Session F

Tuesday, May 5, 10:00 am – 1:00 pm, Exhibit Hall C

F1 Distractor Reactivation with Age: Evidence for Cluttered Memory Representations

Terek Amer, Columbia University, Joan Ngo, University of Toronto, Lynn Hasher, University of Toronto

Reduced attentional control with age has been associated with the processing of and subsequent memory for task-irrelevant information. Although there is evidence that such irrelevant information is maintained in memory, the nature of the memory representation requires further study. Here, we present direct evidence that, relative to young adults, older adults store simultaneously presented target and irrelevant information as cluttered, bound memory representations. In particular, in a 3-stage implicit reactivation paradigm, we demonstrate that re-presenting a target item (as a partial cue) that was previously paired with a distractor spontaneously reactivates the previously associated distractor, such that it becomes more accessible than an unreactivated distractor in a subsequent implicit memory task. This study provides evidence that reduced attentional control influences both the processing and representation of incoming relevant and irrelevant information.

Topic Line: ATTENTION: Development & aging

F2 The frontal aslant tract (FAT) white matter microstructure differentiates young children with ADHD from typical controls

Anthony Dick, Florida International University, Dea Garic, Florida International University, Paulo Graziano, Florida International University

Attention-deficit/hyperactivity disorder (ADHD) is typically diagnosed in early childhood, and is characterized by deficits in executive function (EF) and in motor coordination. The neurobiology of ADHD with respect to EF in young children is not well understood, though identifying biosignatures of EF deficits in ADHD could serve as indicators of treatment response, as well as inform development of future treatments. To this end, we conducted a diffusion-weighted imaging (DWI) study in 196 4-7-year-old children (69% male, Mage = 5.7 yrs, with (n = 100) and without (n = 96) a diagnosis of ADHD). We mapped a recently-defined fiber pathway known as the frontal aslant tract (FAT). Given its connectivity profile connecting the right inferior frontal gyrus with the pre-SMA/SMA, and its previous association with EF in children (Garic et al., 2019), Dick and colleagues (2019) proposed that the right FAT might be involved in the planning, sequencing, and inhibitory control of potentially conflicting motor plans for manual movements. Results of the DWI study were in line with that prediction. We found that group status (ADHD vs Control) moderated the significant association between right FAT microstructure and performance on a motor sequencing task requiring inhibitory control (i.e., the Head-Toes-Knees-Shoulders task; $p < .05$). Group status did not moderate the significant association between microstructure and performance on typical EF tasks (Flanker and Dimensional Change Card Sort). Thus, 1) the right FAT is a potential biosignature of early ADHD diagnosis, but 2) only for tasks that require inhibitory control over sequenced movements.

Topic Line: ATTENTION: Development & aging

F3 Potential biomarker for ASD: Reduced pupil responses to repeated multisensory stimuli in young children with autism

Jonathan Doyon, George Washington University, Ashley Darcy-Mahoney, George Washington University, Chynna Golding, George Washington University, Sarah Shomstein, George Washington University, Gabriela Rosenblau, George Washington University

Autism spectrum disorder (ASD) is characterized by hypersensitivities to sensory stimuli which may result from deficits in habituation, i.e., encoding temporal regularities in the environment and adapting predictions accordingly. Here, we investigate whether changes in pupil dilation-decreases of pupil diameter (PD) over time-are a useful biomarker for attenuated habituation to multisensory stimuli in young children with ASD. Neurotypical (n = 27, M = 44.58 mos., SD = 14.14) and ASD (n = 7, M = 50.37 mos., SD = 15.76) participants viewed repeated audio-visual stimuli of varying complexity: from discrete beeps with continuous optic flow field to naturalistic movies. PD changes were tracked with the remote Eyelink 1000 plus tracker that allows free head movement. We extended preprocessing pipelines in the PsychoPhysiological Modeling toolbox to clean data and correct for blinks, saccades, and system artifacts. Preliminary analyses indicate larger average PDs for the ASD group relative to the neurotypical group over time, reflecting an attenuated habituation response. PD trajectories also show nonlinear (quadratic) structure across trials. A significant interaction between group and trial, reflected a faster habituation response in the neurotypical group. Significant group differences in habituation were modulated by stimulus complexity: group differences in habituation were smaller for more complex stimuli. These results provide preliminary evidence that pupillary responses can measure habituation differences between neurotypical and ASD groups. Our results also suggest that exploring stimulus dynamics and complexity through computational modeling may yield a mechanistic account of habituation deficits in ASD.

Topic Line: ATTENTION: Multisensory

F4 Multiple task set boundaries constrain the congruency sequence effect

Lauren Grant, University of Michigan, Daniel Weissman, University of Michigan

Control processes that adapt to recent events can operate more effectively in some contexts (e.g., ignoring a bench while jogging) than in others (e.g., ignoring a cupcake while dieting). However, the nature of these contextual boundaries remains unclear. Prior findings suggest that different sensory modalities can serve as boundaries for a popular behavioral measure of adaptive control called the congruency sequence effect (CSE). However, modality changes are often confounded with changes involving the stimulus-response (S-R) mapping. Thus, we investigated whether modality changes, S-R mapping changes, or both reduce the CSE in two experiments involving a cross-modal, prime-probe task. In this task, a 1150 ms inter-stimulus-interval (ISI) separates an initial prime from a subsequent congruent or incongruent probe. In Experiment 1, participants responded to the prime (during the ISI) and then to the probe after it appeared, such that only the common sensory modality (visual or auditory) in which these stimuli appeared could change across consecutive trials. In Experiment 2, participants responded only to the probe, such that both the sensory modality and the S-R mapping (e.g., 'respond to the probe' followed by 'do not respond to the prime') could change across consecutive trials. We observed a reduced CSE when only the sensory modality changed in Experiment 1 and no CSE when both the sensory modality and the S-R mapping changed in Experiment 2. These findings suggest that (1) the sensory modality in which task stimuli appear and (2) the S-R mapping can serve as 'task set' boundaries for the CSE.

Topic Line: ATTENTION: Other

F5 Behavioral induction of a high beta state leads to movement slowing

Vignesh Muralidharan, University of California San Diego, Adam Aron, University of California San Diego

Understanding the role of beta oscillations (13-30 Hz), a common observation in sensorimotor regions, is essential to unravelling its influence in healthy functioning and disease states. Several theories of sensorimotor beta have been proposed, however sorting them out has been affected by a lack of experimental protocols which successfully modulate beta and test its functional effects on behavior at the same time. We have developed a novel behavioral paradigm where a participant performs a primary movement, inducing a strong beta state (beta rebound) in the contralateral sensorimotor cortex and within that time frame embedded a cue which required a rapid secondary movement. In two experiments (N = 11 and N = 15), where we recorded scalp electroencephalography, we show that the primary movement induced high beta state led to slower cue-triggered secondary movement. We also show that this high beta state related to lower mu/beta desynchronization of the subsequent movement. Furthermore, the transient features of the beta state, i.e. beta bursts, specifically its timing and amplitude related to the degree of slowing. These results suggest that the beta state, at least post-movement, corresponds to an inhibitory state - insofar as it retards subsequent movement. Since our behavioral framework requires people to proactively, using an instruction, create a high beta state, this opens up possibilities of clinical research to explore how to best and most strongly create sensorimotor beta states that have retardive properties.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

F6 Tracking horizontal eye movement via ocular components extracted from EEG by second-order blind identification (SOBI)

Sun Rui, The University of Hong Kong, Cynthia Chan, The University of Hong Kong, Janet Hsiao, The University of Hong Kong, Akaysha Tang, The University of Hong Kong

Ocular artefact in EEG has long been viewed as a problem for interpreting EEG data in basic and applied research. Recently we have shown (in companion abstract 44616121) that two components (Comps), recovered by SOBI, can code horizontal (H) and vertical (V) saccadic eye movements. In the present study, from EEG data collected from a single motivated participant performing 10 blocks of 16 trials of directed eye movement (8 directions and 2 distance of 12.2° and 6.1° visual angles), we extracted H and V Comps from using the first k blocks of the data (k=1, 2, … 9). Using these 9 sets of H and V Comps as predictors and an eye tracker measured gaze positions as predicted gaze positions, we constructed 9 linear regression models (M1, M2,…, M9) for predicting future gaze position in the remaining (10–k) blocks using EEG data alone. The models accounted for 93%+/-2% (N=9) variance in the eye tracker measured horizontal gaze position (R= 0.967+/-0.011). The prediction accuracy on testing data reached asymptote at M3 (using 3 calibration trials per target location). A precision and reliability of 0.84° and 1.63° of visual angles were obtained which correspond to a precision and reliability of 6 and 11 mm at a 40 cm recommended distances for reading and 6 cm and 11 cm at a 4 meter recommended distance for watching a 32' TV. These preliminary results raised the possibility of transform ocular artifacts into predictive signals for tracking eye movement during natural reading.

Topic Line: METHODS: Electrophysiology

F7 RAGNAROC: A computational model to describe why attentional capture only occurs sometimes

Chloe Callahan-Flintoft, Brad Wyble, Pennsylvania State University, Gabriella Larkin, US Army Research Lab, Michael Geuss, US Army Research Lab, Alfred Yu, US Army Research Lab, Chou Hung, US Army Research Lab

The human visual system is often presented with a dense array of information from our complex and dynamic environment. Reflexive spatial attention is thought to be a collection of mechanisms by which the brain prioritizes some information over others for enhanced processing. This form of attention has been shown to be guided by both the bottom-up saliency of stimulus (Theeuwes, 1994) and one's top-down control settings (Folk, Remington, & Johnston, 1993). Here, we present the Reflexive Attention Gradient through Neural AttRactOr Competition (RAGNAROC), as framework by which to understand how the brain mediates between these two factors. The model uses hierarchical neural

circuits specifically adapted for rapid, parallel decision making to simulate how locations of the visual field compete for attention. The result of this competition is an excitatory attractor state established at attended locations and suppression applied to others. The current work demonstrates how the model is able to account for seemingly conflicting results in the literature (i.e. how some experimental paradigms show evidence of attentional capture while others show evidence of suppression to salient distractors) by simulating both behavioral and electrophysiological patterns found in experimental data. Finally, with the introduction of augmented reality, it is now possible for artificial intelligence systems to direct a user's visual attention to task relevant locations or potential threats. RAGNAROC demonstrates how certain displays may in fact encourage the suppression of information rather than its enhancement by generating explicit predictions of users' eye movement patterns when information is overlaid on a dynamic scene.

Line topic: ATTENTION: Spatial

F8 NSF Funding Opportunities for Cognitive Neuroscience

Kurt Thoroughman, NSF, Kurt Thoroughman, NSF

F9 Contiguous locations increase reliability of parietal maps

Summer Sheremata, Florida Atlantic University, Young Seon Shin, Florida Atlantic University

Reducing the correlation of stimulus positions protects visual retinotopic maps from artifacts known to affect properties such as the size of the spatial representation. Outside of visual cortex, however, it is not clear what properties are necessary to demonstrate map structure. In the parietal cortex spatial attention increases map reliability. While it is not clear what properties of spatial attention drive these effects, one possibility is that presenting stimuli in contiguous spatial locations serves as a spatial cue with which the stimulus can be tracked. In this experiment, we used the population receptive field (pRF) method while presenting stimuli at contiguous or discontiguous spatial locations to determine whether stimulus presentation affected the properties of spatial representations in parietal cortex. We compared the first and last runs of each stimulus presentation to estimate reliability of size and preferred location estimates. As predicted by known properties of spatial attention, contiguous spatial presentation led to greater reliability of spatial representations across parietal cortex. However, greater reliability also occurred with larger pRF sizes for contiguous as compared to discontiguous presentations. These results demonstrate contiguous stimulus presentations allow demonstrating parietal retinotopic map structure more reliably that may be collected with fewer runs despite changes in individual pRF properties.

Topic Line: ATTENTION: Spatial

F10 WITHDRAWN

F11 Lateral Prefrontal Cortex-Amygdala Functional Connectivity at Rest Predicts Reappraisal Success Less in Later Adulthood

Parker Longwell, University of Massachusetts, Amherst, Youna Choi, Amherst College, Holly Laws, University of Massachusetts, Amherst, Bruna Martins-Klein, University of Massachusetts, Amherst

Reappraisal - reinterpreting a situation to change emotional response - is an effective emotion regulation strategy that relies on cognitive control network activity, including engagement of lateral prefrontal cortex (LPFC), to attenuate amygdala activity. Greater LPFC-amygdala functional connectivity predicts instructed reappraisal task success, and daily use of reappraisal for younger adults. Greater resting-state functional connectivity (RSFC) of LPFC-amygdala is associated with cardiac biomarkers of successful emotion regulation for younger, but not older adults, but the relationship of RSFC and reappraisal task success across the lifespan has yet to be investigated. Participants from the Cambridge Center for Aging Neuroscience database (N=299, 51% Female, 18-88 years, M= 54.4, SD= 18.6) completed an 8-minute resting-state fMRI scan, and an emotion regulation task. On each trial, participants either viewed or reappraised a negative film and reported post-regulation positive affect. RSFC across bilateral amygdala and right LPFC was calculated with Matlab's CONN Toolbox. Regression analyses revealed main effects of greater curvilinear age (B= 0.004, SE= 0.001, p< 0.001), and greater negative right LPFC-amygdala RSFC with positive affect (B= -0.419, SE= 0.159, p=0.009). A significant interaction was found between Age x RSFC, in which right LPFC-amygdala RSFC was less predictive of positive affect with increasing age (B= 0.009, SE= 0.004, p=0.022, R2 = 0.700). Findings suggest that LPFC-amygdala RSFC can predict regulation ability in younger, but not older adults. Future research should explore if older adults rely on differing neural networks, and examine effects of task-based connectivity can predict reappraisal success in later life.

Topic Line: EMOTION & SOCIAL: Development & aging

F12 fMRI of aesthetic experiences with landscape videos

Ilkay Isik, Max Planck Institute for Empirical Aesthetics, Edward A. Vessel, Research Scientist

Humans regularly derive pleasure from visual experiences, even when not associated with primary rewards. Such 'aesthetic' experiences with artworks, performances or natural settings unfold in time, yet most of what is known about the psychological and neural basis of such experiences comes from studies with static images (paintings, photography, landscape). Previous imaging studies with artworks suggest that aesthetically pleasing experiences modulate activity not only in subcortical reward regions (ventral striatum), but also in portions of the ventral visual pathway and the default-mode network (DMN). We investigated behavioral and neural responses to temporally extended, aesthetically engaging stimuli (videos), using fMRI in combination with continuous behavioral ratings. Participants (n=26) were scanned as they viewed 40 video clips of landscapes (30 s) and indicated their moment-to-moment liking, as well as a final

summary rating at the end of each clip. Category-selective visual regions in ventral occipitotemporal cortex (e.g. Parahippocampal Place Area, Fusiform Face Area) were identified using a functional localizer scan, and core regions of the DMN were identified using a 'rest' scan, in each individual. A parametric regression analysis of the fMRI data using overall ratings as regressors revealed sensitivity to aesthetic appreciation in several scene selective regions (Parahippocampal Place Area, Retrosplenial Cortex and Occipital Place Area) as well as ventral striatum and inferior frontal sulcus, but not in the DMN. These results suggest that aesthetically pleasing landscape videos may modulate a wider network of higher-level visual regions than their static counterparts and rely less on top-down information for their aesthetic appeal.

Topic Line: EMOTION & SOCIAL: Emotional responding

F13 A critical role of the rTPJ in empathic and prosocial responses to sad and fearful events: a 1-Hz rTMS study

Shin Ah Kim, Korea University, Jae Hyun Kim, Korea University, Sang Hee Kim, Korea University

The right temporo-parietal junction (rTPJ) plays a critical role in perspective-taking and understanding others' emotional states. Although functional neuroimaging studies also highlighted activations in the rTPJ during prosocial decision-making, the direct relationship between the rTPJ and prosocial decision has been less frequently investigated. The present study aimed to investigate the causal role of the rTPJ in eliciting empathy and prosocial intention by temporarily disrupting neural activity in the rTPJ using low-frequency repetitive transcranial magnetic stimulation (rTMS) techniques. Nineteen healthy adults participated in two sessions of 1-Hz rTMS and sham stimulation over the rTPJ, separated by 1 week. Following each stimulation, participants viewed a series of video clips made of excerpts from movies or tv dramas, which were divided into 3 emotional categories: fearful, sad, and neutral. Both fearful and sad clips depicted characters who suffered from threatening events, such as house on fire, and sad events, such as family separation, respectively. At the end of each video clip, participants rated empathic concern, personal distress, and helping intention, elicited by each clip. Results revealed that rTMS disruption of the rTPJ resulted in significant reduction of empathic concern and helping intention in response to sad clips relative to sham stimulation to the rTPJ. No 1-Hz rTMS dependent changes were found for fearful clips. These results suggest potentially different roles of rTPJ-dependent perspective-taking in generating empathic responses and prosocial motivations for others experiencing sad and fearful events.

Topic Line: EMOTION & SOCIAL: Emotional responding

F14 Predicting Depression from Speech Recordings: A Machine Learning and Feature Selection Approach

Siamak Sorooshyari, UC Berkeley, Thomas Van Vleet, Posit Science, Alit Stark-Inbar, Posit Science, Heather Dawes, UC San Francisco, Deanna Wallace, UC San Francisco, Morgan Lee, UC San Francisco, Michael Merzenich, Posit Science, Edward Chang, UC San Francisco, Mor Nahum, Hebrew University of Jerusalem

Features of recorded speech have been shown to be predictive of depression severity. However, little consensus exists on the appropriate combinations of voice features that should be used to successfully identify depression. The current study sought to find the voice features most relevant for an accurate classification of depression. Voice recordings and depression ratings (PHQ-9 scores) were remotely collected from 49 adult participants. Prosodic, phonetic and spectral voice features were extracted using two software packages: Praat and openSMILE. A support vector machine (SVM) was trained on various combinations of the voice features, and their accuracy in depression classification was evaluated. A leave-one-out (LOO) cross-validation analysis was used to assess the predictive capability of our methodology. Comparison between the performance attained with Praat and openSMILE showed that the optimal Praat set yielded nearly equivalent performance to the optimal openSMILE set using a significantly fewer number of features. The results support the importance of pruning the feature space prior to training a machine learning algorithm, as a larger number of features does not necessarily result in superior classification. Collectively, these results provide encouraging evidence for remotely recorded speech as an effective means of predicting depression.

Topic Line: EMOTION & SOCIAL: Emotional responding

F15 Reframing anxiety: how domain anxieties affect performance on cognitive tasks framed as domain-specific

Griffin Colaizzi, Georgetown University, Richard Daker, Georgetown University, Ariana Mastrogiannis, Georgetown University, Adam Green, Georgetown University

Educationally relevant anxieties have been shown to impact performance in specific educational domains. For example, math anxiety is associated with underperformance in and avoidance of math and careers that involve math (Hembree, 1990; Dowker et al., 2016). Creativity anxiety (i.e., anxiety specific to creative thinking) has recently been shown to exist across diverse content domains, affecting creative thinking and performance in everything from music to science, and predicts individual differences in creative achievement (Daker, Cortes, Lyons, and Green, 2019). We hypothesized the negative performance effects associated with domain anxieties could be ameliorated by reframing problems as being unrelated to the domain of an individual's anxiety. To test this hypothesis, we paired administration of three cognitive measures that are not strongly tied to math or creativity, with instructions indicating that the task was either math-related, creativity-related, or neutral. We predicted that individual differences in domain-specific anxiety would interact with instruction type such that individuals would perform worse when a task was described as relevant to their anxious domain and better when it was not. In addition to measuring task performance, we collected physiological measures of anxiety (autonomic arousal) using psychophysiology apparatus. Consistent with our prediction, we found impacts of both the type and level of individual anxiety and effects of instruction type on both behavioral and physiological outcomes. These findings have potential implications for education, as educators might effectively ameliorate domain anxieties by changing how a topic is presented or framed for students.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

F16 WITHDRAWN

F17 Decreased Inhibitory Control Activity in Veterans with Post-Traumatic Stress Disorder (PTSD) during Emotion Regulation

Bruna Martins-Klein, University of Massachusetts-Amherst, Jasmeet P. Hayes, The Ohio State University

Emotion dysregulation and hyperarousal are core deficits of Post-Traumatic Stress Disorder (PTSD). Reappraisal and suppression are two well-studied emotion regulation strategies that decrease amygdala activation to emotionally intense stimuli. However, little is known regarding the neural activity involved for these regulatory strategies in PTSD. In this study, we explored neural differences use of reappraisal and suppression in PTSD with fMRI. Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) Veterans with PTSD (n=15) and trauma-exposed controls (n=18) underwent fMRI during an emotion regulation task. Veterans viewed negative images, and were cued to passively view or actively regulate their emotion via detached reappraisal or suppression of facial expression, and rated post-regulatory intensity. We found that the PTSD group had lower activity than the controls during both strategies (relative to passive viewing) in regions of the right putamen, right Inferior Frontal Gyrus (IFG), and Supplementary Motor Cortex (SMA). No significant self-reported differences were found across groups in intensity ratings. Findings also showed a significant association between greater activity in the right putamen and emotion regulation success (more positive post-regulatory emotion ratings). Results support that patients with PTSD have difficulty recruiting brain regions that support emotion regulation and inhibitory control. A potential consequence of this decreased control activity is failure to inhibit salience regions of the brain associated negative emotion and expression, such as the amygdala and insula. Future studies should determine whether failure of regulatory brain regions observed in this study is a reliable biomarker of emotional dysregulation and emotional hyperarousal in PTSD.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

F18 Joint Effects of Self-Referencing and Emotion on Memory in Aging and aMCI

Nishaat Mukadam, Brandeis University, Katelyn Parisi, Brandeis University, Eric Fields, Brandeis University, Ryan Daley, Boston College, Andrew Budson, VA Boston Healthcare System, Elizabeth Kensinger, Boston College, Angela Gutchess, Brandeis University

Memory decline is a common occurrence in cognitively healthy older adults (OAs) and is even more prominent in people with amnestic mild cognitive impairment (aMCIs). Certain types of information, such as information that is related to the self (self-reference effect) or that which is emotional (emotional enhancement effect), can enhance memory performance, but there has been little work considering the joint influence of these processes, particularly with aMCI. In our study, 28 OAs and 22 aMCIs participated in an incidental encoding task where they read a series of emotionally valenced (positive or negative) or neutral sentences in a first-person or third-person frame. They later completed recall and recognition tasks for these sentences. Both self-referencing (first-person frame) and emotion increased memory performance in the recall and recognition tasks among both groups. Although both groups similarly benefitted from emotion on the recall task, the effects differed by valence on the recognition task. OAs exhibited better memory for both positive and negative information over neutral information whereas aMCIs showed enhanced memory for positive information only. These results suggest that emotion can boost memory both when information is self-referential and when it is not, although memory in aMCI may benefit most from positive emotional content.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

F19 Aversive Distracter Words and Working Memory Filtering

Richard Ward, University of Wisconsin - Milwaukee, Sofia Mattson, University of Wisconsin - Milwaukee, Joseph Kornkven, University of Wisconsin - Milwaukee, Salahadin Lotfi, University of Wisconsin - Milwaukee, Han-Joo Lee, University of Wisconsin - Milwaukee, Christine Larson, University of Wisconsin - Milwaukee

Threatening stimuli attract attention, even when they are task-irrelevant. Prioritization of this threatening information can yield negative consequences on downstream cognitive systems. For example, prior evidence shows that threatening stimuli are inefficiently filtered from working memory, and that this effect is enhanced in individuals with anxious traits. Based on previous literature demonstrating that negative words also attract attention, we aimed to investigate the effects this attentional bias has on working memory filtering. We recorded the contralateral delay activity (CDA), an event-related potential that indexes the number of items retained in working memory, as participants completed a lateralized change detection task using word stimuli. This task contained four main conditions: one target, two targets, one target and one neutral distracter, and one target and one aversive distracter. The two distracter conditions allow for assessment of the ability to filter task-irrelevant distracter stimuli. Our current results (n = 18) revealed no differences in filtering efficiency across both behavioral and CDA measures. Despite the lack of group level filtering effects, we observed individual differences in filtering of aversive words as a function of self-reported intolerance of uncertainty (IUS). Specifically, individuals with higher scores on the IUS unfairness subscale showed reduced filtering efficiency of aversive. In contrast, individuals with higher scores on the IUS negative subscale showed increased filtering efficiency for aversive words. These results suggest that individual differences in IUS may modulate one's ability to efficiently filter aversive distracter words from working memory.

