

Social & Affective Neuroscience Society

Annual Meeting 2012

April 20-21, Marriott Downtown
New York, NY

Local Organizers

Kevin Ochsner, Columbia University
David Amodio, New York University

Talk/Poster Selection Committee

Elliot Berkman, University of Oregon
Kateri McRae, University of Denver
Kevin Ochsner, Columbia University
Jennifer Pfeifer, University of Oregon
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Jamil Zaki, Harvard University

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Jennifer Beer, University of Texas at Austin
Elliot Berkman, University of Oregon
Todd Heatherton, Dartmouth University

Schedule-at-a-glance

Thursday, April 19

Start	End	Session
6:00 PM	9:00 PM	Registration, 2nd floor landing

Friday, April 20

Start	End	Session
8:00 AM	8:50 AM	Continental Breakfast and Registration
8:50 AM	9:00 AM	Welcome Address by Kevin Ochsner
9:00 AM	10:15 AM	Symposium Session A: Empathy
10:15 AM	10:35 AM	Coffee Break
10:35 AM	11:50 AM	Symposium Session B: Culture
11:50 AM	1:30 PM	Break for Lunch
1:30 PM	2:45 PM	Symposium Session C: Social Interaction
2:45 PM	4:15 PM	Poster Session D (Empathy, Culture, Social Interaction, Health)
4:15 PM	5:30 PM	Symposium Session E: Person Perception
6:00 PM	7:15 PM	Keynote Debate: Mirror Neurons
7:15 PM	9:00 PM	Reception

Saturday, April 21

Start	End	Session
8:00 AM	9:00 AM	Continental Breakfast and Registration
9:00 AM	10:15 AM	Symposium Session F: Health
10:15 AM	10:30 AM	Coffee Break
10:30 AM	12:00 PM	Poster Session G (Person Perception, Development, Self-Control)
12:00 PM	1:30 PM	Break for Lunch
1:30 PM	2:45 PM	Symposium Session H: Development
2:45 PM	4:15 PM	Poster Session I (Emotion, Choice)
4:15 PM	5:30 PM	Symposium Session J: Emotion, Choice and Self-Control
6:00 PM	7:15 PM	Keynote Debate: Valuation and Emotion

Presentations

Session A **Empathy**

Friday, April 20, 2012

9:00 - 10:15 AM

Shihui Han, Peking University

Sylvia Morelli, University of California, Los Angeles

Jamil Zaki, Harvard University

Tania Singer, Max Planck Institute

Organizer: Sylvia Morelli and Matthew Lieberman, UCLA

A B S T R A C T S

MANIPULATIONS OF COGNITIVE STRATEGIES AND INTERGROUP RELATIONSHIPS REDUCE THE RACIAL BIAS IN EMPATHIC NEURAL RESPONSES

Shihui Han, Peking University; and Feng Sheng, Peking University – Social relationships affect empathy in humans such that empathic neural responses to perceived pain decrease to racial out-group members more than to racial in-group members. Why does the racial bias in empathy (RBE) occur and how can we reduce it? We hypothesized that perceiving an other-race person as a symbol of a racial group, rather than as an individual, decreases references to his/her personal situation and weakens empathy for that person. This hypothesis predicts that individuating other-race persons by increasing attention to each individual's feelings or enclosing other-race individuals within one's own social group can reduce the RBE by increasing empathic neural responses to other-race individuals. In Experiment 1, we recorded event related brain potentials from Chinese adults as they made race judgments on Asian and Caucasian faces with pained or neutral expressions. This experiment identified the RBE by showing that, relative to neutral expressions, pain expressions increased neural responses at 128-188 ms after stimulus onset over the frontal/central brain regions, and this effect was evident for same-race faces but not for other-race faces. Experiments 2 and 3 found that paying attention to the observed individual's feelings of pain and including other-race individuals in one's own team for competitions respectively eliminated the RBE by increasing neural responses to pain expressions in other-race faces. Our results indicate that the RBE is not inevitable and that manipulations of both cognitive strategies and intergroup relationships can reduce RBE-related brain activity.

EMPATHY FOR POSITIVE AND NEGATIVE EMOTIONS: IMPLICATIONS FOR BRAIN AND BEHAVIOR

Sylvia A. Morelli, University of California, Los Angeles – Despite the wealth of fMRI studies of empathy, no study has examined empathy for both positive and negative emotions. Including both is critical to the identification of processes central to a general empathic state and to emotion-specific empathic processes. In addition, examining how these empathic neural responses differentially relate to daily empathic experiences may provide insight into interpersonal behaviors. In the current investigation, 32 participants completed an fMRI session assessing empathic responses to others experiencing happiness and anxiety. The same participants also completed a 14-day experience-sampling study to assess daily frequencies of empathy, social connection, and

prosocial behavior. Neural regions that were common to the empathic state across emotions included areas associated with mentalizing and caregiving. Other limbic regions (dorsal anterior cingulate, anterior insula) were more active during one of the target emotions. In addition, participants who showed increased neural activity in regions associated with vicarious reward (i.e. ventral striatum) and empathy (i.e. medial prefrontal cortex) also showed higher daily frequency of shared positive emotions and prosocial behavior. Together, these results provide evidence for a set of neural regions that maintain or generate an empathic state across different target emotions, as well as limbic regions that play emotion-specific roles in empathy. Furthermore, individual differences in daily empathic experiences are reflected in empathic neural responses.

FLAVORS OF EMPATHY AND THEIR RELATIONSHIP TO PROSOCIAL

BEHAVIOR *Jamil Zaki, Harvard University, Jason Mitchell, Harvard University* – Empathy is a multifaceted construct comprising distinct, but related information processing mechanisms. Two of these mechanisms have received a great deal of attention from human neuroimaging research: experience sharing--perceivers' tendency to vicariously adopt the sensorimotor, visceral, and affective states of social targets--and mentalizing--perceivers' explicit cognitive inferences about targets' states. Strikingly, these two processes engage largely distinct sets of neural structures, suggesting that they may reflect dissociable routes for understanding and reacting to other people. Here, we examine how and when each of these processes predict a particular "downstream" social outcome: perceivers' decisions to act prosocially towards others. While being scanned using fMRI, perceivers (1) passively observed targets receiving money and (2) drew explicit inferences about targets' mental states. During passive viewing, perceivers engaged a common area of ventromedial prefrontal cortex (DMPFC) when receiving rewards themselves and observing targets receiving rewards, a common signature of experience sharing; this common neural response further predicted prosocial giving in a separate set of trials. By contrast, when actively drawing inferences about targets, perceivers engaged an area of dorsomedial prefrontal cortex (VMPFC), an area commonly associated with mentalizing, which likewise predicted prosocial behavior. These data suggest that both experience sharing and mentalizing can predict prosocial behavior, but in a manner that depends on the context in which these processes are deployed.

HOW TO UNDERSTAND OTHERS' FEELINGS: EMPATHY, SELF-OTHER

DISTINCTION AND EGOCENTRICITY BIAS *Tania Singer, Max Planck Institute for Human Cognitive and Brain Sciences* – With the emergence of social neuroscience, researchers have started to investigate the underpinnings of our ability to share and understand the feelings and minds of others. I will give a short overview about the evidence for the existence of "shared networks" underlying our ability to share feelings derived from investigating empathic brain responses elicited by the observation of others in pain. Moreover, I will then highlight the importance of self-other distinction in the process of empathic understanding and present a series of behavioral, functional magnetic resonance imaging (fMRI), and repetitive transcranial magnetic stimulation (rTMS), which focus on the investigation of emotional egocentricity bias and the ability for self-other distinction. More specifically, fMRI results suggest an important role of the right angular gyrus when subjects have to disengage from self-related affective states in order to avoid biased judgments about the others' affective states when these are incongruent to their own. These findings are discussed in light of recent models of social cognition.

Session B Culture

Friday, April 20, 2012

10:35 - 11:50 AM

Jiyoung Park, University of Michigan

Anne Krendl, Stanford University

Elizabeth Losin, University of California, Los Angeles

Joan Chiao, Northwestern University

Organizer: Joan Chiao, Northwestern University

A B S T R A C T S

NEURAL RESPONSE (ERN) REVEALS SELF-SERVING BIAS: CULTURE MATTERS

Shinobu Kitayama, University of Michigan; and Jiyoung Park, University of Michigan – Self-serving bias may result from increased motivational significance of self-relevant (vs. other-relevant) events. At present, however, the underlying neural mechanisms remain unclear. Here, we assessed electrocortical responses of European American and Asian participants as they performed a flanker task while instructed to earn as many reward points as possible either for the self or for their same-sex friend. For European Americans, error-related negativity (ERN) – an event-related brain potential (ERP) contingent on error responses – was significantly greater in the self- than in the friend-condition. Moreover, European Americans showed increased post-error slowing – an index of cognitive control to reduce errors – in the self-condition, but not in the friend-condition. Neither of these self-serving effects was observed among Asians, consistent with prior cross-cultural behavioral evidence. Interdependent self-construal negatively predicted both of the two self-serving effects. Our findings provide the first evidence for neural mechanisms underlying self-serving bias.

CULTURE AND THE NEURAL MECHANISMS ENGAGED IN STEREOTYPE

FORMATION *Anne C. Krendl, Stanford University; and Nalini Ambady, Stanford University* – Emerging research in cultural neuroscience suggests that individuals from Eastern and Western cultures engage distinct patterns of neural activity when evaluating negative affective information. However, it remains largely unexplored whether these differences extend to the neural mechanisms engaged when these individuals evaluate negative social targets, such as individuals who are stigmatized. Indeed, extensive research in social psychology suggests that unique experiences have a powerful impact on how individuals form impressions of outgroup members. We used a cultural neuroscience approach to examine the effects of different cultural backgrounds on the neural mechanisms engaged when individuals evaluate outgroup members. We recruited recent Chinese immigrants, first generation Chinese-Americans, and Caucasians and instructed them to make passive evaluations of outgroup members and normal controls while undergoing functional magnetic resonance imaging. Additional measures were collected outside of the scanner to consider individual differences such internal and external motivation to control prejudice. Data will be presented examining the responses of U.S. Caucasian Americans, recent Chinese immigrants, as well as individuals who have been exposed to both cultures (first generation Chinese-Americans) when evaluating when evaluating outgroup members.

RACE-RELATED AMYGDALA ACTIVITY EXHIBITS AN INGROUP BIAS DURING PASSIVE FACE VIEWING

Elizabeth A. Reynolds Losin, University of California, Los Angeles; Marco Iacoboni, University of California, Los Angeles; and Mirella Dapretto, University of California, Los Angeles – There is currently debate over the amygdala's role in race processing. Most studies have found heightened amygdala activity to faces of racial outgroup members or members of a stigmatized racial group (African Americans). Such responses have been found across fMRI tasks requiring a variety of different judgments about the social category or spatial location of faces. These findings suggest the amygdala may instantiate negative associations with outgroup races. A few studies, however, have demonstrated that these amygdala responses can be eliminated – or even reversed to ingroup biases – during judgments that direct attention away from race (e.g.,

individuating judgments), or engage culturally-specific processing (e.g., fear identification). It is not clear whether studies demonstrating outgroup biases in amygdala activity reflect the default response of the amygdala in racial processing, or are instead an artifact of the particular judgments made. Many studies also had small sample sizes and a single racial group of participants (white), making it problematic to interpret these findings in terms of general ingroup/outgroup biases, as results could apply only to a specific racial group of participants responding to a particular racial outgroup. We aimed to shed light on this debate by investigating amygdala responses to race when no explicit judgment was required. We tested 40 participants from two racial groups (20 white [EA], and 20 African American [AA]), while they passively viewed still portraits of actors representing three racial groups (EA, AA and Chinese American [CH]) – one racial ingroup and two racial outgroups for each participant group. If the outgroup or AA biases found in prior studies reflect the default response of the amygdala to individuals from another racial group, then we would expect to see this effects when no judgment is required, in both groups of participants, and across two racial outgroups. We performed a bilateral amygdala region of interest analysis using the Harvard-Oxford probabilistic atlas. We extracted parameter estimates of activity from this region and entered them into a subject race (EA, AA) X actor race (EA, AA, CH) repeated measures ANOVA, which yielded a significant actor race by subject race interaction. Planned comparisons revealed more amygdala activity in response to ingroup faces (EA faces for EA participants; AA faces for AA participants) than outgroup members (AA and CH faces for EA participants; EA and CH faces for AA participants). This ingroup bias was significant across both groups of participants and for two different racial outgroups, suggesting this effects truly reflects an ingroup bias rather than a race-specific effect. These results demonstrate that when people passively view individuals from different racial groups, the amygdala responds more strongly to racial ingroup rather than outgroup members. We hypothesize this effect may relate to the inherent motivational salience of ingroup members as reflected in ingroup favoritism and ingroup advantages for face recognition and memory. More broadly, these findings suggest that processing negative associations is not the default response of the amygdala in racial processing. Thus, contributing to the growing literature on amygdala responses to positive stimuli that are motivationally relevant.

CULTURAL INFLUENCES ON THE NEURAL BASIS OF PERSPECTIVE-TAKING

Joan Y. Chiao, Northwestern University; and Tokiko Harada,, Nagoya University – Cultural values of individualism and collectivism influence how people think about themselves and their relation to the social and physical environment. Individualists think of people as relatively independent of each other, whereas collectivists think of people as highly interconnected with one another. Collectivists have been shown to take the perspective of others to a greater extent, compared to individualists who are more likely to adopt a first-person perspective. However, whether cultural values of individualism and collectivism affect neural responses underlying perspective-taking remain unknown. Here we investigated how cultural values of individualism and collectivism modulate the neural basis of perspective taking using fMRI. During scanning, participants took either a first-person perspective (1Ps) of themselves or their close friend (1Po) or a third-person perspective of their close friend (3Po). Results indicate that people who were more individualistic showed greater VMPFC response when adopting the first-person perspective of themselves. By contrast, people who were more collectivistic showed greater VMPFC response when adopting the first-person perspective of their close friend and greater DMPFC response when adopting the third-person perspective of their close friend. Taken together, these results suggest that collectivists recruit a greater extent of neural resource within medial prefrontal cortex when adopting the perspective of close others, facilitating their ability to conform to collectivistic cultural norms of social harmony and interdependence.

Session C **Social Interaction**

Friday, April 20, 2012

1:30 - 2:45 PM

Ray Lee, Princeton University

Pranjal Mehta, University of Oregon

Mirre Stallen, Erasmus University Rotterdam

Karin Roelofs, Radboud University Nijmegen

A B S T R A C T S

THE DEFAULT MODE NETWORK COUPLING IN CERTAIN SOCIAL

INTERACTIONS OBSERVED IN DYADIC fMRI *Ray Lee, Princeton University* - The default mode network (DMN) in the human brain is often associated with the brain's intrinsic activities that are not engaged with the external world. However, such a self-referential nature might also play a role in social identity. Using a newly developed dyadic fMRI (dfMRI) which can scan two human brains simultaneously inside one MRI scanner, some initial evidence suggests that the DMN could also have a social effect in certain relationships among certain type of subject pairs. About 20 dfMRI studies were conducted with subject-pairs lying on their sides, face-to-face, inside the magnet bore. The subject-pairs were instructed to periodically open and close their eyes, either simultaneously or alternately. The functional data was post-processed with the software package FSL (Oxford University, UK). The ICA results show that: (1) In the majority of pairs, individual DMNs are decoupled, each DMN is a separate independent component; (2) In the romantically involved pairs, the DMNs of the less affectionate ones are often intact, but the DMNs of the more affectionate ones become difficult to be identified; (3) In the case of dominant/passive pair, the DMN of the dominant subject is coupled with the lateral prefrontal cortex (LPFC) of the passive one. These preliminary results seem to indicate that in a social resting state, DMN has the characterization of self, and such social identification could affect other via romance or aggressive gaze.

THE ROLE OF TESTOSTERONE IN STATUS-SEEKING BEHAVIOR

Pranjal Mehta, University of Oregon; Erik Knight, University of Oregon; Veerle van Son, Radboud University, Donders Institute for Cognitive Neuroimaging; Alan Sanfey, Radboud University, Donders Institute for Cognitive Neuroimaging; Ale Smidts, Erasmus University, Rotterdam School of Management; and Karin Roelofs, Radboud University, Donders Institute for Cognitive Neuroimaging - Scholars have argued that testosterone plays a role in status-seeking behaviors (e.g., competitive and dominant behaviors, Mazur & Booth, 1998; Mehta & Josephs, 2006), but to date no human research has explicitly tested the causal role of testosterone in status-seeking. Further, although correlational studies suggest that higher testosterone is related to increased reactivity to wins and losses in competitive status-related encounters, experimental studies have yet to investigate context-dependent effects of testosterone on human social behavior. Here we sublingually administered testosterone or placebo to 54 healthy women in a double-blind between-subjects design. Four hours after administration participants were scanned with fMRI in 90 trials of a competitive task in which the opponent's social status (lower status, same status, or higher status) and the outcome of the competition (win/lose) were experimentally manipulated. After each trial of the competition, participants chose whether or not to compete again against the same player in a second round of competition. Results revealed a statistically significant status x competition outcome interaction on competitive behavior regardless of treatment condition; participants showed heightened behavioral sensitivity to wins and losses when

their opponent was higher status. Importantly, there was a statistically significant effect of testosterone on competitive behavior such that testosterone treatment increased the behavioral discrepancy between win and loss trials compared to placebo treatment (outcome sensitivity effect). The findings provide causal evidence for a context-dependent effect of testosterone on status-relevant behaviors. Preliminary imaging analyses will examine neural mechanisms for hormonal influences on social behavior, and implications of the findings for biosocial theories of human status hierarchies will be discussed.

THE ROLE OF OXYTOCIN IN SOCIAL NORM ENFORCEMENT *Mirre Stallen, Erasmus University Rotterdam, Donders Institute for Brain, Cognition and Behaviour; Amber Heijne, Donders Institute for Brain, Cognition and Behaviour; Ale Smidts, Erasmus University Rotterdam; Carsten K.W. de Dreu, University of Amsterdam; and Alan G. Sanfey, Donders Institute for Brain, Cognition and Behaviour* - The hormone oxytocin has long been considered important for prosocial behavior, with researchers exploring the relationship between oxytocin and factors such as trust, empathy, cooperation, and generosity. However, contrary to the popular belief of oxytocin being a 'love hormone', recent studies are beginning to suggest that oxytocin does not necessarily lead to indiscriminately prosocial behavior, but rather that it plays a role in a broader range of social behaviors. The aim of this study was to explore the possible effects of oxytocin on social norm enforcement. If oxytocin does indeed play a key role in social behavior, then does administration of oxytocin foster the choice to punish social norm violators? Or might oxytocin lead to a greater willingness to compensate the victim of a social norm violation? To investigate the role of oxytocin in social norm enforcement, we conducted a between-subject, double-blind, placebo-controlled, experiment in which participants played three versions of a monetary game while undergoing functional neuroimaging. These games were: a second-party punishment game, a third-party punishment game and a third-party compensation game. Hypothesizing that the effects of oxytocin do extend into a wider range of social behavior, we predicted that participants who received oxytocin would respond more intensely to social norm violations than participants in the placebo group, and thereby show increased punishment and/or compensation behavior. Our behavioral results demonstrated that oxytocin did increase sensitivity to social norm violations. Participants in the oxytocin group showed a greater willingness to punish those who violated a social norm. This effect was present in both punishment games, demonstrating that the effects of oxytocin on social norm enforcement extend into the domain of altruistic punishment. Interestingly, oxytocin did not enhance compensation behavior, thereby supporting the hypothesis that the positive effects of oxytocin on prosocial behavior are context-dependent. These results suggest that oxytocin is involved in a broader range of social behaviors than has been previously shown. Additionally, we collected neuroimaging data to assess the neural mechanisms by which oxytocin mediates social norm enforcement. Both behavioral and neuroimaging data will be presented.

NEURO-ENDOCRINE CONTROL OF SOCIAL MOTIVATIONAL BEHAVIOR *Karin Roelofs, Radboud University Nijmegen; Inge Volman, Radboud University Nijmegen; Ivan Toni, Radboud University Nijmegen* - Social motivational behavior can be roughly divided into social approach and social avoidance. On social approach-avoidance tasks, people generally tend to avoid social threat cues (such as angry faces), whereas they tend to approach social affiliation cues (such as smiling faces). We are interested in the effects of psychological and neurobiological markers of social anxiety and aggression on the neural control of those automatic social action tendencies. Based on animal studies, we predicted that the steroid hormones cortisol and testosterone, as well as variations in serotonin transporter availability would affect frontal control over amygdala-driven social approach-avoidance tendencies. I will present a series of fMRI studies in which we tested these hypotheses. First, I will present effects of individual differences in social anxiety and aggression-related symptoms, hormones (cortisol and testosterone) and genetic variations (serotonin transporter gene polymorphisms) on frontal-amygdala connectivity during an fMRI adapted social approach-avoidance task. In addition, to be able to infer causal relations, we investigated effects of direct hormone (testosterone) and neural (Transcranial Magnetic Stimulation) manipulations on social approach-avoidance behavior. I will report connectivity analyses, including Dynamic Causal Modelling, suggesting that down-

regulation by the anterior prefrontal cortex (aPFC) of the amygdala is critical in overriding automatic social approach-avoidance tendencies. These findings have implications for our understanding of the neuroendocrine regulation of social motivational behavior in healthy individuals, as well as in patients with social motivational disorders, like social phobia and psychopathy.

Session D Poster Presentations: Session 1

Empathy, Culture, Social Interaction, Health

Friday, April 20, 2012

2:45 - 4:15 PM

Session E Person Perception

Friday, April 20, 2012

4:15 - 5:30 PM

Jamil Palacios Bhanji, University of Texas at Austin

Nicola Sportorno, Université Lyon

James P. Morris, University of Virginia

Antonia Hamilton, University of Nottingham

A B S T R A C T S

FROM SNAP JUDGMENTS TO FINAL IMPRESSIONS: NEURAL REGIONS INVOLVED IN CHANGING ONE'S MIND ABOUT OTHERS *Jamil Palacios Bhanji, University of Texas at Austin; and Jennifer S. Beer, University of Texas at Austin* – People may make snap judgments of others based on factors that do not tell the whole story, such as the person's physical appearance. However, people will change those snap judgments when further information suggests that they should change their mind about a person. For example, a manager may make a positive snap judgment of a job applicant's competence that is driven by the applicant's physical attractiveness, but then may reevaluate after hearing the applicant's poorly spoken answers in a job interview. What factors determine how much an evaluation of another person will change from a snap judgment to a final impression, and conversely how much a snap judgment will persist in the face of more complete information? We use fMRI data to examine how the brain processes information to reevaluate snap judgments of other people. Participants judged job applicants' competence after viewing only a picture (snap judgment) and judged them again after viewing videos of the applicants' interview responses (reevaluation). Competence-related statements in the videos portrayed applicants at parametrically varying levels of competence. Participants' snap judgments were higher for physically attractive compared to less physically attractive applicants, but this difference was diminished in reevaluations after the videos. Dorsal medial prefrontal cortex (DMPFC) and lateral temporal cortex activity increased with parametrically decreasing levels of portrayed competence in the videos. Furthermore, DMPFC and lateral temporal cortex

activity was associated with the degree to which participants lowered their competence judgments from the snap judgment to the reevaluation. In other words, greater DMPFC and lateral temporal cortex activity was associated with greater change from a snap judgment to a final impression. Left amygdala activity was greater when participants judged less physically attractive compared to more attractive applicants. Left amygdala activity also increased with lower competence snap judgments. The findings suggest that neural distinctions in processing information about others may influence whether getting to know someone leads to a change of mind or whether a snap judgment persists. DMPFC and lateral temporal cortex activity may relate to changing one's mind about somebody whereas amygdala activity may relate to the persistence of a snap judgment.

