overlap with language. These results suggest that the domain general executive network is crucial for expertise in culturally derived symbol manipulation.

Topic Line: THINKING: Problem solving

C129 Neural Correlates Underlying Passive and Active Abstract Rule Inferencing

Wan-Rue Lin, National Taiwan University, Taipei, Taiwan; Yu-Shiang Su, Academia Sinica, Taipei, Taiwan; Joshua Oon Soo Goh, National Taiwan University, Taipei, Taiwan

Forming inferences about the environment can be an active process, whereby hypotheses drive actions to modify inferences, or passive, whereby inferences are modified based only on observation data. This study evaluated neural correlates underlying the engagement of active relative to passive inference processing. 20 participants (23.8±5.1 yrs old, 7 females) underwent a rule-learning task functional magnetic resonance imaging (fMRI) experiment. In the Active condition, participants first observed three blank circles in triangular arrangement and then chose to fill each with either red, yellow, or blue colors for the cue phase. Participants then answered whether the color cue configuration they chose was classified as a red, yellow, or blue color category. Feedback was

then provided based on predetermined cue-category association rules. The Passive condition was similar except that color cue configurations were predetermined. Behavioral performance times and tries-to-criterion were similar for both inference types. Nevertheless, Active neural responses were higher than Passive during observation in bilateral superior frontal areas. Cue phase Active responses increased but Passive responses decreased in the left inferior parietal region and were higher than Active across bilateral visual, superior parietal, striatal, and orbitofrontal, and left thalamus, precentral, and supplementary motor areas. Answer phase responses across bilateral inferior temporal, insula, putamen, and medial frontal and supplementary motor areas decreased for Passive but increased for Active conditions. Feedback responses in left putamen and insula, and right parahippocampal areas decreased for Active but increase for Passive conditions. These findings characterize progressive neural processing stages involved during generation of hypothesis-driven actions.

Topic Line: THINKING: Reasoning

C130 Decoding Pre-trial Pupil Diameter from EEG dynamics in an Auditory Oddball Task

Blake L. Elliott, Arizona State University; Deanna L. Strayer, Arizona State University; Matthew K. Robison, Arizona State University; Chris Blais, Arizona State University; Samuel M. McClure, Arizona State University; Gene A. Brewer, Arizona State University

The adaptive gain theory posits that the locus coeruleus-norepinephrine (LC-NE) system is crucial in regulating arousal and task-engagement. Importantly, this theory hypothesizes that tonic activation of the LC-NE system has an inverted U-shaped relationship with task engagement and performance. The current study is direct replication and extension of Murphy et al. (2011) which investigated two proposed psychophysiological biomarkers of the LC-NE system: pupil diameter and the P3 event-related potential (ERP). Data was collected during a two-stimulus auditory oddball task. We replicate the results from Murphy et al. (2011). Pre-trial pupil diameter exhibited and inverted U-shaped relationship with P3 amplitude. Furthermore, decoding methods were used to predict pre-trial pupil diameter from ERP scalp topographies and oscillatory activity. The results provide evidence for the adaptive gain theory, as well extend our understanding of different ERP and oscillatory dynamics that may underlie arousal and task-engagement.

Topic Line: ATTENTION: Auditory