Topic Line: EMOTION & SOCIAL: Emotion-cognition interactions

F20 Neural Differences in Hypoactive Sexual Desire Disorder: An ERP Microstate Study

SungJun Cho, University of Chicago, Wasuwat Siewsrichol, University of Chicago, Stephanie Cacioppo, University of Chicago.

The top-down neurofunctional model of hypoactive sexual desire disorder (HSDD) proposes that specific cognitive processes such as self-inspection and personal evaluation interfere with sexual desire of patients prior to or during their sexual activities (Cacioppo, 2017). Supporting this model, recent neuroimaging studies comparing controls and HSDD patients show stronger neural activation in self-referencing neural network of patients. However, limited studies have been done on identifying neural differences between pre- and post-menopausal HSDD patients. ERP data from HSDD-diagnosed premenopausal (PREM; n=20) and postmenopausal women (POSTM; n=10) were recorded while participants performed Desire Intention Task (DIT). Two common and three discrete microstates, with maximum threshold of 11x10^(-12) pA/m, were measured for between-group analysis of PREM and POSTM using Chicago Electrical Neuroimaging Analysis (CENA). PREM had an additional microstate compared to POSTM with mean GFP (graded field power)=2.66μV and standard deviation=0.27μV. Activated brain regions of corresponding microstates were further source reconstructed into 3-dimensional spatiotemporal image from ERP time series and analyzed by power spectral analysis and Freesurfer's Desikan-Killiany atlas. Both groups revealed high activation in superior temporal gyrus (self-other mental association) and fusiform gyrus (face and body processing), consistent to Cacioppo et al. (2017). Activation in PREM showed close association with prefrontal cortex and bilateral temporal lobes. Both microstate analysis and source localization suggest PREM patients tend to overthink about their sexual desire and associated decisions more than POSTM. Conversely, POSTM lacked extra microstate that is highly involved with prefrontal cortex and showed distributed activation across occipital, temporal, and parietal lobe.

Topic Line: EMOTION & SOCIAL: Other

F21 Cortisol and Experiences of Discrimination Modulate Medial Temporal Lobe Structures in Older Adults

Michael Rosario, Graduate Program for Neuroscience, Amara Ayoub, Department of Anatomy and Neurobiology, Razan Alotaibi, Department of Anatomy and Neurobiology, Karin Schon, Department of Anatomy and Neurobiology

The medial temporal lobes (MTL) are modifiable by experience. Animal models have shown structural changes in the amygdala and hippocampus associated with environmental enrichment and chronic stress. These MTL regions modulate the hypothalamic-pituitary-adrenal (HPA)-axis, which regulates the stress response. Experiences of discrimination (EoD; e.g., sexism, racism, ageism) are chronic psychosocial stressors that affect physical and mental health. Cumulative stress may alter the body's ability to regulate the physiological stress response. Limited insight exists on the impact of chronic EoD on the MTL in older adulthood. Previous research has shown aberrant amygdala activity related to EoD, however, structural brain changes have not been examined. We collected salivary cortisol from 30 participants (55-86 years, 56% female, 16% African American) to evaluate HPA-axis function. T1-weighted structural MR images captured on a 3T Philips Achieva were analyzed using FreeSurfer's automatic segmentation to evaluate relationships between EoD scores and left and right hippocampus and amygdala volumes. Multiple regression models showed a striking association between left amygdala volume and salivary cortisol (ug/dL) ($p < .0003$, $t(24) = 4.282$) and left amygdala volume and EoD scores ($t(24) = -4.073$, $p < 0.0004$). Additionally, the results showed an association between salivary cortisol and right hippocampal volume ($t(24) = 2.915$, $p < 0.00759$). Our results extend previous work to structural MTL integrity in the aging brain and suggest structural changes in the MTL associated with cumulative psychosocial stress could underlie cognitive deficits seen in older adulthood. Future research will examine associations with MTL-dependent episodic memory performance.

Topic Line: EMOTION & SOCIAL: Other

F22 Normalizing Anomalies with Mobile Exposure (NAME): A novel intervention for reducing implicit biases

Nadir Bilici, University of Pennsylvania, Clifford Workman, University of Pennsylvania, Stacey Humphries, University of Pennsylvania, Roy Hamilton, University of Pennsylvania, Anjan Chatterjee, University of Pennsylvania

This pre-registered study used a smartphone-based intervention to test the hypothesis that implicit biases are attributable to a lack of exposure to the groups targeted by such biases. We predicted that exposure to people with facial anomalies would reduce implicit biases, and that this reduction would be greater than reductions for people of color (POC) since exposure to POC is more common than to facial anomalies. Forty participants completed Implicit Association Tests (IAT) before and after an exposure intervention (to anomalous faces or to POC, N=20 per intervention). In the first IAT, participants associated faces with and without anomalies with good and bad words. In the second, faces were either white or POC. In the intervention (twice per day over 5 days), they saw 10 faces. Then, they saw an additional face paired with a story about a time this person behaved prosocially. Finally, participants rated their feelings and indicated whether they found it easy to take the person's perspective. Across all participants, there was a significant main effect of time. For the anomalous faces intervention, there was an additional main effect of bias-type (anomalous or POC), with steeper reductions in implicit biases against anomalous faces than POC. Dispositional empathy (perspective taking) predicted the magnitude of reduction in implicit biases against anomalous faces but not POC. For the POC intervention, no main effects or interactions were significant. These results demonstrate the specificity of the Normalizing Anomalies with Mobile Exposure (NAME) intervention in reducing implicit biases against people with facial anomalies.

Topic Line: EMOTION & SOCIAL: Person perception

F23 Validating an fMRI task for assessing theory of mind in clinical populations: Neural response to and clinical correlates

Emily Dudek, University of Rochester, Bridget Shovestul, University of Rochester, Abhishek Saxena, University of Rochester, J. Steven Lamberti, University of Rochester Medical Center, David Dodell-Feder, University of Rochester

Theory of mind (ToM)-the ability to infer the mental states of others-is foundational for our ability to successfully navigate the social world. When impaired, our social lives are negatively impacted. Indeed, ToM and its neural basis is impaired in psychiatric disorders involving social functioning deficits, most notably, schizophrenia. Due to ToM's impact on functional outcomes, these social impairments have become targets for intervention. In order to understand the mechanisms contributing to these deficits and assess the impact of interventions, it is necessary to have validated measures to assess these neural impairments and their improvements over time. Despite hundreds of neuroimaging studies investigating the theory of mind network, few tasks have been empirically validated and made efficient for fMRI. Recently, the 'Why/How Task' (Spunt & Adolphs, 2014), in which participants are asked yes/no questions about social and nonsocial photos, has been shown to be one such task for localizing theory of mind regions. Here, we present findings from the first clinical application of the Why/How Task in a sample of people with schizophrenia compared with healthy controls. Using a priori regions of interest, preliminary results show hyperactivation among people with schizophrenia in regions such as the right and left temporoparietal junction and the ventromedial prefrontal cortex. Additionally, we find that the extent of these differences correlate with aspects of social ability. These findings demonstrate the clinical validity and utility of the Why/How Task for use in clinical studies of social dysfunction and its treatment.

Topic Line: EMOTION & SOCIAL: Person perception

F24 WITHDRAWN

F25 Perspective taking reduces group biases in neural motor resonance

Jeremy Simon, Brandeis University , Yanyi Jiang, Brandeis University

Similar neural circuits are activated during movement and the observation of movement and this motor resonance is thought to support action understanding and social coordination. Previous research shows that group biases can restrict motor resonance to the ethnic ingroup, with potential negative consequences for intergroup encounters and relations. We tested whether an empathic mindset can alleviate such group biases in motor resonance. Participants (n = 48) were told to adopt either an objective mindset or an empathic mindset while writing about a racial outgroup member and were then shown videos of ingroup and outgroup members performing a simple motor movement while electroencephalographic (EEG) recordings were taken. Motor resonance was measured as suppression of mu-wave oscillations (8-13 Hz) above left sensorimotor areas (electrode C3). Mindset and target group membership interacted such that participants resonated most with outgroup targets whose perspectives they took, suggesting that taking the perspective of an ethnic outgroup member can reduce group biases in motor resonance, potentially fostering an intuitive understanding across groups. In addition, participants taking the perspective of an outgroup member were less prejudiced and prejudice moderated the effect of group on resonance. Higher prejudice participants actually resonated more with outgroup targets, perhaps because outgroups' motivational relevance increases with prejudice. These results suggest that attitudes do influence group biases in resonance and that taking an empathic mindset can affect both attitudes and neural motor resonance.

Topic Line: EMOTION & SOCIAL: Person perception

F26 Large-scale Network Connectivity as a Predictor of Age: Evidence Across the Lifespan from the Cam-CAN Dataset

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Changes in the functional architecture of the brain-particularly increased coupling between executive cognitive control regions (EC) and the default mode network (DMN)-have been recently theorized to underlie shifts in cognitive abilities between young and older adults (Spreng & Turner, 2019). A prioritization of fluid cognition in young adulthood progressively gives its place to crystalized knowledge and an emphasis on semantic cognition in older adulthood, shifts that take place along with changes in functional connectivity between EC and DMN areas. In line with this model, here we used a large cohort (N = 530) of participants from the Cam-CAN database (18 - 88 years old) to examine whether resting-state functional connectivity between executive and default mode networks predicts participant age. In extension of past work, we further examined how connectivity between EC, DMN, and salience network regions impacts the hypothesized increased connectivity between EC and DMN areas as a result of aging. A series of multiple regression analyses revealed that connectivity between dorsolateral and ventromedial prefrontal cortex and parietal regions, including the precuneus, accounted for a significant portion of age variability and that the inclusion of the salience network improved the models' explanatory power. Follow-up analyses by age cohort further highlighted that these relationships dynamically change across the lifespan. We discuss these findings in the context of the default-executive coupling hypothesis for aging and propose avenues for future research in refinement of this model.

Topic Line: EXECUTIVE PROCESSES: Development &aging

F27 Age-related decline in resting state brain signal variability: Cause and Consequences

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Brain signals as measured by fMRI vary considerably from moment-to-moment even in the absence of any task and this variability declines with age. However, there are significant individual differences in the brain signal variability. What are the behavioral consequences of these differences and what is their neurochemical basis? Based on computational and animal research we hypothesized that individual differences in GABA (the brain's major inhibitory neurotransmitter) might play a critical role. In order to investigate this hypothesis, we recruited 50 older and 50

young adults and measured 1) brain signal variability using resting-state fMRI, 2) GABA levels using MR Spectroscopy in the bilateral ventrovisual, auditory and somatosensory cortex, and 3) behavioral performance on standardized fluid processing tasks from the NIH toolbox. We also pharmacologically manipulated GABA activity in a subset of our sample by administering lorazepam (a benzodiazepine, known to potentiate GABA activity). We found that whole-brain signal variability was significantly lower in the older adults and was significantly associated with their fluid processing ability. GABA levels in the visual, auditory and somatosensory cortex were also reduced in the older group and were associated with brain signal variability even after controlling for age and tissue-composition. Finally, potentiating GABA activity with lorazepam significantly increased brain signal variability relative to a placebo. These results are consistent with the hypothesis that age-related declines in GABA levels cause age-related declines in brain signal variability which in turn contribute to individual differences in fluid processing abilities among older adults.

Topic Line: EXECUTIVE PROCESSES: Development &aging

F28 Dimensional Label Learning: A Building Block for Later Dimensional Attention

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Previous research suggests learning labels for visual features is a building block of dimensional attention, known as the dimensional label learning (DLL) hypothesis. A model of the dimensional change card sort task (DCCS) investigated this hypothesis by demonstrating that strengthening label-visual feature associations (increased frontal-posterior connectivity) led to better performance. Our goal was to explore this hypothesis longitudinally from 33- to 45-months of age. We investigated activation while children performed dimensional label (DL) tasks for colors, shapes, embedded shapes and three task types (production, comprehension, matching). We used functional near-infrared spectroscopy (fNIRS) to measure from left frontal, left temporal-parietal, and right parietal regions previously implicated in dimensional attention. Clusters were thresholded at a value of $F=7.54$, $p<.01$ family-wise-error. Patterns of activation differed across tasks and dimensions, but groupwide activation was found in left middle frontal gyrus, bilateral supramarginal gyrus, and right angular gyrus. At 45-months, we gave children the DCCS and examined how DL activation was associated with performance. We found associations with the DCCS and shape comprehension ($r=.565$, $p<.05$) and matching tasks (color: $r=-.564$, $p<.05$; shape: $r=-.627$, $p<.01$; embedded: $r=-.605$, $p<.01$). Children also completed a control task (the Flanker) that we predicted would not be related to activation during the DL tasks. We found that the Flanker was unrelated to DL task activation. These results support the DLL hypothesis, as DCCS performance was related to earlier activation in the DL tasks. This suggests that learning labels for visual features is connected to later dimensional attention development. Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

F29 Contributions of task set inertia and task set preparation on voluntary task selection

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Most theories describing the cognitive processes underlying task switching allow for contributions of active task-set reconfiguration and task set inertia. Manipulations of the Cue-to-Stimulus-Interval (CSI) are generally thought to influence task set reconfiguration, while Response-to-Cue (RCI) manipulations are generally thought to influence task set inertia (i.e., proactive interference from the previous task-set). However, these theories do not adequately account for the processes underlying voluntary task selection, because a participant can theoretically prepare for an upcoming trial at any point. To this end we used drift diffusion models to examine the contributions of reconfiguration and task set inertia in 216 undergraduate students who performed either cued or voluntary task switching paradigms. In both paradigms, CSI manipulations primarily affected preparation on switches; however, longer CSIs did also facilitate preparation on repeats, suggesting CSI manipulations might influence general task set preparation rather than just reconfiguration. In the voluntary condition, RCI manipulations also facilitated preparation (captured by model parameters) when CSI was short. In both paradigms, RCI manipulations also affected task set inertia, and these effects were primarily on repeat trials. The results suggest that drift diffusion models can measure contributions of inertia and preparation to task switching performance, including identifying preparation that occurs outside of the CSI in voluntary switching. The results also suggest that reductions in switch cost caused by reduced inertia might be more related to impeding repeat performance rather than facilitating switch performance. Future work should attempt to link these effects to related brain networks.

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

F30 Neural Processes Underlying Context-Sensitive Cognitive Flexibility Adjustments

Audrey Siqi-Liu, Duke University, Tobias Egner, Duke University, Marty Woldorff, Duke University

Adaptive behavior requires finding, and adjusting to, an optimal tradeoff between focusing on a current task-set (cognitive stability) and updating that task-set when the environment changes (cognitive flexibility). Such dynamic adjustments of cognitive flexibility are observed in cued task-switching paradigms, where switch costs (the slowing in response time for switch relative to repeat trials), decrease as the proportion of switch trials in a block increases. However, the neural underpinnings of this block-proportion switch effect are not well understood. Here, we recorded 64-channel EEG as participants switched between letter and digit categorization tasks based on a cue preceding each trial. We investigated event-related potentials (ERPs) time-locked to the cue and to the target to reveal the neurocognitive processes that culminate in the observed final response-time differences that characterize the block-proportion effect. The cue-locked analyses replicated some previous findings of an early, anterior, switch-

related ERP negativity. Crucially, this switch-related negativity was larger in the high-switch-proportion blocks, suggesting it may be associated with the recruitment of control processes to reduce switch costs. Our novel target-locked analyses found that repeat trials elicited larger attention-shift-sensitive N2pc's compared to switch trials, indicating that the detection of and orienting to the relevant target may be easier on repeat trials. This effect was mainly driven by low-switch-proportion blocks and diminished in high-switch-proportion blocks, along with the behavioral advantage for repeat trials. These results provide insight into the series of top-down and bottom-up control processes that are recruited during the implementation of effective control of cognitive flexibility.

Topic Line: EXECUTIVE PROCESSES: Goal maintenance & switching

F31 Changes in the Nature of Associations between Internalizing Symptoms and Inhibitory Control from 3 to 5 Years of Age

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Emotional and cognitive functioning may bidirectionally influence each other over childhood, with the nature of the association changing with development. The goal of this study was to test associations among internalizing symptoms, specifically anxiety and social withdrawal, and executive functioning, specifically inhibitory control, in a sociodemographically diverse cohort (N=114) of children at 3.5 and 5 years of age. At both ages, children completed a Go/No-go task to assess inhibitory control, and their mothers completed the Child Behavior Checklist (CBCL), which provided measures of child anxiety and withdrawal symptoms. Across ages, inhibitory control scores showed moderate stability, whereas anxiety and withdrawal symptoms showed relatively low stability. At 3.5 years of age, increased anxiety and withdrawal symptoms were each associated with poorer inhibitory control, specifically as reflected in the inhibition of incorrect responses (sensitivity ranxiety= -0.217, rwithdrawn= -0.209; percent correct NoGo ranxiety= -0.212, rwithdrawn= -0.231). At 5 years of age, these associations were no longer significant and trended toward the positive direction; moreover, the differences in the correlation coefficients at 3.5 vs 5 years of age were significant for the associations of both anxiety and withdrawal symptoms with inhibitory control. These findings suggest that the nature of the association between internalizing symptoms and inhibitory control may change over early childhood. These findings have implications for how we conceptualize the development of inhibitory control in early life and how this executive functioning ability may relate to internalizing difficulties across early childhood.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

F32 Reward prediction error is modulated by cooperation in group task

Chikara Ishii, Kwansei Gakuin University, Jun'ichi Katayama, Kwansei Gakuin University

Computation of reward prediction error (RPE) is a vital processing for adaptive survival. The present study investigated the process in a time-estimation task with three people using simultaneous EEG recording. In experiment 1, we compared groups of three participants with individual participants. The task was to accurately estimate one second intervals and participants were rewarded with 10 JPY per trial, if the majority (at least two out of three) responded correctly (otherwise they lost 10 JPY). Consequently, the performance of an individual would affect the amount of rewards of all members in the group. For individual condition, responses by other members were simulated by a computer. A visual indicator displayed who responded correctly, and EEG was recorded from outcome onset for all participants. Epochs were averaged over outcome (correct, error) and trial type (uniform, majority, minority) within subjects, and between condition (group, individual). Difference FRN (error – correct ERP) for uniform-trial (i.e., all collect or error) was larger than those for majority- and minority-trials in the group condition, but not in the individual condition. In experiment 2, we investigated whether the effect was driven by group cooperation or simply the presence of others. Here, participants' individual performance did not affect others' reward. Difference FRN for all trial types did not differ with each other. These results suggest that the presence of others' is not enough to modulate the RPE.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

F33 Neurophysiological Responses in Prefrontal Regions Differ Between Musicians and Non-Musicians

Benjamin Schwartzmann, Simon Fraser University, Prabhjot Dhami, University of Toronto, Sylvain Moreno, Simon Fraser University, Faranak Farzan, Simon Fraser University.