“OF COURSE THERE IS NO THEORY OF MIND ACTIVATION IN VERBAL IRONY”: AN FMRI INVESTIGATION *Nicola Spotorno, Université Lyon; Eric Koun, Université Lyon; Jérôme Prado, Northwestern University; Jean-Baptiste Van Der Henst, Université Lyon; and Ira A. Noveck, Université Lyon* – Verbal irony provides prima facie evidence that the linguistic code is insufficient for communicating the complete meaning of an utterance. Consider an opera singer who tells her interlocutor: a) “Tonight we gave a superb performance!” when the performance was clearly awful. The ironic speaker expresses a dissociated (mocking) attitude. It is now well established that communicators interpret others’ mental states/attitudes through what has been called “Theory of Mind” (ToM). Thanks to a range of clever neuroimaging studies, there is now some general agreement about the best candidate regions for a neural-ToM-network. They are the right and left temporal parietal junction (rTPJ, lTPJ), the medial prefrontal cortex (MPFC) and the precuneus (PC). The present work is the first that aims to show how these regions are integral to language comprehension. It demonstrates that the ToM network becomes active when a participant is understanding irony and, moreover, it shows — through Psychophysiological Interactions (PPI) analyses — that ToM activity is directly linked with language comprehension processes. 20 healthy adults were tested in an event related fMRI design (1.5 T scanner) while they read 60 7-sentence-long stories. Twenty-four stories were devoted to the present investigation. The first five lines of the stories in the Ironic condition set up a negative context (e.g., one where a performance was disappointing) which was followed by a target-line delivering an ironic utterance (e.g., a) and by a wrap-up sentence. Matched Literal stories were practically identical except that the context was positive (e.g., the performance was good); the Target-line remains the same as above. We also included Decoy stories in which a negative event leads to a non-ironic/banal utterance. The decoys prevent negative contexts from being cues for ironic remarks. We conducted also an analysis based on the regions of interest (ROIs) that were isolated in a recent meta-analysis of the literature on ToM. The functional connectivity was estimated using PPI. Data were analysed using standard SPM8 methods. The Ironic>Literal contrast on the target sentence in both whole brain (cluster-wise FDR corrected $p < .05$ and voxel-wise uncorrected $p < .001$) and ROIs analysis shows that verbal irony understanding activated the entire network usually associated with ToM (MPFC, rTPJ, lTPJ and PC). Interestingly, PPI reveals that the ironic condition prompts an increase of functional connectivity between the left IFG of the language network, on the one hand, and the MPFC and the rTPJ (from the ToM network) on the other. The present data can be considered a first step in determining the extent to which language processing interacts with our ability to understand others’ mental states. Although verbal irony was our test bed, we do not believe that linguistically-driven ToM activity is limited to such cases. What remains to be seen is the extent to which one can find ToM activity in other kinds of pragmatic inference-making.

EPIGENETIC VARIABILITY IN OXYTOCIN RECEPTOR GENE (OXTR) IS ASSOCIATED WITH NEURAL ENDOPHENOTYPES OF SOCIAL PERCEPTION *James P. Morris, University of Virginia; Allison Jack, University of Virginia; and Jessica J. Connelly, University of Virginia* – The oxytocin pathway has been implicated in a myriad of social behaviors in mammals. Genetic studies have identified common variants in the oxytocin receptor gene (OXTR), rs53576 and rs2254298, that are associated with individual variability in social behavior, in the structure and function of brain regions supporting social perception, and in autism spectrum disorders (ASD), which are characterized by

atypical social behavior. These studies generally consider candidate single nucleotide polymorphisms (SNPs) as markers of genetic variability and brain structure or function as an endophenotype of behavior. In order to address biological and statistical limitations of the SNP approach, examination of additional molecular markers such as epigenetic variation is required. DNA methylation is an epigenetic modification that can result in changes in gene function through changes in gene expression. Recent work has suggested that, for at least some cytosine residues in the genome, DNA methylation can vary within the human population, remain stable across time, and be predictive of phenotypic variability. In the case of OXTR, several CpG sites that influence expression of the OXTR gene are variably methylated in humans and have been shown to be more highly methylated in individuals with ASD. Importantly, these results were obtained in DNA derived from both the brain and the blood, suggesting that methylation level in the blood could be used as a surrogate for methylation level in the brain. In the present study, we hypothesized that epigenetic variability could be associated with individual differences in brain activity underlying social perception in the general population. To test our hypothesis, forty-two neurologically normal volunteers submitted blood samples and then participated in two common social perception paradigms while undergoing fMRI. The first paradigm assessed activity associated with processing facial expressions of emotion. Here we found an allele specific relationship between DNA methylation and activity in the amygdala during emotional face perception. Specifically, carriers of the rs53576 GG genotype show a strong positive association between DNA methylation of OXTR and amygdala activity. The second paradigm assessed the response of the brain to visual displays of socially relevant motion by means of modified Heider and Simmel films. Here we found an allele specific relationship between DNA methylation and activity in brain regions often implicated in mentalizing behavior. Specifically, carriers of the rs2254298 GG genotype showed a positive relationship between DNA methylation and activity in the posterior superior temporal sulcus, anterior cingulate and temporal pole during perception of socially relevant motion. These data demonstrate that at least some epigenetic variability may be assessed via peripheral blood cells and that this variability may substantially improve our ability to explain individual differences in imaging genetic association studies.

MACHIAVELLIAN MIMICRY *Antonia Hamilton, University of Nottingham; and Yin Wang, University of Nottingham* – Unconscious mimicry of other people's actions is a ubiquitous social behaviour which is influenced in a subtle fashion by different social cues. Here we describe a series of new findings from behavioural and fMRI studies of mimicry which reveal the mechanisms controlling mimicry responses. In all these studies, we measure mimicry as the difference in reaction time between trials where participants observe an action congruent to the action they perform, and trials where participants observe an action which is incongruent. We find that eye contact from an interaction partner just before a participant's response rapidly and specifically enhances mimicry, but only if the eye contact remains during the response phase. fMRI with dynamic causal modeling reveals that this effect is due to top-down control signals from medial prefrontal cortex impacting on visuomotor processing in mirror neuron systems. We further show that control of mimicry is not a simple process of summing positive or negative social cues, but is subtly guided by the character of different interaction partners. For example, participants mimic more when an interaction partner is described as high-status and nasty than when a partner has high-status and is nice. They also mimic more when primed with self-relevant prosocial sentences or when primed with third-party anti-social sentences. This talk will bring these diverse and sometimes counter-intuitive results together under a framework of Machiavellian mimicry and will highlight important directions for future research into the interaction of top-down control processes and automatic responding in social behaviour.

Debate

Keynote Debate: Mirror Neurons

Friday, April 20, 2012

6:00 – 7:15 PM

Christian Keysers, University Medical Center Groningen, KNAW

Geoff Bird, University of London

FORMAT and CONTENT

Each keynote debate will begin with a 20-minute presentation by each speaker followed by 5 minutes for each speaker to offer a rebuttal and questions from the audience. This keynote debate will focus on the status and functions of the putative mirror neuron system (MNS) in humans. Christian Keysers will speak first, presenting one perspective on the functions of the MNS in action perception and other behaviors. Geoff Bird will speak second, offering an alternative take on the functions of MNS.

Session F

Health

Saturday, April 21, 2012

9:00 - 10:15 AM

Naomi Eisenberger, University of California, Los Angeles

Peter Gianaros, University of Pittsburgh

Steve Manuck, University of Pittsburgh

Tor Wager, University of Colorado, Boulder

Organizer: Naomi Eisenberger, University of California, Los Angeles

ABSTRACTS

FROM BRAIN TO BODY AND BODY TO BRAIN: EXAMINING THE NEURAL MECHANISMS THAT LINK SOCIAL DISCONNECTION WITH INFLAMMATION

Naomi I. Eisenberger, University of California, Los Angeles - Considerable research has demonstrated the importance of social relationships for physical health; those who report feeling more socially isolated show an increased risk of all-cause mortality and several inflammatory-related diseases. Although it has been hypothesized that the relationship between subjective social isolation ('social disconnection') and health may be due to the inflammatory-enhancing effects of social disconnection, it is also possible that increases in inflammatory activity contribute to a heightened sense of social disconnection. In this talk, I will review two studies that examine the reciprocal links between social disconnection and inflammation. The first study demonstrates that neural regions implicated in processing physical and social pain play a role in the downstream effects of social rejection on inflammatory activity. The second study demonstrates that these same neural regions appear to be involved in the upstream effects of inflammation on increased

feelings of social disconnection and depressed mood. I will discuss the implications of these findings in light of a hypothesized overlap in the neural systems underlying physical and social pain and will suggest that the physiologic responses which have been adaptive in the context of physical pain may be observed in response to social pain because of the overlap in these systems.

DO INFLAMMATORY PATHWAYS LINK SOCIOECONOMIC INEQUALITIES TO THE INTEGRITY OF BRAIN NETWORKS? *Peter J. Gianaros, University of Pittsburgh* -

Socioeconomic disadvantage confers risk for poor physical health across the lifespan. Such risk may be partly attributable to inflammatory influences on the integrity of brain networks. This presentation will review findings from a study testing specifically whether socioeconomic disadvantage relates to the integrity of white matter tracts connecting regions in distributed brain networks via anthropometric, behavioral, and molecular factors associated with systemic inflammation. In this study, healthy adults (N=155, aged 30-50 years, 78 men) completed protocols assessing indicators of socioeconomic position (SEP), anthropometric and behavioral measures of adiposity and cigarette smoking, measures of circulating C-reactive protein (CRP), and assessments of white matter integrity by diffusion tensor imaging. Path analyses were used to quantify associations between multilevel SEP indicators and measures of white matter tract integrity, as well as indirect mediating paths. Results showed that those completing less schooling, earning lower incomes, and residing in disadvantaged neighborhoods exhibited graded decreases in white matter fractional anisotropy and increases in radial diffusivity, relative to their more advantaged counterparts. Moreover, analysis of indirect paths showed that these effects were accounted for by elevated adiposity and higher smoking rates among disadvantaged individuals. The latter findings implicated systemic inflammation as a plausible mediator of reduced tract integrity. This inference was supported by the observation that CRP partially mediated anthropometric and behavioral paths from SEP to tract integrity. Socioeconomic disadvantage may relate to emergent aspects of ill health via inflammatory factors that impact the integrity of distributed brain networks.

EARLY FAMILY ENVIRONMENT COVARIES WITH PUBERTAL TIMING AND MIDLIFE CARDIOMETABOLIC RISK AS A FUNCTION OF POLYMORPHIC VARIATION IN ESTROGEN RECEPTOR- α (*ESR1*) *Stephen B. Manuck, University of Pittsburgh* -

Life History Theory accounts for variation in the developmental trajectories of organisms as a function of unfolding environmental conditions, which might be predicted from circumstances of early rearing. Deficient maternal nurturance of female rat pups has been shown, for instance, to hasten pubertal development and potentiate early sexual behavior, mediated in part via epigenetic alteration in the expression of estrogen receptor- α (ER- α) in brain regions regulating hypothalamic-pituitary-gonadal function. In analogous observations on a sample of 455 European American women (45.1 ± 6.6 yr), we found that individuals raised in families characterized by discord and an absence of close interpersonal relationships reached menarche earlier and gave birth at a younger age than counterparts reared in families described as cohesive and lacking in conflict. In apparent gene x environment interaction, moreover, adverse family relationships were associated with earlier pubertal development primarily in individuals homozygous for the minor alleles of two prominently studied polymorphisms of the gene encoding ER- α (*ESR1*; rs9304799, rs22234693). Additionally, the same interaction of *ESR1* genotype with quality of the rearing environment predicted women's heightened cardiovascular risk, as seen on biomarkers of insulin resistance, dyslipidemia, adiposity, and systemic inflammation. Together, these findings suggest that genotype-dependent influences of the childhood psychosocial environment may extend over the lifecourse to affect both developmental timing and later health status. More generally, they support predictions from Life History Theory, which posit that cues to future risk and uncertainty (such as early life adversities) occasion life history trade-offs that prioritize accelerated reproductive maturation over allocation of metabolic resources to continued growth and development or long-term somatic maintenance.

THOUGHTS AS THINGS: CORTICAL-SUBCORTICAL SYSTEMS CONNECTING THE MIND AND BODY

Tor D. Wager, University of Colorado, Boulder - It is widely believed that the contents of thought, and in particular the meaning ascribed to situations and events, can influence health in important ways. But how, and where, are such thoughts formed in the brain, and how do they influence the rest of the body and brain? Neurons in the ventromedial prefrontal cortex (vmPFC) project directly to the subcortical and brainstem centers that regulate the autonomic and endocrine systems. Here, I will argue that a central function of the vmPFC is to integrate information from several sources into representations of affective *meaning* – conceptualizations of the significance of sensory and internal cues for physical and social health. Thus, the vmPFC is an important part of the way that the contents of thought influence the body. After making this central argument, I will review data on the ways in which conceptual meaning is related to physiological outcomes and evidence on the role of pathways connecting vmPFC to hypothalamic and brainstem nuclei in mediating these effects.

Session G Poster Presentations: Session 2

Person Perception, Development, and Self-Control

Saturday, April 21, 2012

10:30 AM – 12:00 PM

Session H Development

Saturday, April 21, 2012

1:30 – 2:45 PM

Jennifer A. Silvers, Columbia University

Leah Somerville, Weill Cornell Medical college

Shir Atzil, Bar-Ilan University

Jennifer H. Pfeifer, University of Oregon

A B S T R A C T S

DEVELOPMENTAL EFFECTS ON THE NEURAL BASES OF EMOTION

REGULATION OF SOCIAL STIMULI *Jennifer A. Silvers, Columbia University; Jocelyn Shu, Columbia University; Jochen Weber, Columbia University; Kevin N. Ochsner, Columbia University*

Adolescence is a critical time for the development of self-regulatory abilities that support healthy social and emotional functioning throughout the life span. While prior work has demonstrated age-related differences in passive viewing of socioemotional stimuli and in cognitive control tasks, little research has examined the development of the ability to use cognitive strategies to control emotional responses to socioemotional stimuli. The present study sought to do just that by scanning 39 healthy individuals aged 10-22 years ($M=16.29$, $SD=3.75$) while they performed an emotion regulation task involving social stimuli. On each trial, participants viewed an aversive or neutral social image while either drawing themselves closer to the emotional details of the picture ("close" trials) or

mentally distancing themselves from such details (“far” trials). At the conclusion of each trial, participants rated their negative affect. Across all ages, participants reported significantly more negative affect for close/negative than close/neutral trials (‘emotional reactivity’) and significantly less negative affect for far/negative trials than close/negative trials (‘regulation success’). While emotional reactivity did not vary with age, regulation success improved significantly. Age predicted greater recruitment of dorsomedial and dorsolateral prefrontal cortex (dmPFC and dlPFC), two brain regions known to support emotion regulation in adults, for the far>close contrast (FWE, $p < .05$). Additionally, a single-level random-effects mediation analysis revealed that dmPFC was a significant mediator of the relationship between age and regulation success. To assess whether distancing exerted sustained effects on affective processing, we next examined neural responses while participants passively viewed the same images five minutes after completing the regulation task. Regulation success at the time of task predicted less amygdala responsivity during the re-presentation period for images from which participants had previously distanced themselves in comparison to pictures from which they had previously immersed themselves. Taken together, the present research suggests that emotional regulation capacity for social stimuli improves over the course of adolescence and that this may be supported by maturing prefrontal-subcortical circuits.

AFFECTIVE INFLUENCES ON COGNITIVE CONTROL IN ADOLESCENCE *Leah Somerville, Weill Cornell Medical College; BJ Casey, Weill Cornell Medical College* - Some accounts of adolescents liken them to “mini-adults”, whose psychological capabilities consistently fall between that of younger and older individuals. However, research has begun to identify contexts in which adolescent behavior violates linear patterns, instead showing unique behavioral trends relative to both children and adults. Across a number of studies, contexts of heightened emotion have been related to selective impairments in cognitive control and decision making in adolescents. This presentation will highlight findings demonstrating that the presence of positive emotional cues interrupt impulse control to a greater extent during adolescence than during other times of life. Functional MRI findings suggest that this nonlinear behavior change is paralleled by a selective amplification in the recruitment of affective valuation systems in the brain during adolescence, paired with an intermediate engagement of cognitive control circuitry. These findings offer clues to the neural mechanisms that give rise to unique behavioral patterns of adolescents, which may inform the developmental trajectories of real-world behaviors such as risk-taking.

SPECIFYING THE NEUROBIOLOGICAL BASIS OF HUMAN ATTACHMENT: BRAIN, HORMONES, AND BEHAVIOR IN POSTPARTUM MOTHERS AND FATHERS *Atzil S, Bar-Ilan University; Hendler T., Tel-Aviv Sourasky Medical Center, Tel Aviv University; Weintraub Y., Tel-Aviv Sourasky Medical Center; Feldman R., Bar-Ilan University* - Parental neurobiology manifests in social and motivational brain-systems. The integration between these two systems could possibly explain the variability in parental attachment, pointing out similarities and differences among mothers and fathers, and between them. While extant research has addressed the brain-basis of mothering, only few studies assessed the neural-basis of human fathering. The current study is the first to address the coordinated neurobiology of mothering and fathering by assessing the parents' fMRI response to a dynamic, ecologically-valid infant stimuli and testing the maternal and paternal brain-synchronization in response to their own infant. Additionally, we address the specifications of each gender parental response and the parents' plasma Oxytocin and Vasopressin association with their brain responses to the infant. fMRI scans were performed on 29 mothers and 15 fathers while they observed two-minute movies of their own infant-related stimuli. Control videos presented unfamiliar infants. Video vignettes were also used for behavioral analysis, yielding a measure of mother-infant synchrony. To detect the brain areas that synchronize in parental brain responses, we developed an inter-couple correlation analysis. To evaluate the neural differences between mothers and fathers, a GLM as well as functional connectivity maps were computed. Covariate analyses assessed the brain responses that correlate to the plasma levels of Oxytocin and Vasopressin. Last, mothers' brains were assessed according to their synchrony with the infant. The results of the inter-couple-correlation demonstrate

synchrony between mothers' and fathers' brains in visual-cortex, motor cortices, IPL, IFG, and insula when responding to their infant. The differences between mothers and fathers focus on the right-amygdala and the right-temporal pole, where mothers had higher activations. Fathers show higher activations in the dPFC. The connectivity analysis reveals that mothers display a limbic network with right-amygdala, including the collateral amygdala and STS. In contrast, fathers display cortical functional correlations to the right-amygdala in parietal, occipital and frontal gyri. Oxytocin and Vasopressin correlated differently to brain responses of mothers and fathers. Oxytocin correlated to limbic areas including ventral-ACC, amygdala and NAcc only in mothers. Vasopressin correlated only in fathers to social cognition areas including IFG, temporal pole and IPL. Additionally, maternal neural networks were differentiated by the mother-infant synchrony: Synchronous moms were characterized by higher NAcc activations and DMPFC involvement. Intrusive moms had higher amygdala and OFC activations. Parents' brain responses to baby stimuli involve two networks: Sub-cortical/affective areas may process the intuitive approach of a parent to a baby, while cognitive 'Theory Of Mind' areas integrate a complex synchronous relationship with the baby. Whereas mothers and fathers are synchronized in social cognition areas, the anxiety and vigilance response may be unique to mothers. Mothers showed greater activation at limbic-motivation areas and such activation was associated with their Oxytocin levels, suggesting a more intuitive approach to infant care. Fathers exhibited greater response in cognitive areas related to emotion modulation and mirror systems, which may suggest a more cognitive response. Additionally, the outcome of maternal behavior depends on the combination between the affective and social-cognition networks.

WHAT DEVELOPMENT, DISORDERS, AND INDIVIDUAL DIFFERENCES HIGHLIGHT ABOUT THE NEURAL SYSTEMS SUPPORTING SELF-PROCESSING

Jennifer H. Pfeifer, University of Oregon - A rich area of study in the social and affective neurosciences is that of the brain systems supporting various aspects of self-processing. A strong body of evidence suggests the medial prefrontal cortex (mPFC) is preferentially engaged during self-appraisals. Meanwhile, a small but growing list of recent studies identifies additional regions that may also be important during self-appraisals, including ventral striatum (VS), middle cingulate cortex (MCC) and temporo-parietal junction (TPJ). Despite this intense research focus, we are just beginning to understand the developmental trajectories of brain function in these regions during self-appraisals, including relevant group and individual differences in these trajectories. In this presentation, I will integrate several new studies that help to flesh out this picture, and further propose that this evidence should influence how we think about the neural systems supporting self-processing. Previous cross-sectional studies comparing young adults with either children or adolescents (Pfeifer et al., 2007, 2009) suggested activity in mPFC during self-appraisals decreases by adulthood. However, longitudinal analyses may provide better traction on the precise developmental trajectory. In an ongoing study, over 60 neurotypical 10-year-old children were recruited, and have since returned at ages 13 and 16. Retention in the sample exceeds fifty percent. In the fMRI paradigm, participants listened to short phrases in the social and academic domains, and engaged in social or academic appraisals of self and another well-known target (Harry Potter). The longitudinal technique allowed for the identification of various linear and non-linear trends in the data. For example, responses in ventral mPFC during self > other increased specifically from age 10 to 13 (Pfeifer et al., in prep). In addition, there were highly stable responses across timepoints in key regions of interest. Other-appraisals elicited more activity in medial posterior parietal and retrosplenial cortex (mPPC/RSC), while self-appraisals elicited more activity in perigenual/rostral anterior cingulate cortex, VS, and MCC. In this developmental sample, social self-appraisals were particularly likely to elicit VS activity. Furthermore, longitudinal changes in task-dependent functional connectivity suggest that with development, mPPC/RSC and dorsal mPFC become more tightly coupled during other > self (Veroude et al., in prep). Other relevant individual and group differences we have observed provide additional insights about neural functioning during self-processing. For example, we found that differentiation between self and other in ventral mPFC is lacking in children and adolescents with autism spectrum disorder (ASD; Pfeifer et al., under review). In neurotypical children and adolescents who comprised the

matched control group for those with ASD, greater self-other differentiation in ventral mPFC was associated with enhanced parent-reported social competencies. In another cross-sectional study from our lab, interactions between age group, target of appraisal, and domain of appraisal identified VS and TPJ as key regions of interest, although here we observed physical self-appraisals trumped the saliency of social self-appraisals in early adolescence (Jankowski et al., in prep). Together, these studies of development, disorders, and individual differences enrich our understanding of the neural systems supporting self-processing in important ways.

Session I Poster Presentations: Session 3

Emotion and Choice

Saturday, April 21, 2012

2:45 – 4:15 PM

Session J Emotion, Choice and Self-Control

Saturday, April 21, 2012

4:15 – 5:30 PM

Christian Waugh, Wake Forest University

J. David Creswell, Carnegie Mellon University

Ajay Satpute, Northeastern University

Elliot Berkman, University of Oregon

A B S T R A C T S

TEMPORAL DYNAMICS OF EMOTION PROCESSING IN THE BRAIN *Christian Waugh, Wake Forest University* - Emotions happen over time. From the initial appraisal of an emotional event that can occur within hundreds of milliseconds (Schupp, et al., 2000) to event-induced moods that can endure for weeks (McCullough, Orsulak, Brandon, & Akers, 2007). Although often ignored empirically, time is an important parameter in most major theories of emotion. Process-models of emotion, for example, have emphasized that emotions endure and change over time, and that temporal approaches to understanding emotions should yield discoveries about how emotions are fundamentally processed (Larsen, Augustine, & Prizmic, 2009). Despite the importance of timing in understanding emotional experience, it has been mostly ignored in neuroimaging studies. The reason is simple: traditional functional magnetic resonance imaging (fMRI) statistical techniques do not estimate time. The overwhelming majority of fMRI analyses model the data with canonical gamma-based hemodynamic response functions (HRFs; Friston, Jezzard, & Turner, 1994). When these canonical HRFs are used to model the data, only one parameter – height – is allowed to vary. The temporal parameters of the HRF, such as the delay and dispersion, are typically fixed which does not allow for the estimation of possible temporal dynamics of the underlying blood oxygenation-level dependent (BOLD) response. There is a delay from neural activity to measurable BOLD response (Bandettini, Jesmanowicz, Wong, & Hyde, 1993), so these time-invariant HRFs only assess

hypothetical neural activity occurring in the first second after stimulus onset while failing to account for significantly delayed neural responses or neural responses of longer duration. This means that fMRI studies of emotion in large part fail to capture the development of emotional experience beyond the initial response to the emotional stimulus. I present several recent studies that have used time-varying HRFs and other time-varying fMRI techniques to show why estimating temporal features of the BOLD response may prove critical to understanding emotional dynamics. In one study, we used the summation of three inverse-logit curves as a time-varying HRF (Lindquist & Wager, 2007) to examine how the duration of BOLD activity relates to self-reported intensity of emotional experience (Waugh, Hamilton, & Gotlib, 2010). We found that separable regions within the mPFC responded to intense negative images with either heightened magnitude of activation or extended duration of activation. In another study, using change-point analysis (Lindquist, Waugh, & Wager, 2007), we found that the mPFC exhibited extended duration of activity during a long-epoch stress paradigm. In another study, we found that this mPFC activation during a stressor differentiated those diagnosed with major depressive disorder from those diagnosed with social anxiety disorder. In sum, these studies show that assessing temporal dynamics of emotional processes in the brain aid in our understanding of both normal and pathological emotional dynamics. These studies also demonstrate that the mPFC is a key region that may be involved in both the initial generation and continued maintenance of emotional episodes. Future studies will need to better specify the precise psychological mechanisms that contribute to the temporal dynamics of emotions and the specific role that the mPFC plays in those mechanisms.