Neuroscience research has shown that musical training is associated with extensive structural and functional neuroplasticity. Differences between musicians and non-musicians have been found in several areas of the brain, including motor-related cortices, as well as in areas involved in executive functioning, particularly the frontoparietal regions. However, how musical training may influence the neurophysiology of these specific regions has yet to be investigated. Here, we used transcranial magnetic stimulation (TMS) in conjunction with electroencephalography (TMS-EEG) to examine neurophysiological differences between musicians and non-musicians. Single pulse TMS-EEG was employed to assess cortical reactivity in bilateral dorsolateral prefrontal cortex, bilateral motor cortex, and bilateral intraparietal lobule. More specifically, we focused on the N100 and P200 TMS-evoked potentials (TEPs), which have been shown by prior literature to be indices of cortical inhibition and excitability. To gain insight into whether these neurophysiological measures are linked to inhibitory control, we correlated these TEPs with behavioral performance scores on an inhibitory control-related task. We also investigated how the

neurophysiological correlates of inhibitory control might differ between musicians and non-musicians. We specifically examined the N2 and P3 event-related potentials (ERPs), which are neurophysiological responses occurring during successful inhibitory control. Musicians were found to exhibit differences in neurophysiological-related inhibition and excitability measures in the prefrontal regions, but not in motor-related cortices and parietal cortices. Musicians were also found to exhibit greater negativity of the N2 ERP, suggesting that musical training may alter the neural correlates of inhibitory control.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

F34 Neural correlates of response inhibition in young children

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In this study, we examined the amplitude of the N2 event-related potential during a Go-NoGo task to better understand the emergence of response inhibition during the late toddler/early preschool period. Twenty-one 3-year-olds (M= 38.4 months, SD = 2.09 months; 10 males) completed a Go-NoGo task while electroencephalography was continuously recorded from a 64-channel EGI sensor net. Accurate, artifact-free trials were retained for analysis; on average, participants contributed 63 Go trials and 25 No-Go trials. Parents also completed the Child Behavior Questionnaire (Rothbart & Bates, 2006) to assess individual differences in temperament between children. N2 amplitudes were analyzed across frontal, central, and parietal clusters along the midline and in the left and right hemispheres. The N2 amplitude was larger for NoGo compared to Go trials across frontal and central sites, $F(1,20) = 5.46$, $p = 0.03$, particularly in the right hemisphere, $F(2,40) = 3.34$, $p < 0.05$. The magnitude of the N2 difference between Go and NoGo trials in the frontal right region was negatively associated with parental reports of toddler's inhibitory control, $r(18)= -0.55$, $p = 0.02$; children with lower inhibitory control showed more negative N2 amplitudes and a larger N2 difference between trial types. These results extend previous research supporting the N2 as a neural marker of response inhibition (e.g. Buss et al., 2011, Lamm et al., 2006, Hoyniak & Petersen, 2019) by 3-year-olds and suggest that parental reports of children's temperament are associated with differences in neural processing.

Topic Line: EXECUTIVE PROCESSES: Monitoring & inhibitory control

F35 The Central Executive Network in Schizophrenia: A Meta-Analysis of Structural and Functional MRI

Katrina Daigle, Suffolk University, Malvina Pietrzykowski, Suffolk University, Abigail Waters, Suffolk University, Lance Swenson, Suffolk University, David Gansler, Suffolk University

The neural structural and functional architecture of executive functions (EF) are of considerable interest given the strong clinical utility of EF as transdiagnostic predictors of adaptive functioning. Importantly, there is a gap in the meta-analytic literature assessing this relationship in neuropsychiatric populations, the concordance between structural and functional architecture, and the relationship of neuropsychological assessment of EF. Given the core EF deficits and neural abnormalities observed in individuals with Schizophrenia (SCZ), this serves as a useful population from which to understand this relationship. We conducted a meta-analysis of published studies (k=529) to elucidate the relationship between EF and central hubs of the central executive network (CEN) in vivo for structural (k=127; N=8) in SCZ (n=229) adults, and for functional (k=402; N=4) in SCZ (n=104) adults. To calculate mean effect sizes and confidence intervals (CIs) for the relationship between both functional and structural and neuropsychological assessment measures of EF, random effects modeling was used. Results revealed concordance in the brain behavior relationship between functional and structural measures such that larger size (r=.57, 95% CI=.26-.75) and greater BOLD activation (r=.54, 95% CI= .21-.99) were both associated with better performance on measures of EF. These results indicate that, when assessing the relationship between brain and EF behavioral performance, both structural and functional imaging, when taken in the CEN, are similarly predictive of EF performance. Findings are impactful in the context of methodological decisions in multi-modal neuroimaging research.

Topic Line: EXECUTIVE PROCESSES: Other

F36 Neural alpha oscillations during turn-taking piano duet index creative thinking and engagement to the partner's action

Barbara Nerness, Stanford University, Noah Fram, Stanford University, Kunwoo Kim, Stanford University, Aditya Chander, Yale, Cara Turnbull, Princeton, Elena Georgieva, Stanford University, Sebastian James, Stanford University, Matthew Wright, Stanford University, Takako Fujioka, Stanford University

Musical improvisation requires a complex organization of brain functions in order to generate musical ideas, translate them into actions, and integrate auditory and tactile feedforward/feedback for future planning. In addition, ensemble performance involves real-time coordination using a joint-action scheme. This study investigates how alpha oscillations index creative ideation and attention to one's partner during a turn-taking duet improvisation. Simultaneous EEG were recorded from two pianists while they alternated playing a scored or improvised melody, for a total of 4 phrases. Alpha power for each phrase was analyzed depending on whether a pianist was a starting or joining player. Prior to playing, both players showed a larger alpha ERD for improvisation than score, reflecting additional cognitive processes for preparation for the former. Furthermore, when listening to one's partner, alpha ERS occurred only if the partner played the score, indicating less attention paid to the partner's actions. Interestingly, when the joiner listened to the first phrase played by the starter, alpha ERD was significantly stronger than when they listened to the second phrase played by the starter, indicating higher engagement of the joiner, perhaps because they must fit their part to the new melodic context set by the starter. Our results suggest that a player's role in the musical structure as well as source of musical content both affect attentional engagement between duet partners.

Topic Line: PERCEPTION & ACTION: Audition

F37 Selectively Reinforcing the Speed-Accuracy Trade-Off in Decision Making

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Recent theories on cognitive control suggest that control functions are subject to the same reinforcement learning principles as other forms of behavior, and thus, can be conditioned by reward feedback. We investigated this idea on a well-studied control function, namely the regulation of one's speed-accuracy trade-off (i.e., 'caution') in decision making, which can be quantified by the drift diffusion model parameter boundary separation. As such, across two experiments, participants performed a random moving dots task, over the course of which their boundary separations were estimated and selectively reinforced on a trial-by-trial basis. Specifically, participants in the increase group were reinforced to increase their boundary separations, while participants in the decrease group were reinforced to decrease their boundary separations. While participants were unaware of this reinforcement learning rule, as assessed in a post-experiment questionnaire, their behavior did change accordingly. In the first experiment, we found the expected changes in boundary separations when comparing the first and last learning blocks, but not when comparing the neutral pre- and post-learning phases. Therefore, in a second experiment, we added random reward feedback to the pre- and post-learning phases, to make them more comparable to the learning phase. In this second experiment, we did find the expected changes in boundary separations when comparing the pre- and post-learning phases. Taken together, these findings support the idea that abstract control functions can be conditioned by reward.

Topic Line: EXECUTIVE PROCESSES: Other

F38 WITHDRAWN

F39 Enhanced cortical activity after n-back working memory training: An event-related potential source localization study

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Working memory (WM) is a core cognitive ability that involves the short-term maintenance and manipulation of information. There is some evidence (though mixed) that targeted training of WM can potentially enhance neural activity underlying cognition. We previously found that WM training resulted in improved cognitive performance and enhancement of N2 and P3 event-related potential (ERP) component amplitude. Here, we seek to extend these findings by identifying the cortical activity that is associated with these training-related ERP effects. Participants (n = 19) completed twenty sessions of adaptive, at-home n-back training (visual-letter stimuli, 25-30 minutes per session). Before and after training, participants completed a visual letter 3-back task, during which electroencephalographic (EEG) data were obtained. ERPs were derived from the EEG data. Cortical source activity was estimated using the local autoregressive average method, within the N2 (200-250 msec post-stimulus) and P3 (350-550 msec post-stimulus) time windows. Posttest vs. pretest activity was examined with paired t-tests (for 66 gyri, Benjamini-Hochberg corrected p-values). Within the N2 time window, parietal, occipital, and cingulate regions had significantly greater activity at posttest compared to pretest. This is suggestive of training-related enhancement of interference control and WM storage mechanisms, which are engaged by cingulate cortex and posterior-parietal regions, respectively. Within the P3 time window, prefrontal cortical areas (and additional regions) had significantly greater activity at posttest compared to pretest, suggesting enhanced executive control. These findings provide insight into the neural correlates of training-related improvements in WM.

Topic Line: EXECUTIVE PROCESSES: Working memory

F40 Sensory modality and information domain modulate behavioral and neural signatures of working memory interference

Justin Fleming, Harvard University, Michelle Njoroge, Boston University, Abigail Noyce, Boston University, Tyler Perraachione, Boston University, Barbara Shinn-Cunningham, Carnegie Mellon University

Recent evidence from functional magnetic resonance imaging has revealed interleaved sensory-biased regions in the lateral frontal cortex that are preferentially recruited during either visual or auditory attention and working memory (WM). These regions participate in sensory-biased cortical networks that can be flexibly recruited depending on information domain. Spatial auditory WM tasks recruit the visual-biased network, while temporal visual WM tasks recruit the auditory network. Using electroencephalography (EEG) and a WM interference paradigm, we assessed the behavioral costs and neural signatures of recruiting the same versus the complementary network during WM retention. Participants (N=20) were asked to remember spatial or temporal properties of auditory or visual stimuli. To explore effects of network interference, a second auditory task was sometimes presented during the retention period; this interfering task emphasized either spatial or temporal processing. Performance on the interfering task was worst when auditory information was being held in WM, reflecting a cost of increased load on the auditory network. In contrast, no behavioral costs of switching between the visual and auditory networks were observed. Neurally, we identified time-frequency-channel regions of interest (ROIs) in which the interfering tasks significantly altered oscillatory power. ROIs were found during the retention and probe task phases in the theta (4-7 Hz) and alpha (8-12 Hz) frequency bands. Within these ROIs, we observed differential signatures of WM depending on whether the sensory modality and information domain matched between the two tasks. These results help quantify the relative costs of loading one cognitive network versus switching networks mid-task.

Topic Line: EXECUTIVE PROCESSES: Working memory

F41 Neural Mechanisms underlying Discrimination of Pitch Intervals: Effects of Interval Deviation and Interval Size

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A pitch interval is determined by the frequency ratio of two pitches. Past studies have demonstrated the perception of the pitch interval is categorical. However, a few musicians are able to discriminate fine differences (less than a semitone) between an out-of-tune interval and a standard interval. Notably, the discrimination threshold of interval deviation has been found to increase along with the interval size. The aim of the present study was to examine the effects of interval size and interval deviation on neural activity during discrimination of pitch intervals. Twenty-nine trained participants (22.8±2.4 years old, 2 left-handed, 19 females) underwent an fMRI experiment, in which they were asked to determine whether heard intervals were larger than the standard intervals showed on screen. We used a factorial design with factor Deviation (semitone versus quartertone) and Size (minor second and minor sixth). Behavior data and fMRI data were subjected to 2x2 ANOVA. We observed significantly better performances for the larger interval deviation and smaller interval size. The main effect of interval deviation revealed that the 'tonal loop' or sensorimotor network displayed stronger activity for the smaller deviation. The main effect of interval size revealed that the sensorimotor network and occipitoparietal regions (including the intraparietal sulcus, superior parietal lobule, precuneus, and primary visual cortex) displayed stronger activity for the larger interval size. This finding suggests that occipitoparietal regions implicated in amodal spatial processing and general magnitude processing play a key role in discrimination of pitch interval with larger sizes.

Topic Line: EXECUTIVE PROCESSES: Working memory

F42 Cross-frequency coupled entrainment of EEG activity by transcranial alternative current stimulation

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Transcranial current stimulation is a potent neuromodulation technique used to enhance human cognitive function in a non-invasive manner. In this study, we investigated whether a cross-frequency coupled transcranial alternative current (CFC-tAC) stimulation improved working-memory performance. Eighteen participants were recruited for a tAC-treated group, and eighteen age-sex-matched controls also participated in this study as a sham group. Participants were instructed to perform a modified Sternberg task, where a combination of letters and digits was presented in three different workload conditions (3, 5, and 7 items to be encoded) before and after the tAC or sham stimulation. The stimulation group was treated with CFC-tAC stimulation for 20 mins (input channel: F3, return channels: Fp1, Fz, F7, and C3). In the present study, we analyzed parietal delta-phase/frontal high-gamma-amplitude cross-frequency coupling (CFC) of electroencephalographic data to find neural correlates for the enhancement of working-memory performance by tAC-treatment. We observed significant CFC differences between the tAC-treated and sham groups in the most difficult task condition (i.e., 7-workload). Since low-frequency phase and high-frequency amplitude coupling reflects large-scale communication during cognitive processing, this finding may reflect tAC influenced functional connectivity between frontal and parietal regions, resulting in performance-enhancement of working memory. Our observations provide neural correlates for the enhancement of working-memory performance by the CFC-tAC non-invasive stimulation.

Topic Line: EXECUTIVE PROCESSES: Working memory

F43 Microstructure in the posterior parietal cortex supports working memory function in 9-10-year-old children

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Research on Attention-Deficit/Hyperactivity Disorder (ADHD) implicates the critical role of executive function processes. An important and widely recognized component of executive function is working memory (WM), and an impaired WM function is commonly observed in ADHD, although the specificity of these deficits at a mechanistic level and their underlying neurobiology are still lacking. The current investigation leveraged the Adolescent Brain Cognitive Development (ABCD) study (https://abcdstudy.org) to evaluate individual differences in the microstructure of key regions that support WM across two tasks (NIH toolbox list WM, and emotional n-back tasks, see Casey et al., 2018; Garavan et al., 2018) and how they modulate ADHD-related effects in WM performance. Our analyses indicate that neurite density in the left ventrolateral prefrontal cortex (VLPFC) and bilateral posterior parietal cortex (PPC) regions predicted performance in the list WM task. Neurite density in the right VLPFC, the right PPC, and the right hippocampus predicted performance in the n-back task. The data further indicate that neurite density in the PPC, namely the intraparietal sulcus region differed across individuals with ADHD and healthy developing children. The PPC, in particular the intraparietal sulcus, has been frequently observed during WM operations. Notably, this region has been previously implicated for its importance in supporting focus of attention during WM operations (Öztekin et al., 2009; Cowan et al., 2011). The current set of results complement previous WM research, and provide further insight into our understanding of ADHD related deficits in working memory and their underlying neural substrates.

Topic Line: EXECUTIVE PROCESSES: Working memory

F44 An investigation of verbal vs. tonal working memory using non-invasive brain stimulation

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Working memory (WM) allows for the maintenance and manipulation of different types of information. Evidence for clear differences in working memory for auditory and visuospatial information exists, but it is unclear whether there are further distinctions between different types of auditory stimuli like verbal and musical information. Anodal transcranial direct current stimulation (tDCS) is thought to increase neural excitability, which has the potential to influence cognition. However, the influences of tDCS on cognition have been mixed. This study used tDCS to help determine whether neural dissociations exist between musical and verbal WM, if tDCS can enhance musical WM, and the influence of tDCS on verbal and tonal long-term memory (LTM). Participants (N = 67) completed a verbal 2-back task, a tonal 2-back task, and a LTM test in which memory for stimuli presented in the WM tasks was tested and confidence was assessed. Participants were randomly assigned to three tDCS conditions: no stimulation, sham, or stimulation. Stimulation occurred for twenty minutes over the left supramarginal gyrus and then participants completed both WM tasks and a LTM assessment. We failed to find enhancing effects of tDCS on WM or LTM performance. Tonal WM task accuracy was higher than for the verbal WM task, but no difference in performance was found in the LTM test. Participants were more confident on musical stimuli judgments compared to verbal stimuli in the LTM test. Musical and verbal information may be processed differently in WM, but similar effects do not appear to extend to LTM.

Topic Line: EXECUTIVE PROCESSES: Working memory

F45 Non-invasive Vagus Nerve Stimulation in treatment of disorders consciousness ? longitudinal case study

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Disorders of consciousness are notoriously difficult to rehabilitate. New techniques of brain stimulation may offer a glimmer of hope. Corazzol et al. (2017) reported promising results of vagus nerve stimulation on a patient in a persistent unresponsive wakefulness ('vegetative state', VS). We extend this line of research to a similar patient, but utilise a non-invasive stimulator from 'tVNS Technologies©'.

If transcutaneous vagus nerve stimulation (tVNS) helps restore consciousness, we hypothesized improvement in behavioural responses on a Coma Recovery Scale ? Revised (CRS-R) as well as increased peak oscillations in the theta-alpha range (4-16 Hz) in resting state EEG.

tVNS was applied for 4 hours daily, for 6 months. CRS-R was assessed weekly, while EEG bi-monthly. Both of these measures show signs of improvement. CRS-R scores initially ranged from 4-6 and rose to 9 in the first month, dropped to 5-6 in the second, to rise to the heights of 12 and 13 in the third and fifth month, fluctuating between 7 and 12 in the final month. Peak oscillations in the theta-alpha range showed a little rise from 6.24 to 6.56 Hz. The most noteworthy finding is the re-emergence of a second, smaller peak in this range, which was not present in this patient in a period preceding the stimulation. Healthy controls typically show two peaks in this range. These results suggest that tVNS may offer a promising and scalable tool to improve treatment of disorders of consciousness.

Topic Line: OTHER

F46 WITHDRAWN

F47 Images support novel word learning paired with novel meaning: An EEG study

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According to the complementary learning systems theory, novel words are initially encoded as episodic memory traces in the hippocampal system, separate from one's existing lexicon (Davis & Gaskell, 2009). After a period of consolidation (e.g. overnight sleep), these memory traces gradually become lexicalized and achieve stable and longer-term neocortical representations. To study whether the lexicalization of novel words can be expedited by integrated learning of verbal definitions and images (relative to verbal definitions learning only, Bakker et al., 2015), monolinguals were trained on two unique lists of novel words, one on Day 1 and another on Day 2. Both lists were tested using an EEG recorded semantic priming task on Day 2 and Day 8. Lexicalization of the novel words was studied by examining the N400 and LPC time windows. Day 2 ERP data show that, only for novel words learned on Day 1 but not for novel words learned on Day 2, novel words preceded by semantically related primes elicited an enhanced positive LPC response relative to novel words preceded by unrelated primes. Also, an N400 semantic priming effect emerged for novel word learned on Day 1 in the Pz channel. Day 8 ERP data indicate a more widespread LPC semantic priming effect for Day 1 novel words. This suggests that only novel words learned the day before and not on the day of testing demonstrate lexicalization and consolidation, in line with the complementary learning systems theory.

Topic Line: LANGUAGE: Lexicon

F48 Good enough' plausibility based processing modulates the N400 ERP component in online comprehension

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Does language comprehension proceed strictly according to syntactic rules as assumed by classic linguistic theory? Frequent misinterpretations of sentences such as 'The dog was bitten by the man' suggest that representations formed during sentence comprehension are sometimes influenced by event plausibility ('good enough' processing; Ferreira et al., 2003). However, it has been suggested that these influences of plausibility, at least when probed using comprehension questions, do not reflect online

language processing but rather reflect memory based processing subsequent to routine comprehension (Bader & Meng, 2018). We addressed this issue by recording event-related brain potentials (ERPs) during comprehension. Participants read passive sentences for which the plausibility of the agent and patient thematic roles was manipulated. Participants were asked to identify the agent or patient of the described event directly after each sentence. As expected, they made more errors for implausible role-reversed sentences such as 'The doctor was treated by the patient'. Intriguingly, N400 amplitudes patterned with (mis)interpretation. Amplitudes to the second noun were increased in correctly processed implausible sentences, and were equally attenuated in plausible sentences and in incorrectly interpreted implausible sentences. These results show that plausibility based 'good enough' processing happens online during comprehension. Furthermore, the results are in line with the view that N400 amplitudes reflect the change in an initial heuristic representation of sentence meaning (Rabovsky et al., 2018), but seem difficult to reconcile with accounts suggesting that the N400 reflects lexical retrieval (Brouwer et al., 2017).

Topic Line: LANGUAGE: Semantic

F49 Examining the neurocognitive basis of reading fluency in children with dyslexia & comorbid dyslexia/ADHD

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Dyslexia and attention-deficit/hyperactivity disorder (ADHD) are among the most common neurodevelopmental disorders, affecting 15% of school-aged children. The comorbidity of dyslexia and ADHD is striking, with 25-40% of children with one diagnosis meeting the diagnostic criteria for the other. However, limited research has examined the neurocognitive mechanisms underlying the reading challenges present in these populations. We examined the neurocognitive processes underlying fluent reading in three groups of children (ages 6-13 years old): typically developing (TD; n = 15), dyslexia (RD; n = 13), and comorbid dyslexia/ADHD (RD+ADHD; n = 8). Participants completed an fMRI task in which they read aloud stories while being recorded. In-scanner behavioral performance revealed that RD and RD+ADHD groups showed reduced accuracy and slower rate compared to TD. Compared to TD, there was reduced left-hemisphere activation during story reading in both RD and RD+ADHD. Within the left-hemisphere reading network, compared to TD there was comparable hypoactive recruitment of the inferior frontal gyrus and fusiform gyrus for RD and RD+ADHD. RD+ADHD differed from TD in the middle temporal gyrus and angular gyrus, whereas RD differed from TD in the superior temporal gyrus and supramarginal gyrus. There were no brain activation or in-scanner performance differences between RD and RD+ADHD in contrast to predictions of the 'cognitive subtype' hypothesis positing that RD with ADHD would show more severe deficits than RD alone when reading text. Overall, these findings further our understanding of the neurocognitive processes supporting reading, and how these processes compare in RD and RD+ADHD.