NEURAL MECHANISMS OF UNCONSCIOUS THOUGHT IN DECISION MAKING

J. David Creswell, Carnegie Mellon University; James K. Bursley, Carnegie Mellon University; Ajay B. Satpute, Northeastern University - Unconscious processes have been shown to facilitate many higher-level human behaviors. For example, brief periods of unconscious thought have been shown to improve a decision when that decision is complex (e.g., choosing a car to purchase from a set of cars with various positive and negative characteristics). In this talk, I will describe neuroimaging and behavioral studies conducted in my lab that reveal a neurobehavioral explanation for these puzzling effects. Specifically, we find that neural regions that support the encoding of decision information continue to remain active during an unconscious thought period (while participants are asked to complete a difficult distractor task), an effect we refer to as unconscious neural reactivation. Moreover, this unconscious neural reactivation was predictive of improved subsequent decision making performance after unconscious thought. Two follow-up behavioral studies test and extend this unconscious neural reactivation hypothesis in decision making. Conclusions will focus on the role of unconscious processing in learning, decision making, and insight.

LANGUAGE SHAPES EMOTIONAL EXPERIENCE

Ajay B. Satpute, Northeastern University; Jochen Weber, Columbia University; Kevin N. Ochsner, Columbia University - Emotions are often considered to be continuous, free-flowing experiences. But, our ability to describe them using language requires that we place emotions into discrete linguistic categories, or words. Hence, situations can arise in which the emotional experiences we have are on the boundary between categories. These boundary cases would produce increased conflict between experience and available categories, and resolving this conflict would require that boundary items be forcibly grouped into one category or the other. Such resolution could be trivial if boundary experiences are arbitrarily assigned to a category, and doing so has little to no effect on how these items are experienced. Alternatively, conflict resolution may rely on cognitive control processes, which, according to biased-competition models, may alter the experience of the event to be more category-consistent. To address these hypotheses, participants completed a novel neuroimaging paradigm in which they were presented with stimuli that varied in affective intensity, and either categorized or made continuous ratings of their emotional responses to these images. Results showed that categorizing experiences on the boundary elicited activity in prefrontal and cingulate cortex regions commonly involved in conflict and cognitive control. But how is this conflict resolved? We examined affect-sensitive

portions of the insula, and found that in this region, boundary items that were described as more negative resulted in greater activity whereas items that were described as less negative resulted in reduced activity, relative to the same stimuli had they not been categorized. These results support the conclusion that requirements to categorize emotion, as necessitated by language, may shape the way emotions are experienced.

SELF-CONTROL NETWORK PLASTICITY INDUCED BY A THREE-WEEK

RESPONSE INHIBITION TRAINING *Elliot T. Berkman, University of Oregon; Junaid S.*

Merchant, University of Oregon; Matthew D. Lieberman, UCLA; Lauren E. Kahn, University of

Oregon - The dominant theory of self-control from social psychology, the Strength Model, predicts that self-control will be amenable to change through training. Although some behavioral data exists to support this idea, no parallel studies have been conducted in the cognitive neurosciences to establish the underlying pathways through which these behavioral improvements are made. We conducted a longitudinal training study to investigate which neural systems, if any, show plasticity concomitant with changes in behavioral improvements in self-control. Thirty-eight participants were randomly assigned to receive self-control training (via a modified stop-signal task) or a control training that did not involve self-control. Participants in both groups came to the lab for ten sessions and engaged in a brief computerized task at each, but only participants in the self-control training condition engaged in response inhibition as part of this task. Task-related brain activation during behavioral self-control (i.e., stop-signal task) and affective self-control (i.e., emotional reappraisal) was measured in all participants before and after the training. A whole brain interrogation of the group (training/control) by time (pre-training/post-training) interaction found greater changes in activation across time in the training group (compared to the control group) in both tasks in a self-control and attention regulation network including inferior frontal gyrus, dorsolateral prefrontal cortex, and inferior parietal cortex. Within the training group, increases in activation from pre- to post-training in the inferior frontal gyrus were correlated with increases in performance on the stop-signal task. These results support the Strength Model of self-control, and elucidate the neural pathways by which training can lead to improvements in several forms of self-control.

Debate

Keynote Debate: Valuation and Emotion

Saturday, April 21, 2012

6:00 – 7:15 PM

Antonio Rangel, California Institute of Technology

Elizabeth Phelps, New York University

FORMAT and CONTENT

Each keynote debate will begin with a 20 minute presentation by each speaker followed by 5 minutes for each speaker to offer a rebuttal and questions from the audience. This keynote debate will focus on what neuroscience data can tell us about the relationship between valuation, as studied in neuroeconomics, and emotion, as studied in social, cognitive and affective neuroscience. Antonio Rangel will speak first, presenting the view from neuroeconomic research on choice and decision-making. Elizabeth Phelps will speak second, offering an alternative view from neuroscience research on affective learning and emotion perception, experience and regulation.

Poster Sessions

Session D Empathy, Culture, Social Interaction & Health

Friday, April 20, 2012

2:45 - 4:15 PM

Session G Person Perception, Development & Self-Control

Saturday, April 21, 2012

10:30 – 12:00 PM

Session I Empathy & Choice

Friday, April 20, 2012

4:15 – 5:30 PM

SAN Poster Prize

We are pleased to commend a selection of posters as having scored among the top 5% for their submission category (as judged by the selection committee). We have designated these posters as receiving a SAN poster prize.

SAN poster prize recipients will be designated throughout the program with a ★ next to their poster number.

Poster Session D

D-01 ★

5-HTTLPR POLYMORPHISM INFLUENCES THE ASSOCIATION BETWEEN A CULTURAL VALUE AND BRAIN ACTIVITY UNDERLYING SOCIAL COGNITION

Yina Ma Bingfeng Li, Chenbo Wang, Zhenhao Shi, Yun Sun, Feng Sheng, Yifan Zhang, Wenxia Zhang, Yi Rao, Shihui Han; Peking University - Thinking about the self and others consists of a key component of social cognition that guides social behaviors. Recent research has shown that sociocultural experiences influence the brain activity underlying social cognition (e.g., the processing of the self and others). What remains unknown is whether and how biological factors interact with sociocultural experiences to affect the brain activity involved in social cognition. We investigated whether the serotonin transporter gene promoter polymorphism (5-HTTLPR) affects the association between cultural values and brain activity associated with the processing of the self and a significant other. Using functional MRI, we scanned adults with short/short (s/s) or long/long (l/l) alleles of 5-HTTLPR during judgments of social, mental, and physical attributes of themselves and a close other (i.e. mother). We first found that a measure of a specific cultural value related to self-construals was correlated with the neural activity associated with judgments on the self and mother in brain regions such as the medial and lateral frontal cortex, temporoparietal junction, superior parietal cortex, insula, hippocampus, and cerebellum. Moreover, the association between the cultural value and brain activity related to mental attribute judgments was moderated by 5-HTTLPR, being stronger in l/l carriers than in s/s carriers. In sum, our functional neuroimaging results showed evidence for a gene-culture interaction in shaping the association between a cultural value (i.e., interdependence in self-construal) and brain activity related to the processing of the self and a close other. While there has been considerable evidence for cultural influences on human activity underlying multiple cognitive processes (Han and Northoff, 2008), the current study raised the question of whether and how cultural effects on brain activity are constrained by an individual's genetic makeup.

D-02

NEGATIVE EMOTION IN COLLECTIVISTIC CONTEXTS: THE EFFECTS OF INDIVIDUALISM-COLLECTIVISM ON AMYGDALA FUNCTION AND SOCIAL COGNITION

Lisa A. Hechtman, Northwestern University; Ahmad Hariri, Duke University; Tokiko Harada, Nagoya University; Yoko Mano, Tohoku University; Norihiro Sadato, National Institute for Physiological Sciences; Todd B. Parrish, Northwestern University; Tetsuya Iidaka, Nagoya University; Joan Y. Chiao, Northwestern University - Mood

and anxiety disorders have been linked to a number of biological mechanisms, including variations in the serotonin transporter gene, and decreased functional connectivity between amygdala and regulatory prefrontal cortex regions (Pezawas et al., 2005). Most of this work, however, focuses mainly on outcomes in Western, individualistic contexts, and treats heightened emotional sensitivity as maladaptive. One theory holds that living according to collectivistic norms requires particular sensitivity to negative information in one's surroundings, due to increased emphasis on group membership and hierarchy (Chiao & Blizinsky, 2010). Here we examine the interrelationship between cultural values of individualism-collectivism, amygdala response to negative emotional stimuli, and social cognitive abilities. Bicultural Asian Americans completed an individualistic or collectivistic essay prime, and subsequently matched a series of emotional scenes and geometric shapes (control) during fMRI scanning. After scanning, participants played a prisoner's dilemma game, and completed a theory of mind task (Reading the Mind in the Eyes; Baron-Cohen, 1997). ROI analysis within bilateral amygdala revealed that participants' degree of primed collectivism positively predicts percent signal change in response to emotional scenes. Greater amygdala response predicted both increased cooperation in the prisoner's dilemma game, and better theory of mind ability; however, scores on social cognitive tasks were unrelated to primed levels of collectivism. These findings demonstrate that temporarily heightening awareness of collectivistic cultural values enhances emotional vigilance, whereas social-cognitive advantages more likely relate to more chronic levels of emotional vigilance. The results provide new hypotheses about the role of emotional sensitivity in collectivistic contexts.

D-03

NEURAL RESPONSES TO EMOTIONAL STIMULI ARE MODULATED DIFFERENTLY BY CULTURALLY SIMILAR AND DISSIMILAR OTHERS

Kate A. Woodcock, University of Peking University of Birmingham; Dian Yu, University of Peking; Yi Liu, University of Peking; Shihui Han, University of Peking - One important aspect of individual differences in emotional responding is how different individuals control their emotions in different ways. There has been much interest in the neural correlates of specific strategies for emotion regulation (how people control their emotional experience and expression) and internal factors (e.g. personality, mental health symptomatology) associated with individual differences in these strategies. However, how social context can impact on emotional responding and its regulation, remains poorly understood. This study investigated whether and how the presence of a researcher perceived by participants as pertaining to a more similar or more different cultural background, influenced emotional responding. We recorded participants' event

related potentials (ERPs) and self-report ratings of arousal and emotion regulation from Chinese female adults, whilst they observed positive, negative or neutral photographs in the presence of a Chinese or British researcher, or whilst alone. Participants' cultural values were measured using self-report questionnaires. We found that ERP responses to positive stimuli at 120-180ms post photograph onset, over a frontal region, were significantly down-modulated in the presence of the British researcher and this down-modulation was significantly associated with self-reports of increased emotion regulation. Early ERP responses to negative emotional stimuli were modulated in different directions in the presence of the British (downwards) versus the Chinese (upwards) researcher. Increased differentiation between the degrees (positive emotion) and directions (negative emotion) of modulation of early neural responses to emotional stimuli, in the presence the British versus the Chinese researcher, were associated with decreased interdependent self construal. Possible differences between the emotion regulation triggered by researchers perceived by participants as pertaining to a more similar versus more different cultural background will be discussed. The association between increased interdependence and decreased differentiation between the two contexts in terms of emotional responding will be discussed with respect to contemporary theories of self construal.

D-04 ★

CULTURE MODULATES ELECTROCORTICAL RESPONSES DURING EMOTION SUPPRESSION: ASIANS ARE BETTER SUPPRESSERS

Asuka Murata, University of Michigan; Jason S. Moser, Michigan State University; Shinobu Kitayama, University of Michigan - Emotion regulation is an important concept in personality and social psychology. To achieve goal-directed outcomes, we manage and modify our emotional experience and expressions. Growing literatures have demonstrated the interpersonal functions of emotion regulation. As one of the major functions of culture is to maintain social order, cultures create rules, guidelines, and norms regarding emotion regulation. Previous behavioral studies have indicated that Asians habitually suppress their emotional responses more than European Americans do. This cultural difference may come from Eastern cultural values, which consider low arousal emotions as more desirable and emphasize self-control relatively more than Western cultures. Yet, little is known about the underlying neural mechanisms that support such differences between Asians and European Americans in emotion suppression. Here we examined the effects of suppression instruction on the centro-parietally distributed LPP (late positive potential), an event-related brain potential that is thought to reflect arousal level to emotional stimuli. The LPP, which is elicited by emotional stimuli, peaks around 500 ms and lasted for the duration of the stimuli. Seventeen European Americans and seventeen Asians were

presented with neutral and unpleasant pictures in random order under two different instruction conditions. First, in the attend condition, they were instructed to pay attention to the picture and the emotional responses that were naturally elicited by the pictures. Second, in the suppress condition, they were asked to minimize and hide their emotional responses that were naturally elicited by the picture. Our predictions were that the amplitude of the LPP would be decreased during instruction to suppress emotional responses compared to the attend instruction and that Asians would show a greater LPP reduction during emotional suppression than European Americans. We first analyzed the mean amplitude of the LPP between 400 and 700 ms post-stimulus and found that the LPP was significantly greater for the unpleasant pictures than for the neutral pictures. There were no effects of culture and instruction in this time window. However, when we analyzed the LPP mean amplitude between 1500 and 3500 ms, Asians showed a significant decrease under the suppress condition compared to the attend condition. In contrast, European Americans did not show such LPP reduction in the suppress condition (vs. attend condition). Post-experimental questionnaires of task engagement and task difficulty revealed that both cultural groups were equally engaged and worked hard. These results suggest that both European Americans and Asians strongly experienced negative emotion shortly after being exposed to the emotional stimuli, however, in less than two seconds, Asians succeeded in suppressing their emotional responses, whereas European Americans failed. The failure of European Americans to decrease the LPP was unlikely to be an artifact caused by lack of motivation. Our findings provide strong evidence that neural mechanisms of emotion regulation are shaped by culture.

D-05

CULTURAL VALUES OF INDIVIDUALISM-COLLECTIVISM MODULATE PREFRONTAL RESPONSE DURING RESPONSE INHIBITION

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on individualism-collectivism values, the participants then performed a Go-No Go task in the fMRI scanner. Our results show that collectivists exhibit greater lateral and medial prefrontal response during response inhibition compared to individualists, irrespective of nationality or geographic region. Taken together, this is a novel evidence showing that inhibitory-related neuronal activity varies as a function of cultural values.

D-06

POLITICAL IDEOLOGY IS RELATED TO THE INTRINSIC FUNCTIONAL ORGANIZATION OF THE HUMAN BRAIN

Christine L. Cox, New York University; John T. Jost, New York University; F. Xavier Castellanos, New York University, Nathan Kline Institute; Michael P. Milham, Nathan Kline Institute, Child Mind Institute; Clare Kelly, New York University; Jay J. Van Bavel, New York University - Political ideology (i.e., liberalism/conservatism) has long been thought to arise from differences in beliefs about human nature and personal experiences. However, recent research suggests that individual differences in political ideology are associated with more basic cognitive and motivational orientations toward the world (e.g., Oxley et al., 2008). In the current research, we examined whether individual differences in political ideology would be associated with the intrinsic functional architecture of the brain. Previous research has shown that political ideology is associated with both the structure and function of the dorsal anterior cingulate cortex (dACC). Liberalism is associated with increased gray matter (Kanai et al., 2011) and increased conflict-related processing in dACC, hypothesized to underlie liberals' greater responsiveness to complex information (Amodio et al., 2007). Consistent with this interpretation, the dACC is part of a network of regions, including the insula and striatum, that process emotionally significant stimuli (Seeley et al., 2007). Regions within this "salience network" also exhibit correlated intrinsic (task-independent) low-frequency fluctuations in the resting-state fMRI (R-fMRI) signal, quantified using intrinsic functional connectivity (iFC) methods. Therefore, we investigated the relationship between the iFC of the dACC and individual differences in self-reported political ideology. Several recent studies have related individual differences in the strength of iFC between specific brain regions to stable personality variables (e.g., Cox et al., 2010). Twenty-one adults (mean age=29.6 yrs; 18 male) completed a 6-minute R-fMRI scan and a self-report questionnaire assessing political ideology (i.e., how liberal or conservative) and system justification, the tendency to believe that existing social and economic institutions and arrangements are fair and legitimate (Kay & Jost, 2003). Standard preprocessing was implemented using FSL and AFNI. The residual timeseries from 4mm spherical regions of interest (left and right dACC) was then extracted for each individual and correlated with every other voxel in the brain. Political ideology scores were entered as a covariate of interest in group-level analyses (with age and sex as nuisance covariates), producing maps of significant political orientation/iFC

relationships ($Z > 2.3$, $p < 0.05$, corrected). Political ideology was significantly negatively related to iFC between the right dACC and a cluster spanning the right insula and putamen. Greater liberalism was associated with increased, while greater conservatism was associated with decreased iFC between these regions. Post-hoc analyses showed that iFC between these regions was also negatively correlated with system justification scores. Greater system justification was associated with decreased iFC ($r = -0.42$, $p < 0.05$). Our results demonstrate a relationship between the intrinsic functional organization of the brain and political ideology. Greater liberalism was associated with increased iFC among regions in the salience network, while greater conservatism was associated with decreased iFC. This provides the first evidence that political ideology is related, not only to task-evoked responses in the dACC itself, but to the intrinsic communication among regions within a broader functional network. More generally, these results are consistent with the idea that political ideology manifests in observable differences in the functional architecture of the human brain.

D-07 ★

THE COST OF COMPARISON: ACHIEVEMENT GOALS, GENDER, AND REBOUND FROM FAILURES IN MATH

Jennifer Mangels, Baruch College, City University of New York; Laura Deering, Baruch College, City University of New York; Catherine Good, Baruch College, City University of New York - Achievement in STEM disciplines is not determined by ability alone, but also by social and motivational factors. Recently, there has been considerable focus on the role stereotypes play in handicapping females' ability to optimally utilize cognitive resources for math problem solving. Although environments that neutralize stereotype threat should theoretically eliminate gender differences, if females internalize achievement goals that emphasize comparison of one's ability to others (normative goals), they may still experience differentially poor outcomes when cues in the environment suggest that their ability is lacking. In particular, normative goals may simulate the effects of stereotype threat by enhancing arousal and attention to failure cues (e.g., negative feedback) that then interfere with the more adaptive cognitive responses that could promote effective rebound from failure (see Mangels et al. [2011]). In contrast, achievement goals focusing on challenge and mastery are likely to be associated with persistence and rebound after failure, regardless of gender. In the present study, males and females who primarily identified with either normative (N-bias) or challenge goals (C-bias) participated in a difficult test-feedback-retest math paradigm under non-threat framing. N-biased students, regardless of gender, were impaired compared to C-biased students in their ability to utilize instructive feedback to correct errors on the subsequent surprise retest. To better understand how later error correction was related to the initial response to failure, we focused our analysis on event-

related potentials (ERPs) to negative accuracy feedback following first-test errors (using the response to positive feedback as a baseline) and the quantity and quality of participants' engagement with a subsequent computerized math tutor. With regard to the ERPs, both early/fast (feedback related negativity [FRN], frontal P3a) and later/sustained (late positive potential [LPP]) indices of motivated attention were evaluated. Females exhibited a more negative-going FRN, regardless of goals. Yet, C-biased males exhibited an enhanced P3 relative to C-biased females. The LPP did not demonstrate any overall effects of gender or goals. There also were no gender or goal differences in the quantity of tutor use, however females and C-biased students self-reported the tutor as more helpful overall. We then turned to structural equation modeling to examine whether goals and gender influenced the extent to which any differential responses to negative feedback and tutor engagement predicted correction of errors on the retest. For females, it was normative goals that best predicted enhanced orienting to negative feedback (P3a), reduced the quality of tutor engagement, and led to poorer outcomes on the retest. In contrast, for males, challenge goals were the strongest predictor of better outcomes on the retest, of more adaptive responses to negative feedback (reduced LPP), and of greater quantity and quality of tutor use. These findings illustrate the costs of emphasizing normative comparison over mastery in both males and females undertaking challenging math tasks. Additionally, they show that for females, this cost is linked directly to normative goals that simulate the effects of stereotype threat, whereas for males these costs reflect the lack of benefit from approaching math from a perspective of challenge.

D-08 ★

NOT FEELING YOUR PAIN: NEURAL RESPONSES TO PAIN IN SELF AND OTHERS IN YOUTHS WITH PSYCHOPATHIC TRAITS

Abigail A. Marsh, National Institute of Mental Health, Georgetown University; Elizabeth C. Finger, University of Western Ontario; Katherine A. Fowler, National Institute of Mental Health; Christopher J. Adalio, National Institute of Mental Health; Ilana T.N. Jurkowitz, National Institute of Mental Health; Julia C. Schechter, National Institute of Mental Health; Daniel S. Pine, National Institute of Mental Health; Jean Decety, Ph.D., Centers for Disease Control and Prevention; R. J. R. Blair, National Institute of Mental Health - Psychopathic traits, including reduced empathy and guilt, affect a subgroup of youths with the disruptive behavior disorders Conduct Disorder and Oppositional Defiant Disorder. These traits are detectable early in childhood, persist into adulthood, and heighten youths' risk for recurrent antisocial acts and future criminal behaviors. In line with the clinical presentation of reduced empathy, individuals with psychopathic traits are impaired in recognizing distress-related cues like fearful and sad facial expressions that normally inhibit interpersonal aggression. Moreover,

youths with disruptive behavior disorders and psychopathic traits show reduced amygdala responses to fearful expressions. Whether impaired responding to distress cues extends to pain cues is currently unknown, but elevated antisocial behavior in psychopathy suggests potential disruptions in processing others' pain. We used functional magnetic resonance imaging (fMRI) to investigate neural responses to increasing pain intensity perceived as occurring to the self or others in healthy adolescents and adolescents with psychopathic traits. Fourteen adolescents with Oppositional Defiant Disorder or Conduct Disorder and psychopathic traits and 21 control subjects were scanned as they viewed photographs of hands and feet in being injured (e.g., being crushed or burned) or in neutral contexts. In each trial, adolescents were either instructed to imagine that the limbs were their own or that they belonged to another person. Regressors were weighted according to the intensity of the perceived pain. Behavioral and fMRI data were analyzed using random-effects analysis of variance. Youths with psychopathic traits showed less of an increase in activity, relative to healthy youths, within rostral anterior cingulate cortex and ventral striatum (putamen) as the depicted pain increased. Within the amygdala, this reduction in activity particularly occurred when the pain was perceived as occurring to another. Responsiveness within both amygdala and rostral anterior cingulate cortex as a function of apparent pain to another was negatively correlated with the severity of psychopathic traits. These results indicate that youths with psychopathic traits show less sensitivity in regions implicated in the affective response to another's pain as the perceived intensity of this pain increases. Moreover, this insensitivity appears to predict symptom severity. Given suggestions that the pain of others may trigger empathic distress in the observer, providing a basis for moral development, we conclude that dysfunction in response to others' pain may contribute to the behavioral deficits observed in this population.

D-09

RACIAL DIFFERENCES IN THE TIME-COURSE OF PAIN PERCEPTION PREDICT BIASES IN HELPING BEHAVIOR

Stephanie Echols, University of Chicago; Jean Decety, University of Chicago - Individuals are more likely to feel concern for- and help in-group members in pain than out-group members (i.e., Hein, et al., 2010). This investigation explored whether the time-course of pain perception differs for racial in- and out-group members, and whether this difference predicts in-group biases in helping behavior. Event-related potentials (ERPs) were recorded while Caucasian participants viewed images of Caucasian and African-American men expressing either pain or no emotion. Participants indicated via key-press what expression was displayed. Upon completion of this task, participants received \$5 for correctly identifying the emotion in the images. Next, participants watched short video clips of men in pain, and were given the opportunity to help by donating a portion of the \$5 they

earned to help pay the cost of each individuals' medical bill. Results showed that both early and late ERP components of pain processing were moderated by the race of the target. Participants exhibited more negative occipital N170s for in-group pain compared to in-group neutral ($t(18) = -2.8, p < .05$) and out-group pain expressions ($t(18) = -2.3, p < .05$). N170 deflections to out-group pain did not differ from neutral expressions ($t < 1$). Similarly, frontal P200 deflections were greater to in-group pain than neutral expressions ($t(18) = 2.9, p < .05$), and marginally greater than out-group pain ($t(18) = 1.8, p < .09$). No P200 differences were observed for out-group pain vs. neutral expressions ($t < 1$). Participants also exhibited enhanced P300 to in-group pain than neutral expressions ($t(18) = 2.1, p < .05$), whereas no expression differences emerged for out-group members ($t < 1$). Notably, ERP components differentially predicted helping behavior for in- and out-group members. Enhanced N170 deflections to in-group members predicted in-group helping ($r's > 0.45, p < .05$), whereas reduced N100 deflections to out-group neutral expressions predicted out-group helping ($r = 0.6, p < .05$). Results are discussed in terms of automatic and controlled components of pain perception and how they may be related to helping behavior. This investigation sheds light on the cognitive processes that underlie pain perception for in- and out-group faces, and contributes to our understanding of group biases in empathic concern and helping behavior.