Topic Line: LANGUAGE: Other

F50 Child and adult cortical selectivity for English and American Sign Language using fMRI

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Our goal was to determine whether the same cortical regions are selective for language in American Sign Language (ASL) speakers and English speakers, in both children and adults. d/Deaf and hearing adults and children listened to or watched stories while undergoing functional magnetic resonance imaging (fMRI). Participants included hearing English-speaking adults (n=24), signing adults (n=36, 29 d/Deaf, 7 hearing children of d/Deaf adults (CODA)), English-speaking children (n=96, age range 5-12 years), and signing children (n=24, 20 d/Deaf, 4 CODA, age range 6-12 years). For each participant, we extracted the contrast value for English stories > foreign language (English speakers) and ASL stories > non-signs (ASL speakers), within the top-50 voxels per parcel per participant, in parcels from the Brainnetome atlas. Next, we calculated the correlation of the language effect size across parcels (i.e. which regions showed relatively smaller or larger language responses), comparing each individual to a group average. We found that adult ASL speakers activate a consistent set of regions for language comprehension, but these were significantly different from the regions activated by English. We further tested whether delayed access to sign language impacted these results by splitting the ASL speakers into separate groups of native signers and delayed signers.

Topic Line: LANGUAGE: Other

F51 Laminar specific fMRI reveals directed interactions in distributed networks during language processing

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Interactions between top-down and bottom-up information streams are integral to brain function but challenging to measure noninvasively. Laminar resolution, functional MRI (lfMRI) is sensitive to depth-dependent properties of the blood oxygen level-dependent (BOLD) response, which can be potentially related to top-down and bottom-up signal contributions. In this work, we used

lfMRI to dissociate the top-down and bottom-up signal contributions to the left occipitotemporal sulcus (LOTS) during word reading. We further demonstrate that laminar resolution measurements could be used to identify condition-specific distributed networks on the basis of whole-brain connectivity patterns specific to the depth-dependent BOLD signal. The networks corresponded to top-down and bottom-up signal pathways targeting the LOTS during word reading. We show that reading increased the top-down BOLD signal observed in the deep layers of the LOTS and that this signal uniquely related to the BOLD response in other language-critical regions. These results demonstrate that lfMRI can reveal important patterns of activation that are obscured at standard resolution. In addition to differences in activation strength as a function of depth, we also show meaningful differences in the interaction between signals originating from different depths both within a region and with the rest of the brain. We thus show that lfMRI allows the noninvasive measurement of directed interaction between brain regions and is capable of resolving different connectivity patterns at submillimeter resolution, something previously considered to be exclusively in the domain of invasive recordings.

Topic Line: METHODS: Neuroimaging

F52 L1 Morphological Typology Influences Patterns of Neural Activation for L2 Inflectional Processing: An fNIRS study

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Inflectional morphology is a persistent problem in L2 learners and serves as a clinical marker for language disorders. This study investigated how cross-linguistic differences in L1 morphological typology impact bilinguals' neural responses to processing L2 inflections. Languages differ in morphological typology along a continuum: synthetic to analytic. Spanish (synthetic) has a complex inflectional system, while Mandarin Chinese (more analytic) lacks inflection but uses a rich compounding process. Left inferior frontal gyrus (L-IFG) is involved in processing inflected words, while left middle temporal gyrus (L-MTG) is involved in lexical-based semantic processing such as compounding. We hypothesized that English (L2) inflectional morphemes would evoke more L-IFG engagement in Spanish bilinguals (rich inflection) and more L-MTG engagement in Mandarin bilinguals (rich compounding). While undergoing functional near-infrared spectroscopy (fNIRS) neuroimaging, Spanish-English bilingual (n=19), Mandarin-English bilingual (n=20), and English monolingual (n=20) adults completed a picture-sentence judgment task targeting the third person singular -s. English monolinguals showed significantly higher accuracy than the bilingual participants. No behavioral differences was found in accuracy or response time between the two bilingual groups. Preliminary fNIRS analysis revealed that Chinese-English bilinguals showed greater activation in areas including left MTG and anterior prefrontal cortex compared to English monolinguals. Conversely, Spanish-English bilinguals showed greater activation in L-IFG as well as dorsolateral and medial prefrontal cortex than English monolinguals. Results supported our hypotheses and suggested that L2 learners process inflectional morphology differently from L1 learners, and the differences in brain activations were linguistically principled on the typological features of their L1.

Topic Line: LANGUAGE: Other

F53 White matter pathways support dual routes for pre-reading in early childhood

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Reading is a complex cognitive process involving decoding and comprehending of the printed texts and is critical for individuals to acquire knowledge. Reading is related to academic success. Learning to read requires transformation from print to speech and print to meaning, which involves multiple functional brain regions connected through white matter pathways. Research has shown that changes of white matter are sensitive measures to use for early identification for children at-risk for reading difficulties. Multiple white matter pathways have been linked to language or reading. This study presents the white matter characteristics of two pathways in pre-readers. 19 typically developing children, between the age of five to seven, were scanned. Our results demonstrate the brain-behavior correlation using white matter data from pre-readers. High fractional anisotropy (FA) of posterior arcuate fasciculus tract is correlated with high raw scores of phonological awareness (PA), while high FA of posterior left inferior fronto-occipital fasciculus tract is correlated with high verbal IQ. PA tests the phonological ability and verbal IQ examines the semantic skill. Our findings suggest white matter microstructure changes before formal reading instructions start and white matter tracts also have different traits (e.g., AF as dorsal pathway correlates with phonological processing, while IFOF as ventral pathway correlates with semantic processing), which is already present in pre-readers (age 4:6 ? 6:9 years: months).

Topic Line: LANGUAGE: Other

F54 Acoustic entrainment of speech supports comprehension under moderate noise, but degrades under more severe adversity

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Daily life demands comprehending speech under noisy conditions, like conversation in a noisy restaurant. Multivariate temporal response function (mTRF) modeling identifies electrophysiological signals that entrain to continuous speech, providing evidence that cortical entrainment of an acoustic signal reflects directed attention to that speech. Entrainment degrades under noise, predicts comprehension, and increases for non-native listeners. We test the hypothesis that listeners modulate cortical entrainment of speech under different adverse conditions, reflected by an increase in entrainment under moderate noise or second language but decrease under severe noise. Twelve Chinese-English bilinguals in Beijing underwent EEG while listening to 60 minutes of an audiobook recorded in both Mandarin and English. Twelve additional participants are being recruited. After each one-minute track, participants answered two comprehension questions. Half of

the tracks were presented in Mandarin and the other half were presented in English (on separate days), counterbalanced between subjects. In each language, speech was mixed with three levels of noise: none, moderate, and severe. We estimated cortical entrainment for each track using mTRF and performed a linear mixed-effects regression, controlling for comprehension accuracy. Contrary to our prediction, we found that entrainment of the non-native language was significantly lower than the native language ($B=0.02$, $p<0.001$). In both languages, entrainment significantly increased under moderate noise ($B=0.01$, $p<0.001$), but did not significantly differ between no noise and severe noise ($B<0.01$, $p=0.82$). Our hypothesis regarding noise intensity is supported, and proficiency differences between our sample and previous studies may explain the unexpected non-native language finding.

Topic Line: LANGUAGE: Other

F55 Distinct neural signatures of semantic retrieval and event updating during discourse comprehension

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Currently, there are multiple competing accounts of the functional significance of the N400 component of the event-related brain response. Some previous studies have linked this neural response to the difficulty of retrieving semantic information associated with incoming words from memory, but it is unclear to what extent this ERP response may also reflect the updating of prior discourse information. To help distinguish the neural mechanisms underlying semantic retrieval and event updating, we developed a set of discourse scenarios with critical words that were either highly informative or uninformative (e.g. 'The way things were going, no one expected it to happen. It left all of the onlookers completely speechless. After the touchdown/commotion?...). As confirmed by offline ratings, only informative continuations were useful for re-interpreting information in the prior context. These critical words were carefully matched on lexical characteristics, predictability, and semantic association with the preceding context. Contrary to the predictions of some accounts, this novel informativeness manipulation produced no differences in the amplitude of the N400, and instead produced a long-lasting frontal positivity, beginning approximately 250ms after word onset. When semantic predictability was manipulated in a separate set of discourse scenarios, this produced clear differences in the N400, which differed in both polarity and scalp distribution from the effects of informativeness. Finally, the magnitude of the informativeness effect correlated significantly with participants' offline comprehension accuracy. These findings provide evidence for two distinct neural signatures associated with semantic retrieval and retroactive event updating during reading comprehension.

Topic Line: LANGUAGE: Semantic

F56 Bilateral Frontal Aslant Tract Association With Verbal Fluency in Young Children With and Without ADHD

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Attention-deficit hyperactivity disorder (ADHD) is a disorder typically diagnosed in early childhood, and is characterized, in the majority of children, by deficits in executive function (EF). There is a well-known comorbidity between ADHD and speech-language disorders (McGrath et al, 2008; Efron & Sciberras, 2010). In this study, we examined the relationship between a recently discovered bilateral language pathway, the Frontal Aslant Tract (FAT), and phonemic and semantic scores on the NEPSY in 196 children with (n=100) and without (n=96) ADHD using diffusion weighted imaging. The FAT is a long association fiber pathway (Catani et al, 2012) in the frontal lobe that is thought to play an important role in verbal fluency and speech production (Dick, Bernal, & Tremblay, 2014). The FAT is most commonly thought to connect the inferior frontal gyrus (pars opercularis (Op) and pars triangularis (Tri)) to pre-supplementary motor area (pre-SMA) and supplementary motor areas (SMA) (Broce et al., 2015; Catani et al, 2013). The left FAT (preSMA_Op segment) predicted higher NEPSY total phonemics scores for the control group ($B=0.23$, $p<0.05$), but there was no effect for the ADHD group. Furthermore, for the right FAT (preSMA_Tri segment) predicting semantic scores an interaction was found between the control and ADHD group ($B=-0.18$, $p<0.05$). In the control group, the right FAT predicts improved semantics scores ($B=0.48$, $p<0.001$) but decreased semantics scores in the ADHD group ($B=-0.33$, $p<0.01$). These findings imply that the bilateral FAT might be an important biomarker for speech dysfunction in children with ADHD.

Topic Line: LANGUAGE: Semantic

F57 A graded effect of real-world plausibility on the N400 evoked by lexically unpredictable words

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It is well established that the N400 varies with the semantic probability of a word. However, because most studies have used cloze as a proxy for semantic probability, it has been difficult to characterize N400 differences on words that might vary in their semantic predictability (based on real-world knowledge) but that are lexically unpredictable. We measured electroencephalogram (EEG) as participants read highly constraining discourse scenarios that included lexically unpredictable words (<1% cloze), which varied continuously in their event plausibility from merely unexpected to highly implausible. We observed a linear, graded effect of plausibility on the N400, with additional effects on a later, post-N400 positivity. Moreover, in a delayed recall task, participants were most likely to misremember words that they had predicted in very implausible scenarios. These results suggest that the N400 is sensitive to real-world semantic knowledge, even when

specific lexical items cannot be predicted, and that plausibility can have downstream influences on memory.

Topic Line: LANGUAGE: Semantic

F58 Comprehension of spatially-related words relies on direction-specific processes in the spatial attention network

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We investigated conceptual processing of nouns referring to objects that are typically perceived up or down in space (e.g., cloud, floor). Previous behavioral research has demonstrated that processing of up/down words influences response times to subsequently presented visual targets in compatible vs. incompatible locations. Recent eye-tracking experiments observed that processing up/down words speeds up saccades to both subsequently and simultaneously presented visual targets in compatible locations. In fMRI studies, such processing activates prefrontal and parietal brain areas involved in oculomotor processes. Building on this background, we conducted a combined TMS-fMRI study to test whether spatial word processing shares patterns with covert spatial attention. Using machine-learning techniques to analyze brain activity, we found significant word decoding (up vs. down) and cross-decoding from covert spatial attention (up/down) to words (up/down) in the occipital-parietal cortex and the left frontal eye field region. Moreover, we found that TMS delivered to the frontal eye field (FEF) area differentially affected the processing speed of spatial relative to non-spatial/abstract words when participants performed a concreteness judgement task but not when they performed an explicit spatial judgement task. Our findings suggest that retrieving spatial aspects of word meanings involves the activation of direction-specific processes in the cortical network for spatial attention that are shared with overt and covert spatial attention.

Topic Line: LANGUAGE: Semantic

F59 The P600 as a measure of Implicit Knowledge in Artificial Grammar Learning

Sarah Alam, , Sarah Alam, Harvard University MGH Institute of Health Professions, Yael Arbel, MGH Institute of Health Professions

The P600 is an event-related potential associated with the processing of syntactic violations and various studies have implicated the P600 as a measure of implicit grammatical knowledge. This project used two versions of an Artificial Grammar Learning (AGL) paradigm to investigate the effects of explicit and implicit learning on the elicitation of the P600. In a 'No Suppression' version of the AGL task, participants were passively exposed to grammatically correct strings in the training phase and asked to judge the grammaticality of string in the testing phase. Stimuli consisted of strings of 2-6 shapes (circle, square, diamond, hexagon). In a 'Suppression' version of the task, participants were instructed to repeat a sentence out loud during the training phase as grammatically correct strings were shown on the screen. Stimuli consisted of strings of 2-6 abstract symbols. This secondary task aimed to occupy the participants' phonological loop by eliminating their ability to rehearse and memorize the incoming strings, thereby decreasing their ability to engage in explicit learning strategies. In the testing phase, participants were similarly asked to judge the grammaticality of strings. Using the P600 as a neurophysiological indicator of grammar learning, participants' EEG data were analyzed to see if P600 elicitation was sensitive to grammaticality of strings, accuracy in participants' judgments of grammaticality, or suppression of explicit learning strategies. While no accuracy differences were found between the suppression and the no suppression conditions, amplitude differences in the P600 were found between the two conditions.

Topic Line: LANGUAGE: Syntax

F60 Evaluating Morpho-Syntactic Aspects of the Neural Working Memory Circuit

Emily Wood, University of South Carolina, William Matchin, University of South Carolina

A phonological working memory (WM) loop (Baddeley, 1974; 2003) is commonly thought to support sentence comprehension. However, psycholinguistic research suggests the existence of a WM architecture more specific to sentences (Lewis et al., 2006: Caplan & Waters, 1999). We tested whether anterior portions of the inferior frontal gyrus might underlie a sentence-specific WM system (Fedorenko et al., 2011; Matchin, 2017) by performing an fMRI study in 20 healthy, right-handed, native English speakers comparing the subvocal rehearsal of three conditions matched for number of syllables: (i) meaningless speech sequences (phonological condition, e.g. ninyo pobset), (ii) meaningful words without structured syntax (semantic condition, e.g., hermit dogma), and (iii) jabberwocky phrases with minimal semantic content but syntactic structure (syntactic condition, e.g. , these clopes this pand), using a standard perceive and rehearse paradigm used previously to localize sensorimotor WM circuits (Venezia et al., 2015), subtracting out perception-related activation, localizing the rehearsal process. Preliminary analyses reveal that all three conditions produce similar activation in the inferior frontal and precentral gyri (Hickok & Poeppel, 2007; Buchsbaum et al., 2011), without preferential activation for syntactic rehearsal in anterior portions of the inferior frontal gyrus. However, we did identify stronger activity for syntactic rehearsal in bilateral supplementary motor area (SMA). The SMA has been previously implicated in prosodic processing during comprehension and timing during production (Kotz et al., 2016). Suggesting that the neural architecture involved in WM depends on the nature of the internal

content of the stimulus, which for phrases and sentences crucially involves prosodic information.
Topic Line: LANGUAGE: Syntax

F61 Test-retest consistency of hippocampal subfield volume measures in a developmental sample

Roya Homayouni, Wayne State University, Qijing Yu, Wayne State University, Sruthi Ramesh, NYU Long Island School of Medicine, Ana Daugherty, Wayne State University, Noa Ofen, Wayne State University

The hippocampus (Hc) is composed of cytoarchitectonically and functionally distinct subfields: subiculum, cornu ammonis sectors (CA1-3) and dentate gyrus (DG). Limited evidence on humans and animals suggests differential maturation rates across the Hc subfields. While longitudinal studies are essential in demonstrating differential developmental changes across Hc subfields, a prerequisite for interpreting meaningful longitudinal effects is establishing test-retest consistency of Hc subfields volume measures obtained in different time points. Here, we examined test-retest consistency in Hc subfields in two independent developmental samples. Sample 1 (n=28, ages 7-20 years, mean=12.64, SD=3.35) underwent MRI twice with a one-month delay. Sample 2 (n=27, ages 8-17 years, mean=11.90, SD=2.78) underwent MRI twice with a two-year delay. Specialized high-resolution T2-weighted MR images (0.4×0.4×2 mm3) were collected and manually traced using a reliable longitudinal manual demarcation protocol. In both samples, we found excellent consistency between Hc subfield volumetric measures in the two visits, assessed by two-way mixed intra-class correlation (ICC(3) single measures≥0.87). Bland-Altman plots further indicated that volumetric differences between the two time points (Visit2–Visit1) were not significantly different from zero ($|t|\leq1.86$, $p\geq0.07$). Moreover, difference values were not related to the mean values in the two visits in any subfield ($|\text{Pearson's } r|<0.30$, $p\geq0.17$) suggesting there was no systematic inconsistency between the volumes of two visits. Overall, we demonstrate excellent longitudinal consistency of Hc subfields volume implying the high reliability of these methods using manual demarcation protocol in assessing longitudinal changes across development.

Topic Line: LONG-TERM MEMORY: Development & aging

F62 Concept organization in adults and young children

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Knowledge is organized by connecting related concepts together, but it is likely that, as more knowledge is gained across development, the structure of this organization will change. Yet, little is known about how knowledge structure changes from childhood to adulthood. Do adults and children organize concepts differently? Research on false memory suggests that consistency in structure increases with age, with adults demonstrating stronger, predictable connections while preschool-aged children demonstrate idiosyncratic organization (Brainerd et al., 2008). However, studies addressing this directly have been inconsistent in their findings and have only included older children (Dubossarsky, De Deyne, & Hills, 2017; Zortea et al., 2014). Further, some false memory studies suggest that children and adults differ on which concepts are centralized in an organizational network (Carneiro et al., 2007), yet this has not been addressed directly. To characterize concept organization in adults and young children, we had 100 adults and 100 4- and 5-year-olds perform a free association task with 25 word cues. Analyses revealed that adults were more consistent in their responses, with children providing more responses per cue and a higher percentage of idiosyncratic responses. Importantly, consistent responses within an age group were also more likely to be consistent across age groups. These consistent responses also had more connections and were more centralized in each respective network. These findings suggest that as knowledge is acquired, it is structured in an increasingly organized fashion that is shared across individuals. However, the foundation for this knowledge structure is present even in early childhood.

Topic Line: LONG-TERM MEMORY: Development & aging

F63 Memory after hippocampal vs parahippocampal damage

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It is highly disputed whether familiarity is dissociable from recollection at the neurofunctional level within the medial temporal lobes (MTL). According to 'dual-process' models, the former relies on the parahippocampal gyrus, especially the perirhinal cortex (PRC), whereas the latter relies on the hippocampus (HPC). We sought to assess this dissociation in the recognition memory of patients with different profiles of MTL damage. We recruited an exceptionally rare patient with focal PRC damage, along with 8 patients with atrophy in the HPC, which extended to various degrees in parahippocampal structures. Of those 8 patients, only one showed additional PRC atrophy. Healthy controls (n=15) and patients (n=9) participated in 3 custom-made tests of visual recognition memory: 2 paradigms used confidence ratings and different response deadlines to assess recollection and familiarity for faces, scenes, and words; 1 paradigm assessed source and item memory. Both patients with PRC damage showed impaired item memory and familiarity, especially for faces. However, the patient with additional HPC atrophy also showed impaired source memory and recollection. Patients with HPC but no PRC damage showed impaired recollection and source memory, which correlated with the extent of their HPC atrophy. Their familiarity and item memory estimates were associated with the volume of entorhinal, PRC, and parahippocampal cortices in a material-

specific fashion. This double dissociation provides strong evidence in support of dual process models of recognition memory, whereby familiarity and item memory rely on the parahippocampal gyrus, whereas recollection and source memory rely on the HPC.

Topic Line: LONG-TERM MEMORY: Episodic

F64 Disassociations in the specificity of functional networks centered on hippocampus and VTA following exposure to novelty

Emily Cowan, Temple University, Matthew Fain, Temple University, Ian O'Shea, Northeastern University, Vishnu Murty, Temple University.

Our memory systems are selective, prioritizing memory for salient changes in the environment. The ability to detect novelty is therefore critical for the formation of adaptive memories. Exposure to novelty has been shown to facilitate memory consolidation, processes that are mediated by both the VTA and hippocampus (Wang & Morris, 2010). While these regions are known to work in concert, it is unclear whether they support systems-level consolidation within specific task-relevant regions or more diffusely across large-scale memory networks. Participants completed resting-state scans prior to and following exposure to novel scene images (N=37). We examined changes in hippocampal and VTA functional coupling with both targeted task-relevant ROIs, and broad scale posterior medial and anterior temporal (PMAT) memory networks (Ritchey et al., 2014). Following exposure to novelty, hippocampal coupling with task-relevant regions in parahippocampal cortex was increased (pre vs. post-encoding rest: p=0.04), but there were no differences in coupling with either large-scale network (pre vs. post-encoding rest: PM: p=0.62, AT: p=0.38). In contrast, following exposure to novelty, VTA coupling with parahippocampal cortex did not significantly differ from pre-encoding rest (p=0.7), but coupling with both large-scale networks was enhanced (PM: p=0.05, AT: p=0.003). Together, this double dissociation suggests that consolidation mechanisms for the hippocampus and VTA may act on different spatial scales, supporting a model by which the hippocampus targets reactivation of specific memory traces whereas the VTA facilitates information processing across large-scale networks.

Topic Line: LONG-TERM MEMORY: Episodic

F65 Visual imagery absence in Aphantasia is associated with a reduced capacity to remember the past and imagine the future

Alexei Dawes, University of New South Wales, Rebecca Keogh, University of New South Wales, Thomas Andrillon, Monash University, Joel Pearson, University of New South Wales

Visual imagery is a cognitive tool thought to play an instrumental role in supporting episodic construction processes such as autobiographical memory and future prospection. Some individuals, however, lack the ability to voluntarily generate visual imagery altogether – a congenital condition termed "aphantasia". Recent findings using objective measures of sensory imagery strength suggest that aphantasia is a condition defined by the veritable absence of visual imagery, rather than poor metacognitive awareness of imagery. Across two studies, we investigated the impact of visual imagery absence on both subjective and objective measures of episodic memory and future prospection. In Study 1, we employed a large sample, self-report design to demonstrate that compared to participants with normal visual imagery ability, aphantasic participants report less vivid and phenomenologically rich episodic memories and imagined future events. In Study 2, we extended these findings by assessing objective episodic construction performance in an independent sample of aphantasic participants using an adapted form of the Autobiographical Interview. Aphantasic participants exhibited a reduced capacity to generate episodic events compared to participants with visual imagery, both when remembering the past and imagining the future. These alterations were predominantly driven by a deficit in episodic details and a reduction in perceptual language use, and were mirrored by significantly lower self-rated event vividness. It is argued that individual differences in visual imagery ability must be accounted for when investigating episodic memory performance. Overall, our data suggest that visual imagery may act as a normative representational format for remembering the past and imagining the future.

Topic Line: LONG-TERM MEMORY: Episodic

F66 Reward-related memory benefits cannot be explained by post-encoding rehearsal

Matthew Fain, Temple University, Arielle Tambini, University of California Irvine, Vishnu Murty, Temple University

Previous research shows periods of post-encoding rest are known to facilitate consolidation of reward-related memory (Murayama & Kitagami, 2014; Patil et al., 2016; Murty et al., 2017). However, the mental operations that contribute to memory consolidation during these rest periods are relatively unknown. Periods of post-encoding rest may allot an opportunity to rehearse valuable information or, alternatively, an opportunity for quiescence which enables incidental memory replay. In this study, we systematically manipulated rehearsal of high-value information using a post-encoding reward incentive structure. Subjects first completed a reward-motivated encoding task where they were instructed to make associations for image and word pairs ? each of which was categorized as either high or low reward. To manipulate rehearsal after encoding, we either encouraged rehearsal of high-reward pairs before an incentivized memory test (n=32) or immediately administered an incentivized memory test prior to a period of rest (n=31) using a between-subjects design. After a 24-hour memory test, we found that item memory (Hits-FA) was greater for high-reward versus low- reward items (p=0.03), and there were no differences in reward-related memory enhancements between groups (p=0.8). Similarly, associative memory was greater in the high-reward versus low-reward conditions (p=0.02), and again there were no differences for reward-related memory enhancements between groups (p=0.5). These findings suggest that rehearsal of high-value material during a post-encoding period does not provide more reward-motivated memory benefits when juxtaposed with endogenous consolidation processes occurring during post-encoding rest.

Topic Line: LONG-TERM MEMORY: Episodic

F67 Changes in neural activity across repeated retrievals of autobiographical memories

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Research using laboratory-based measures of episodic memory have documented changes in neural activity, particularly within the hippocampus, across repeated retrievals of a memory. However, less is known about how this repetition effect manifests during naturalistic forms of memory such as autobiographical remembering. To address this knowledge gap, we ran an fMRI experiment in which twenty-four participants retrieved pre-selected autobiographical memories at four time points within a single testing session. Using a multivariate analytic approach (Partial Least Squares), we established a pattern of neural activity across the brain that dissociated between early (first retrieval) and later rehearsals (third and fourth retrievals) of the same memory. Early rehearsal was associated with activity within the autobiographical memory network that included medial temporal lobe regions (e.g., bilateral parahippocampi and anterior hippocampi). Later rehearsals were associated with distributed activity within the parietal cortices (e.g., bilateral inferior parietal lobules). A subsequent analysis examined repetition effects within the hippocampus ? a structure critical for constructing autobiographical memory representations. This analysis revealed that repeatedly retrieving an autobiographical memory was associated with a decrease in hippocampal activity that was restricted to anterior regions. These data indicate that initially retrieving an autobiographical memory requires the autobiographical memory network to construct a mental representation of the remembered event more so than subsequent retrievals. Our findings further suggest that the anterior hippocampus plays a critical role during initial memory construction. Altogether, these data show how the neural mechanisms of autobiographical memory change as a function of what has already been recalled.

Topic Line: LONG-TERM MEMORY: Episodic

F68 WITHDRAWN

F69 Musical rhythm orchestrates neural activity and influences stimulus processing at specific moments in time

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The brain spontaneously tracks rhythmic temporal regularities in the environment, such as music, through synchronization of neural oscillations to the beat. In a recent study, we found that individual variability in this neural tracking of rhythm correlated with the rhythmic modulation of memory across participants (Hickey et al, under review). Specifically, individuals with stronger neural tracking of a background beat during encoding demonstrated better subsequent memory for visual images presented in-synchrony versus out-of-synchrony with the beat. An outstanding question is whether differential neural processing also occurs at the time of stimulus presentation within subjects and enhances processing of images presented in-synchrony (on-beat) versus out-of-synchrony (off-beat) with the background beat. To address this question, we analyzed data from our prior EEG study in which participants incidentally encoded on-beat or off-beat images in the presence of a background musical rhythm. Results revealed differences in the amplitude and phase angle of electrophysiological responses at the time of stimulus presentation for on-beat versus off-beat images. Specifically, N2/P3 ERPs were enhanced for on-beat images compared to off-beat images over frontocentral electrodes. In addition, on-beat images occurred closer to the peak of the ongoing oscillations at the beat frequency (1.25 Hz). These results reveal differential neural processing on a trial-by-trial basis within subjects depending on the alignment of the stimulus with the background rhythm (on-beat versus off-beat). More broadly, these results support the hypothesis that neural responses to external rhythms influence higher-order cognitive functions, such as memory, by prioritizing processing at specific moments in time.

Topic Line: LONG-TERM MEMORY: Episodic

F70 ERP and Oscillatory Dynamics Differentiate Forget and Thought Substitution Cues in Intentional Forgetting

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Prior research has demonstrated that people are capable of intentionally forgetting information when instructed to do so. One popular method for studying forgetting is the directed forgetting paradigm, where 'forget' cues are presented either after each item (item-method) or after an entire block of items (list method). The specific mechanisms underlying directed forgetting remain a topic of debate, with accounts ranging from terminating rehearsal of forget items, direct suppression of forget items, or disengaging from contextual information through thought-substitution to reduce retrieval access for forget items. Here, we investigated these accounts by incorporating a thought-substitution condition ('Imagine' cue) along with Remember and Forget cues in an item-method directed forgetting paradigm. Imagine cues instructed participants to imagine themselves in a particular context following the presentation of each study word. This has previously been shown to shift context in list-method paradigms, but has never been examined in an item-method paradigm. Behaviorally, similar forgetting was found for Forget and Imagine cues, with both conditions producing lower recognition accuracy compared to Remember cues (n=28). Additionally, EEG was recorded during instruction cues to examine neural activity related to remembering, forgetting, and imagining. Both event-related potentials (ERPs) and oscillatory activity dissociated remember and forget cues, as well as forget and imagine cues. These results suggest that different strategies can produce similar forgetting, but may rely on separable neural mechanisms. Our results may aid in adjudicating between theoretical accounts of the directed forgetting phenomenon.

Topic Line: LONG-TERM MEMORY: Episodic

F71 Whole brain ultrahigh resolution functional magnetic resonance imaging analysis of associative mnemonic processes

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The hippocampus, which is integral for encoding and retrieving bound representations of events, can be anatomically segmented into subfields, which have differential roles in mnemonic processes (eg., mnemonic discrimination, match detection). Cortical regions across the brain are also critical for encoding associative memories; however, since standard functional magnetic resonance imaging (fMRI) spatial resolution precludes the ability to examine hippocampal subfield activity in conjunction with cortical regions, their roles are unstudied in the context of these subfield-level processes. The current project leveraged a novel imaging sequence that combines 1mm3 spatial resolution with a whole-brain field of view. Healthy young adults engaged in an associative memory task while undergoing fMRI. Participants were tasked to study and retrieve pairs of famous names and pictures of everyday objects. During the retrieval phase, pictures were either targets (the same picture as what was previously paired with the name), lures (very similar to but not the same as the original picture), mispaired (a previously studied picture but not with the given name), or novel (an unstudied picture). Evoked BOLD response was computed for each retrieval condition. Contrasts demonstrated marked differences in cortical activity during discrimination and match detection, as compared to retrieval of targets, in parietal and frontal regions, including dorsolateral prefrontal and orbitofrontal cortices. Additionally, lures elicited stronger activity in visual processing regions, whereas mispaired items elicited stronger temporal lobe activity. This study demonstrates the diffuse cortical activity that supports successful mnemonic discrimination and match detection, highlighting the importance of further examining hippocampal subfield-cortical activations.

Topic Line: LONG-TERM MEMORY: Episodic

F72 Test Query Affects Late Frontal Event-Related Potentials (ERP) During Recognition Memory

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Recognition memory ERP studies have consistently reported an ERP component that reflects familiarity/conceptual fluency (i.e., FN400) and a component that reflects recollection (i.e., the Late Positive Component, LPC). The present study examined the effect of the test query focus during recognition. Thirty-five participants encoded words using a shallow task (i.e., counting number of vowels in the word) and then completed two recognition tasks that demanded yes/no responses. On one test, participants considered whether the probe was studied (i.e., 'Old?'), whereas they considered whether the probe was unstudied (i.e., 'New?') on the other test. The 'New?' query led to more correct rejections, fewer hits, and a more conservative decision criterion. The FN400 (400-600 ms) was observed during both tests, but the LPC (600-800 ms) was significant for only the 'New?' test. These results suggest that the test question alters decision criterion and affects the reliance on recollection to make a yes/no judgment. In addition, late ERPs (800-1000 ms) were more positive over right-frontal electrodes during the 'New?' test suggesting that detecting new items prompted more general monitoring processes like those that have been observed during tests of source memory (e.g., Wilding & Rugg, 1996).

F73 The reversion of information processing between episodic learning and retrieval across the adult lifespan

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Memory theories suggest that reconstruction of prior encoding experiences supports successful episodic memory and that the temporal dynamics of episodic reconstruction are reversed to those of encoding. However, it is unclear exactly how age and attention impact these dynamics. We designed a context memory task in which subjects encoded objects along with scene and color context features, one of which was to be ignored, to assess the hypothesis that low-level perceptual (color) features are encoded prior to high-level (scene) features, while high-level features are reconstructed prior to low-level ones during retrieval. To be more specific, we performed multivariate decoding analyses to investigate the time at which successfully remembered context features are most discriminable from forgotten contexts at both encoding and retrieval. We found that during encoding, low-level features were encoded earlier than high-level features while the opposite was found during retrieval, across age. However, the temporal dynamics were affected by attention, such that low-level context features were encoded earlier when they were attended and retrieved later when they were ignored (not attended). Importantly, age reduced the sensitivity of these temporal dynamics to top-down attention, consistent with an age-related difficulty using cognitive control to control episodic encoding and reconstruction. Collectively, these results suggest that while the reversion of information processing between encoding and retrieval is largely preserved with age, the ability to use top-down attentional control to impact these dynamics is not, which in turn contributes to worse memory performance.

Topic Line: LONG-TERM MEMORY: Episodic

F74 Did I see it? An event-related potential (ERP) study of material-specific prioritization of recollection.

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In order to prioritize recollection of sought-for information, people are thought to adopt retrieval orientations which bias their memory

search. Previous studies have suggested that prioritization of recollection can occur when the targeted information is easy to recollect, or alternatively, when retrieval cues more strongly overlap with targeted memory traces. We investigated this using electroencephalographic event-related potentials (ERPs) in a recognition memory exclusion task. Participants studied object pictures and auditorily presented object names, then memory was probed with visually presented object names. When targets were auditory words, the left-parietal ERP old/new effect from 500-800 ms, associated with recollection, was reliable for targets but not for non-targets (items studied as pictures). However, when targets were pictures, a left-parietal effect was present for both targets and non-targets (items studied as auditory words), suggesting that recollection was prioritized only when participants used visual word cues to remember auditory words, as opposed to pictures. Since participants could identify targets from the picture source equally well and faster than targets from the auditory source, the ERP difference did not reflect easier recollection of auditory words. We also replicated Hornberger, Morcom & Rugg's (2004) finding that unstudied items elicited a widespread positive-going ERP effect between 300-900 ms when auditory words versus pictures were targets, indicating that different retrieval orientations were adopted. The data favor a cue strength account, in which the degree of diagnostic overlap between retrieval cues and the targeted versus competing memory traces determines whether recollection can be prioritized.

Topic Line: LONG-TERM MEMORY: Episodic

F75 ERP evidence of suppression and intrusions of autobiographical memories of past immoral acts

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Memories of our past immoral acts can haunt us, leading to unpleasant emotions such as guilt and shame. People may therefore be motivated to suppress the memory by actively preventing thoughts of the event from coming to mind. Sometimes suppression fails however, leading to involuntary memory intrusions. Recent research has begun to delineate the cognitive and brain processes that underlie intrusions of relatively simple memories such as memories of words or pictures, but cognitive-neuroscience research on autobiographical memory intrusions is scarce. We used a modified Think/No-Think (TNT) task to investigate the intrusiveness of autobiographical memories of immoral acts and the underlying brain mechanisms as measured with EEG. Participants first generated 20 different memories of their own past morally wrong and morally right acts, and then completed the TNT task 24hrs later, where they were asked to either repeatedly think of these autobiographical memories or to try to prevent thinking of them, in response to cues. After each attempt, participants rated the extent to which the memory came to mind, in order to measure involuntary intrusions. Results suggest that unpleasant autobiographical memories of past immoral acts are more intrusive than memories of past moral acts. ERPs recorded during voluntary retrieval and suppression of autobiographical memories showed similar ERP effects as found in prior TNT research for simpler types of memories. Interestingly, these ERP components were different during initial attempts of retrieval vs. suppression compared to later attempts, and were also modulated by the morally right versus wrong nature of the memories.

Topic Line: LONG-TERM MEMORY: Episodic

F76 Temporal dynamics supporting the multidimensional quality of episodic memory

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Episodic memories contain a wealth of multimodal details that can be reconstructed with varying degrees of precision. Despite such variability, research has only recently begun to identify the neural processes supporting recovery of different kinds of memory features that have been bound to an individual episode. In a recent fMRI study, we showed that continuous measures of episodic memory quality were correlated with cortico-hippocampal network integration during episodic retrieval (Cooper & Ritchey, 2019). Furthermore, distinct neural processes supported memory precision for different kinds of memory features. The temporal dynamics of episodic reconstruction, however, remain poorly understood. In this study, we used EEG to investigate the timing of retrieval processes related to a measure of multidimensional episodic memory quality. Participants (N=23) studied a series of objects presented in a specific location within a 360-degree panorama scene, in a color sampled from a continuous color spectrum, and accompanied by either an unpleasant or a neutral background sound. In a memory test, participants were asked to recall each object's encoding event and reconstruct its original color and scene location, providing fine-grained measures of memory quality. Time-frequency analyses revealed that overall episodic memory quality was associated with widespread alpha and beta desynchronization occurring approximately 1000 to 2500 ms after cue onset. These effects were differently related to memory for individual features. When considered alongside our previous fMRI results, these findings suggest that successful retrieval is associated with large-scale network integration as well as temporal desynchronization as episodic memory features are reconstructed.

Topic Line: LONG-TERM MEMORY: Episodic

F77 The diminishing precision of temporal information in episodic memory retrieval

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The temporal information signifying when a memory was encoded can play important roles in episodic retrieval, from distinguishing among multiple traces to effectively guiding search strategy. Numerous studies employing cognitive and neural measures have investigated changes in retrieval success for recent versus remote memory, but less is known about the precision of judging temporal information associated with individual memories, how precision might change over time, and how other decision factors influence such judgments. Here, we apply a computational approach commonly used to test retrieval precision in working and episodic

memory to understand how the time when a memory was encoded is estimated. Subjects (N=32) first studied continuous lists of pictures and then undertook a test in which they placed each picture, as precisely as possible, along a continuous timeline of the study list. The primary results, based on mixture-modeling, were that precision was enhanced for items studied recently compared to more remotely, and there was virtually no contribution of guessing to such judgments. Finally, we observed a clear effect of response bias, whereby items tended to be judged as more recent then their actual study time. The results are discussed in the broader context of how recollection precision changes over time, and how memory for time might be distinct from that for other continuous features (e.g., spatial location, a color spectrum).

Topic Line: LONG-TERM MEMORY: Episodic

F78 Multi-Step Prediction and Integration in Naturalistic Environments

Hannah Tarder-Stoll, Columbia University, Christopher Baldassano, Columbia University, Mariam Aly, Columbia University

Memories of past experiences allow us to flexibly anticipate future events at multiple timescales, including seconds, minutes, or hours in the future. Yet, most studies of prediction investigate only short timescales (Schapiro et al., 2012, Brown et al., 2016). How do we represent, and use, multiple timescales of prediction? We had participants learn sequences of rooms in immersive virtual reality. The same rooms were experienced in different orders along two routes, enabling the identification of context-specific learning. After learning, participants generated predictions about upcoming rooms up to five steps ahead in a given (cued) route. Participants successfully anticipated upcoming rooms in the cued route, identifying which of two rooms occurs sooner along the route with 88.4% accuracy. Performance decreased with distance into the future: accuracy was 90.2% for target rooms one step away and 83.9% for four steps away. Thus, individuals generate multiple ! timescales of predictions about upcoming events in well learned environments, and predictions flexibly change based on the context. To find further evidence of flexible predictions, we asked whether participants could learn a link between two of the sequences, and then predict upcoming rooms along this single, integrated route. Participants successfully updated their predictions to reflect the integrated sequence, and performance improved over time (final prediction accuracy of 86.8%). These results indicate that memory can be used to generate predictions about future events along a range of timescales and, critically, such multi-step predictions can be flexibly updated in dynamic environments.

Topic Line: LONG-TERM MEMORY: Episodic

F79 WITHDRAWN

F80 WITHDRAWN

F81 Classifying EEG spectral features that predict subsequent memory performance across multiple sessions

David DiStefano, Tufts University, Elizabeth Race, Tufts University

Prediction of subsequent memory using pre-stimulus electroencephalography (EEG) data has practical implications in cognitive science and brain-computer-interface (BCI) research. Prior research has demonstrated that it is possible to use machine learning to classify pre-stimulus EEG signals that predict whether a stimulus will be later remembered or forgotten. An open question is whether classification of brain states that predict later memory within a session can generalize to a novel dataset and predict memory performance in a different session. To investigate this question, the current study collected EEG data from seven participants while they performed a long-term memory task (Session 1). Participants were then brought back the next day for a second long-term memory task (Session 2). We then used a guided feature selection process to identify EEG frequency bands from the encoding portion of Session 1 that optimally trained support vector machines (SVM) for each participant to classify subsequent memory performance on held-out trials from Session 1. The subject-specific models optimized for Session 1 were then tested on Session 2 datasets, yielding greater-than-chance classification accuracy for 5-out-7 participants with a mean classification accuracy of 58% across all participants. These results suggest that individualized, frequency-based feature selection can provide useful input for EEG classification model design that generalizes to novel datasets and predicts memory performance across time. Additionally, these SVM results serve as a baseline for comparison of more promising models such as Bayesian neural networks.

Topic Line: LONG-TERM MEMORY: Other

F82 Differential Influence of Lesions to Ventromedial Prefrontal Cortex on Schema and Category Knowledge

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Prior knowledge (PK) has long been implicated in a variety of memory-related operations, such as acquisition and retrieval. Mnemonic effects of PK may result from its influence on how we interpret incoming information. To do so, PK must first be reinstated and instantiated as it interacts with incoming information. We focused on two types of PK, semantic categories presumed to be mediated by the anterolateral temporal lobes (ATL) and schemas, presumed to be mediated by the ventromedial prefrontal cortex (vmPFC). However, because semantic categories are also implicated in schematic knowledge, vmPFC damage may also impair category processing. Patients with vmPFC damage (n=11) and matched controls (n=13) brought to mind a schema or a category (reinstatement) and then classified stimuli belongingness to it (instantiation) while electroencephalography was recorded. Rejecting schema lures was slower than category lures, and patients had particular difficulty inhibiting competing information of both types. Reinstating PK was associated with pre-stimulus low-frequency vmPFC-posterior parietal desynchronization for schemas and lateral-temporal with inferotemporal for categories. Patients showed abnormal synchrony patterns in both conditions.