D-10

HOW EMOTIONAL STATE AFFECTS EMPATHY FOR PAIN—AN ERP STUDY *Rui Sun* - Social and developmental psychology research have found that individuals' emotion can affect empathy. However, different research have reached different conclusions, and few research have directly explored the relationship between the two using neuroimaging methods. The current study used the high time-resolution event-related potentials (ERPs), and used movie clips to prime subjects into happy, neutral and sad emotions aimed at directly studying the relationship between emotion and empathy. Subjects were instructed to judge the expressions they saw to be painful or neutral. Results showed that during 80-110ms, in happy emotion, painful faces triggered a larger N1 compared to neutral faces, while there's no difference between painful and neutral faces in neutral and sad emotions. During 300-400ms, in happy emotion, the difference between painful and neutral emotions decreased but in sad and neutral emotions, there were still difference between two expressions. The results proved our previous early and late model of empathy for pain, suggesting that emotional states can dynamically affect empathy for pain in both early automatic emotion sharing stage and late cognitive appraisal stage. It also indicated that happy emotion would increase the ability to detect painful expression in the early stage but would decrease empathy for pain in the late cognitive appraisal stage; sad emotion could not increase the detection of painful expression in the early stage but would last longer in the late stage.

D-11

EMPATHIC CONCERN, POWER, AND P2 RESPONSE TO OTHERS' EXPRESSIONS OF PAIN *Michael E. W. Varnum, Peking University; Zhenhao Shi, Peking University; Shihui Han, Peking University* - In an exploratory study, we investigated the relationship between a self-report measure of trait empathy (Empathic Concern), power, and brain responses to others' suffering. Previous research suggests that power is negatively related to sensitivity to others' distress. People with low SES and those primed to feel low in SES show greater accuracy in determining others' emotional states (Kraus, et al., 2010) and engage in more prosocial behavior (Piff, et al., 2010). In the present study we used an ERP paradigm to investigate whether power affected people's responses to images of others in pain, focusing on an early attentional component (P2) that has previously been shown to increase in response to faces expressing pain (Feng, et al., under review). Based on previous research, we suspected that inducing subjects to feel a low sense of power would heighten P2 in response to painful (as opposed to neutral) faces. We employed a 3(Power: High, Low, Neutral) \times 2(Facial Expression: Painful vs. Neutral) within-subjects design. Although we did not observe the predicted 3 \times 2 interaction, exploratory analyses revealed that Low Power did increase P2 response to painful vs. neutral faces among participants who were low in Empathic Concern (EC). Further, we observed significant 2 (EC) \times 3 (Power) \times 2 (Face) interactions at four frontal electrodes. Including only the High Power and Low Power conditions, 3-way interactions were observed at 13 frontal electrodes. This study suggests that low power may indeed increase sensitivity to others' pain (as indexed by P2), but that this effect seems to be confined to people who are low in trait empathy. Our results also suggest that among those high in EC, a ceiling effect may be present. We are seeking to replicate this finding, pre-selecting participants based on extremity of EC scores. We also hope to explore whether individual differences in trait-level empathy might also be related to more general differences in attention to and encoding of emotional and social information about others.

D-12

EFFECT OF THE BENZODIAZEPINE AGONIST OXAZEPAM ON PSYCHOPHYSIOLOGICAL AND SELF-REPORTED INDICES OF EMPATHY *Gustav Nilssonne, Sandra Tamm, Armita Golkar, Andreas Olsson, Martin Ingvar, and Predrag Petrovic; Karolinska Institutet* - Perpetrators of violent crimes sometimes self-medicate with benzodiazepines in order to release inhibitions against violent behavior, according to case series reports from forensic psychiatry. Aims: We investigated the effect of the benzodiazepine Oxazepam on self-reported and psychophysiological measures of empathy. 66 healthy male experimental subjects were randomized to 25 mg oral Oxazepam or placebo, in a double-blind design. Subjects were introduced to an assistant who pretended to also be an experimental subject. Before the experiment,

subjects completed questionnaires for dispositional empathy (Interpersonal Reactivity Index), alexithymia (Toronto Alexithymia Scale-20), and anxiety (State-Trait Anxiety Inventory), as well as pain titration using a skin electrode to find pain thresholds of VAS 10 (perceptible stimulus, but not actually painful) and VAS 80 (worst tolerable pain). Subjects were seated next to the assistant but with a screen between them, so that only the hands with electrodes were visible to the other. The experimental paradigm consisted of alternating electrical shocks to the subject and to the assistant, although the latter only pretended to receive pain stimulation. Cues were given on a computer screen in front of the subject and the assistant. After each shock, the subject rated the intensity and unpleasantness of the stimulation. Skin conductance was measured using finger electrodes and Biopak recording hardware. The Oxazepam group showed increased reaction times in the psychomotor vigilance task, reflecting the sedative effect of the drug ($p=0.02$). The Oxazepam group also showed lowered self-reported anxiety after the experiment compared to before the experiment, using the State-Trait Anxiety Inventory, reflecting the anxiolytic effect of the drug ($p=0.01$). Subjects were unable to tell whether they had been given Oxazepam or placebo, confirming the integrity of the blinding. Oxazepam did not significantly decrease ratings of pain nor galvanic skin responses to others' pain. Self-rated unpleasantness to others' pain was significantly correlated to rated trait empathy using the Interpersonal Reactivity Index. 25 mg Oxazepam did not cause a significant decrease in empathy for pain.

D-13

THE LEFT TEMPORAL POLE IS NOT NECESSARY FOR THEORY OF MIND

Caroline Michel, Catholic University of Louvain; Agnesa Pillon, Catholic University of Louvain; Adrian Ivanoiu, Catholic University of Louvain; Renaud Lhommel, Catholic University of Louvain; Dana Samson, Catholic University of Louvain - Neuroimaging studies have shown that the anterior temporal lobes (aTLs) are part of the neural network consistently activated when people are engaged in Theory of Mind (ToM) tasks, i.e., tasks requiring to reason about other people's mental states. These findings have led some researchers to conclude that the aTLs play a critical role in our mentalizing ability, by either subtending the social scripts (Gallagher & Frith, 2003) or the social concepts that we need to infer other people's mental states (e.g., Ross & Olson, 2010). Here, we report the case of a patient, C.M., who suffers from semantic dementia following a brain degeneration affecting mainly the left aTL. The patient showed a severe impairment in tasks probing his semantic knowledge about the world, including social semantic knowledge tested in a series of tasks contrasting social and non-social concepts. However, despite his lesion, C.M. was perfectly able to infer other people's mental states in non-verbal tasks, including other people's intentions, knowledge and beliefs, even when material that has been shown to activate the left temporal pole in neuroimaging

studies was used. These findings challenge the assumption that the aTLs play a critical role in ToM: they suggest that, as far as the left temporal pole is concerned, despite its recurrent activation in neuroimaging studies, this region is not necessary for inferring mental states. Implications for the localization of social knowledge in the brain will be discussed.

D-14

FUNCTIONAL NEURAL PLASTICITY AND ASSOCIATED CHANGES IN POSITIVE AFFECT AFTER COMPASSION TRAINING

Olga Klimecki, Max Planck Institute, Leipzig; Susanne Leiberg, University of Zurich; Claus Lamm, University of Vienna; Tania Singer, Max Planck Institute, Leipzig - Compassion allows us to relate to the suffering of others in a positive, prosocially-oriented way. To study the functional neural plasticity of compassion, we compared fMRI responses in a group of female participants receiving short-term compassion training to a control group undergoing memory training. Before and after training, participants completed a newly developed Socio-affective Video Task optimized for the repeated measurement of empathy, positive and negative affect in response to distress witnessed in others. Compassion training compared to memory training increased neural activity in medial orbitofrontal cortex along with putamen, pallidum and ventral tegmental area - key regions involved in the experience of positive social affect. Compassion, but not memory training, also augmented the subjective experience of empathy and positive affect even when exposed to distressing stimuli. These findings suggest that cultivating compassion offers a new coping strategy that fosters resilience and allows individuals to respond to distressing situations with other-oriented positive affect.

D-15

MORAL VALUES ARE ASSOCIATED WITH INDIVIDUAL DIFFERENCES IN REGIONAL BRAIN VOLUME

Gary J Lewis, University of California, Santa Barbara; Ryota Kanai, UCL; Timothy C Bates, University of Edinburgh; Geraint Rees, UCL - Moral sentiment has been hypothesized to reflect evolved adaptations to social living. If so, individual differences in moral values may relate to regional variation in brain structure. We tested this hypothesis in a sample of 70 young, healthy adults examining whether differences on two major dimensions of moral values were significantly associated with regional gray matter volume. The two clusters of moral values assessed were "individualizing" (values of harm/care and fairness), and "binding" (deference to authority, in-group loyalty, and purity/sanctity). Candidate regions were those previously linked to empathy, mentalizing, and disgust processing. Individualizing was positively associated with dorsomedial prefrontal cortex volume, and negatively associated with precuneus volume. For binding, significant positive associations were found for bilateral subcallosal gyrus and left anterior insula volumes. These findings demonstrate that variation in

moral sentiment reflects individual differences in brain structure and suggest a biological basis for moral sentiment, distributed across multiple brain regions.

D-16

FACE-TO-FACE FMRI: INVESTIGATING THE NEURAL RESPONSE TO LIVE SOCIAL GAZE

Laura A. Loesch, J. Michael Tyszka, Jed T. Elison, Ralph Adolphs; California Institute of Technology - Gaze is an important social communicative cue in primates, used to convey information about emotion, mental states, and detected changes in the environment. The networks involved in gaze perception have been studied extensively in humans and non-human primates; disturbances in gaze processing have been investigated in individuals who exhibit deficits in social interaction, namely individuals with autism or amygdala damage. While existing studies have made much progress in understanding how gaze cues are processed, social neuroscience has yet to benefit from a clearer understanding of how the brain processes live social gaze. In an effort to preserve experimental control, experimental designs have traditionally favored pre-recorded and carefully prepared visual stimuli rather than more ecologically valid alternatives. While more interactive, dynamic eyetracking-controlled stimuli are beginning to be utilized, the fact remains that the neural response to actual gaze is not well understood. Actual eye-gaze feels qualitatively different from simulated gaze; responses to static and recorded faces habituate rather quickly, compared to the subsisting feeling elicited by being stared at by another. Additionally, skin conductance responses are greater for live than recorded gaze stimuli (Hietanen, et. al, 2008). Our study investigates the neural substrates underlying this heightened physiological and experiential response to live gaze and attempts to contribute to a cohesive view of social gaze processing in the human brain. We contextualize social gaze as being mediated by three cortical systems: (1) a gaze network that includes the inferior parietal lobule, fusiform gyrus, and a nonopponent multichannel system in the anterior superior temporal sulcus (Calder, et al., 2007), which together detect dynamic gaze shifts and gaze direction; (2) the right posterior STS, modulated by the right anterior insula (Ethofer, et al., 2011) and the amygdala serve to attach social significance to gaze shifts; and (3) the temporal parietal junction, anterior insula and a mentalizing system (Spunt, et al., 2011) that includes the medial prefrontal cortex, posterior cingulate cortex, and temporal poles will be differentially activated during joint gaze with a live agent. Through a novel blocked-design fMRI experiment that used real actors as stimuli, and therefore allowed the social-interactive component of gaze to be present, we examine the interaction of all of these systems and the corresponding three components of social gaze: gaze detection, social significance, and mentalizing through gaze.

D-17

SMILE AND I SMILE WITH YOU: FURTHER EVIDENCE FOR THE FACIAL FEEDBACK THEORY

Janek S. Lobmaier, University of Bern; Martin H. Fischer, University of Potsdam - The facial feedback hypothesis states that activation of facial muscles can influence emotional experience. For example, an individual who is forced to smile during a social event will actually find the event more enjoyable. Here we investigate to which extent activation of certain facial muscles influences the interpretation of other people's emotional expressions. Fifty-nine participants observed self-paced morph-sequences either showing a happy or sad face turning to a neutral expression, or a neutral face turning to a face expressing happiness or sadness. The task was to report the frame where the initial expression changed to another expression. In counterbalanced blocks, participants held a pen either between their teeth (activation the zygomaticus muscle as if the participant was smiling), or between their lips (activating the corrugator supercilii muscles, as if frowning; cf. Strack, Martin, & Stepper, 1988). In a control block no pen was used. Repeated measures ANOVA analyzed the frame number at which the change was detected with the factors morph sequence (happy-neutral, sad-neutral, neutral-happy, neutral-sad) and pen condition (teeth, lips, no pen). We found a significant main effect of morph sequence and of pen condition, and the interaction between morph sequence and pen condition was also significant. Specifically, a happy expression was perceived to persist longer and sadness was perceived to fade sooner if participants were forced to smile (by holding the pen between the teeth) compared to when the pen was held between the lips. These results are discussed in the light of the facial feedback hypothesis and the possible involvement of mirror neurons when interpreting other people's emotional expressions.

D-18

STRUCTURAL BRAIN IMAGING IN SUICIDE BEHAVIOR AND DEPRESSION

Jorge Mario Rodríguez-Fernández, Columbia University; Christine DeLorenzo, Columbia University; J. John Mann, Columbia University, New York State Psychiatric Institute, Ramin V. Parsey, Columbia University, New York State Psychiatric Institute - Suicidal behavior is listed as one of the symptoms in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) for a depressive episode. Currently there is no consensus regarding structural differences in the suicidal brain in major depressive disorder (MDD), but some recent findings have shown decreased volume in the prefrontal cortex. Suicidal ideation in patients with co-morbidities has been associated with decreased frontal volumes, relative hypometabolism and reduced perfusion in the prefrontal cortex. This evidence supports the idea of limbic dysregulation and impaired impulse control in MDD patients with suicidal behavior. In this work, we investigated possible differences in MRI-derived cortical thickness among suicidal versus non-suicidal depressed patients and controls. 5 MDD patients with suicidal behavior, 5 MDD patients with non-suicidal behavior and 5 controls received T1-weighted MRI scans. The demographic data included age (mean=46±10.6, 41.2±4.1,

and 42.2 ± 2.4 , respectively), sex (60%, 40%, 60%, male for each group), handedness (100% right handed), and Hamilton Depression Rating Scale (mean = 31 ± 4.18 , 29.8 ± 3.3 , and 1.8 ± 1.6 respectively). Participants were scanned in a 3-T Signa Advantage system (GE Healthcare). Final voxel size was $1.02 \times 1.02 \times 1.00$ mm. Using the freely available software package *Freesurfer* (<http://surfer.nmr.mgh.harvard.edu>) with the standard options, we computed cortical thickness measures of the prefrontal cortex in each subject. A two-tailed unpaired t-test was used to compare mean regional cortical thickness between groups. We did not find statistically significant evidence of a difference in mean cortical thickness in the subregions of the prefrontal cortex: orbitofrontal cortex, dorsolateral prefrontal cortex, medial prefrontal cortex and ventrolateral prefrontal cortex, across the three groups. The present findings could be explained by the small sample size, although these findings agree with the absence of consensus in structural imaging in the depressed patient with suicidal behavior. Future projects will involve imaging a larger cohort of patients and voxel based morphometry analysis. Finally, it is possible that, in this cohort, MDD and suicidal behavior were not associated with changes in gray matter.

D-19

NEURAL ACTIVITY TO DEATH-RELATED THOUGHT AND DISPOSITIONAL DEATH ANXIETY

Zhenhao Shi, Shihui Han; Peking University - Objective: Recent research has shown that perception of death-related vs. death-unrelated linguistic cues produced increased frontoparietal activity but decreased insular activity. The current study investigated (1) whether the increased frontoparietal and decreased insular activities are respectively associated with transient trial-specific processes of linguistic cues of death and sustained death-related thought during death-relevance judgments on linguistic cues and (2) whether the neural activity underlying death-related thought can predict dispositional death anxiety. Method: A hybrid design was used in which participants were presented with death-related/unrelated words, life-related/unrelated words, and negative/neutral words in separate sessions. Participants were scanned using functional magnetic resonance imaging while they performed death-relevance, life-relevance, and valence judgments on the words, respectively. Results: The contrast of death-related vs. death-unrelated words during death-relevance judgments revealed transient increased activity in the left inferior parietal lobule, the right frontal eye field, and the right superior parietal lobule. The contrast of death-relevance judgments vs. life-relevance/valence judgments showed decreased activity in the bilateral insula. The transient frontoparietal activity was correlated with subjective reports of death-relevance of linguistic cues, whereas the sustained insular activity was correlated with dispositional death anxiety, but only in those with weak transient frontoparietal responses to death-related words. Conclusion: Our results dissociate the transient and

sustained neural activities that are respectively associated with trial-specific processes of death-relevance of stimuli and continued death-related thoughts and suggest that the combination of the transient and sustained neural activities involved in death-related thought can predict dispositional death anxiety.

D-20

SPONTANEOUS BRAIN ACTIVITY AND FUNCTIONAL CONNECTIVITY AMONG PTSD PATIENTS: A RESTING-STATE FMRI STUDY

Xiaodan Yan, NYU School of Medicine; Victoria Cressman, Manhattan VA Medical Center; Mariana Lazar, NYU School of Medicine; Adam Brown, NYU School of Medicine; Leslie Prichep, NYU School of Medicine; Clare Henn-Haase, NYU School of Medicine; Thomas Neylane, University of California, San Francisco; Owen Wolkowitz, University of California, San Francisco; Steven Hamilton, University of California, San Francisco; Rachel Yehuda, Mount Sinai School of Medicine; Daniel Sodickson, NYU School of Medicine; Michael Weiner, VA Medical Center, San Francisco; Charles Marmar, NYU School of Medicine - The goal is to examine the amplitudes of spontaneous brain activity as well as functional connectivity (FC) patterns associated with posttraumatic stress disorder (PTSD). Resting state fMRI (rs-fMRI) data were obtained from 38 combat veterans, with 19 diagnosed as PTSD+ and 19 PTSD-, after comprehensive behavioral and diagnostic assessments. A protocol was adapted to analyze the amplitude of low frequency fluctuation (ALFF) from rsfMRI, giving rise to group difference statistical maps of ALFF values. Significant clusters showing group differences were identified, from which average pre-processed time series were extracted for analyzing pairwise FC patterns. Compared to the PTSD- group, the PTSD+ group showed significantly decreased ALFF at the precuneus, dorsal middle prefrontal cortex (dMPFC), posterior cingulate cortex (PCC) etc, and increased ALFF at the anterior cingulate cortex (ACC), insula, and orbitofrontal cortex (OFC). PTSD+ group also showed significant decrease in thalamocortical functional connectivity. Regional ALFF values demonstrated significant association with clinical scores that represent re-experiencing symptoms, depression symptoms, dissociative symptoms etc. The neural networks derived from global FCs also showed significant changes in graph properties and network architecture. These findings indicate important changes in spontaneous brain activity as well as intrinsic FCs associated with PTSD, which might underlie the changes of neural activity observed in task-based fMRI studies. The multiple neural parameters showing PTSD-dependent differences might have important diagnostic values, which will be investigated further in future studies.

D-21

IN VIVO QUANTIFICATION OF MONOAMINE OXIDASE-A USING [11C]-HARMINE AND POSITRON EMISSION TOMOGRAPHY IN HUMANS

Jorge Mario Rodríguez-Fernández, Columbia University;

Christine DeLorenzo, Columbia University; J. John Mann, Columbia University, New York State Psychiatric Institute; Ramin V. Parsey, Columbia University, New York State Psychiatric Institute- Previous studies have shown that MAO-A binding in the brain can be measured using Positron Emission Tomography (PET) and the radiotracer Methoxymethylpyridoindole ([11C]-harmine), which makes it an ideal candidate to evaluate the monoamine neurochemistry in neuropsychiatric disorders(1). In order to determine the optimal modeling parameters for this radiotracer, a test-retest study was performed. In addition, the most appropriate reference region for reference tissue approaches was examined. PET scans of healthy nonsmoking subjects (n = 5) were performed using [11C]-harmine and coregistered with magnetic resonance imaging data. Each subject was scanned for 120 mins, ensuring that high binding regions reach equilibrium. Six different modeling methods were applied and BPP (regional ligand concentration relative to ligand concentration in plasma) was calculated based on regional time activity curves. Five metrics were used to evaluate the model fits, including percent difference (PD), Within Subject Mean Sum of Squares (WSMSS), variance, Intraclass Correlation Coefficient (ICC), and Identifiability (ID). The two tissue compartment (2TC) model performed better than the others due to its low variability in BPP estimates across subjects and within the same subject (mean PD= 22.6±14.8%, WSMSS= 2.3±2.3 (mL/cm3)², variance= 2.79±2.06 mL/cm3 and ICC= 0.22±0.31). The most appropriate reference region was found to be the cerebellum, due to the low binding in this region and its kinetics. Test-retest results indicate that within subject binding variability of [11C]-harmine is low using a 2TC model. As such, this tracer may allow characterization of the neurochemistry of monoamines using PET in the pathogenesis of panic disorders(2), social phobia(3), chronic pain(4) and some cases of MDD(5), in which MAO-A inhibitors are used as second line management(6).

D-22

SOCIOECONOMIC STATUS MODERATES NEURAL RESPONSE TO IMAGES OF POVERTY

Sarah Ketay, Bard College; Zohn Rosen, Columbia University; Peter Muennig, Columbia University; Michael Silverman, Mount Sinai School of Medicine - The relationship between socioeconomic status (SES) and health, the income gradient—the relative increase in mortality with lower income—accounts for a greater loss of health than any risk factor other than normal human aging. While there is a considerable amount of descriptive evidence for how SES might “get under the skin”, theories regarding how SES might affect health through psychological pathways include stress-induced pathophysiology, negative emotional style, and mental illness. One possibility is that diminished life satisfaction, such as that associated with living in an impoverished environment while repeatedly being exposed to more preferable conditions impacts psychosocial health. This study examined neural processing of emotionally valenced stimuli in participants

across low and high socioeconomic status. Twenty-two unmedicated African American participants were scanned while observing emotionally-valenced stimuli from the International Affective Picture System as well as validated images of poverty. Emotionally valenced images as well as scrambled foils were serially-presented within a block design paradigm. Subjects were instructed to make a 2-alternative forced choice when presented with an emotionally valenced image or scrambled foil. Image acquisition was performed on a research-dedicated Siemens Allegra Magnetom 3 Tesla head dedicated MRI scanner (maximum gradient strength ~60mT/m, max gradient slew ~600T/m/s). Image processing and analysis (linear mixed effects model) were performed using the FSL software package. Changes of activation (increases or decreases) were analyzed according to regional a priori hypothesis, i.e. activation changes in limbic and frontal regions. Results indicate that people of low SES respond differently than individuals of higher SES and demonstrate differential activation patterns in response to similar images of poverty compared to negatively valenced stimuli. More specifically, participants defined as being of lower SES demonstrated attenuated activation in limbic regions including hippocampal and parahippocampal as well as frontal regions including the superior frontal gyrus. Results may indicate that low SES individuals display a diminished emotional response to the poverty imagery than general negative images. Future studies in this line may investigate if this response represents a coping mechanism or other adaptive response.

D-23

BRAIN RESPONSE TO FOOD LOGOS IN OBESE AND HEALTHY WEIGHT CHILDREN

Amanda Bruce, University of Missouri-Kansas City; William Black, University of Missouri-Kansas City; Jared Bruce, University of Missouri-Kansas City; Janice Henry, University of Missouri-Kansas City; Rebecca Lepping, University of Kansas Medical Center; J. Bradley Cherry, University of Missouri-Kansas City; Vlad Papa, University of Kansas Medical Center; Laura Martin, University of Kansas Medical Center; Ann Davis, University of Kansas Medical Center; Cary Savage, University of Kansas Medical Center - Product branding has a powerful effect on both food familiarity and preference. Brain regions associated with reward and motivation are activated differentially between obese and healthy weight children's brain in response to visual food cues. No neuroimaging studies have examined how children respond to branded food logos. The purpose of the present study was to examine how obese and healthy weight children's brains activate in response to common food and nonfood logos. As part of a validation study, 32 participants aged 9-16 (13 males; mean age 11.5 years) were asked to rate 239 common brand logos on familiarity, valence, and arousal. The 120 most familiar food and nonfood logos were selected and matched on the aforementioned attributes. Examples included Nike®, Playstation® (nonfood), McDonalds®, and Cheetos® (food). Fourteen healthy weight children (mean BMI percentile 50.4; 8 males; mean

age 12.1 years) and ten obese children (mean BMI percentile 98.1; 6 males; mean age 11.8 years) were then scanned using functional magnetic resonance imaging (fMRI). The paradigm was a block design using the selected food and nonfood logos, and a blurred baseline condition. fMRI data were analyzed using Brain Voyager QX with random effects. Voxel values were considered significant if the activation survived a statistical threshold of $p < .01$ corrected for multiple comparisons with a cluster level threshold of 7 voxels ($p < .05$), determined by Monte Carlo simulation. When compared to healthy weight children, obese children demonstrated decreased activation to food versus baseline images in bilateral middle frontal gyrus BA 10 (450 contiguous voxels; max voxel 36, 38, 19; $t = -4.55$, $p < .001$; 323 contiguous voxels; max voxel -30, 46, 7, $t = -4.35$, $p < .001$). Similarly, obese children demonstrated decreased activation to food versus nonfood logos in two regions of interest: right middle frontal gyrus BA 10 (308 contiguous voxels; max voxel 27, 56, 19; $t = -4.98$; $p < .001$) and left anterior cingulate BA 32 (443 contiguous voxels, max voxel -9, 41, -5; $t = -4.46$; $p < .001$). Branding has a significant impact on food preferences but little is known about how children evaluate branded food items at the neural level. These preliminary results suggest that food logos activate brain regions known to be associated with food motivation and reward. Obese children demonstrated less activation in brain regions associated with cognitive control when compared to healthy weight children.