Instantiating PK was indexed by post-stimulus low and high-frequency power decreases in the anterior neocortex. While some differences emerged between schemas and categories, the activity in the vmPFC and lateral temporal cortex overlapped considerably. Notably, however, only patients with damage to the subcallosal vmPFC showed deficits specific to schematic processing. We conclude that damage to vmPFC influences processing of both schemas and categories, but the underlying network-level mechanisms of this disruption differ.

Topic Line: LONG-TERM MEMORY: Other

F83 Cognitive biases linger after reading a transporting narrative

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Narratives have the ability to transport us into alternate worlds. The subjective experience of transportation is well-characterized, but we know little of its cognitive consequences. In this study, we asked how the experience of narrative transportation affects our patterns of subsequent thought. To this end, we measured 'spontaneous thinking', via a 5-minute free association task, before and after participants read a narrative text. In the 'Intact' condition, participants read a 271-sentence narrative, one sentence at a time, at their own pace. In the 'Scrambled' condition, participants read the same content, but with the sentences in a randomized order. We then used word-embeddings to examine how spontaneous free associations differed before and after participants read the story. Participants who reported stronger feeling of transportation during the story subsequently produced free associates whose semantic meanings were closer to the story themes. This was true irrespective of whether participants were in the Intact or Scrambled conditions. Surprisingly, we could not detect a post-stimulus semantic influence of the narrative amongst participants who were not transported; this was true even when they successfully understood the narrative (e.g., in the Intact condition, with high comprehension scores). Finally, we replicated these results in a second group of participants with a different published story. Overall, we observed lingering semantic biases after reading a transporting narrative; these lingering effects appeared to covary with the subjective experience of transportation, more than story comprehension.

Topic Line: LONG-TERM MEMORY: Priming

F84 Cerebellum and semantic memory: a TMS study with the DRM task

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It has been proposed that memory is not actually a memory system, but rather a predictive system. This view accounts for the 'errors' that memory makes under normal conditions and for the adaptive value of processes such as transformation, reconsolidation and updating. In the last decades, it has also been shown that the cerebellum is involved in a wide range of motor and non-motor functions linked to predictive processes. Neuromodulation studies reported cerebellar involvement in semantic domains, such as semantic prediction and semantic priming, but no brain stimulation study has directly investigated whether the cerebellum is also involved in semantic memory processes. Here, we administered online transcranial magnetic stimulation (TMS) during a classical semantic memory task, the DRM, to investigate the role of the right cerebellar hemisphere in semantic memory. The TMS was administered during the recognition phase over the right cerebellum and over the vertex as control condition. In Experiment 1, cerebellar TMS impaired participants' sensitivity for studied words compared to strongly related lures without affecting control conditions suggesting that cerebellar TMS had an enhancement effect on the gist trace that, according to the fuzzy-trace theory, is responsible for the production of false memories. In Experiment 2 we used a more complex version of the task, and cerebellar TMS impaired participants' sensitivity for studied words in general. Moreover, during cerebellar TMS participants' correct response latencies were faster compared to control stimulation. Overall, results support the hypothesis of cerebellar involvement in semantic memory.

Topic Line: LONG-TERM MEMORY: Semantic

F85 Desirable difficulty in Learning from Errors

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Experimental evidence has shown that making errors, if it is followed by corrective feedback, can benefit learning. This effect has been usually found with semantically related learning material as word-pairs. The goal of this study is to investigate if learning from errors is modulated by semantic relationship of the stimuli. In Experiment 1, we manipulated semantic relationship by presenting a mixture of strongly and weakly semantically related word-pairs based on forward associative strength. Experimental procedure included learning phase, initial cued recall test followed by corrective feedback and final test. Results showed an interaction between semantic relationship (strong vs. weak) and learning experience on the initial test (error vs. correct). Only material with weak semantic relationship exhibited a significant error-generation benefit on the final test: there was a higher correct-answers percentage after experiencing an error on the initial test compared with experiencing a correct answer. In Experiment 2, the same procedure was followed with two groups of participants: one group studied semantically related word-pairs and the other group unrelated word-pairs. Results showed that there was an error-generation benefit on the final test for both, semantically related and unrelated material. However, the error-related benefit was greater for semantically unrelated word-pairs. Thus, in both experiments, less semantically related conditions and therefore, harder to learn conditions, benefited more from experiencing errors. Previous evidence has shown that certain difficulties increase long-term retention because greater elaborative processing and attention are engaged responding to difficulties.

Error learning benefit may be relying on these processes as well.
Topic Line: LONG-TERM MEMORY: Semantic

F86 Learning the internal structure of novel categories

Sarah Solomon, University of Pennsylvania, Anna Schapiro, University of Pennsylvania

How do we learn the internal feature co-occurrence structure of a new category? We constructed novel animal categories using a network science framework in order to examine category structure learning. Two categories were defined by distinct graph structures in which nodes corresponded to features (e.g., 'bushy tail', 'black fur') and edges captured within-category feature co-occurrences. The graphs contained isomorphic core structures, in which certain features occurred in all category exemplars. In a high-modularity graph, additional features formed clusters of co-occurring features, whereas in the low-modularity graph additional features were randomly distributed. Participants learned about these categories in a missing-feature task which probed different kinds of category structure knowledge. Though core structure was identical across categories, core structure was better learned in the high- relative to low-modularity category. In order to explore the mechanisms underlying this pattern of category-structure learning, we trained a neural network model on categories structured identically to those used in the behavioral experiment and tested the model on the same missing-feature task given to human participants. The modeling results mirrored the behavioral results: core structure was better learned in the high- relative to low-modularity category even though the core-structure was identical across categories. These results suggest that learning features of a new category is influenced by the global structure of the concept, and also reveal correspondences between learning in humans and neural network models.

Topic Line: LONG-TERM MEMORY: Semantic

F87 Noninvasive stimulation frequency doubly dissociates cerebellar involvement in episodic memory ver linguistic prediction

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Cerebellar cortex is associated with a number of distributed brain networks serving cognitive functions, including episodic memory and language processing. How the cerebellum selectively interacts with distributed brain regions for distinct functional outcomes is currently unknown. One possible explanation is that functional coordination across the brain depends on synchronized interregional activity at different frequency bands. Episodic memory for instance, is associated with hippocampal-cortical synchrony in the theta frequency band. In contrast, frontal, temporal, and parietal cortex exhibit beta-frequency synchrony during linguistic prediction. We sought to test if cerebellar participation in these functions could be biased by application of noninvasive brain stimulation (TMS) at frequencies matching each network's endogenous rhythm. Across 3 sessions, 24 adults received right lateral cerebellar stimulation at a theta-frequency (i.e., theta-burst) pattern, right lateral cerebellar stimulation at a beta-frequency pattern, and stimulation at an out-of-network control site. Relative to control stimulation, theta-burst stimulation improved episodic memory encoding, whereas beta-frequency stimulation had no effect on memory. In contrast, beta-frequency stimulation enhanced ERP correlates of linguistic prediction (i.e., the N400), whereas theta-burst stimulation did not. Significant cross-over interaction ($p = .01$) indicated that theta-burst versus beta-frequency stimulation frequencies doubly dissociated cerebellar involvement in memory versus linguistic prediction. These findings indicate that discrete cognitive abilities can be enhanced via appropriately patterned stimulation of cerebellum and supports the role of synchronized oscillatory activity in cerebellar interactions with distinct functional networks.

Topic Line: METHODS: Electrophysiology

F88 Cortical Activity Tracks Fractal Complexity in Both Artistic and Mathematical Images, but with Different Mechanisms

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Previous electrophysiological studies have shown that viewing fractal patterns of differing dimensions in natural scenery and in computer-generated fractals leads to differences in brain activity. However, few studies have investigated electrophysiological brain activity in human-generated artistic fractals of varying dimensions. This study aimed to investigate differences in brain electrical activity while participants viewed and rated artistic- versus computer-generated mathematical fractals. Fractal dimensions describe how fractal patterns at different magnifications combine to form their final shape and fall between Euclidean dimensions (e.g., a line, D=1, and a filled plane, D=2). We recorded EEG while participants ($n = 19$) viewed a range of normally distributed fractal images with dimensions between 1.12 and 1.98 and rated how much they liked each image. Half of the fractal images were artistic (Jackson Pollock white layers), and each artistic fractal had a mathematical twin (random Cantor set) with the same dimension. EEG were decomposed to a time-frequency representation, and single-trial Spearman correlations were computed between fractal dimension and time-frequency EEG. Significance of correlations were tested using cluster-based permutation analysis. Results revealed that for the mathematical fractals, low-frequency power over central scalp locations accurately tracks fractal dimension. However, for the artistic fractals, low-frequency phase over parietal regions accurately tracks fractal dimension. This demonstrates that different brain regions (central versus parietal) and mechanisms (power versus phase) track complexity of artistic and mathematical fractal patterns, at approximately the same time scale. Future work will examine whether brain responses while viewing fractal patterns differ in high versus low creative individuals.

Topic Line: METHODS: Electrophysiology

F89 Developmental changes of brain rhythms to naturalistic social and non-social stimuli in infants: an MEG study

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To better understand the contribution of neural network activity to social behaviors early in life, the present study evaluated associations between social brain measures and social behaviors in infants and toddlers aged 2-42 months. Using infant magnetoencephalography (MEG), neural activity was measured in 49 typically developing infants (411Â±295 days, 33 males) while participants viewed videos with social (women singing nursery thymes) and non-social (dynamic toys) content. For each infant, MEG was co-registered to an age-appropriate MRI template. Whole-brain source images were computed using dSPM, and the average power at pediatric delta (1-3Hz), theta (3-6Hz), and alpha (6-9Hz) frequencies estimated for social and non-social conditions. Social behaviors were measured using Vineland Adaptive Behaviors Scale-III. Significant differences in occipital theta and alpha activity were observed between social and non-social conditions (ps<0.01). The dominant frequency of brain rhythms decreased as infants aged (R2=0.68, p<.0001), and across all frequencies and conditions occipital power increased as a function of age (R2=0.21 p<.0001). Finally, stronger occipital alpha power was associated with better social abilities (R2=0.15, p<.005). In sum, results showed regional differences in brain rhythms between social and non-social conditions in infants. Findings indicated that occipital brain rhythms to social and non-social stimuli matured rapidly during the first few years of life, with alpha (6-9Hz) power and the dominant peak frequency shown as promising predictors of social ability in infants.

Topic Line: METHODS: Neuroimaging

F90 Parcellating the social, cognitive, and motor topography of the cerebellum

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The standard narrative about cerebellar function is that it plays a role in fine-grained motor functions. However, it is becoming increasingly clear that the cerebellum plays a functional role in many aspects of cognition. Whether its contribution happens in a domain general or domain specific way is heavily debated. To address this question, we used the Human Connectome Project (HCP) dataset, which is a large-scale multimodal neuroimaging dataset. We used fMRI task activation maps for emotion, language, motor, social, and working memory. We extracted clusters of activation for each task and local maxima within each cluster. Then we used the Sørensen?Dice coefficient to calculate the cluster overlap between each task and calculated the Euclidean distance between all peak activations (local maxima) within each cluster. Of the ten possible cluster pairs, only four displayed >10% overlap: language and social (46%), motor and working memory (21%), emotion and social (19%), social and working memory (11%). Within these overlapping clusters, language and social had two pairs of local maxima (out of 64) with a Euclidean distance

Topic Line: METHODS: Neuroimaging

F91 Using fMRI to model nonlinear interactions between brain regions

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Whenever we perform a cognitive task, multiple brain regions are engaged, and information is transformed from brain region to brain region. A new method (MVPD, Anzellotti et al. 2017, Li et al. 2019, Fang et al. in preparation) goes beyond standard functional connectivity, capturing the interactions between multivariate patterns of response in different brain regions. In addition to being multivariate, interactions between brain regions are likely nonlinear. However, it remains unknown whether nonlinear models of the interactions between brain regions can be effectively estimated from fMRI data. We used artificial neural networks to model the interactions between brain regions during the viewing of complex visual stimuli (the film Forrest Gump), comparing out-of-sample predictions of linear and nonlinear versions of three different neural network architectures (1 hidden layer, 5 hidden layers, and a 5 layer dense net). We found that the relative effectiveness of linear and nonlinear models depended on the network's architecture and on the brain regions analyzed. Across all networks, linear models better predicted variance explained in a higher proportion of voxels (1 layer model: 55.31%; 5 layer model: 68.18%; 5 layer dense model: 68.07%), however, the voxels that were better explained by the linear models were significantly grouped in the posterior regions of the brain (p = .002). In contrast, voxels that were better explained by nonlinear models were consistently clustered in the anterior regions of the brain, though these clusters failed to reach statistical significance. This pattern of linear/nonlinear model performance was consistent across all network

Topic Line: METHODS: Neuroimaging

F92 Predicting Cardiovascular Disease Risk Using Functional Connectivity and Structural Morphology Metrics

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Cardiovascular disease (CVD) may be influenced by the brain's regulation of autonomic and hemodynamic processes that maintain homeostasis. We previously demonstrated a unimodal pattern of brain activity that reliably associates with individual differences in stressor-evoked blood pressure reactivity, a predictor of poor long-term cardiovascular health outcomes. Recent work in the emerging field of neurocardiology has demonstrated the ability of brain-based markers to better predict CVD risk over conventional clinical markers. We hypothesized that a multimodal approach will generate a brain-based biomarker that reliably predicts a vascular marker of CVD risk, specifically mean intima media thickness (IMT). Neuroimaging and demographic data from 324 participants from the Pittsburgh Imaging Project were included in our analyses. We implemented a prediction stacking algorithm that combined multimodal neuroimaging data to predict mean IMT. Specifically, we included intrinsic networks of functional connectivity and subcortical and cortical structural brain metrics. Predicted and observed IMT were moderately related ($r = 0.23$, $p < 0.001$). Our model accounted for 5.3% of the variance, which is in the typical range for predication modeling given that a majority of the variance in mean IMT is accounted for by demographic factors, such as age and sex. This work builds on growing neuroimaging evidence by showing that functional and structural features of neural circuits, particularly those involving processing of stressful environmental events, may complement conventional risk factors for predicting CVD.

Topic Line: METHODS: Neuroimaging

F93 Relationship of mood, cognition and physical activity in Depression: Remote symptom monitoring using wearable technology

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The ubiquity of digital technology in our day-to-day life, such a mobile phones and wearable technology, has allowed researchers to capture the daily fluctuations in mood and cognition that many individuals with psychiatric disorders experience. Here we demonstrate the feasibility of remotely collecting cognitive data in individuals suffering from Depressive Disorder, as well as the relationship of these high-frequency cognitive assessments with the remote monitoring of symptoms and physical activity. This was a study of six weeks duration in 30 adults with mild-moderate depression, stabilized on antidepressant monotherapy. Daily remote data collection (via an Apple Watch) consisted of a working memory assessment (N-back) up to 3 times a day, self-reported mood assessments, step count and average heart rate. Participants showed an initial improvement in N-back performance, but reached a learning plateau on average of 10 days after study onset. N-back performance also showed a significant diurnal effect for the time of day, and step counts were lower at the beginning and end of each week. Higher step counts overall were associated with better N-back learning and increased daily step count was associated with better mood on the same and following day. Daily N-back performance covaried with self-reported mood after participants reached their learning plateau. The current results support the feasibility of deploying remote symptom monitoring techniques via wearable technology in psychiatric populations and establish methods for synthesizing high-frequency cognitive data, brief mood and biometric data in order to create sensitive digital profiles of clinical symptoms.

Topic Line: METHODS: Other

F94 Pattern-based genome-wide relatedness analysis of human brain structure

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The human brain underpins various cognitive functions, however, the genetic association of its structure is still not fully understood. We adopted a pattern-based genome-wide relatedness analysis which correlates local genetic relatedness with brain structure relatedness between individuals in a population-based cohort. The local genetic relatedness was calculated using the genotyping pattern of neighbouring SNPs within a genetic block with fixed length, providing a more informative measure by combining multiple adjacent single nucleotide polymorphisms. This method greatly reduces the number of independent tests. Moreover, it provides a flexible way to incorporate co-factors, for example, genome-wide genetic relatedness which accounts for shared ancestry. We applied this method to genome-wide data and brain imaging data of a population-based sample of 708 healthy participants from the Cambridge Centre for Ageing and Neuroscience project. Specifically, we extracted the first principle components of regional grey matter (GM) volume and fractional anisotropy of white matter (WM) fiber tracts, which were used to calculate the brain structure relatedness of GM and WM. Brain structure relatedness of GM and WM was separately tested against local genetic relatedness of non-overlapping genetic blocks across the whole genome. Significance was determined by permutation test with up to 2 million randomizations. One hit block on chromosome 17 was identified for the GM, another hit on chromosome 10 was found for WM. importantly, these results were consistently found with different block lengths (i.e., 50KB, 100KB). Our approach provides a more robust and flexible way to investigate the genetic association of brain structure.

Topic Line: METHODS: Other

F95 Volumetric MRI Analysis of Brain Areas in Patients with ANKS1B Neurodevelopmental Syndrome

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Haploinsufficiency in the gene ANKS1B underlies a rare genetic disorder that presents as a neurodevelopmental syndrome. This gene encodes the protein AIDA-1, which was shown to be present throughout the brain by mouse proteomic analysis. This potentially indicates a wide-spread influence of AIDA-1 on many neuronal functions, but it is unclear which areas of the brain are most affected by this disorder. Several families with deletions in this gene were found and diagnosed; a few of these families were brought in for more in-depth neuropsychological testing and neuroimaging at our institute. The symptoms of the affected patients include Autism, Attention Deficit/Hyperactivity Disorder, speech and motor deficits, and global developmental delays. Structural MRI scans were collected during clinical testing - based on the clinical read, the majority of the patients had abnormal findings such as dysgenesis or thin body of the corpus callosum and hyperintensities in white matter. Additionally, we have obtained MRI scans of an ANKS1B deletion mouse model to complement our smaller patient population. Based on these findings, we are now studying the effects of this syndrome on specific areas of the brain within the patient population with a focus on the corpus callosum and the cerebellum. Preliminary quantitative analysis of the human and mouse sMRI scans using voxel-based morphometry indicates a smaller corpus callosum and a smaller cerebellum, which may explain the motor deficits. In conclusion, quantitative results support the original clinical read, and suggest possible functional properties of this gene for future analysis.

Topic Line: NEUROANATOMY

F96 Differences in Resting-State Midbrain Connectivity in Parkinson's Disease

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Functional MRI has shown dissociations between networks centered on Substantia Nigra (SN) and Ventral Tegmental Area (VTA; Murty et al., 2014). Connectivity of the dopaminergic midbrain is known to mediate the neurobehavioral deficits associated with Parkinson's disease (PD). During early phases of the disorder, PD is defined by degradation of the SN while sparing the VTA. Prior fMRI studies have characterized SN connectivity in PD using resting-state fMRI; however, these studies often utilized relatively small sample sizes. Further, prior research rarely characterized interactions across SN and VTA, which could be altered by sub-region specific changes in dopaminergic tone. Here, we characterized connectivity differences in midbrain sub-regions in PD patients and healthy controls. Using 3 publicly-available resting-state fMRI datasets (N=111; Badea et al., 2017; Tessa et al., 2019), we compared functional coupling of seeds placed in the VTA and SN with a-priori target ROIs. Results showed a group*seed interaction in the sub-genual cingulate ($p<0.005$). Controls showed greater connectivity of the VTA with the sub-genual cingulate compared to the SN ($p<0.05$), whereas no such differences existed in PD patients ($p=0.29$). There were no reliable group differences in other a-priori ROIs including putamen, nucleus accumbens, motor cortex, and supplementary motor cortex. These findings provide a novel assessment of differences in midbrain microcircuits in PD, which could provide a target to better understand a pathophysiology and neurobehavioral deficits.

Topic Line: NEUROANATOMY

F97 Beyond Pavlov: Distinct Electrophysiological Responses to Aversive First-Order and Second-Order Conditioned Stimuli

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Stimuli in daily life only rarely directly co-appear with primary rewards or punishments, and so motivated behaviour is thought to be driven by complex higher order associations with stimuli that had acquired value through first-order conditioning. Rodent research has revealed distinct neural structures, including the hippocampus, are required for the formation and maintenance of higher-order but not first-order conditioning. In this study, we aimed to determine if this held true for humans with two predictions: (1) The electrophysiological responses of first order and higher order conditioning are distinct and (2) The hippocampus is involved in higher order associations. Participants underwent first order conditioning pairing tones (CSÂ±) with either aversive bursts of white noise (unconditioned stimulus) or neutral tones. Subsequent second order conditioning paired CS+ and CS- with new tones (SO+ and SO-). Behavioural and neural responses were indexed by pupil dilation and electroencephalogram responses respectively in middle-aged participants (40 â€' 65 years, n = 18). CS+ tones led to a greater P200 component which was source estimated to left insula, whereas SO+ tones led to greater N150 component which was source estimated to posterior hippocampus. Both differences correlated with pupil dilation in the absence of a US. This experiment demonstrates that first order and second order conditioning have distinct temporal neural signatures and possible different sources of electrophysiological responses. Consistent with previous rodent studies, second-order conditioning may engage the hippocampus, suggesting a role for this structure in higher-order aspect of value learning.