D-24

SOCIAL NEUROSCIENCE IN THE NATIONAL INTEREST Joshua C. Poore, *The Charles Stark Draper Laboratory*; Andrea K. Webb, *The Charles Stark Draper Laboratory* - In the past decade, the US department of defense (DoD) and Intelligence Community (IC) has recognized the potential for the neurosciences to provide enabling technologies and methodology dramatically expand their capabilities in key areas of defense, as well as intelligence, surveillance and reconnaissance (ISR). More recently, these communities have demonstrated an increasing demand for social neuroscience to address their enduring missions and expand their capabilities. In this talk, we will outline some of the core interests of the DoD and IC in the social neuroscience, including social cognitive neuroscience and social affective neuroscience. Additionally, we will present trends for the inclusion of calls for social neuroscience in large DoD/IC sponsored programs within the past few years and describe some of enabling technologies that these communities are currently investing in and the impact they may have on the neurosciences. Finally, we will outline strategies for academic researchers in social neuroscience to identify opportunities, get involved in research for both the DoD and IC, and compete for large funding contracts offered by these communities.

D-25

OXYTOCIN MODULATES SOCIAL APPROACH BEHAVIOR IN HUMANS Sina Radke, *Radboud University Nijmegen*; Karin Roelofs, *Radboud University Nijmegen*, Ellen R.A. de Bruijn, *Radboud University Nijmegen*, Leiden University - Oxytocin (OXT) is a neuropeptide implicated in prosociality and the attenuation of responses to stress and threat. Besides anxiety reduction as an underlying mechanism, it has been argued that OXT increases the salience of social stimuli and, more recently, that OXT facilitates approach-related social behaviors. While research in humans frequently focuses on perceptual aspects of emotion processing, animal studies show that OXT fosters affiliation and social approach behavior. Approach and avoidance are fundamental responses associated with appetitive and aversive motivation, usually triggered by pleasant/positive stimuli (approach) and threatening/negative stimuli (avoidance). The control of approach-avoidance behavior has been assessed with tasks that involve overriding these automatic action tendencies, e.g. the Approach-Avoidance Task (AAT). Importantly, although OXT is presumably engaged in social approach behavior in humans, direct investigations of these processes have not been conducted until now. The current study therefore aimed at investigating the role of OXT on the control of social motivational behavior. Social anxiety measures were included in the analyses, as it is known to modulate approach-avoidance behavior. In a randomized, placebo-controlled, double-blind within-subjects design, 24 healthy volunteers received 24 IU OXT (Syntocinon; Novartis) intranasally. Social anxiety was assessed with the Liebowitz Social Anxiety Scale. In the AAT, participants reacted to happy and angry facial expressions with direct and averted gaze by pulling a joystick towards (approach) or pushing it away from their body (avoid). Effect-scores were calculated by subtracting the individual median RTs for pull from the median RTs for push movements. Negative effect-scores denote avoidance, while positive effect-scores reflect approach. Under PLC, participants displayed the typical action tendencies, i.e. approach towards happy ($M = 14.01$) and avoidance of angry ($M = -19.29$) faces with both direct and averted gaze ($p = .006$). Importantly, OXT altered approach-avoidance behavior towards emotional expressions with direct gaze ($p = .008$). This was driven by increased approach towards angry faces after OXT administration ($M = 13.00$) compared to PLC ($M = -10.46$, $p = .003$), whereas there was no change in response to angry faces with averted gaze ($p = .90$). Further, the OXT-induced change of approach-avoidance behavior was modulated by social anxiety ($p = .04$): Low socially anxious individuals exhibited stronger OXT-induced approach towards social threat signals directed at them. The general predisposition of approaching positive, while avoiding negative stimuli, complements earlier findings. However, OXT administration reversed the avoidance pattern for angry faces, as participants displayed an OXT-induced approach to these stimuli. This effect was restricted to angry faces with direct gaze and modulated

by social anxiety. Importantly, social threat can elicit anxiety and withdrawal, but also aggressive, i.e. approach behavior. Apart from its anxiolytic effects, OXT has been linked to maternal aggression in animals and defensive aggression in humans. Interestingly, our results suggest that low socially anxious individuals are more susceptible to the effects of OXT in facilitating social approach-related behaviors, even when approach does not imply prosocial, but rather aggressive actions.

D-26

EXOGENOUS OXYTOCIN DECREASES TRUST IN PEOPLE WITH HIGH PERSPECTIVE-TAKING TO PROMOTE SOCIAL COMMUNICATION

Lara Moody, George Mason University; Mary Lee, NIDA; Raja Parasuraman, George Mason University; Kevin McCabe, George Mason University; Peter Twieg, George Mason University; Ewart de Visser, George Mason University; Martin O'Hara, INOVA Fairfax Hospital; Frank Krueger, George Mason University - The neuropeptide oxytocin both modulates social behavior such as trust and varies based on different personality characteristics. Trust is an essential aspect of interpersonal relationships. The ability to determine when to trust relies heavily on our ability to take the perspective of others and understand the intentions of all parties in an interaction. Often, we decide when to trust and not to trust based on communication between individuals. For example, when a doctor writes a prescription and recommends that a patient take a medicine, it is up to the patient to decide whether or not to trust the doctor and do as the doctor says. In the present study, we investigated the effect of oxytocin on trusting behavior in participants with differing abilities to take the perspective of others. Previous oxytocin studies used the standard trust game to evaluate interpersonal trust. In this study, we used a modified trust and communication game to explore the effects of oxytocin on trusting behavior and communication. Ninety-six healthy males received either intranasal oxytocin or placebo in a randomized, double-blind, placebo-controlled, between-subject design. Participants played a modified version of a trust and communication game, in which an advisor makes a monetary recommendation to another participant, the decision-maker. The recommendations include one egalitarian option (\$0.30 to both the advisor and the decision-maker), one trustworthy option (\$0.90 to the advisor and \$1.50 to the decision-maker) and one selfish option (\$1.20 to the advisor and \$0.90 to the decision-maker). The decision-makers then choose to trust the advisor by choosing the recommended option or not to trust the advisor by choosing another option of unknown monetary value. After each trial, both advisors and decision-makers receive feedback indicating if the recommendation was followed and if they received the most money. Participants were in the role of both the advisor and the decision-maker, randomly, throughout the study. Participants also played trials with both another human participant and a lottery system programmed to give random advice and make random decisions. To

screen participants for differences in the ability to take the perspective of others, we used the Interpersonal Reactivity Index (IRI), which surveys empathy, with specific interest in the dispositional perspective-taking subscale. Our results show that there is no overall treatment effect for the advisor or the decision-maker in the human or lottery condition. However, we found an interaction effect between oxytocin and dispositional perspective-taking for the decision-maker. People who were more inclined to take the perspective of others, as determined by the IRI, trusted less when they were in the oxytocin group than the control group. These results support the hypothesis that oxytocin is personality-characteristic dependent. In summary, this is the first study to show that oxytocin decreases trust to promote social communication and consequently increase prosocial behavior.

D-28

OXYTOCIN ADMINISTRATION TO PARENT ENHANCES INFANT PHYSIOLOGICAL AND BEHAVIORAL READINESS FOR SOCIAL ENGAGEMENT

Omri Weisman, Orna Zagoory-Sharon, Ruth Feldman; Bar-Ilan University - The social milieu provides the context for the organism's survival, endurance, and adaptation. In mammals, social participation originates within the parent-infant bond and is supported by the Oxytocin (OT) system, whose functioning is transmitted from parent to child through patterns of parental care. Human studies indicate that OT administration increases affiliative behavior, including trust, empathy, and social reciprocity. Here we examine whether OT administration to parent can enhance physiological and behavioral processes that support parental social engagement, but, moreover, can have parallel effects on the infant. Utilizing a double-blind, placebo-controlled crossover design, 35 fathers and their five-month-old infants were observed twice following administration of OT or placebo to father in the face-to-face-still-face (FTFSF) paradigm. Parent and infant's salivary OT was assessed at multiple time-points, respiratory sinus arrhythmia (RSA) measured in the three FTFSF episodes, and parent and child's social behaviors were micro-coded for indices of social engagement. OT administration increased fathers' salivary OT, RSA during free play, and key parenting behaviors that support parental-infant bonding. Parallel increases were also found in the infant's salivary OT, RSA response, and engagement behavior, including social gaze, exploration, and social reciprocity. Results are first to demonstrate that OT administration to one attachment partner can have parallel effects on the other and underscore the role of OT in the cross-generation transmission of human social participation. Findings have translational implications for conditions associated with early risk for social-emotional growth, including autism or prematurity, without the need to administer drug to young infants.

D-29 ★**TESTOSTERONE AFFECTS IMPLICIT SOCIAL APPROACH-AVOIDANCE TENDENCIES**

D. Enter, Leiden University, Radboud University Nijmegen; P. Spinhoven, Leiden University; K. Roelofs, Radboud University Nijmegen, Donders Centre for Cognitive Neuroimaging - The gonadal hormone testosterone plays an important role in the regulation of social-motivational behavior. Several studies of testosterone administration to healthy female participants confirmed the causal relationship between testosterone and its dominance-enhancing and social-anxiolytic properties. Nevertheless, the effect of testosterone on social approach-avoidance tendencies has not yet been investigated. This study set out to test this effect in healthy female volunteers using an objective implicit measure of social motivational behavior. Using a double-blind, within-subject design, twenty-four participants received a single dose of 0.5mg testosterone and a matched placebo, at two separate days. On both days, they performed the social Approach-Avoidance Task (AAT), a reaction time task requiring participants to approach or avoid visually presented emotional (happy and angry) faces, by pulling a joystick towards them or pushing the joystick away from themselves, respectively. According to expectations, participants showed diminished avoidance tendencies to angry faces after testosterone administration. Social anxiety scores (Social Phobia and Anxiety Inventory: SPAI) moderated this effect. These findings suggest that testosterone reduces social submissive behavior in a healthy female population. In addition, they further the understanding of the psychoneuroendocrinological regulation of social motivational behavior in social psychopathologies, such as social anxiety disorder.

D-30 ★**POORER NEIGHBORHOOD QUALITY AT AGE 12 PREDICTS STRONGER ACC ACTIVATION TO REJECTION SENSITIVITY IN YOUNG ADULthood**

Marlen Z. Gonzalez, Lane Beckes, Joanna Chango, Joseph P. Allen, James A. Coan; University of Virginia - We investigated the association between neighborhood quality at 12 years of age and neural correlates of social rejection. Twenty-two economically and racially diverse young adult participants were recruited from a longitudinal community sample originally located in central Virginia (cf., Hare, Marston, & Allen, 2011). We created a composite childhood neighborhood quality variable by aggregating measures of neighborhood cohesion, level of risk and crime, and overall quality, all measured at 12 years of age. As adults (ages 23-26), participants completed the CyberBall task (cf., Eisenberger, Lieberman, & Williams, 2003), a virtual "catch" game used to persuade participants that they are being systematically excluded from playing a game of catch with two other players. Functional regions of interest (ROIs) were determined a priori using regions frequently identified in

previous CyberBall studies through the rejection inclusion contrast (e.g., Eisenberger, Lieberman, & Williams, 2003). These were the anterior cingulate cortex (ACC) and the right insula (RI). Poorer neighborhood quality at 12 years of age corresponded with greater rejection-related activity in the ACC ($r = .60$, $p < .01$, Cohen's $d = -.64$). The ACC is a neural hub that has been demonstrated to signal affective distress both for social and physical stressors and acts as a neural alarm indicating that certain environmental stimuli require attention (Rainville, Duncan, Price, Carrier, & Busnell, 1997; Eisenberger, Lieberman, & Williams, 2003). Poor neighborhood quality in young adulthood may encourage heightened ACC reactivity or "vigilance" toward potential relationships due to the heightened consequences of rejection in an area of low social resources and high potential threats.

D-31**REJECTION SENSITIVITY MODULATES NUCLEUS ACCUMBENS ACTIVITY WHEN ANTICIPATING SOCIAL FEEDBACK**

Katherine E. Powers, Dartmouth College; Leah H. Somerville, Weill Cornell Medical College; William M. Kelley, Dartmouth College; Todd F. Heatherton, Dartmouth College - Prior research suggests that humans have a fundamental need to belong to social groups, and that some individuals are more attuned to the possibility of rejection than are others. Specifically, individuals high in rejection sensitivity tend to anxiously expect and readily perceive rejection in their social interactions (e.g., Downey et al., 2004). Behavioral research on rejection sensitivity has primarily focused on reactions to rejection, leaving an understanding of how these individuals behave while anticipating social feedback less well understood. Here, we examined neural activity during both expectations of and reactions to rejection as a function of rejection sensitivity. Across two studies, participants ($N = 41$) underwent fMRI scanning while making social judgments (e.g., "Would this person like me?") about supposed peers at other colleges and receiving evaluative social feedback from those individuals. The nucleus accumbens, a central component of the brain's reward circuitry, was engaged both when participants anticipated and received evaluative social feedback. Nucleus accumbens activity was modulated by rejection sensitivity when participants anticipated social feedback, such that individuals high in rejection sensitivity displayed exaggerated neural responses when anticipating social feedback compared to individuals low in rejection sensitivity. Rejection sensitivity, however, had no effect on nucleus accumbens activity after receiving feedback. These results highlight the importance of anticipating evaluative social feedback for individuals high in rejection sensitivity, and suggest a role for the nucleus accumbens in these processes.

D-32**IS ALTRUISTIC PUNISHMENT AUTOMATIC? EFFECTS OF COGNITIVE LOAD ON THE REJECTION OF UNFAIR OFFERS AND ON MFN AMPLITUDE IN**

THE ULTIMATUM GAME Joana B. Vieira, *University of Porto, Georgetown University*; Pedro R. Almeida, *University of Porto*; Fernando Ferreira-Santos, *University of Porto, UCL*; Francisco Marques-Teixeira, *University of Porto*; Fernando Barbosa, *University of Porto*; Abigail Marsh, *Georgetown University*; João Marques-Teixeira, *University of Porto* - Dual-process accounts of social cognition consider the existence of two modes of processing: type 1 (automatic, fast, unconscious, not requiring working memory) and type 2 (controlled, slow, conscious, requiring working memory) (Evans, 2008). There is evidence that the rejection of unfair offers in the Ultimatum Game (UG) is driven by a negative emotional reaction to unfairness and that the acceptance of unfair offers requires cognitive effort (Sanfey et al., 2003). It has also been demonstrated that in prosocial individuals, inequity aversion is associated with activation in the amygdala but not in frontal regions, which further suggests that it results from automatic and emotional responses, rather than deliberative processes (Haruno & Frith, 2010). In this study, we explored the automaticity of altruistic punishment in the UG by increasing the cognitive load during the task and analyzing its effect both on performance and on the Medial Frontal Negativity (MFN). This ERP component is thought to be generated in the anterior cingulate cortex (ACC) (Gehring & Willoughby, 2002) and has been shown to be sensitive to the fairness of UG offers (Boksem & De Cremer, 2010; Van der Veen & Sahibdin, 2011). In this pilot experiment, six subjects performed the UG in two experimental conditions: No load and Load. In the No load condition, participants played the classical version of the UG, while in the Load condition they played a modified version, in which they were asked to memorize a sequence of 5 digits at the beginning of each trial and to recognize it at the end. Subjects played 84 trials of each condition, counterbalanced across subjects. In each block, 42 unfair (20-33% of the stake) and 42 fair offers (40-50% of the stake) were presented. Behavioral and electrophysiological data (EEG; 32 channels) were collected. Analysis of the percentage of acceptances revealed a main effect of fairness ($F(1,5) = 9.63, p = .027$), with fair offers being accepted more often than unfair ones ($M(\text{fair}) = 83.93, SD = 15.84; M(\text{unfair}) = 48.21, SD = 36.44$). No effect of cognitive load or cognitive load*fairness interaction emerged. No effect of cognitive load on MFN amplitude at Fz was found. These preliminary results suggest that even under more cognitively demanding conditions individuals engage in altruistic punishment and turn down offers that are perceived as unfair. This is consistent with the results reported by Haruno and Frith (2010) regarding subjects that displayed a prosocial orientation and lends further support to the notion that, in these individuals, inequity aversion and consequent altruistic punishment rely on automatic processes. To further investigate the role of automatic and controlled processes in social interactions, ongoing research is exploring the effects of cognitive load in healthy subjects varying in social value orientation and also in traits that have been shown to be associated to

abnormal patterns of social decision-making (e.g. psychopathy).

D-33

AVERSIVE DISINHIBITION OF BEHAVIOR AND STRIATAL SIGNALING IN SOCIAL AVOIDANCE

Verena Ly, *Radboud University Nijmegen*; Roshan Cools, *Radboud University Nijmegen*; Karin Roelofs, *Radboud University Nijmegen* - Social avoidance is a major factor for the development and maintenance of anxiety and depressive symptoms. Although anxiety and depression have long been associated with abnormal aversive processing and hyperactive amygdala signalling, the consequences of these features on decision making and neural structures implementing action selection, such as the striatum, remain unclear. Here, we used fMRI to compare effects of aversive (versus appetitive) processing on behavioural inhibition versus activation and associated striatal signals in 42 high and low socially avoidant individuals. Participants were presented with aversive (angry) faces and appetitive (happy) faces and had to learn by trial and error whether to make a 'go' or a 'nogo' response in order to obtain reward or avoid punishment. As expected, high compared with low socially avoidant individuals showed enhanced amygdala signalling for angry versus happy faces. Interestingly, high compared with low socially avoidant individuals showed reduced behavioural inhibition for aversive faces relative to appetitive faces. Furthermore, this behavioural effect correlated significantly with greater striatal signal, associated with behavioural activation, for angry versus happy faces. The performance pattern resembles that seen after central serotonin depletion, which also induced aversive behavioural disinhibition. This observation is remarkable given that anxiety and depression are often treated with drugs that enhance serotonin transmission (selective serotonin reuptake inhibitors). The results concur with recent theorizing about aversion, serotonin and behavioural inhibition and suggest that aversive disinhibition of behavioural and striatal activation might represent a core phenomenon of serotonin-related disorders.

D-34

TRAIT ANXIETY MODERATES THE RELATIONSHIP BETWEEN SOCIAL SUPPORT AND THE NEURAL RESPONSE TO THREAT.

Erin L. Maresh, *Lane Beckes, James A. Coan; University of Virginia* - We investigated whether the neural response to threat of shock was associated with trait anxiety and how this effect might be influenced by social support. We scanned 22 individuals using fMRI while facing threat of shock under three conditions: alone (alone condition), while holding the hand of a stranger (stranger condition), and while holding the hand of a friend (partner condition). Higher trait anxiety was significantly associated with lower threat-related brain activation during the alone condition in the thalamus, amygdala, supplementary motor cortex, and putamen. Threat-related activation during the stranger

condition was unrelated to trait anxiety. During the partner condition, however, greater threat-related activity in the thalamus was associated with higher trait anxiety scores. A similar pattern was subsequently observed in an independent sample of 24 adults in same-sex romantic partnerships. Here too, higher trait anxiety was associated with lower threat-related brain activity in multiple brain areas, including the nucleus accumbens, posterior cingulate cortex, orbitofrontal cortex, putamen, supramarginal gyrus, precentral gyrus, insula, and ventromedial prefrontal cortex, but only during the alone condition—no similar associations were observed in either the stranger or partner conditions. Because trait anxiety was associated with less threat-related activity, we hypothesized that people with higher trait anxiety simply have a higher “baseline” neural response in threat responsive brain regions while alone, resulting in less signal change between the safety and threat conditions. To investigate this, we contrasted brain activity in the safety/alone condition with brain activity in both the safety/stranger and safety/partner conditions and examined the correlation of this activity with trait anxiety. No significant correlations were found, implying that the negative correlations between trait anxiety and brain activation are not due to increased baseline threat-related activity in the alone condition. An alternative possibility is that trait anxiety is a form of chronic stress, which has itself been associated with habituation to threat cues (reviewed in Grissom & Bhatnagar, 2009). Our findings may indicate that higher trait anxiety may, even at sub-clinical levels, lead to increased habituation to stress, dampening adaptive neural threat responses in the absence of social resources. Further research on what is mediating this effect and why it was not seen in the presence of social support is warranted.

D-35

NEURAL DECODING OF BEST FRIEND OR FRENEMY *Rebecca J. Von Der Heide, Temple University; Ingrid R. Olson, Temple University* - Social networks have two important dimensions: the number of individuals in the network and the quality or complexity of the relationships with the individuals in the network. The number or size of one's social network has been shown to correlate with the size of brain regions devoted to processing complex social information such as the amygdala (Bickart et al., 2011; Kanai et al., 2011). Less is known about the neural basis of the second dimension, the quality of social networks. In this study we asked whether parts of the brain that have a known role in person perception (the fusiform face area) and person knowledge (the anterior temporal lobe (ATL)) play an important role in processing social closeness, the variable that allows us to classify individuals as 'best friend' or 'frenemy' for instance. Social closeness was compared to assessments of geographic closeness of the same peers. Participants were asked to bring in 2 different photos of the faces of 5 best friends, 5 close friends, and 5 acquaintances to the first testing session. In Session 1, they rank ordered these

photos of their peers by their social proximity (i.e. best friend to most distant acquaintance) and then based on the geographic proximity of the home of each peer to their home (i.e., closest to most distant). In Session 2, fMRI was used to assess functional brain activity. Participants completed 5 functional runs. On each trial, participants were simultaneously presented with photos of two peers. During half of the blocks in a run participants indicated which of the two peers was psychologically closest to them and during the other half, they indicated which peer lived geographically closest to them. In addition, photos of 'best friends', 'close friends' and 'acquaintances' were presented in separate blocks during the social proximity condition and photos of the same peers that lived 'closest', 'medium-distance', and 'far' were presented in separate blocks during the social proximity condition and photos of the same peers that lived 'closest', 'medium-distance', and 'far' were presented in separate blocks during the geographical proximity condition. Standard localizer runs were used to individually define the FFA and parahippocampal place area (PPA). We predicted that (a) activity in brain regions that have been associated with high-level social information processing (e.g., ATL, amygdala, medial PFC) would increase with levels of psychological closeness but not with levels of geographical closeness; (b) that activity in brain regions associated with spatial information processing (e.g., PPA and/or retrosplenial cortex) would increase with levels of geographical closeness but not with levels of psychological closeness. Preliminary results show greater activation of areas of the brain (ATL, medial PFC) implicated in social information processing when participants made judgments about the social proximity of peers in their social networks compared to their geographical distance.

D-36

KNOW YOUR ENEMY - A FUNCTIONAL APPROACH TO GROUP BIASES IN MOTOR RESONANCE. *Jennifer Gutsell, University of Toronto; Michael Inzlicht, University of Toronto* - Motor resonance refers to the vicarious activation of the neural system for action during perception of action and is considered important for an intuitive understanding of other's actions, intentions and emotions. Motor resonance, however, is restricted to social in-groups such that people show less motor resonance when observing ethnic out-group members, as compared to in-group members performing neutral actions - an effect magnified by prejudice and for disliked groups. Reduced motor resonance in response to out-group members thus seems to be yet another detrimental aspect of prejudice, potentially hampering social coordination and interactions. A functional approach to motor resonance, however, suggests that these biases might be overwritten when the actions of an out-group member become motivational relevant, for example when they are threatening. Using electroencephalographic (EEG) oscillations as an index of motor resonance, we investigate how the meaning and intention of out-group member's

actions influence motor resonance in the observer. Participants watched videos of ethnic in- and out-group members displaying positive, threatening and neutral actions and expressions. Reflecting group biases in motor resonance, participants generally show activity over motor areas in response to in-group members, but not in response to out-members. Interestingly, as predicted by a functional account to motor resonance, only when the actions and expressions of out-group members are threatening, do participants show an increase in motor resonance. Therefore, faced by a threatening out-group member participants no longer show an in-group bias in motor resonance.

D-37

SITUATIONAL DISCOUNTING OF POSITIVE OUTGROUP BEHAVIORS

Jennifer Kubota, New York University; Tobias Brosch, University of Geneva; Rachel Mojdahbakhsh, New York University; James S. Uleman, New York University; Elizabeth Phelps, New York University - Social psychological theory suggests that individuals have a propensity to ignore situational information when making attributions to others' behavior (known as the fundamental attribution error, FAE), and that incorporating situational information into attributions requires an additional controlled correctional step. Recent neuroimaging research finds that incorporating situational information into attributions is associated with increases in activity in DLPFC. This research extended these findings to intergroup attributions. The Ultimate Attribution Error (UAE) represents a systematic ethnocentric bias whereby positive outgroup and negative ingroup behaviors are attributed to situational causes, whereas positive ingroup and negative outgroup behaviors are attributed to dispositional causes. To assess this, participants provided attribution ratings for Black and White targets. For each target, participants read a positive or a negative behavior, as well as qualifying situational information. Overall, we found mixed support for the UAE. For negative behaviors, individuals made more situational attributions for ingroup compared to outgroup members. However, for positive behaviors, individuals made similar dispositional attributions for both ingroup and outgroup members. Our findings suggest that biased intergroup attributions were more common in negative compared to positive scenarios. For negative behaviors, when ingroup members behave in stereotype inconsistent ways, situational information can be incorporated into judgments and this is achieved most likely through an additional controlled correctional step in the attribution process.

D-38

THE EFFECT OF TEAM ENVIRONMENT ON THE ALLOCATION OF ATTENTIONAL RESOURCES TO NOVEL STIMULI

Matthew W. Miller, University of Maryland; Alessandro Presacco, University of Maryland; Sean Burr, University of Maryland; Lawrence J. Groman, University of Maryland; Jeremy C. Rietschel, Veterans Health

Administration; Rodolphe J. Gentili, University of Maryland; Craig G. McDonald, George Mason University; Seppo E. Iso-Ahola, University of Maryland; Bradley D. Hatfield, University of Maryland - The orienting of attention to novel stimuli is critical to human performance in that it facilitates individuals' cognitive processing of unexpected events relevant to task execution. As cognitive load increases, attentional resources are depleted, limiting the ability to attend to novel stimuli and hindering performance. A number of factors have been shown to affect the cognitive load a task imposes upon individuals' while they perform in non-team environments. However, individuals often perform tasks in team environments (e.g., military, athletic, & industrial settings). Team environments vary in quality such that adaptive team environments, which are characterized by high levels of perceived competence of and trust in one's teammates as well as task-cohesion, are associated with superior individual performance, whereas maladaptive team environments, which can be characterized by low levels of these factors, are associated with poor performance. Despite the frequency with which individuals perform in team environments of variable quality as well as the robust relationship between allocation of attentional resources to novel stimuli and performance, the impact of team environment on allocation of attentional resources has only recently begun to be investigated. The electroencephalographic (EEG) technique can be employed to assess the allocation of attentional resources to novel stimuli. Specifically, the reflexive orientation of attention to novel stimuli can be inferred from the magnitude of the electrocortical response to these stimuli, in particular, the novelty-P3 event-related potential (ERP). Higher novelty-P3 amplitudes indicate increased allocation of attentional resources to stimuli. To examine the impact of team environment on the allocation of attentional resources to novel stimuli, the novelty-P3 elicited by unexpected auditory stimuli was assessed while participants performed a cognitive-motor task (the videogame Tetris®) in neutral, adaptive, and maladaptive team environments. Tetris® performance was significantly better in the adaptive team environment than the neutral and maladaptive team environments. Participants exhibited significantly attenuated novelty-P3 amplitudes in the maladaptive team environment in comparison to the neutral and adaptive team environments. Amplitude of the novelty-P3 was undifferentiated between the neutral and adaptive team environments. Results suggest that participants exhibited a reduction in attentional orienting to novel stimuli in a maladaptive team environment in comparison to neutral and adaptive team environments. Attentional allocation did not differ between a neutral and adaptive team environment. As the ability to allocate attentional resources is inversely related to the cognitive load imposed by task performance, it was concluded that participants performing in a maladaptive team environment experienced a greater cognitive burden relative to when they were engaging in neutral and adaptive team environments. Additionally, as task

performance was superior in an adaptive team environment relative to a neutral team environment while attentional resource allocation was undifferentiated, it was concluded that participants performing in an adaptive team environment were able to attain their superior performances without corresponding increases in cognitive effort. The present study suggests that maladaptive team environments diminish allocation of attentional resources to novel stimuli and adaptive team environments facilitate task performance without increasing cognitive load.

D-39

EMULATING SOCIALITY: A COMPARISON STUDY OF PHYSIOLOGICAL SIGNALS FROM HUMAN AND VIRTUAL SOCIAL INTERACTIONS. Joshua C. Poore, *The Charles Stark Draper Laboratory*; Andrea K. Webb, *The Charles Stark Draper Laboratory*; Matthew J. Hays, *USC Institute for Creative Technologies*; Julia Campbell, *USC Institute for Creative Technologies*; Matthew Trimmer, *USC Institute for Creative Technologies*; Laura M. Major, *The Charles Stark Draper Laboratory* - Mediating interpersonal conflicts requires a complex set of skills best gained through well structured practice. This study provides pilot data from an evaluation of a conflict-mediation training platform that features a high-fidelity virtual human designed to emulate real-human interactions. Specifically, we tracked physiological signals from participants during their interactions with the virtual human and compared them to signals during their interaction with a live human actor. A total of 21 participants were recruited from Naval Reserve Officer Training Corps (NROTC) programs at major southern California undergraduate institutions. The participants completed an intake questionnaire featuring a personality inventory (BFI; John, et al., 1991) and other measures prior to attending a laboratory session. During the laboratory session, the participants interacted with both a virtual human and a real human actor using the same semi-structured conflict mediation script; both human actors and virtual humans expressed the same affect and mannerisms during interactions. Presentation order was counterbalanced and participants were instrumented for electrocardiography (ECG) and electrodermal activity (EDA) during their interactions. Analyses used signals averaged across interactions as well as signals averaged across events wherein actors/virtual humans expressed specific affect (i.e., exasperation, irritation, etc.). No statistically significant differences between the two interactions for EDA. Inter-beat interval (calculated from ECG) was significantly longer during interactions with actors, compared to interactions with virtual humans ($t = 2.97, p < .01$), however, these differences were driven by interaction-order effects. Event-related analyses reveal that IBI, but not GSR, discriminated between different affect expressed by actors and virtual humans ($F(2, 28) = 4.98, p < .05$). And, while IBI also revealed difference between human and virtual interaction partners ($F(2, 28) = 4.98, p < .05$), these effects were moderated by interactions with presentation order (F

(1, 28) = 4.23, $p = .06$). Further analyses reveal that differences in trait openness to experiences and were related to physiological reactions to negative affect ($b = .35, p = .10$) expressed by virtual humans, and that these differences may be partially accountable for interaction order effects. Taken together, this pilot study suggests that high-fidelity virtual humans may be effective in emulating real-human interactions, given similarities at the physiological level. As a result, this technology may be an effective avenue for training social skills and interpersonal intervention strategies. Furthermore, that physiological features related to nervous system activity can discriminate between experiences related to perceived affect encourages future research into using physiological and neurological signals measured from simple contact sensors to drive the behavior of virtual agents, making more adaptable and authentic social skills training platforms.

D-40

SOCIAL RANK IN ECONOMIC DECISION-MAKING Sagan A. Schultz, *New York University*; Lasana Harris, *Duke University*; Mauricio R. Delgado, *Rutgers University*; Elizabeth A. Phelps, *New York University* - Using the tools of economics we examined how social ranking, or one's position held in society, modulates human choice. Previous research has demonstrated that losing the social competition of an auction is linked to a striatal 'loss' response that is correlated with how much participants 'overbid' in relation to the Nash equilibrium (Delgado et al., 2005). These results suggest the fear of losing the social competition inherent in an auction is linked to overbidding behavior. It is therefore plausible that another type of loss, namely loss in the form of decreased social rank, might also result in increased overbidding. In two separate experiments, participants competed in a dynamic auction game bidding against a single partner for monetary goods. The participants were then given feedback about their performance relative to their partner. Our findings show that participants ranked as "worse" than their opponent made significant changes to their original bidding strategy in the form of increased overbidding, while those ranked "better" did not. Interestingly, this act of overbidding produced a significant loss in potential monetary earnings. These results indicate one of the means by which social rank may play a modulatory role in choice behavior.

D-41

EFFECTS OF SOCIAL NETWORK ON REWARD-RELATED BOLD SIGNALS IN A COMPETITIVE CONTEXT Dominic S. Fareri, *Rutgers University*; Michael A. Niznikiewicz, *Rutgers University*; Meredith P. Johnson, *Rutgers University*; Mauricio R. Delgado, *Rutgers University* - Extensive research implicates corticostriatal circuitry as critical for reward-related processing, showing sensitivity to outcome valence (e.g., positive vs. negative) and the motivational context in which outcomes are experienced. These findings extend to the social domain, as striatal and

prefrontal regions process social outcomes (e.g., Somerville et al., 2006; Izuma et al., 2010; Lin et al., 2011) and outcomes across differing social contexts (e.g., cooperative, competitive; Rilling et al., 2004; Delgado et al., 2008). Evidence suggests that when participants engage in competition with a computer, whereby computer losses signify a positive outcome for participants, the striatum monitors the competitor's losses (Howard-Jones et al., 2010), and other work indicates a role for medial prefrontal regions coming online during strategic interactions (Hampton et al., 2008). However, we typically engage in a variety of behaviors (e.g., cooperative, competitive) with others whom may be within or outside of our social network (e.g., close friend, new business colleague). It is yet unclear whether the experience of positive and negative outcomes in a competitive context varies as a function of social network. MRI participants played a card-guessing game (adapted from Delgado et al., 2000) against three different competitors: a close friend, a confederate, and a random number generator (non-social condition). The goal of this task was to guess whether the value of a card would be higher or lower than 5. MRI participants' role alternated during the task, from making the guesses (Player) and observing their competitors make the guesses (Spectator). Correct guesses resulted in monetary gain for the respondent and no gain for the competitor, whereas incorrect guesses resulted in no monetary gain for the respondent, but monetary gain for the competitor. Preliminary neuroimaging analysis reveals a main effect of competitor during outcome processing in corticostriatal circuitry. A region of ventromedial prefrontal cortex in particular demonstrates a more positive BOLD response during outcomes won or lost against their friend, as compared to the confederate or random number generator. This suggests that competing for outcomes with an in-network other may carry more positive value than when competing with an out of network or non-social entity. Future analysis will further probe effects of individual difference measures on the BOLD response during outcome processing, as well as connectivity between regions of corticostriatal circuitry at the time of outcome.

D-42

A PENNY FOR YOUR PAIN? THE FINANCIAL COMPENSATION OF SOCIAL PAIN AFTER SOCIAL EXCLUSION *Gert-Jan Lelieveld, Leiden University; Bregtje Gunther Moor, University of Amsterdam; Eveline A. Crone, Leiden University; Johan C. Karremans, Radboud University Nijmegen; Ilja van Beest, Tilburg University;* - Previous research has shown that only a few factors can really mitigate the distress caused by social exclusion. In the current work, we directed our attention to a factor that has received mixed support (Van Beest & Williams, 2006; Zhou, Vohs, & Baumeister, 2009). We focus on the effects of money on social exclusion. We investigated whether the distress caused by social exclusion can be financially compensated. In two studies (a behavioral and an fMRI

study), participants were included or excluded in a game of Cyberball. They either received money each time they did not receive the ball, or they did not. In the behavioral study we measured participant's need satisfaction immediately after Cyberball to investigate how participant's feelings of distress. Results showed that although participants' need satisfaction was lower when they were excluded than when they were included, financial compensation buffered these effects in the exclusion condition. In addition to self-reported distress, in the second study we also used fMRI to investigate whether the pain and distress caused by social exclusion could be financially compensated. Participants first played an inclusion game and subsequently an exclusion game, both in the scanner. Moreover, we were not only interested in intrapersonal feelings, but also in interpersonal behavior. That is, we tested how financial compensation would mitigate subsequent money allocations. After the Cyberball game, participants played a dictator game (Forsythe, Horowitz, Savin, & Sefton, 1994), where they could offer new money (i.e., not the money that they had received in the Cyberball) to the players who had excluded them, players who included them, and unrelated others. fMRI results showed increased activation in the bilateral anterior insula when participants did not receive the ball in the exclusion game, compared to when participants did not receive the ball in the inclusion game. When looking at the effects of financial compensation, we found increased activation in the dACC, a region found active during physical and social pain, when participants did not receive money, compared to when they did. These results suggest that the negative experience of social exclusion was mitigated when participants were financially compensated. The dictator game results revealed that participants offered less to those that excluded them than to those that included them or to unrelated others. However, the offers to the players that had excluded participants were higher when participants were financially compensated, compared to when they were not. We thus showed that money not only affects social exclusion during or right after the experience, but also subsequent interpersonal behavior in a dictator game. Although the negative effects of social exclusion have been shown to be very powerful, financially compensating these feelings thus reduces the negative experience.

D-43

AMYGDALA AND VENTROMEDIAL PREFRONTAL CORTEX STRUCTURAL VARIATION PREDICT MEMORY FOR IMPRESSIONS IN OLDER ADULTS *Brittany S. Cassidy, Brandeis University; Avi Aizenman, Brandeis University; Angela H. Gutchess, Brandeis University* - Past lesion work has illustrated the importance of amygdala integrity in the retention of impressions (Todorov & Olson, 2008). Other research has shown that increased thickness in ventromedial prefrontal cortex (vmPFC) corresponds with enhanced fear extinction (Milad, et. al., 2005), highlighting the salience of this

region in remembering emotional information. Recent neuroimaging work suggests that there exists a specialized neural system underlying social information and memory that functionally, may be relatively spared with age. With advancing age, the cortex thins and subcortical volumes atrophy. Memory for social information, while potentially spared with age, may partially rely on the integrity of the regions involved in this social processing system. We investigated how the integrity of regions involved in socioemotional memory (vmPFC, amygdala) and regions implicated in explicit memory (hippocampus) affected memory for impressions in young and older adults. Anatomical scans for fifteen young and fifteen older adults were obtained using MRI, and reconstructed to gather information about cortical thickness and subcortical volume. Young adults had greater amygdala and hippocampus volumes relative to old, although there was no difference in vmPFC thickness between the age groups. All participants completed a behavioral task in which they formed impressions of faces paired with trait-inferring sentences. During the task, they responded to prompts that were interpersonally meaningful ("Do I want this person to play a role in my life?"), social but interpersonally irrelevant ("Does this person have a pet?") or non-social ("Does the sentence have any three-syllable words?") after forming impressions. Participants additionally completed a retrieval task where they viewed all previously seen faces with two behavioral traits listed below, and chose which trait they remembered as being associated with the face. Across all participants, greater left amygdala volume predicted enhanced overall memory for impressions. However, when split by age group, this relationship held for older, but not younger, adults. Additionally, increased right vmPFC thickness in older adults correlated with enhanced memory for impressions formed in the interpersonally meaningful context, whereas young adults did not display this relationship. Interestingly, although older adults had decreased left hippocampal volume relative to young, hippocampal volume was not predictive of memory for impressions. Overall, these findings demonstrate the importance of the integrity of regions linked to socioemotional processing in the retention of impressions with age, and support the existence of a social memory system relatively independent of the hippocampus.

D-44 ★

DIMINISHING PAROCHIALISM IN INTERGROUP CONFLICT BY DISRUPTING THE RIGHT TEMPORO-PARIETAL JUNCTION Thomas Baumgartner*, University of Basel; Bastian Schiller*, University of Basel; Jörg Rieskamp, University of Basel; Daria Knoch, University of Basel; * The first two authors equally contributed to this work. - Social groups constitute the building blocks of human society and influence our behaviour strongly. While people show extraordinary altruistic behaviour towards ingroup members, they often act with hostility towards outgroup

members, a phenomenon known as parochialism. Recent evidence from functional magnetic resonance imaging studies suggests that among other areas the temporo-parietal junction (TPJ) plays a key role in discriminating ingroup and outgroup members in perception, judgments and in affecting parochialism. However, functional imaging studies, although indispensable, do not permit causal inferences about the effect of brain processes on human judgments and behaviour, because the observed neural activations might just be an epiphenomenon or a consequence and not necessarily the cause of the judgments or behaviour. In contrast, brain stimulation techniques, such as transcranial magnetic stimulation (TMS) allow researchers to draw causal conclusions about the behavioural impact of the stimulated brain region. Here we studied whether diminishing neural activity in the TPJ by means of neuro-navigated repetitive transcranial magnetic stimulation (rTMS) impacts parochialism. We recruited 36 fans of two rival soccer teams. Subjects' parochialism was measured in a third-party punishment game, where subjects as third-parties could assign costly punishment points towards out- and ingroup members on the basis of their decisions in a previously played prisoner's dilemma game (PDG). Behavioural studies show that third-parties punish outgroup members, who committed a norm violation in the PDG, more strongly than ingroup members. Our research question was whether disrupting TPJ function would reduce this parochial punishment. For that purpose, subjects received low-frequency (1Hz) rTMS before playing the third-party punishment game, either over the right (n=13) or the left TPJ (n=12), or sham stimulation (n=11). We were able to demonstrate that the transient disruption of the right TPJ diminishes parochial punishment: Subjects with a temporarily inhibited right TPJ punished out- and ingroup members more equally compared to those subjects in the left TPJ and sham stimulation group. We were thus able to provide the first causal evidence that the right TPJ - an area known to be involved in perspective-taking, mentalizing, and moral judgment - might be decisive in parochialism. We discuss the possible functional role of this area in parochialism and its significance for our social functioning in general.

D-45 ★

HOW SOCIAL IS PROSOCIALITY? COMPARING THE NEURAL CORRELATES OF PROSOCIAL AND SELF-ORIENTED MOTIVATION. J. L. Livingston, A. C. Savine,

T. S. Braver; Washington University in St. Louis - Recent findings have clearly demonstrated that self-oriented motivational incentives (e.g., earning money, praise, or consumed rewards for the self) can enhance executive function and goal pursuit. These enhancements have been found not only in terms of behavioral indicators, but also in modulations of neural activity in brain regions associated with reward and cognitive control, during attention, working memory, and task-switching paradigms. However, human motivation is often prosocial

in nature (e.g., giving benefit to another); it is not known whether prosocial motivation might engage similar or distinct neural mechanisms from that engaged by self-oriented motivation. In the current study, participants performed cued task-switching in two separate mixed block-event related fMRI scanning sessions that were analogous in structure and differed only in terms of motivational incentives (self-oriented vs. prosocial) available for optimal performance. In each session, participants met a confederate whom they believed would simultaneously participate in the experiment. In the self-oriented condition, participants earned money for themselves, whereas in the pro-social condition, participants earned money for the confederate. Behaviorally, both self-oriented and prosocial motivational incentives enhanced cognitive control and reduced task-switch costs, but via distinct performance profiles. Consistent with prior work, brain activation increases were observed in cognitive control and reward regions in both incentive conditions, relative to baseline. Most notably, increased sustained activity in right dorsal lateral PFC was observed in the self-oriented condition relative to the prosocial condition, but for transient activity, the reverse was observed. This finding supports the idea that prosocial motivation and self-oriented motivation produce distinct effects on cognitive control strategy. We explore the extent to which this distinction is primarily social in nature or is instead related to the abstract nature of prosocial rewards.

D-46

SOCIAL INCLUSION ENHANCES BIOLOGICAL MOTION PROCESSING: A FUNCTIONAL NEAR-INFRARED SPECTROSCOPY STUDY *Danielle Z. Bolling, Kevin A. Pelphrey, Martha D. Kaiser; Yale University*

- Humans are especially tuned to the movements of other people. Neural correlates of this social attunement have been proposed to lie in the right posterior superior temporal sulcus (STS), which robustly responds to biological motion in contrast to a variety of non-biological motions. This response persists even when no form information is provided, as in point-light displays. No study to date has investigated the effects of social interactions on subsequent neural responses to biological motion. The current study explored the effects of social inclusion and exclusion on brain responses to point-light displays of coherent and scrambled biological motion in the right frontal and temporal lobes using functional near-infrared spectroscopy (fNIRS). During an fNIRS scan, participants (12 healthy adults) viewed ten distinct 24-second videos of point-light displays of coherent and scrambled biological motion (alternating) at three time points in the experiment: baseline, post-social inclusion, and post social-exclusion. The experiences of social inclusion and exclusion were elicited using Cyberball, an online ball-toss game, where participants were either included or excluded from a game of catch on the computer for 30 throws. All participants in the fNIRS study also underwent functional magnetic resonance

imaging (fMRI) scans where they viewed the same videos of coherent and scrambled biological motion, which allowed us to cross-validate the measurement of brain activation to biological motion using two distinct neuroimaging modalities. Several methodological strategies were used to attempt to account for the poor spatial resolution of fNIRS measurements compared to fMRI. First, we took into account variability inherent in optical neuroimaging by coregistering fNIRS data with structural MRI images in each participant, and in turn normalizing the location of recording channels into standard space. This coregistration also allowed us to identify recording channels in specific regions of interest unique to each participant's structural morphology, providing more accurate and individualized analyses of functional activation measured with fNIRS. Results: Brain responses to coherent versus scrambled biological motion (collapsed across the three time points) measured with fNIRS correlated with brain responses to identical stimuli measured with fMRI in the same participant group. Compared to baseline, social inclusion increased brain responses to biological motion in right posterior STS and supramarginal gyrus. There was no significant modulation of activation to biological motion post-exclusion compared to baseline. Analysis methods for fNIRS employed in the current study allowed us to replicate brain responses to biological motion measured with fNIRS and fMRI in an identical participant group. In addition, subtle experience-dependent fluctuations of these brain responses were detected with fNIRS, demonstrated here by the manipulation of social inclusion. These results suggest that future studies using fNIRS can measure brain responses to such point-light displays in young children and infants. Specifically, investigating these brain responses in infants at high risk for developing autism may illuminate early neural markers of the disorder, as brain responses to such stimuli have been identified as a potential neural endophenotype in children with autism.

D-47

BRAIN MECHANISMS FOR EXPERIENCING AND IMAGINING AFFECTIVE TOUCH *Molly V. Lucas, Yale Child Study Center; Laura C. Anderson, Yale Child Study Center; Kevin A. Pelphrey, Yale Child Study Center; Martha D. Kaiser, Yale Child Study Center*

- Recent work in our laboratory has implicated a number of social brain regions in processing pleasant, affective touch targeting a special class of nerve fibers, C-tactile (CT) afferents. CT-afferents, present only in the hairy skin of mammals, respond to slow gentle touch ranging from 1-10cm/s. Such touch is reminiscent of that shared in social interactions between bonded individuals. Our initial fMRI study comparing the brain response to CT-targeted touch (to the hairy skin of the forearm) and non-CT touch (to the glabrous skin of the palm) implicated portions of the insula, the right posterior superior temporal sulcus/gyrus (STS/STG) and the medial prefrontal cortex (mPFC) in processing CT-targeted affective touch. It is unclear whether participants

were imagining or visualizing the touch, which may have influenced the brain regions identified as important for processing CT vs. non-CT touch. Thus, we sought to examine whether imagining and experiencing gentle touch processed by CT-afferents recruit similar or distinct brain mechanisms. In the current fMRI study, typical adults experienced and imagined gentle brush strokes to their right forearm and palm in alternating blocks (Experience Arm, Imagine Arm, Experience Palm, Imagine Palm). Auditory instructions preceded each block, and participants wore sleep masks to eliminate visual stimulation. During the experience blocks, a trained experimenter used a watercolor brush to stroke the arm (CT-afferents) and palm (lacking CT-afferents) at a pleasant, CT-optimal speed of 8cm/s. During the imagine blocks, participants were instructed to imagine the same two types of touch. Experience Arm blocks preceded Imagine Arm blocks, and Experience Palm blocks preceded Imagine Palm blocks to facilitate the imagining for each condition. Preliminary analyses have focused on similarities between experiencing and imagining gentle touch to the arm versus the palm. A contrast of Experience Arm + Imagine Arm > Experience Palm + Imagine Palm revealed a network of regions including posterior STS/STG, ventral mPFC, temporal pole, and anterior insula. The differential response to arm and palm touch was comparable in the experience and imagine conditions in all of these regions indicating a network of brain regions supporting both actually experiencing gentle touch processed by the CT-system and imagining such touch. In addition, we found a significant difference in the anterior insula response to Experience Arm and Imagine Arm. Specifically, imagining CT-targeted touch to the arm elicited a greater response than experiencing it. Initial results from this fMRI study suggest that overlapping brain mechanisms support experiencing and imagining affective touch processed by CT-afferents. Key social brain regions including the posterior STS/STG region, mPFC, temporal pole, and anterior insula were differentially involved in processing both experiencing and imagining gentle touch to the arm versus the palm. Involvement of these regions in processing arm touch highlights the inherently social nature of the CT-system. These results support the hypothesis that the anterior insula is involved in re-representing sensory input (i.e., interpreting the affective content of touch). Our preliminary findings help to characterize the function of key social brain regions and deepen our understanding of the brain mechanisms underlying affective touch processing.