Topic Line: OTHER

F98 The Emergence of Early Sound Categorical Responses in the Human Brain

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Environmental sounds are quickly transformed through a cascade of representations from the auditory mid-brain to higher level cortical areas, giving a complete understanding of the auditory environment in a few hundred milliseconds. Knowing whether a sound originated from an animal or an object, for instance, allows humans to effectively interact with their surroundings. Even though distinct brain regions have been found for different sound categories (Jung et al., 2018; Kim et al., 2011), the spatio-temporal dynamics involved in category-specific auditory analysis make it a difficult phenomena to investigate. Here, we specifically studied how different categories of sounds (human voices, animal noises, sounds generated by objects, and sounds from large scenes) are represented over time in the whole human brain. We extended the fMRI-MEG fusion approach of Cichy and collaborators (Cichy et al., 2016) to track down the regions and dynamics of particular types of sounds. Results show that sound representation emerge by 80-90 msec in the early auditory cortex, with responses diverging in different brain regions after 150 msec as a function of the sound category. These results suggest that some brain regions function as classifiers while other regions specialize in processing specific categories of sound. Understanding the auditory system's precise dynamics and organization responsible for this reliable and quick categorization presents an opportunity to develop robust and efficient artificial learning.

F99 Altered Resting-state Functional Connectivity Patterns Associated with Metabolic Syndrome

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Objective: To examine whether metabolic syndrome (MetS), the clustering of three or more cardiovascular risk factors, such as hypertension, obesity and diabetes, disrupts the resting-state functional connectivity (FC) of the large-scale cortical brain networks, including the default mode (DMN), executive control (ECN) and dorsal attention networks (DAN). Methods: Resting-state functional magnetic resonance imaging (fMRI) data were collected from seventy-eight middle-aged and older adult (27 MetS; 51 non-MetS; 45-75 years). Surface-based functional parcellation was used to extract time series of intrinsic activity in the large-scale brain networks. The spatially averaged time series of the brain networks were then correlated with all brain voxels using a whole-brain seed-based FC approach. Group level analyses were conducted using multiple linear regressions. Results were corrected for multiple comparisons ($p<0.05$). Further, MetS related between- and within-network effects were estimated and explored. Results: Participants with MetS showed hyperconnectivity across the large-scale brain regions, including DMN, DAN and ECN, when compared with non-MetS individuals. Furthermore, patterns of higher between-network MetS-related effect were observed across most of the networks in both hemispheres. Conclusion: These findings indicate that MetS is associated with alterations in FC among the large-scale brain networks. Further, the between-network FC measures are generally more affected by MetS than within-network FC measures, suggesting that the co-occurring vascular risk factors in MetS may have more detrimental effect on the long-range connections among brain networks.

Topic Line: OTHER

F100 Interpretable model based phonetic selectivity using high density µECoG

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Previous work has demonstrated that the human auditory cortex encodes phonetic information during speech perception. The cortical mapping of these phonetic features can be used to develop effective speech prosthesis using ECoG; however, the micro-scale spatial specificity of these features is unknown. Decision tree analysis is an interpretable modeling technique that can characterize the spatial importance of electrodes for phonetic feature selectivity. We, therefore, combined high-density neural recordings with decision-tree models to produce interpretable phonetic maps in the human cortex. To validate this technique, we use an ensemble decision-tree model to predict neural-responses to auditory tones in the rat auditory cortex, since the tonotopy is well established. We played 13 different tones (90 trials each) and recorded cortical signals from an anesthetized rat's auditory cortex using a 60 channel (406 um pitch) µECoG array. Our results reveal an above-chance decoding accuracy in tone prediction (ROC-AUC: 0.93 ± 0.015), and we observed spatial clustering of decision weights for each tone in accordance with existing tonotopy. We then recorded human-cortical signals using a 256 channel (1.72 mm pitch) µECoG array implanted on the superior temporal gyrus of an awake epileptic patient who listened to 58 different sentences during resective surgery. Results (ROC-AUC: 0.74 ± 0.02) demonstrated spatial clustering of decision weights for certain classes of phonetic features. These findings indicate that phonetic information is spatially selective at the micro-scale in human STG, and the decision tree modeling can be a reliable tool for cortical phonetic feature mapping.

Topic Line: PERCEPTION & ACTION: Audition

F101 Implicit perceptual-motor learning of repeating auditory sequences

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The implicit extraction of regularities through experience is hypothesized to be important for language. Perceptual-motor sequence learning tasks with visual cues have established implicit

learning without awareness, while statistical learning paradigms have demonstrated automatic extraction of regularities from auditory input. However, implicit auditorily-cued sequence learning is not well-established. Here, we report results from an auditorily-cued variant of the Serial Interception Sequence Learning task. Auditory cues signaled precisely-timed motor responses based on cue pitch, with keys D, F, J, and K mapped to distinct starting frequencies. Participants were not informed that a covertly embedded 12-item repeating sequence was present on 80% (training) and 33% (test) of trials. In Experiment 1, the offset of a glissando cue shape (20% rise in pitch frequency) signaled the timing of each motor response. In Experiment 2, motor responses were timed to the third onset of a three-cue sequence (100ms tones separated by 325ms on average). Participants exhibited sequence-specific learning via reliably greater motor response accuracy to cues within the repeating sequence than repeating foils, Experiment 1, $t(11)=2.3$, $p<0.05$; Experiment 2, $t(23)=4.7$, $p<0.001$. The auditorily-cued motor response task was quite difficult, leading to exclusion of some participants for failing to complete the protocol (14/26, Experiment 1; reduced to 10/34, Experiment 2). Auditorily-cued perceptual-motor sequence learning produced learning effects comparable to visual cues for similar numbers of sequence repetitions, suggesting a common underlying mechanism. Implicit auditory sequence learning may reflect the same mechanisms that support auditory statistical learning and are hypothesized to support language learning.

Topic Line: PERCEPTION & ACTION: Audition

F102 WITHDRAWN

F103 Neural correlates of perspective taking in youths

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Visual perspective taking (VPT) refers to the ability to adopt another person's visual view to understand or infer that person's belief and mental status. Such ability is regarded as an important part under the Theory of Mind (ToM) system. In the present study, the Dot Task was used to explore effects of Perspective (Self/Other) and Consistency (Consistent/Inconsistent) between Self/Other perspectives) on task performance. We used the [Self Inconsistent > Self Consistent] contrast to reflect the neural substrates underpinning perspective taking. Twenty-eight healthy Taiwanese participants (age range: 15-20 years old) were asked about how many dots he/she (Self trials) or a cartoon character (an avatar, Other trials) saw on a screen. In the Consistent condition, the participant saw the same number of dots as the avatar, while in the Inconsistent condition the participant saw a different number of dots from the avatar. Neuroimaging data were simultaneously acquired using an event-related functional Magnetic Resonance Imaging (fMRI) design. Functional imaging results for the contrast [Self Inconsistent > Other Inconsistent] yielded greater activation in the medial prefrontal gyrus (MPFC), temporal-parietal junction (TPJ) and left inferior frontal gyrus (IFG). These findings suggest that during the Dot task, participants may have to distinguish other's perspective from one's own, and select relevant perspective while inhibit irrelevant one to calculate perspectives.

Topic Line: EMOTION & SOCIAL: Other

F104 Neural Resonance to Syncopated Rhythms: Model Predictions and Experimental Tests

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We examined neural responses to rhythms with no spectral energy at the pulse frequency, the frequency people perceive as the basic beat of the rhythm. A dynamical systems model based on Neural Resonance Theory (NRT) predicts that for “missing pulse” rhythms, strong oscillations will emerge at the missing pulse frequency in a motor planning network, but will be weak or absent in primary auditory areas. First, in a behavioral session, we measured subjects’ abilities to synchronize with missing pulse rhythms, as well as with isochronous and random controls. Next, in an EEG session, we measured subjects’ steady state evoked potentials (SS-EPs) using 256-channel high density EEG, and localized cortical sources using individual MRI images. In the isochronous control rhythm, we observed strong pulse-frequency SS-EPs in multiple cortical areas including bilateral primary auditory cortex (A1), bilateral premotor cortex (PMC), and bilateral supplementary motor area (SMA). No pulse-frequency SS-EPs were observed in these areas in the random control. Importantly, in the missing pulse rhythms we observed pulse-frequency SS-EPs in bilateral SMA and other cortical areas, but not in A1. Our results are consistent with a model of pulse perception as emergent population oscillations, and critically point to cortical sources of pulse frequency oscillations.

Topic Line: PERCEPTION & ACTION: Audition

F105 Caesarean-section birth is associated with atypical intrinsic functional connectivity of visual regions in adulthood

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The rate of caesarean-section (C-section) births has been steadily increasing worldwide since the 1990s. While several studies have demonstrated that a range of early birth factors affect cognitive development, relatively few have examined the effects of delivery method. Adler and Wong-Kee-You (2015) demonstrated that human infants born via C-section have impaired stimulus-driven reflexive visual attention at 3-months of age. Moreover, they recently found that this effect persists into adulthood. We aimed to determine whether these deficits are associated with altered intrinsic functional network architecture in the brain. Multi-echo resting-state functional MRI scans were acquired from healthy young adults (n=81) who were born via vaginal delivery (n=61) or C-section (n=20). Seed regions of interest in bilateral primary visual cortex, the superior colliculi, and frontal eye fields were used to examine resting-state functional connectivity (RSFC) of these regions across the brain. Participants born via C-section showed stronger RSFC of left primary visual cortex and the superior colliculi with multiple regions, almost exclusively within the default network. Conversely, they showed weaker RSFC of the right frontal eye field with visual and motor network regions. These results are striking in light of previous work demonstrating that stronger RSFC between

primary visual cortex and the default network in healthy adults predicted worse performance on visual search tasks. Cognitive/perceptual deficits resulting from C-section birth have profound implications, given the rising prevalence of this procedure.

Topic Line: PERCEPTION & ACTION: Development & aging

F106 Visually guided movement with increasing Time-on-Task: Effects on movement preparation and movement execution

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Prefrontally mediated and capacity limited cognitive functions seem to be particularly sensitive to the detrimental effects of fatigue induced by increasing Time-on-Task (ToT). Previous studies have also suggested that movement behavior, especially the preparatory phase, is costly in term of cognitive capacity. Yet effects of ToT specific to the different phases of movements have received little attention. Therefore, in two experiments, we assessed the effect of ToT on a visually guided pointing task. In both experiments, participants (n = 21 and 22) were instructed to point to targets by moving the cursor from the center to the peripheral target. In experiment 1, target stimuli appeared at one of the four positions. In experiment 2, there were 16 possible target positions enhancing the uncertainty about movement direction. The first three blocks of the task lasted 15 minutes without rest. Participants then had a 2-min break followed by an additional block of trials. Variables of movement preparation time, movement execution, and subjective fatigue were recorded. Movement execution was measured as movement time, movement error, peak velocity, path length-task axis length ratio etc. Gaze position recording was used to control fixation. In both experiments, the most robust finding was that movement preparation became slower with increasing ToT. In contrast, movement execution was associated with decreasing speed-accuracy trade-off: fatigued participants made faster but more erroneous movements. To conclude, the results suggest that enhanced level of mental fatigue is manifested in a slow preparatory phase followed by a faster but often more erroneous movement execution.

Topic Line: PERCEPTION & ACTION: Motor control

F107 Distinct causal contributions of DLPFC and M1 in long-term motor skill learning and performance

Taraz Lee, University of Michigan, Quynh Nguyen, University of Michigan, James Brissenden, University of Michigan, Tyler Adkins, University of Michigan, Katy Michon, University of Michigan.

Prior neuroimaging work has shown that local activity and the network connections of cognitive control regions such as the dorsolateral prefrontal cortex (DLPFC) show marked reductions as motor expertise develops. In contrast, motor cortex (M1) activity seems to steadily increase over the course of training. However, neuroimaging data can only provide correlational evidence. Here, we sought evidence for the causal role of both the DLPFC and M1 at different stages of motor skill learning by using a combination of fMRI and continuous theta-burst stimulation (cTBS) using transcranial magnetic stimulation (TMS). Participants trained on six motor sequences in a sequence learning task over 8 weeks. Two sequences were practiced extensively (1200 trials), two moderately (300), and two minimally (25). Following training, participants returned for three separate sessions and received cTBS over right DLPFC, right M1, or vertex (control condition) just prior to performance of all sequences during fMRI scanning. Sequence information could be decoded from a large swath of frontal and motor regions. The effects of stimulation on behavior was highly dependent on depth of training. M1 stimulation led to more marked deficits in the more extensively trained skills. In contrast, DLPFC stimulation led to impairments in performance across all skill levels with larger deficits for novice skills. These results provide evidence that cognitive control regions play a causal role in skilled performance at all stages of learning, but that their contribution diminishes as expertise develops.

Topic Line: PERCEPTION & ACTION: Motor control

F108 Neural correlates of the relation between body ownership and agency: a tDCS study

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Willed actions are accompanied by the experience of controlling the own movements (sense of agency) and the feeling that the moving body part is belonging to the self (sense of body ownership). Agency and ownership have been mainly investigated separately, leaving unexplored the neural underpinnings of the relation between the two. This study explored the causal role of the premotor cortex (PM) and the cerebellum, in modulating the relation between ownership and agency. We used the moving Rubber Hand Illusion (mRHI). Participants looked at a rubber hand while moving their hidden hand. The type of movements (active or passive) and the posture of the rubber hand (plausible or implausible) differed among three conditions (active plausible, passive plausible, active implausible). Subjective reports and proprioceptive drift were used to measure ownership and agency. Anodal and sham tDCS were applied on the PM (Experiment 1) or the cerebellum (Experiment 2) prior the mRHI. We recruited 45 participants. Independently by the type or site of tDCS, subjective reports revealed that active plausible condition evoked both agency and ownership; passive plausible condition evoked ownership but not agency; active implausible condition evoked agency but not ownership. Moreover, in the active plausible condition, anodal tDCS over the PM reduced the drift, whereas anodal tDCS over the cerebellum increased the drift. Our findings suggest that facilitating the activity of PM or the cerebellum had different effects on proprioceptive component of voluntary movements, with the former (PM) preventing and the latter (cerebellum) increasing the proprioceptive drift.

Topic Line: PERCEPTION & ACTION: Multisensory

F109 Cross-modal or not cross-modal, that is the question: The study of aftereffect in variance perception

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We could grasp various features of the outside world by summary statistics efficiently. Variance among them is an index of information reliability, and may affect perceivers' subsequent behavior because large variance may reflect latent anomalies or risks. Previous research showed that prolonged perceiving of ununiform stimuli in a visual property affected subsequent variance perception in different visual properties. In this study, we explored if adaptation to ununiform stimuli affected variance perception in different modality. Four experimental conditions (auditory_to_visual, visual_to_auditory, auditory_to_auditory, and visual_to_visual) were conducted. As an example, in the auditory_to_visual condition, participants first saw a sequence of visual stimuli in which the elements' size was perturbed with one of the six magnitudes of variance, and were required to classify the variance in each stimulus as relatively small or large. Then, they observed a sequence of auditory stimuli perturbed in pitch with certain variance (adaptation session). After that, they did the same visual variance classification task as before. We found that perceived variance got significantly larger after prolonged exposure to small variance adaptors when the adaptor and test stimuli were presented in the same modality. In contrast, when they were presented in different modalities, not the adaptation aftereffect but some priming effect occurred. Our results indicated that the mechanisms of human variance perception are segregated between sensory modalities. We confirmed our results with cognitive modeling based on the Bayesian statistics.

Topic Line: PERCEPTION & ACTION: Multisensory

F110 Modulation of somatosensory interneural inhibition according to behavioral goal: going for overall gist or subtle detail

Irena Arslanova, University College London, Keying Wang, University College London, Hiroaki Gomi, NTT Communication Science Laboratories, Patrick Haggard, University College London

We are surrounded by abundance of stimuli that needs to be processed in a meaningful way to guide behavior. Perceptual studies have almost exclusively focused on brain's ability to select a subset of presented stimuli for preferential processing. Such selectivity is supported by interneural inhibition; whereby adjacent cortical areas tend to inhibit one another when simultaneously activated, leading to enhanced perception of subtle details. However, little is known about the capacity to bring together separate stimuli to build up a single unified percept. Here, we produced tactile motion trajectories in different directions along participants' right index and middle fingerpads. In half of the blocks, participants had to report the difference between the two motion directions (discrimination blocks), while in the remaining blocks they had to report the average direction between the two trajectories (aggregation blocks). During the inter-trial-interval, we delivered mild electrical shocks either to right index, middle, or both fingers simultaneously. In line with previous studies, we found that elicited somatosensory evoked activity to simultaneous shocks was smaller than the linear sum of activity for separate shocks – a marker of intercortical inhibition. Importantly, the inhibition was significantly reduced when participants aggregated the two motion directions relative to when they discriminated the exact same stimuli. This suggests that interneural inhibition can be preparatorily adjusted depending on the behavioral goal. Overall, our results provide novel evidence for brain mechanism that can select whether our perception is dominated by overall gist or discriminative detail.

Topic Line: PERCEPTION & ACTION: Other

F111 The representation of micro-valences in high-level visual processing for everyday images

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Are complex properties, such as micro-valences, integrated in the neural representations of high-level visual stimuli? If so, does this predict behavioral preferences? Micro-valences are the subtle affective valences towards seemingly neutral stimuli. In order to investigate the effect of micro-valences on visual processing of complex images, we examined the affective ratings ('like', 'neutral', or 'dislike') and fMRI data of participants from the BOLD5000 dataset, in which they viewed 5000 'everyday' visual scenes taken from well-established computer vision image datasets such as COCO, ImageNet, and SUN (Chang et al., 2019). Initial analyses showed that affective judgement significantly modulated the BOLD response of at least two category-selective regions: the lateral occipital complex (LOC), a region selective for objects ($F(2, 1788) = 13.43$, $p < .01$), and the parahippocampal place area (PPA), a region selective for scene-processing ($F(2, 1788) = 48.35$, $p < .01$). The BOLD response from the PPA was higher in 'disliked' compared to 'liked' images; the BOLD response from the LOC was higher in 'liked' compared to 'neutral' images. From these results, we hypothesized that in 'everyday' images, object-focused stimuli would elicit positive micro-valences, while scene-focused stimuli would elicit more negative micro-valences. Follow-up ANOVAs revealed that object-categorized COCO images had a more positive affective rating compared to scene-categorized COCO images, $F(1, 4186) = 41.66$, $p < .01$. From this analysis, we suggest affect is an important component of high-level visual processing and should be incorporated into understanding the organization and representation of the ventral visual stream.

Topic Line: PERCEPTION & ACTION: Vision

F112 Koniocellular Pathway Contributions to Saccadic and Manual Responses to Threat Faces

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The human visual system employs parallel pathways that differ in their tuning to luminance, color, and spatial frequency. Recently, neuroimaging studies employing threat cues presented to the

magnocellular (M) and parvocellular (P) pathways revealed differential responses to threat, with greater sensitivity to clear and ambiguous threat cues, respectively. While recent neurophysiology studies have found that simple K stimuli activated the superior colliculus, critical for directing attention and eye gaze, the role of the koniocellular (K) pathway in threat processing has been largely unstudied. To examine K pathway contributions to threat processing, we briefly presented peripheral face stimuli that were psychophysically biased towards M, P, or K pathways, by employing low luminance-contrast, isoluminant red-green and blue-yellow stimuli, respectively. Observers were presented with angry or neutral male and female faces and were instructed to report whether the face was angry or neutral while their eye movements and manual responses were recorded. We found that faces presented to the K pathway evoked saccades with the lowest latency, but the saccade latency did not vary with facial expressive and identity cues. Further, manual responses were also fastest to K-biased stimuli; however, manual response speed and accuracy varied as a function of facial expression and identity cues, depending on the pathway to which the stimuli were presented. Our findings provide initial evidence in humans that threat stimuli presented to the K pathway are able to evoke fast saccadic and manual responses, with the latter responses sensitive to compound facial threat cues.

Topic Line: PERCEPTION & ACTION: Vision

F113 Culture and Spatial Frequency Impact Perceptual and Attentional ERP Components

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Although cross-cultural differences in 'higher-level' processes have been repeatedly demonstrated, recent work suggests that culture also may influence 'lower-level' perceptual processes, such as sensitivity for spatial frequency. In this study, we used EEG and Gabor patches of different spatial frequencies to investigate how individuals with distinct cultural backgrounds differ in the processing of lower versus higher spatial frequency information. 17 Americans and 19 East Asians were recruited from Brandeis University. Stimuli were Gabor patches of 4-degree angular size, with spatial frequencies ranging from 0.5 cycle per degree to 4 cpd. Participants fixated centrally, and Gabor patches were presented on either the left or right side of the screen for 100ms. To ensure participants were on task, participants were instructed to use peripheral vision to monitor onset of an intermittent red dot slightly below the fixation cross, and to press a button as soon as it appeared. We tested the effects of spatial frequency (LSF, HSF) and cultural background (Easterners, Westerners) in a 2 x 2 ANOVA. Although we were particularly interested in perceptual and attentional effects emerging between 100-300 msec at occipital and frontal channels, we used a mass univariate analysis that conducts statistical tests at each electrode and timepoint, applying multiple comparison corrections. Significant main effects of spatial frequency and culture emerged, with LSF evoking widespread effects between 200-300 msec compared to HSF, and East Asians exhibiting a larger P3a component over frontal channels compared to Americans, indexing allocation of attention and expectations.