D-48

SOCIAL WORKING MEMORY AND THE NEUROSCIENCE OF EFFORTFUL SOCIAL COGNITION

Meghan L. Meyer, UCLA; Robert P. Spunt, UCLA; Matthew D. Lieberman, UCLA - Whether keeping track of three friends' perspectives in a conversation, a roomful of colleagues' beliefs during a conference, or the political ideology of someone we just met, we constantly juggle variable amounts of social cognitive information. While

countless social neuroscience studies implicate medial prefrontal cortex (MPFC), tempoparietal junction (TPJ), and posterior cingulate/precuneus (PC/PCC), dubbed the mentalizing network, in social cognitive processing (e.g. Frith & Frith, 2003; 2006), no extant studies have examined how this network responds to systematic increases in social cognitive information. This is problematic, because it is unclear how the mentalizing network would respond to increases in social cognitive demands. While these regions have been shown to engage in simple social cognition tasks relative to cognitive control tasks, another line of research from cognitive neuroscience consistently finds that these regions deactivate during effortful cognition including working memory (Grecius & Menon, 2004; McKiernan et al., 2003; Metzak et al., 2011). In fact, the mentalizing network is virtually identical to a network dubbed the default-mode network, so named because it is more active when individuals are at rest (i.e. by default) than when they engage in a variety of effortful cognitive tasks. The critical caveat however is that previous studies from the default-mode literature have only examined increases in effortful processing with cognitive and perceptual load. None of the studies linking increased effort with decreased activity in the mentalizing network have examined increased effort associated with increased social task demands. To address this question, we developed a novel delayed-response social working memory task that varied social cognitive effort on a trial-by-trial basis. During scanning, participants completed trials in which they were presented with the names of two, three, or four of their friends, mentally ranked their friends along a trait dimension during a delay period, and answered a true/false question about their rank order. Parametric analyses showed linear increases in activation as a function of increasing social demand in the mentalizing/default-mode network. Moreover, nearly all of the regions within the mentalizing/default network were also significantly more active compared to a resting baseline. In common social cognition paradigms, regions within the mentalizing and default mode network show increased activity compared to a non-social control task (i.e., judgments about the physical world; e.g. Mitchell et al., 2005); however they typically show decreased or no activity compared to a resting baseline. Therefore, it is difficult to claim that regions are optimized for social cognition when the tasks used to assess social cognition produce less activity than what is observed during rest. The current data suggest that these prior findings might be due to the lower difficulty levels of prior social cognition tasks. Our results reaffirm the role of these regions in social cognition and suggest the possibility that during rest, individuals are engaged in more complex or effortful social cognition than what is demanded by most fMRI studies of social cognition.

D-50

FROM VOXELS TO MORPHEMES: LINKING NEUROIMAGING DATA WITH MACHINE LEARNING ASSESSMENTS OF LANGUAGE USAGE

TO GAIN SOCIAL PSYCHOLOGICAL INSIGHT

Matthew Brook O'Donnell, University of Michigan; Emily B. Falk, University of Michigan; Matthew D. Lieberman, UCLA - A central goal for social neuroscience is to link neural activity during controlled laboratory paradigms with social phenomena in the real world. An example of the latter is language data recorded during social interaction (e.g. through the Electronically Activated Recorder; EAR; Mehl & Pennebaker, 2001). Recent studies of online social networks, such as Twitter and Facebook, have demonstrated the value of applying tools from fields such as natural language processing (NLP) and information retrieval to richly linked and socially situated language data. Sentiment analysis (SA) of Twitter, for example, has been used to discover opinions regarding new products, identify regional dialects and retrospectively predict political movements. SA uses machine learning algorithms to train classifiers to distinguish between text samples grouped according to some attribute (e.g. positive vs negative opinion, evaluative vs descriptive language, effective vs ineffective outcome etc.) on the basis of a selection of linguistic features (i.e. use of certain adjectives, nouns, 1st person pronouns or private verbs, e.g. think, feel, like, know). We propose the synergy of this type of automated language analysis with neuroimaging data from fMRI studies in which subjects engage in tasks that involve exposure to ideas, objects, or other socially relevant stimuli, and then provide a free-form post-scan language samples expressing preferences, opinions, or engage in other experimentally relevant social interactions (alone or in more complex groups). The resulting language corpus can then be analyzed using NLP tools to provide metrics for sentiment, use of descriptive or interactive language features, and so on, that can be applied as parameters in the analysis of the fMRI data. To illustrate this approach we present data from a study where subjects ($n=20$) were asked to act as interns for a TV production company and during a scanning session viewed ideas for 24 potential shows. After this session they were videotaped describing and evaluating each show. Their language was transcribed and given to a sentiment analysis classifier trained on a corpus of film reviews, which returned ratings for polarity (neutral vs polar) and positivity (positive vs negative). Used as parametric modulators values indicative of more positive sentiment were associated with activation in neural regions associated almost exclusively with self-related processing and social cognition (medial prefrontal cortex; MPFC, and posterior cingulate/precuneus; PCC), and memory encoding (Hippocampus) during initial idea encoding. These results are consistent with more labor-intensive ratings made by trained coders who assessed the enthusiasm expressed by each of the participants about each show. These data provide novel evidence linking neural activity during initial idea encoding to the enthusiasm with which the ideas are subsequently delivered to others and also demonstrate the novel use of sophisticated machine learning tools to link natural language data to neuroimaging data. These results and

methodology also lay the foundation to link basic neurocognitive signals collected using fMRI to complex social interactions collected outside of the scanner (e.g. recorded conversation, expression of preferences or opinions in more open ended formats), as well as to data collected through online social media (e.g. Facebook, Twitter).

D-51

THE INFLUENCE OF SOCIAL POWER ON EMOTIONAL PROSODY RECOGNITION

Silke Paulmann, Ayse K Uskul, Sarah T. Harris, Lauren King; University of Essex - The popular saying "it's not what you say, it's how you say it" nicely illustrates the importance that emotional tone of voice (prosody) plays in our social interactions. In fact, the ability to accurately identify others' emotions is essential in daily-life. Clearly, difficulties in detecting emotions from the voice can lead to severe problems in interpersonal communication. Given emotional prosody's prominent status in social communication it is thus essential to explore how a factor such as social power can impact on its perception. Thus, in two behavioral studies, we explored the role of social power in emotional prosody recognition. Specifically, we will present data from a correlational and an experimental study in which participants were asked to recognize basic emotions (anger, disgust, fear, happiness, sadness, pleasant surprise) or a neutral tone of voice from nonsense-speech ("Klaaff the frisp dulked lanyary"). Results from the correlational study suggest that the generalized sense of power is negatively correlated with recognition accuracy. Results from the experimental study show that participants in the high power condition show significantly lower accuracy than those in the low power condition. These findings indicate that high power is associated with a reduced level of accuracy in recognizing emotions in other people's voice. Importantly, we find power plays a role in the identification of emotions in voice, but not when voice does not communicate any emotion (neutral tone of voice). Based on these findings we further explored how differences in social power on emotional prosody recognition manifest at a neural level. Specifically, a follow-up event-related brain potential (ERP) study examines how latency and amplitude of ERPs that have previously been linked to emotional prosody processing (P200, N300/N400) are modulated by social power. Similar to the second behavioral experimental study described above, participants are primed to feel either powerful or powerless before conducting an emotional prosody recognition task. Previously, early ERP components such as the P200 have been linked to emotional salience detection (e.g. Paulmann & Kotz, 2008), while later components such as the N300 and N400 have been linked to more in-depth processing (e.g. meaning) of emotional vocal stimuli (e.g. Schirmer, Kotz & Friederici, 2002, 2005; Paulmann & Pell, 2010). If emotional prosody recognition decline for high power individuals is related to altered emotional salience detection, we expect early components such as the P200 to differ between high and

low power participants. However, if differences in later stages reflecting emotional meaning processes lead to lower emotional prosody recognition rates in high power individuals, we expect to find altered later negative ERP components in those participants when compared to low power individuals. Taken together, our findings can inform why some people are less adept at “reading between the lines” and will also contribute to the ongoing and unresolved discussion of the role of power in interpersonal accuracy on more general terms.

D-52

SPECIFIC BRAIN MECHANISMS UNDERLYING COMMUNICATIVE ACTIONS COMPREHENSION

Federica Rivar, Yale University, University of Milano-Bicocca; Brent C. Vander Wyk, Yale University; Kevin Pelphrey, Yale University - Comprehending actions is a crucial ability to have successful social interactions. In recent years, several studies have been carried out aimed at investigating the neural basis underlying action understanding. Previous studies have principally focused on relatively non-communicative actions (e.g. grasping) and have usually employed non-interactive tasks (passive observation). However, considering the social extent of action comprehension, dimensions such as communicativeness and interactivity need to be taken into account. The aim of the present study was to investigate brain mechanisms underlying comprehension of communicative actions in an interactive situation employing a semi-naturalistic paradigm by functional Magnetic Resonance Imaging (fMRI). We compared explicit communicative actions with simple motion using either an interactive or a non-interactive task. The experiment consisted of a ball tossing game depicted in a series of interactive video clips. The movies showed two full-body players performed either a communicative or a non-communicative action: gesturing for a ball (Bid, communicative) or a simple up-and-down arm motion (Motion, non-communicative). Players were turned either toward the subjects (Interactive, Toward) or to each other (Non-interactive, Away). Participants were instructed to press a button to throw the ball to a player of their choice whenever a toward-condition was presented. Each condition (Bid-toward, Motion-toward, Bid-away, and Motion-away) included 24 trials that were presented in an event-related design. Data from 11 participants (7 females) were collected. Behavioral data revealed a difference between the -toward conditions providing evidence that the behavior was influenced by the type of action presented. Indeed, the number of times participants threw the ball to the moving player was higher in the Bid toward than in the Motion-toward condition. Regarding the functional data we first considered the communicativeness effect in the interactive situation comparing the Bid-toward with the Motion-Toward condition. This revealed significant activations in a set of different brain areas: the right posterior Superior Temporal Sulcus (pSTS) that is involved in the comprehension of action goal, the dorsal Prefrontal Cortex that is implicated in the recognition of action intention, the

bilateral Precentral Gyrus that is responsible for motor planning and preparation, and the Inferior Frontal Gyrus, an area belonging to the putative Mirror Neuron System that was found to be more active during motor preparation of complementary than imitative actions. Secondly, we contrasted the Bid-away with the Motion away condition in order to examine the communicativeness in a non-interactive situation. For this contrast we didn't find any significant activation. Lastly we compared the two previous contrasts (Bid-toward - Motion-Toward > Bid-away - Motion-away) in order to see the interaction effect of Communicativeness by Interactivity. Results provided significant activations in areas overlapping the ones found active in the Bid-toward vs. Motion-toward comparison. The present study provided evidence that in action comprehension communicativeness is affected by interactivity, demonstrating the existence of a brain network, including associative and motor areas, specifically responsible for processing communicative actions directed toward us, but not for communicative actions directed toward others.

D-53

RELATIONSHIP BETWEEN LOW LEVEL PERCEPTUAL DECISION AND SOCIAL HIERCHARY: A POSSIBLE INTERPRETATION THROUGH BEHAVIOR, ERPS AND COMPUTATIONAL MODEL

Hernando Santamaría García, Mario Panunzi, Alba Ayneto, Gustavo Deco, Nuria Sebastián Gallés - Previous research shows that social aspects can affect high level neural processing. Until now it was unclear if social aspects such as hierarchical rank could influence sensory/ perceptual cognitive processes in primary areas. We evaluated the effects of social comparisons with members of a hierarchy using a basic visual task, which is a priori unaffected by social aspects. Initially, in a computerized game we constructed a strong social hierarchy based on the skills on a visual (Numerosity) task, participants performed the task comparing their results with two covertly simulated players, one superior and the other one inferior. Participants were significantly better and faster when they performed the task simultaneously with the high status player. In a follow up experimental procedure we analyzed the time course of the event related potential response. Two time windows were studied, analyzing early perceptual/sensory processes (< 350 ms) and the late /attentional decisional processes around 350 and 700 ms. We observed significant hierarchical effects even in the early stages of sensory - perceptual processing (0 - 350ms); suggesting early top-down modulations of social aspects. Those differential neural responses of primary cognitive processes also translated into differences in behavioural measures. Furthermore we found specific personality traits related with performance supporting a possible explanation about how human beings act in social comparisons.

D-54**FUNCTIONAL AND STRUCTURAL CORRELATES OF SOCIAL INFLUENCE**

Daniel Campbell-Meiklejohn, NYU, Aarhus University; Ryota Kanai, University College London; Bahador Bahrami, University College London; Dominik Bach, University College London; Raymond Dolan, University College London; Andreas Roepstorff, Aarhus University; Chris Frith, University College London - The extent that we are influenced by expressed values of others is a trait that can define us or align us in society. The tendency to change our values to be more or less like values expressed by others can vary between individuals but is a fairly stable trait across different contexts. This suggests that social influence on value may have a stable anatomical correlate. In a previous study, we found that social influence on value correlates with functional neural responses to initial disagreement with others about value and subsequent influence on reward value processing. That study highlighted physiological dynamics of social influence in the brain but it did not address the structural foundations that would link social influence to developmental and evolutionary theory. Lesion research suggests that orbitofrontal cortex (OFC), often unavailable to reliable functional MRI studies, is causally involved in central components of social influence on value. Damage to this region impairs one's ability to learn from feedback and act appropriately during social interactions. In the same healthy 28 subjects as the functional study (15 male, mean age), we used Volumetric Based Morphometry methods to search for a linear relationship between grey matter volume (GM) in the OFC and a tendency to adopt values expressed by other people. Prior to testing, subjects provided the names of twenty pieces of popular music that they would like to own but did not own yet. They rated each song for desirability on a scale from 1 (low) to 10 (high). Afterward, subjects were told that each song was heard and reviewed by two music experts that subjects had rated as reasonably capable of choosing enjoyable music. Subjects then performed the task. During a given trial, subjects would indicate their preference between a song they submitted and an alternative song they had never heard (subjects almost always chose the submitted one). Next, they were told which song the experts preferred. Each submitted song was evaluated by pairings with 6 different alternatives. After the task, subjects rated their desire for each submitted song again. For each subject, change of song desirability was tested for a linear relationship with net expert preference for the song (times preferred - times not preferred). The resulting correlation coefficient provided a measure of tendency to shift ratings toward or away from opinions of others. Grey matter of a specific region of lateral orbitofrontal cortex (lOFC GM) correlated with the tendency of values to shift towards expressed values of others. This effect was found in precisely the same region of both brain hemispheres. lOFC GM also predicted the functional response to discovering that someone else's values contrasted with one's own, in the middle frontal gyrus - suggesting that lOFC GM may index feedback sensitivity or feedback

contextualization. We can now report the existence of an anatomical correlate of susceptibility to social influence with considerable clinical, developmental and evolutionary implications.

D-55**NEURAL CORRELATES OF SOCIAL INFLUENCES ON AESTHETIC JUDGMENT FOR ARTWORKS**

Seongmin Park, KAIST; Youngjin Jin, KAIST; Chongwook Chung, KAIST; Jaeseung Jeong, KAIST - Aesthetic judgment of artworks is likely influenced by aesthetic judgment of others, but the precise neural mechanism underlying various social influences (expert and peer reviews; positive and negative reviews; review and rating) is unclear. Here we show that 191 female participants changed their aesthetic judgment of abstract paintings to conform to aesthetic judgment of both experts and peers. More significantly, the conflict of initial assessment with the rating of a social group triggered a subsequent change in individual's judgment to conform to the group, which was found to correlate with changes in neural activity in areas associated with error monitoring in 25 viewers: an increase in activity in the rostral cingulate zone (RCZ) and a decrease in activity in the anterior cingulate cortex (ACC). In contrast, subjective changes in computation of aesthetic value to conform to expert's review were correlated with activities in the orbitofrontal cortex (OFC) and the striatum. In addition, social cognition networks such as the medial prefrontal cortex (mPFC) were engaged when the perspective inferred in a peer review was taken into account. These results suggest both informative and normative motives in conforming to others, which is likely altered by both the prediction of the sources' judgment and one's level of agreement with the cognitive reasons behind others' judgments. Our findings provide evidence that social influence of others' aesthetic judgments changes viewer's perception-based aesthetic judgments, and that its neural correlates are responsible for integrating others' assessments into our own subjective aesthetic judgment.

D-56**NEURAL CORRELATES OF THEORY OF MIND: EEG ALPHA DESYNCHRONIZATION**

Joe Dietzel, University of California, San Diego; David Liu, University of California, San Diego - The ability to interpret others' thoughts and beliefs in everyday scenarios is known as mentalizing or theory of mind. Critically, it relies on understanding a distinction that a belief can be false and separate from reality (e.g. the belief that you will receive an iPad for Christmas, and the reality that you won't). Theory of mind has been investigated with functional neuroimaging for its neural underpinnings (Mitchell, 2006; Saxe, 2006; Frith & Frith, 2006). EEG alpha desynchronization is thought to also be a measure of functional neural activation. The present study investigates EEG alpha desynchronization as participants processed the mental states of other people. In this study, adults (n=28, mean age=21yrs) were presented with three story types adopted from those used

in Saxe (2006), which included false-belief stories, physical person description stories, and nonhuman description stories. Following each story, participants answered questions about the story. Throughout the experiment, EEG data was recorded to be analyzed offline. Participants were presented with twenty stories per condition. Overall, participants' accuracy on the questions did not vary by condition. We will describe EEG alpha desynchronization of each condition relative to the resting baseline at each scalp location. We predict greater EEG alpha desynchronization to false-belief stories from electrodes at medial frontal and right posterior scalp locations.

Poster Session G

G-01

SOCIAL GOALS MODULATE AMYGDALA RESPONSE TO FACES *Daniel L. Ames, Princeton University; William A. Cunningham, The Ohio State University; Alexander A. Todorov, Princeton University*- This work examines flexibility in the brain's evaluative subsystems as a function of social context. While undergoing fMRI scanning, participants read scenarios describing social goals that involved either helping others or using others to help the self. After each scenario, participants viewed a series of faces and selected those people who looked most relevant to the given social goal. Scenarios were pretested to make one of four groups of faces situationally relevant (with face groups varying on the dimensions of perceived trustworthiness and perceived dominance). Primary analyses focus on the amygdala, a subcortical structure that provides arousal cues that direct attention and facilitate effective responses to the environment. Results show that the functional profile of the amygdala varies systematically as a function of participants' social goals. Specifically, when a given kind of person (e.g., strong, trustworthy-looking people) is made situationally relevant (e.g., by asking participants to select the people whose help they want in moving to a new apartment), those kinds of faces elicit increased BOLD response in the amygdala relative when they are not motivationally relevant. This effect is observed for both selfish and selfless social goals. In-scanner decisions, individual difference scales, and independent measures of selfish/selfless economic decisions are also analyzed and their respective relationships to BOLD responses in the amygdala are discussed. This work supports a view of amygdala function that is highly sensitive to social context. Moreover, in contrast to theories emphasizing cognitive control mechanisms in exercising selfless behavior, this work suggests that 'low-level' affective responses are automatically tuned to facilitate other-focused goals.

G-02 ★

SPONTANEOUS AND INTENTIONAL SOCIAL INFERENCES: NEURAL EVIDENCE OF A COMMON PROCESS *Frank Van Overwalle, Vrije Universiteit*- Several lines of social neuroscientific evidence seem to contradict extant dual-process models which assume that spontaneous and intentional inferences are guided by different (associative versus symbolic) processes (De Neys, 2006; De Neys, Vartanian & Goel, 2008; Smith & DeCoster, 2000; Uleman, 1999). First, using instructions for spontaneous ("read carefully") or intentional ("what is the goal / trait of this person?") inferences between participants (so that leakage of the intentional instructions into the spontaneous condition was avoided), ERP studies have documented that the onset of social inferences occurs at about the same time irrespective of instructions.

Specifically, the first neural signature was detected after about 200 ms for goal inferences (Van der Cruyssen et al., 2009) and 600 ms for trait inferences (Van Duynslaeger et al., 2007, 2000). This seems to rule out the notion that spontaneous inferences precede and inform (i.e., provide input to) intentional inferences. Second, recent fMRI studies using a between-participants design have consistently found on overlap between spontaneous and intentional instructions in core areas of mentalizing. In a study on trait inferences, Ma et al. (2011) found a significant overlap in the temporo-parietal junction (TPJ) and medial prefrontal (mPFC). Importantly, spontaneous trait inferences significantly recruited only these core mentalizing areas, whereas intentional trait inferences additionally recruited other brain areas, which may reflect thoughts to confirm or validate the spontaneous trait hunches made initially, in a variety of ways. In another recent study on person versus situation causes, Kestemont et al. (2012) found significant overlap in mentalizing areas including the TPJ and precuneus. Interestingly, spontaneous inferences increased the activation of the mPFC, suggesting the operation of the fundamental attribution bias which was prevented under intentional instructions. In a study on trait inconsistencies, Ma et al. (2012) found a significant overlap in the dorsal mPFC, and also recruitment under both instructions of the dorsal part of the anterior cingulate cortex (dACC), which is a domain-general conflict detection area. Taken together, these results suggest that intentional instructions exert their influence only after a common (spontaneous) process produced an initial inference. Specifically, intentional instructions seem to invite observers to think more deeply about the material they read, and consider it in more different and less biased ways to verify the inference made (e.g., to verify an initial spontaneous inference with more details as laid down in memories).

G-03

NEURAL SYSTEMS UNDERLYING THE FUNDAMENTAL ATTRIBUTION ERROR AND ITS CONSEQUENCES FOR PERSON PERCEPTION *Tobias Brosch, New York University, University of Geneva; Daniela Schiller, Mount Sinai School of Medicine, Rachel Mojdehbakhsh, New York University; James S. Uleman, New York University; Elizabeth A. Phelps, New York University*- When making sense of other people, we should consider both dispositional and situational factors as potential causes for a behavior. However, people often ignore the importance of situational factors, a phenomenon known as the Fundamental Attribution Error (FAE). We investigated the brain systems underlying information integration during the attribution process. FAE was associated with reduced BOLD in DLPFC during the encoding of situational information, consistent with the failure of a correctional process that integrates situational information into attributions. We furthermore investigated the impact of attributions on evaluations. Behaviorally, attributions were strongly linked to subsequent evaluations. We observed a dissociation between brain regions involved in

evaluations that integrated situational information and evaluations based exclusively on behavior, with DMPFC emerging as potential substrate of the integration of attributions and evaluations. Our findings demonstrate how top-down control processes regulate impression formation when situational information is taken into account to understand others.

G-04

BRAIN AREA FOR ENCODING TRAITS: AN FMRI ADAPTATION STUDY *Ning Ma, Vrije Universiteit Brussel; Kris Baetens, Vrije Universiteit Brussel; Marie Vandekerckhove, Vrije Universiteit Brussel; Frank Van Overwalle, Vrije Universiteit Brussel*- Neuroimaging studies of trait processing have found a network of brain areas, the critical part of which appears to be medial Prefrontal Cortex (mPFC). In this study, we investigated whether the mPFC plays an essential role in the encoding traits by using fMRI-adaptation, which is a rapid decrease of stimulus-related neuronal responses upon repeated presentation of a stimulus. Participants had to infer an agent's (social) trait from brief trait-implicating behavioral descriptions. In each trial, the critical (target) sentence was preceded by prime sentences that implied the same trait (trait-consistent), the opposite trait (trait-inconsistent), or no trait at all (trait-irrelevant), or the target sentence was not preceded by any prime (baseline trait-singleton). The results revealed robust adaptation effects in the ventral mPFC in all three prime conditions compared to the baseline. Crucially, adaptation after trait-consistent and trait-inconsistent primes was significantly stronger than after trait-irrelevant primes. This effect was absent in other brain areas. In line with previous research on fMRI adaptation, we interpret this finding as indicating that trait concepts are not only processed, but also encoded in the ventral mPFC.