Topic Line: PERCEPTION & ACTION: Vision

F114 Reorganization of functional connectivity does not obviously explain outcome post-lobectomy

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Resection of the epileptogenic zone largely results in seizure reduction in pharmacoresistant epilepsy. Many studies have noted cognitive improvements post-resection, especially when surgery is undertaken earlier in life. Despite the key role of vision in human behavior, rather few studies have explored outcomes following cortical resection of the occipito-temporal cortex in children, who have the most potential for recovery. We have shown that, while hemianopia persists and retinotopy does not reorganize post-surgery, intermediate and high-level visual abilities are within normal limits except in patients with significant comorbidities. The central question addressed here is what mechanism underlies the competence in those individuals with normal perceptual profiles. One hypothesis is the network reorganization in the contralesional hemisphere and perhaps even in the residual tissue in the ipsilesional hemisphere. This hypothesis was tested using pre- and post-resection data from six children who had undergone lobectomy. Using the BOLD response to visual category localizers, we explored the functional connectivity between different brain regions defined from anatomical parcellation. We then examined connectivity between visual category-selective regions present, as well as between networks for given category (e.g. face versus house networks). We also included the LGN and the pulvinar in the analysis, given claims that subcortical regions may regulate communication between cortical areas. The results show almost entirely typical functional cortico-cortical and subcortico-cortical connectivity within the contralesional hemisphere . These findings indicate that the positive cognitive outcome is not obviously a consequence of dramatically rearranged functional networks and that alternative explanations ought to be sought.

Topic Line: PERCEPTION & ACTION: Vision

F115 Pre-stimulation phase modulates high-beta TMS entrainment effects on conscious visual perception

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Prior studies from our laboratory have shown a causal association between the entrainment of high-beta (30Hz) oscillatory activity with Transcranial Magnetic Stimulation (TMS) delivered to the right Frontal Eye Field (FEF) and improvements of conscious visual perception for near-threshold stimuli. However, the response to neurostimulation is known to depend in part on the cortical activity state at the moment of stimulation, raising the question whether the

effects on conscious perception we observed previously are modulated by pre-stimulation brain activity. To this end, we re-analyzed electroencephalographic (EEG) data recorded on healthy human participants (N=14) while they performed a conscious visual detection task and were subjected to brief rhythmic (30Hz) or random bursts of Transcranial Magnet Stimulation (TMS), with an equivalent number and duration of pulses delivered to the right FEF prior to the appearance of lateralized near-threshold target. We pooled trials together according to correct (hits) and failed (misses) detection of the target and compared the EEG preceding the stimulation and subsequent target onset. Our results show significantly higher inter-trial phase theta synchronization over parietal areas prior to stimulation for hits when compared to misses, suggesting that there is a preferential phase for the TMS onset to maximize visual detection. These data are in accord with recently proposed models of attentional orienting that posit an interaction between attentional sampling in theta frequency and higher amplitude of beta and gamma rhythms in fronto-parietal networks during peak phase of theta oscillations.

Topic Line: PERCEPTION & ACTION: Vision

F116 Separating complex spatial perception from scene construction: fMRI and patient investigations of the hippocampus

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The hippocampus has been implicated in scene processing but it remains unclear how specific features of scenes such as their visual complexity, whether or not their content is naturalistic, and the nature of the cognitive process operating upon the scenes (e.g. perception or spatial construction) modulate hippocampal involvement. Here, we devised a novel paradigm where participants searched pairs of images for either colour (perceptual) or layout (constructive) differences. Importantly, images depicted either naturalistic scenes or matched, non-scene phase-scrambled images, as well as containing either a few (simple) or multiple (complex) elements. First, 20 healthy participants performed the task while undergoing functional magnetic resonance imaging (fMRI). We found that the hippocampus was engaged when participants processed naturalistic scenes but not scrambled images. In addition, the posterior hippocampus was recruited during perceptual scene trials while the anterior hippocampus was selectively engaged during constructive scene trials. Second, we tested 12 patients with bilateral hippocampal damage on a behavioural version of the task. The patients performed comparably to healthy controls when identifying differences between the scrambled image pairs, but were significantly worse at detecting differences between the pairs of naturalistic scenes. Of particular note, the effects documented in the fMRI experiment and the patient behavioural study were evident irrespective of the visual complexity of the images. We conclude that the processing and representation of naturalistic scenes, be they simple or complex, may be at least one key function of the hippocampus.

Topic Line: PERCEPTION & ACTION: Vision

F117 Novel objects in a rapid serial visual presentation (RSVP) stream elicit an attentional blink

Ryan Mruczek, College of the Holy Cross

Long-term familiarity with objects alters the neural processing of those objects. Novel images are associated with higher levels of spiking activity in inferior temporal cortex and stronger low-frequency local field potentials (Anderson et al., 2008, CerebCortex). Familiarity is also associated with changes in object recognition efficiency. Visual search is faster when the distractors are highly familiar (Mruczek & Sheinberg, 2005, P&P). Here, it is shown that novel objects also disrupt serial visual processing in a manner akin to the attentional blink. Participants were trained to classify target objects (left or right, participant-specific arbitrary mapping) embedded in an RSVP stream. During a multi-day training phase, participants performed this task with a set of distractor objects. Thus, participant gained familiarity with this set of distractors, without mapping an explicit motor response to those images. Subsequently, participants performed the same target-classification task with a small number of novel distractors embedded in the RSVP stream. During this test phase, targets followed a 'key distractor' (either familiar or novel) with varying lags (0-2 intervening distractors). Reaction times for correct target classification following novel, compared to a familiar, key distractors were significantly slower. This effect was most pronounced for targets immediately following the key distractor (0-lag, 200ms SOA), and was not apparent for longer lags (600ms). These results indicate that novel objects elicit an attentional blink, possibly due to associated prediction errors following unexpected stimuli (e.g., visual mismatch negativity) and the subsequent draw on attentional resources to resolve such prediction errors.

Topic Line: PERCEPTION & ACTION: Vision

F118 Effect of stimulus properties and task on electrophysiological dynamics in the human visual word form area

Clara Sava-Segal, Stanford University, Andreas Rauschecker, Stanford University, Su Liu, Stanford University, Ren Na, Peking University, Omri Raccah, Stanford University, Josef Parvizi, Stanford University

The human visual word form area (VWFA) has been extensively studied with neuroimaging methods which lack precise temporal resolution and focuses largely on measures of response amplitude. We posit that our understanding of the VWFA functions has been limited due to lack of information about the precise timing and duration of neural responses during various stimulus and task conditions. Towards this aim, we recorded directly from the VWFA in seven participants using intracranial electrodes, while subjects

viewed word form stimuli with different orthographic information, noise levels in different visual field positions. Our recordings revealed a delayed and reduced power of activity in the high frequency broadband (HFB) range within the VWFA when word stimuli were presented with noise or in the ipsilateral visual field, whereas real words, pseudowords, and consonant strings elicited similar magnitude and timing of HFB responses. Importantly, switching from incidental reading to lexical decision task had no effect on the timing, but increased the amplitude and duration of VWFA responses. In subjects with simultaneous recordings in lateral inferior temporal gyrus (LITG) language area and Broca's area (BA), we found the onset of activity in the BA and LITG to be simultaneous and consistently later than the VWFA activity. Finally, electrical perturbation of VWFA (3 left and 1 right hemisphere) disrupted subjects' reading ability. Spatiotemporal and causal findings extend our understanding of the privileged functional connectivity between the VWFA and language areas and support a clearly different routing of visual information during passive compared to active reading.

Topic Line: PERCEPTION & ACTION: Vision

F119 The 1-second boundary in time perception is a function of temporal processing windows

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There is a consensus in the literature that there exists a cut-off between sub-second and supra-second time perception processes (e.g. Lewis & Miall, 2003; Buhusi & Meck, 2005; Karmarkar & Buonomano, 2007; Rammsayer & Troche, 2014). In three psychophysical studies in which participants judged the perceived duration of a test segment relative to a standard segment in the visual domain, we tested whether such a cut-off changes (i) as a function of inter-stimulus interval (ISI), a proxy for memory decay, or (ii) as a function of standard segment duration. In each study, we used a two-alternative forced choice design in which we adopted four different ISI durations, mapping the sub-second/supra-second range: 400, 800, 1600, and 2000 ms. Participants decided whether the standard duration (120, 160 or 200 ms, for Experiment 1, 2 and 3, respectively) or the test duration (standard duration + delta t) was longer. We conjectured that the shorter the ISI, the shorter the constant error (CE), as sensory memory decay would decrease performance. In fact, for 120-ms standard duration, longer ISIs translated into higher temporal sensitivity and discrimination, ruling out memory decay as an explanatory factor. Importantly, the benefit of longer ISIs disappeared once the standard duration was increased to 200 ms, at which point performance at all ISIs was statistically indistinguishable. Our results suggest that that sub-second/supra-second cut-off in time perception is a function of standard segment duration, possibly signaling a constraint in the precision of sensory encoding.

Topic Line: PERCEPTION & ACTION: Vision

F120 The Effects of Sleep on Neural Learning Signals

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The importance of sleep has become increasingly apparent; for example, the impact of non-REM sleep on memory consolidation. Indeed, Walker (2008) demonstrated that without adequate sleep, hippocampal function is disrupted and our ability to encode new memories is markedly decreased. But what about non-hippocampal learning systems? For instance, it has recently been posited that humans rely on a reinforcement learning system within the medial-frontal cortex for behavioural optimization. Further, there is currently a lack of research investigating sleep-related effects on other learning systems such as the aforementioned one within the medial-frontal cortex. Here, we sought to address this issue. Specifically, we had participants play a simple two-choice 'bandit' gambling game while electroencephalographic (EEG) data was recorded after obtaining data about their previous night's sleep behaviour. Post experiment, we examined the relationship between hours slept the night before and the amplitude and latency of the reward positivity â?' a component of the human event-related brain potential associated with feedback evaluation. Our results demonstrate a positive relationship between hours slept the night before and reward positivity amplitude. Further, we also saw sleep-related effects on the latency of the reward positivity. In other words, participants with more sleep had larger and faster EEG reinforcement learning signals. Given the increasing trend in society towards diminished sleep cycles, our results speak to a growing need for better sleep hygiene.

Topic Line: THINKING: Decision making

F121 A spatio-temporal analysis on neural correlates of intertemporal choice

Qingfang Liu, The Ohio State University, Woojong Yi, The Ohio State University, Brandon Turner, The Ohio State University

Intertemporal choice requires choosing between an immediate smaller reward and a delayed larger reward. Previous studies suggest a delay discounting mechanism where the subjective value of monetary reward decreases with time delay and this subjective value is tracked by ventral medial prefrontal cortex and ventral striatum. Then an accumulation process subserved by dorsal medial frontal cortex (DMFC) and self-control mechanism subserved by dorsal lateral prefrontal cortex (dlPFC) together select a choice based on subjective valuation result. However, the mechanisms of how value accumulation and self-control interact to make a choice, and how self-control applies on the subjective valuation process remain elusive. To examine these questions in the time course of decision, we developed and performed an EEG experiment and manipulated the probability of choosing delayed option as an independent variable by a staircase procedure before the EEG session. A computational model equipped with mechanisms including power transformation of time and reward information, attention selection and stochastic value accumulation

was developed and fit to choice and response time data in a hierarchical Bayesian approach. Phase-based functional connectivity between putative dmFC and posterior parietal cortex resembles the reconstructed accumulation dynamics from the best-fitting computational model on every experimental condition, and this functional connectivity tracks both value encoding and accumulator competition mechanisms. By combining computational model and phase-based functional connectivity, our result suggests an interaction between choice valuation and accumulation competition in the time course of intertemporal choice.

Topic Line: THINKING: Decision making

F122 Variability in delay discounting is related to anhedonia in individuals exposed to multiple adverse childhood experience

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Background: Adverse childhood experiences (ACEs) contribute to negative physical and psychological outcomes, though there may be significant heterogeneity in response to ACE exposures. Delay discounting (DD) is a potential transdiagnostic marker of disinhibitory and reward-related psychopathology. Although accelerated DD in association with ACE exposure has been shown, clinical correlates of individual differences in DD in the context of high ACEs are unknown. Methods: DD norms were created using a sample of non-trauma exposed healthy controls (n = 18) who reported no exposure to ACEs and who had consistent DD data on a computerized paradigm. We defined normal-range DD as being no more than 0.5 SD accelerated versus this normative control group, and examined symptom profiles in ACE-exposed adults with and without accelerated DD. Results: Among individuals exposed to 4+ ACEs (n = 28), 16 participants showed normal-range DD (within 0.5 SD of the HC mean), and 12 had accelerated DD. There were no significant differences between high-ACE/normal DD and high-ACE/accelerated DD groups in overall PTSD or depressive symptom severity. Despite equivalent overall symptom severity levels, the groups significantly differed in anhedonia (Snaith-Hamilton Pleasure Scale), $F(1,23) = 4.33$, $p = .049$, partial eta squared = .159. Conclusion: While prior research demonstrates that increasing ACE exposure is associated with accelerated DD, our data suggest the presence of significant heterogeneity in DD, even in individuals exposed to four or more ACEs. These results suggest that DD could be used as a behavioral marker specifically sensitive to reward processing deficits within highly ACE-exposed samples.

Topic Line: THINKING: Decision making

F123 Uncovering the use of decision heuristics in a complex, uncertain environment: an eye-tracking study

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Prior research supports the use of decision heuristics, especially under a complex decision environment. Not much work describes what information search strategies are implemented. We focused on analyzing fixation patterns under a complex decision-making scenario, using eye tracking. Fifty subjects performed a 3-phase, 2-option forced-choice probabilistic paradigm, while we monitored their eye-movements. We presented two 2x2 grids, where each cell reflected binary cue domains with probabilistic weights reflecting the probability of winning. Training and first testing-phase (T1) had identical contingencies (D1=0.95/0.05; D2=0.8/0.2; D3=0.65/0.35; D4=0.5/0.5); the second testing-phase (T2) presented all domains with equal contingencies (0.8/0.2). The equal cue contingencies in T2 favors use of a compensatory strategy that equally consider all cue domains over heuristics. Participants chose the cue they considered had higher winning chances, which they learned through trial and error. We provided feedback (win/loss) after each trial. We found decrease in accuracy between T1-T2 ($F(1.97,96.77)=5.92$, $p=0.004$), suggesting use of a decision heuristic during T1 that prioritized certain cue domains and disregarded others. To characterize the search patterns, we tested if they followed the predictions of Take-The-Best (TTB), a heuristic that performs well in non-compensatory scenarios like T1. We found a linear trend on the proportion of fixations allocated across domains in descending order of importance ($t(138)=-4.88$, $p<0.001$). We also found that both fixations ($t(247.99)=7.11$, $p<0.001$) and RT ($t(225.82)=8.44$, $p<0.001$) increased as the best discriminating cue was lower in terms of domain importance. Together these results suggest use of TTB heuristics under a complex, uncertain decision environment.

Topic Line: THINKING: Decision making

F124 The influence of positive and negative incentives on physical effort persistence

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A growing research body seeks to understand how humans weigh the incentives for exerting physical effort. To study trial-by-trial variability in effort-based choice, common tasks vary incentives and measure either which level of difficulty (physical demand) participants choose or how hard they work when they've been assigned a certain difficulty level. These tasks are unable to capture how incentives shape the amount of hard work participant choose to do. To fill this gap, we developed a novel paradigm in which participants are given fixed time intervals to complete as many trials as they want of a physical effort task. Each trial requires a short but rapid series of key presses, after which participants are immediately able to initiate the next trial. The incentives for completing these trials varied across intervals. Study 1 (N=22) varied the amount of money participants would receive for each trial completed in an interval. Study 2 (N=30) additionally varied whether the incentives were framed as positive reinforcement (as in Study 1) or negative reinforcement (avoiding potential loss). We found that participants completed more trials when incentives were larger ($ps < 0.01$) and when they were negatively rather than positively reinforcing ($p < 0.05$). These incentives effects were independently reflected both in how hard the participant worked

within a given trial and how quickly they initiated the next trial. By providing a novel measure of voluntary effort persistence, this work carries promise for studying divergent incentive influences on effort allocation in healthy and clinical populations.

Topic Line: THINKING: Decision making

F125 Neuropsychological Outcomes of Children Under Three Treated with Proton Radiation Therapy

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Introduction: Approximately 4,600 children are diagnosed with brain tumor (BT) annually in the US (20% <3 years of age). Radiation is integral to treatment, yet young children fare poorly following photon radiation (XRT). Proton radiation (PBRT) enables better targeting of tumors and may entail fewer cognitive sequelae. This study examined intelligence (IQ) and adaptive functioning (ADP) longitudinally, and expressive (EXP) and receptive (REC) vocabulary, parent-reported functional communication (COM), visuomotor integration (VMI), and fine motor skills (MOT) cross-sectionally in a cohort of children <3 treated with PBRT.

Methods: 29 patients, ages <3 (Mean=1.99, SD=0.65) were evaluated at PRT initiation (BL) and ≥1 year after (FU) (MeanInterval=2.66, SD=2.14). 76% were infratentorial (59% ependymoma, 10% medulloblastoma). 93% received focal PBRT; 79% chemotherapy; 83% resection; 52% had hydrocephalus. Neuropsychological outcomes were assessed with standardized measures. Scores were analyzed using one-way ANOVAs and paired and independent samples t-tests.

Results: IQ and ADP were unchanged from BL to FU. Scores were all within the average range or higher at FU, except for MOT and COM. At FU, MOT (dominant: $p=0.015$, non-dominant: $p<0.04$, both hands: $p=0.014$) and COM scores ($p=.045$) were significantly lower than same-aged peers. Chemotherapy was associated with lower EXP ($p<.04$). All other clinical/demographic variables were unrelated to outcomes.

Conclusion: 2Ã‚Â½ years after PBRT, IQ and ADP skills were stable, a favorable outcome to XRT. At FU, neuropsychological skills were average or better. Reduced MOT and COM skills suggest need for early intervention. In young children, PRT may reduce negative neurocognitive sequelae associated with XRT.

Topic Line: THINKING: Other

F126 The relationship between macroscale cortical motifs and distinct patterns of ongoing thoughts.

Brontë Mckeown, University of York, Hao-Ting Wang, University of Sussex, Will Strawson, University of Sussex, Jonathan Smallwood, University of York

Contemporary accounts of ongoing thought recognise it as a heterogeneous and multidimensional construct, varying in both form and content. An emerging body of evidence demonstrates that distinct types of experience are associated with unique neurocognitive profiles, that can be described at the whole-brain level as different interactions between multiple large-scale networks. The current study sought to explore the possibility that macro-scale whole-brain functional connectivity patterns at rest may be meaningfully related to patterns of ongoing thought that occurred over this period. Participants underwent resting-state functional magnetic resonance imaging (rs-fMRI) followed by a questionnaire retrospectively assessing the content and form of their ongoing thoughts during the scan. Advanced machine learning was applied to both the rs-fMRI data to identify components explaining the greatest variance in whole-brain connectivity patterns, and to the questionnaire data, to identify components explaining dimensions that explained the variance in ongoing thought patterns. Multivariate analyses revealed that individual differences in whole-brain connectivity components, predicted distinct patterns of ongoing thought - highlighting the utility of macroscale patterns of brain organization as indices of different patterns of thoughts. These results add to an emerging literature that suggests that unique patterns of experience are associated with unique neurocognitive profiles.

Topic Line: THINKING: Other

F127 Facilitating problem solving with targeted memory reactivation during in-lab overnight sleep

Kristin Sanders, Northwestern University, Kara Dastrup, Northwestern University, Lane Patterson, Northwestern University, Anjan Ghosh, Northwestern University, Ken Paller, Northwestern University, Mark Beeman, Northwestern University.

Numerous anecdotes and several experiments suggest that sleep facilitates problem solving, especially when the solution requires thinking about the problem in a new way. In a recent study (Sanders et al., 2019) participants attempted to solve puzzles, each paired with a distinct sound cue, during an initial evening session; then, while participants slept at home in their own beds, we presented some of the sounds associated with participants' unsolved puzzles. In the morning, participants solved more of their previously unsolved puzzles that were Cued during sleep than those that were not cued. The current study used the same general paradigm, except 40 participants slept in the lab while full EEG was recorded throughout the night, allowing the collection of better and additional sleep measures. Across participants, following the first night of sleep, participants solved more Cued than Uncued puzzles. Moreover, this cueing effect positively correlated with the number of cues presented and negatively correlated with measures of sleep disruption. However, following the second night, participants solved reliably fewer Cued than Uncued puzzles. Thus, across the two nights overall, we did not observe a cueing effect on morning solving. Differences between the two sessions suggest sound cues may not have been as effective on the second night of sleep.

Topic Line: THINKING: Problem solving

F128 Religiosity is associated with less prediction of the typical: an event-related brain potential study

Michael Kiang, University of Toronto, Justice Cupid, Ryerson University, Sarah Ahmed, University of Toronto, Jennifer Lepock, University of Toronto, Todd Girard, Ryerson University

Why are some people more religious than others? Researchers have proposed that differences in how individuals process information may contribute to their degree of religiosity. According to one hypothesis, people with stronger tendencies to seek definitive explanations for situations with incomplete information are more likely to be religious. According to a different hypothesis, individuals who exhibit less brain signaling of 'prediction error' in response to unexpected stimuli may be more likely to discount evidence contradicting religious beliefs, making them more likely to maintain such beliefs. We sought neurophysiological evidence for these hypotheses using the N400 event-related brain potential (ERP) response, which is smaller to more contextually probable stimuli, reflecting prediction of probable completions for meaningful situations. We recorded ERPs from participants who viewed category phrases, each followed by a high-typicality category exemplar, low-typicality exemplar, or non-exemplar word. As expected, N400s were largest (most negative) for non-exemplars, intermediate for low-typicality exemplars, and smallest for high-typicality exemplars. Religiosity correlated with smaller N400 amplitude differences between high-typicality exemplars and both low-typicality exemplars and non-exemplars. The results suggest that people with less of a tendency to predict contextually probable relative to improbable stimuli, resulting in smaller prediction error signals, may be predisposed to develop or maintain religiosity.

Topic Line: THINKING: Reasoning