G-05

THE NEURAL BASES OF UPDATING IMPRESSIONS *Peter Mende-Siedlecki, Princeton University; Yang Cai, Princeton University; Sean Baron, Princeton University; Alex Todorov, Princeton University*- As humans, we are faced with a constant challenge: figuring out the other humans around us. We form rapid, robust impressions of other people in service of this challenge, yet impression formation is a dynamic process. Other people are continuous sources of data, and in some cases, it becomes necessary to update our impressions based upon new, inconsistent information. While there have been several neuroimaging investigations of initial, behavior-based impression formation, we sought to explore impression formation over a longer behavioral trajectory. As such, we devised two fMRI studies to identify brain regions involved in updating impressions. In both studies, participants saw faces paired with valenced behavioral information and were asked to form impressions of these targets. Each face was seen five times in a row, each time with a different piece of behavioral information. Critically, some of the targets were inconsistent, in that the valence

of the information changed on the fourth trial—making the fourth and fifth trials inconsistent with information previously learned about that target and necessitating that participants update their impressions. Across both studies, we observed a consistent set of regions associated with updating impressions, including dorsomedial prefrontal cortex (dmPFC), ventrolateral prefrontal cortex (vlPFC), superior temporal sulcus (STS), and inferior parietal lobule (IPL). Moreover, the magnitude of the change in dmPFC activity in response to inconsistent information correlated with the change in participants' in-scanner behavioral ratings, suggesting a direct association between activity in this region and on-line impression updating. In addition, the second study investigated whether neural responses vary as a function of the content of the information. Specifically, we tested for differences in updating based on morality- vs. ability-related attributions. Previous behavioral research has shown that whereas negative information is more diagnostic in the morality domain, positive information is more diagnostic in the ability domain. Although we found the same behavioral pattern of responses, we also found that bilateral vlPFC and inferior frontal gyrus (IFG) were more strongly associated with updating impressions based upon diagnostic information, independent of the content of information. These findings suggest a common neural basis for the aforementioned negativity and positivity biases. In sum, these studies identify a functional network of regions involved in dynamic updating of person impressions. The responses of these regions seem to be driven by the diagnostic value of the behavioral information for the resulting impression.

G-06

PERCEPTUAL ADAPTATION TO CUTENESS AND ATTRACTIVENESS *Jessica Golle; Fred W. Mast; Janek S. Lobmaier* - In the last decade high-level after-effects have been reported for many different facial cues. For example, adaptation to male faces has been found to cause participants to perceive subsequent faces as more feminine and vice versa. Here we examined perceptual adaptation to facial cuteness and attractiveness and its dependency on the sex and age of the face. Three experiments were implemented, each consisting of preadaptation, adaptation and postadaptation phases. In Experiment 1 twenty-four participants adapted to uncute and cute male and female baby faces and subsequently rated the cuteness of male and female baby faces. In Experiment 2 twenty-four participants adapted to cute and uncute baby faces, their subsequent task being to evaluate the attractiveness of adult faces. Finally, in Experiment 3 twenty-four participants adapted to sex-specific attractive and unattractive adult faces and assessed the cuteness of baby faces and the attractiveness of adult faces. The results revealed a sex-specific attractiveness after-effect only for adult faces and a sex-unspecific cuteness after-effect only for baby faces. These results raise the question where the concept of cuteness may be localized in the multidimensional face space. So far, there is no research

concerning the representation of baby faces within the multidimensional face space.

G-07

WHO'S COOLER?: NEURAL CORRELATES OF SOCIAL COMPARISON JUDGMENTS *William E. Moore III, University of Oregon; Junaid S. Merchant, University of Oregon; Jennifer H. Pfeifer, University of Oregon-* Successful social interaction requires successful recall and evaluation of considerable knowledge about the self and other people, much of which is derived from social comparisons. Elucidation of the neural mechanisms associated with this type of interpersonal information processing is an emerging area of research in social neuroscience. Most paradigms employed to date have asked participants to make decisions about abstractly familiar, but not personally acquainted, others. In this fMRI study, we asked participants ($n = 19$) to engage in social comparison between themselves and several acquaintances, selected on the basis of high or low self-similarity. In the scanner, participants were presented with a series of trait adjectives (e.g., "cool," "annoying," "outgoing") and asked to decide, between two pseudo-randomly chosen targets, 'who is more ____'. The four experimental conditions consisted of comparisons between: self and a similar peer, self and a distant peer, or two peers with either high or low self-similarity. Imaging data were acquired using a predictive acquisition sequence to correct for head motion, and then preprocessed in SPM8 including field map correction, realignment, unwarping, coregistration and normalization to the MNI-152 template using DARTEL. First level general linear models were constructed for each participant, and a random effects analysis was conducted across subjects using the contrast images derived for each condition. Differences in reaction time were evident across conditions, with significant main effects of both self-involvement and similarity of comparator. Neuroimaging results demonstrated that BOLD signal varied at the inferior frontal junction and in the rostral anterior cingulate cortex (rACC) as a function of social decision-making context, with an interaction between self-involvement and similarity of comparator. Specifically, comparisons between the self and a highly similar other elicit distinct patterns of activity when contrasted against each other sort of social comparisons, with conjunction analysis revealing a significant cluster of activity in the rACC. Parameter estimates of activity in this region also correlated with independent behavioral measures of self-construal, linking individual differences in medial PFC function during a social cognitive task to individual differences in self-reported, subjective evaluations of the self. These results further suggest that different aspects of interpersonal comparisons rely on distinct neural substrates.

G-08

DOES MEDIAL PREFRONTAL CORTEX ENGAGE EQUALLY FOR REPRESENTATION OF SELF AND

MOTHER IN CHINESE? *Pin-Hao A. Chen, Dartmouth College; William W. Kelley, Dartmouth College; Katie E. Powers, Dartmouth College; Todd F. Heatherton, Dartmouth College-* Neuroimaging studies on self-referential processing have found that the medial prefrontal cortex (MPFC) and the posterior cingulate cortex (PCC) are robustly activated during self-reference tasks (Kelley et. al., 2002; Heatherton et. al., 2006; Moran et. al., 2006; Zhu et. al., 2009 and Ray et. al., 2010). Furthermore, several studies have showed that MPFC activates differently for self and close others (for example, best friends and mother) in Westerners (Heatherton et. al., 2006 and Zhu et. al, 2009). One intriguing study found, however, the same activation pattern in MPFC for self and mother for Chinese participants, presumably because of the collectivist nature of their culture (Zhu et. al., 2009). The current study examined whether the neural representation of self and close other (mother) is modulated when Chinese participants shift between two languages in which they are fluent. Specifically, we examined whether neural representation of self and mother were different when people used Chinese (their first language) or English (their second language). Fifteen newly arrived native Chinese-speaking graduate students, who were also fluent in English, were recruited. An event-related fMRI study with six counterbalanced conditions (self-judgments in English and Chinese, mother-judgments in English and Chinese, font-judgments in English and Chinese) was conducted. A total of 120 Chinese and 120 English trait words matched for meaning were selected from two established pools of personality trait words (English words are from Anderson, 1968, Chinese words are from Yang & Wang, 1999). In order to examine whether MPFC engages differently across conditions, we use two ROIs from two prior studies (Kelley et. al., 2002, 10, 52, 2; BA 10, and Moran et. al., 2006, -3, 47, 0; BA 10). A 2 (language) by 2 (self/mother) ANOVA showed a significant main effect of self/mother condition ($F [1, 14] = 9.6, P < .01$) and language condition ($F [1, 14] = 15.5, P < .005$) for the Moran et al. ROI and a significant main effect in task condition ($F [1, 14] = 9.7, P < .01$) and a marginally significant main effect in language condition ($F [1, 14] = 4.3, P = 0.58$) for the Kelley et al. ROI. The language effect is likely due to the cognitive effects of translating. Our self/mother findings suggest that MPFC differentiates self from mother for Chinese participants whether they processed the terms in Chinese or English. This finding contradicts the prior finding (Zhu et al, 2009) that Chinese use the same neural representation for self and mother. It is possible that our participants may differ in meaningful ways from that study, such as our participants possibly being more individualistically oriented. Future studies are needed to clarify whether the neural representation of self and mother are the same or different in different cultures.

G-09

THE SELF BEYOND THE MEDIAL PREFRONTAL CORTEX: THE EXTENDED NETWORK FOR SELF-APPRAISALS *Junaid S. Merchant, University of Oregon;*

Christabelle L. Moore, University of Oregon; Matthew D. Lieberman, University of California, Los Angeles; Andrew J. Fuligni, University of California, Los Angeles; Chuansheng Chen, University of California, Irvine; Jennifer H. Pfeifer, University of Oregon- Neuroimaging studies on self-referential processing have found that the medial prefrontal cortex (MPFC) and the posterior cingulate cortex (PCC) are robustly activated during self-reference tasks (Kelley et. al., 2002; Heatherton et. al., 2006; Moran et. al., 2006; Zhu et. al., 2009 and Ray et. al., 2010). Furthermore, several studies have showed that MPFC activates differently for self and close others (for example, best friends and mother) in Westerners (Heatherton et. al., 2006 and Zhu et. al., 2009). One intriguing study found, however, the same activation pattern in MPFC for self and mother for Chinese participants, presumably because of the collectivist nature of their culture (Zhu et. al., 2009). The current study examined whether the neural representation of self and close other (mother) is modulated when Chinese participants shift between two languages in which they are fluent. Specifically, we examined whether neural representation of self and mother were different when people used Chinese (their first language) or English (their second language). Fifteen newly arrived native Chinese-speaking graduate students, who were also fluent in English, were recruited. An event-related fMRI study with six counterbalanced conditions (self-judgments in English and Chinese, mother-judgments in English and Chinese, font-judgments in English and Chinese) was conducted. A total of 120 Chinese and 120 English trait words matched for meaning were selected from two established pools of personality trait words (English words are from Anderson, 1968, Chinese words are from Yang & Wang, 1999). In order to examine whether MPFC engages differently across conditions, we use two ROIs from two prior studies (Kelley et. al., 2002, 10, 52, 2; BA 10, and Moran et. al., 2006, -3, 47, 0; BA 10). A 2 (language) by 2 (self/mother) ANOVA showed a significant main effect of self/mother condition ($F [1, 14] = 9.6, P < .01$) and language condition ($F [1, 14] = 15.5, P < .005$) for the Moran et al. ROI and a significant main effect in task condition ($F [1, 14] = 9.7, P < .01$) and a marginally significant main effect in language condition ($F [1, 14] = 4.3, P = 0.58$) for the Kelley et al. ROI. The language effect is likely due to the cognitive effects of translating. Our self/mother findings suggest that MPFC differentiates self from mother for Chinese participants whether they processed the terms in Chinese or English. This finding contradicts the prior finding (Zhu et al, 2009) that Chinese use the same neural representation for self and mother. It is possible that our participants may differ in meaningful ways from that study, such as our participants possibly being more individualistically oriented. Future studies are needed to clarify whether the neural representation of self and mother are the same or different in different cultures.

G-10

THE EVOLUTION OF THE SELF: BODY, AFFECT, AND EPISODIC MEMORY IN THE SOCIAL ANIMAL

Rami Gabriel, Columbia College; Chicago- I describe self within its evolutionary history with particular attention to affect and social habitat. Drawing from affective neuroscience, cognitive psychology, and philosophy of mind, my position is that the human self emerged from the interaction between the mammalian social habitat and affective motivational processes; that there is an evolutionarily older self that mediates action tendencies and primitive affective sentience, which was developed upon into a second self constituted by identity, whose function is navigating the social world. William James's (1899) influential paradigm of self as known and knower is conceptually practical but it obscures how sentience ("I") evolved from the body (material me) and then - in social mammals - developed through its social circumstances (social me) into a practically functional and predictively useful unit (spiritual self) for the purposes of social bonding. At its most basic level, the self is a representation of the body. In social animals, this primitive action tendency platform evolved a social identity based on episodic memory. There are two forms of the self that are manifested on a continuum across nature. The evolutionarily older self arises from movement; any creature that moves must have an internal relation to its environment, which compares goal states, or innate programs, to its actions and surroundings (Dennett, 1996). This relationship is represented/mediated by valence in feedback/feedforward loops, which constitute the most primitive level of sentience. This system becomes elaborated in proportion to the range of movements, behaviors, and complexity of the organism. The platform of valence serves as the relation between motivation and behavior; it is based in the basic biological regulatory processes of homeostasis. Homeostasis needs are so common that brain circuits geared toward their satisfaction become adaptations. Some midbrain systems are geared towards basic regulatory functions like eating and sleeping, while for social animals coordinated relations with conspecifics are required for survival within their habitat. These social animals have homeostatic systems that include social bonding capabilities. I argue that this homeostasis requirement is satisfied by another form of self atop the bodily self for the purpose of effective social bonding. The second form of the self arose from interaction between social habitat complexity and the affective bodily motivational platform as an adaptation for the purposes of providing an effective social unit for bonding to conspecifics, and as organizational locus for prediction of behavior and psychology for the organism itself. The core constituent of this self is Episodic Memory, a system that evolved to provide an internal platform for prediction in the form of a set of reliable dispositions surrounded by specific exceptions (Klein, German, Cosmides, & Gabriel, 2004). This system provides the basis for personality - a set of epigenetic behavioral and psychological dispositions. While fulfilling homeostatic

social needs, this self also provides the basis for a personal narrative that gives meaning to our behaviors through their constitutive relation to our identity within the social world.

G-11

AN FMRI TASK FOR EXPLORING MEMORY EFFECTS OF SIGNIFICANT-OTHER ACTIVATION IN SOCIAL COGNITION

Andrew J. Gerber, Columbia University; Kevin N. Ochsner, Columbia University; Susan M. Andersen, New York University; Bradley S. Peterson, Columbia University- A novel functional magnetic resonance imaging (fMRI) paradigm for exploring the neurobiologic basis of a key aspect of social cognition was developed, adapted from Andersen's transference paradigm (Andersen & Chen, 2002). This paradigm captures the extent to which current memory in relation to a stranger is impacted by activated knowledge of a significant other (SO). Forty healthy young adult participants were seen for two separate sessions and misled to believe that the sessions were unrelated to one another. In the first, participants listed descriptive sentences for each of four different important people in their lives (SOs), chose 20 irrelevant adjectives about each from a list, and provided descriptive sentences about 80 famous individuals. In the second session, at least two months later, participants were shown 20 sentences about each of six different supposed strangers ("targets"). Unbeknownst to participants, two of the targets resembled SOs described by the participant in the initial session ("the experimental targets"), two resembled SOs described by a different participant (the yoked-control), and two were constructed from a random assortment of sentences the participant listed about famous individuals (the no-representation control). The participants were then shown 30 sentences about each target and asked to rate how likely it was that they were just exposed to each about that particular target. For targets resembling SOs, 10 of the 30 sentences (the "lures") had, in fact, not been seen previously about the target, but were from the participant's own description of the pertinent SO. Therefore, participants should incorrectly rate these lures higher when the target resembled their own SO, as compared to the comparable lures in either control condition. Functional MRI images were collected during the entire second session using a GE Signa 3T whole body scanner. Individual and group level fMRI analyses were conducted using SPM8. Replicating Andersen's findings, the average memory recognition score was higher for the "lures" in the SO condition ($M = 2.69$; $SD = .61$) than for those in the yoked-control condition ($M = 2.55$; $SD = .65$), paired $t(39) = 2.01$, $p = .05$. In fMRI analyses, betas reflected the tendency of neural activity to increase when SO-relevant targets were presented during the learning phase and these were used to produce a second-level contrast map which showed significant differences in activation during the presentation of SO-resembling targets, in comparison with the yoked-control condition. Findings were significant at the level of $p < .05$ after correction for multiple

comparisons using the false discovery rate method. Neural activity in bilateral fusiform cortex and the superior frontal gyrus increased during SO activation, while neural activity in the subgenual ACC (sgACC) decreased. This paradigm is a powerful tool for exploring the neural basis of social cognition and may well prove useful in characterizing psychiatric disorders in a developmentally sophisticated way.

G-13

NEURAL CORRELATES OF SEX DIFFERENCES AND WOMEN'S OWN-GENDER BIAS IN FACE RECOGNITION MEMORY

Johanna Lovén, Karolinska Institutet; Agneta Herlitz, Karolinska Institutet; Natalie Ebner, University of Florida; Joakim Svärd, Karolinska Institutet; Håkan Fischer, Stockholm University- Women typically remember female faces better than male faces, whereas men show no reliable own-gender bias in memory for faces. In addition, women are better at remembering faces than men, and particularly female faces. It has been suggested that women's advantage in face recognition memory is a result of better face processing skills, and both behavioral and functional findings are in line with this notion. Women outperform men on perceptual face identification and recognition tasks, and show higher face specificity (i.e., volume of face selective activations) than men in fusiform gyrus while viewing faces compared to non-face objects. Finally, a positive association has been observed between fusiform peak activity in response to faces and performance on facial identification and recognition memory tasks. In the present event-related functional magnetic resonance imaging study, 15 women and 14 men were investigated during incidental encoding of female and male faces. Focus here was on two brain regions important for face perception (inferior occipital gyrus, fusiform gyrus). Based on the findings presented above, we hypothesized that brain activity in these cortical regions would be higher in women than in men during processing of female faces. Second, we hypothesized that women would show higher brain activity in these regions during processing of female faces compared to male faces. Moreover, we assessed whether individual differences in fusiform activity in response to faces were associated with face recognition memory performance, and if this relation was moderated by sex of viewer and face gender. Functional images were acquired with a 3T scanner. Participants passively viewed 24 female and 24 male faces with neutral expressions, one at a time, for 3.5 seconds, randomly intermixed with 24 low-level control trials. After a short retention interval, participants completed a surprise old/new face recognition memory test, comprising the 48 previously seen faces and 48 distractor faces. Results will be presented and discussed at the conference.

G-14

MOTIVATED REASONING AND THE FALSE CONSENSUS EFFECT: AN FMRI STUDY

B. Locke Welborn, UCLA; Ben Gunter, UCLA; Stephanie Vezich,

UCLA; Matthew D. Lieberman, UCLA- The false consensus effect (FCE) is a pervasive and relatively recalcitrant human tendency to presume that others share our attitudes, beliefs, and behaviors. Expanding on prior behavioral research, we used functional magnetic resonance imaging (fMRI) to test alternative theoretical accounts of consensus bias. Motivated reasoning accounts explain consensus bias primarily as the product of a desire to see our own attitudes, beliefs, and behaviors as normal, reasonable, and widely-held. In this way, the social thinker uses egocentric projection as a means to defend a positive self-image against the threat of alternative opinions and viewpoints. In contrast, cognitive availability accounts privilege the greater accessibility of our own attitudes, as well as selective exposure to similar/in-group others who are likely to share our perspectives on the issues. In order to explore the neural correlates of the false consensus effect, we investigated the consensus estimates of undergraduate students on a variety of contemporary social and political issues. While undergoing functional magnetic resonance imaging, twenty-eight UCLA students estimated the attitudes (opposition/support) of the ordinary UCLA undergraduate on approximately 200 contemporary social and political issues using a 100-point sliding scale. Based upon a prior behavioral sample of 200 undergraduates, we were able to calculate the error of participants' estimates relative to the mean attitude of the UCLA undergraduate population on each issue. In conjunction with participants' own expressed attitudes, this information allowed us to interrogate behavioral and neural correlates of variability in consensus bias at both the trial-by-trial and individual level. During some trials, participants received "sample information" in the form of fictitious attitudes purportedly drawn at random from our previous behavioral sample. In fact, all "sample information" reflected either a confirmatory attitude (similar to the participant's own expressed attitude) or a disconfirmatory attitude (similar the sample mean from our larger behavioral study, and dissimilar from the participant's own attitude). This manipulation allowed us to explore the psychological and neural systems involved in integrating attitudinal information from others into a coherent estimate of the ordinary individual's degree of support or opposition on a given issue. Consensus bias was elevated during confirmatory trials relative to estimates generated in the absence of sample information. Conversely, consensus bias in the presence of disconfirmatory information was significantly lower than control. Across all conditions, consensus bias was associated with increased hemodynamic activity in dorsal medial prefrontal cortex (DMPFC), dorsal anterior cingulate cortex (dACC), subgenual ACC, ventral striatum, and amygdala. Given the important roles ascribed to these regions in mentalizing, conflict monitoring, reward and incentive learning, as well as affective processing generally, these results provide support for motivated reasoning accounts of the false consensus effect. In addition, these regions distinguished between the confirmatory and disconfirmatory conditions,

being more strongly recruited in the former than the latter. In the disconfirmatory condition, activity in the right ventrolateral prefrontal cortex (VLPFC) was inversely associated with consensus bias, which may suggest the implicit or explicit deployment of regulatory resources to attenuate bias in the presence of disconfirmatory information.

G-15

USING EVENT-RELATED BRAIN POTENTIAL TO INDEX AUTOMATIC BELIEF REASONING

Joe Dietzel, University of California, San Diego; David Liu, University of California, San Diego- The ability to interpret others' thoughts and beliefs during everyday interactions is known as mentalizing, or theory of mind. Theory of mind is thought to be so pivotal to social interaction that some consider its detriment to underlie autism or other social disorders. Nevertheless, despite accounts of mentalizing playing a central role in everyday social interaction and communication, little is known about the conditions in which people actually reason about others' mental states and actions (Apperly et al., 2006; Cohen & German, 2009). Do people reason about mental states and actions only when overtly instructed to do so, or is this a process that becomes automatically engaged when presented with relevant cues? The present studies use ERP to covertly detect when subjects are 'caught' automatically tracking beliefs while performing a spatial task. In study 1, adults (n=21) watched animations where a person enters a room, places an animal in one of two boxes, and then leaves. While the person is outside the room, the animal hops out of the box and across the room into the opposite box. The person then reenters the room now having a false-belief about where the animal is located (i.e. they believe the animal is where they placed it, even though it is actually in the box which it hopped into). The person begins to walk in to the room and finally is shown standing behind one of the two boxes: either the box the animal was placed in, or the box the animal moved to. Eighty percent of the time, the person will go to the box where they left the animal. Twenty percent of those times, target trials, the subject will have to make a response indicating the person ended standing behind the box on the right side. Twenty percent of the time the person is expected to end up behind the box on the right side, if their beliefs are being tracked, but will instead end up behind the box on the left side, behaving in a way that violates their beliefs. We compared the ERP response from these belief-violation trials to the ERP response from trials that took place on the same side, did not elicit a subject response, and most importantly were belief-consistent. We discovered a P3a component maximally toward the anterior channels FCz and Fz due to subjects automatically tracking the person's belief and noticing when their behavior violates that belief. We also compared the ERP response of the target trials to the remaining belief-consistent trials. A classic P3b component located maximally in the posterior channels Pz and POz was observed here, similar to previous results found in the classic oddball paradigm

literature. In study 2, the animations were modified to test if subjects (n=23) automatically detect behavior that violates a person's true-belief. ERP results were similar to the false-belief study.

G-17

NEURAL BASIS OF THE IDENTIFIABLE VICTIM EFFECT

Alexander Genevsky, Stanford University; Daniel Vastfjall, Chalmers University of Technology, Sweden; Paul Slovic, Decision Research, Eugene Oregon; Brian Knutson, Stanford University- Introduction: The identifiable victim effect describes the fact that people are more willing to help individuals with identifiable information than those who remain anonymous. Previous behavioral research demonstrated that subjects donated more often and at greater magnitudes to orphans when they saw their photograph versus a silhouette. Further, evidence suggests that this effect might be related to the affective impact of the photograph. To further understand the role of affect in this manipulation, we ran an fMRI study on 16 individuals. Methods: Prior to scanning, subjects were given a monetary endowment from which they could choose to donate or not on each trial of the experiment (one of which would be randomly selected to count "for real" at the conclusion the session). While being scanned, during each trial subjects first saw either a photo or silhouette of an African orphan, accompanied with a name (4 sec). They then saw an amount for the requested donation (2 sec). Finally, two boxes (presented in a counterbalanced fashion on the left and right sides of the screen) presented "yes" and "no" options, allowing subjects to choose whether or not to donate (4 sec), followed by a 2-6 sec variable intertrial interval. Results: Analyses of a priori ROIs selected from previous research on reward processing and charitable giving indicate differential activation for face vs. silhouette stimuli in the amygdala, insula and nucleus accumbens. Insular and amygdalar activity was negatively correlated with decisions to give. Further, the nucleus accumbens was differentially activated in give vs no-give trials. Discussion: Current findings suggest that presentation of faces versus silhouettes robustly activates brain regions implicated in facial identification, incentive processing, and affective processing of both positive and negative arousal. Together, this activity may compel people to give to others based on identifiable and affectively compelling characteristics, even at their own expense. Acknowledgements: Stanford Center for Cognitive and Neurobiological Imaging, Stanford Center for Compassion and Altruism Research and Education.

G-18 ★

BDNF POLYMORPHISM--DEPENDENT OFC AND DLPFC PLASTICITY DIFFERENTIALLY MODERATES IMPLICIT AND EXPLICIT BIAS

Chad E. Forbes, Clinical Center and National Institute of Biomedical Imaging and Bioengineering, National Institutes of Health, University of Delaware; Joshua C. Poore, National Institutes of Health; Aron

K. Barbey, Decision Neuroscience Laboratory, Beckman Institute for Advanced Science and Technology, Neuroscience Program, University of Illinois at Urbana-Champaign; Frank Krueger, National Institutes of Health, George Mason University; Jeffrey Solomon, Medical Numerics, Inc.; Robert H. Lipsky, Inova Fairfax Hospital; Colin A. Hodgkinson, National Institutes of Health; David Goldman, National Institutes of Health; Jordan Grafman, National Institutes of Health- This study examined the role of orbitofrontal cortex (OFC) and dorsolateral prefrontal cortex (DLPFC) plasticity in controlling implicit and explicit social biases. Normal controls and patients with varied OFC and DLPFC lesion size and single nucleotide polymorphisms (SNPs) in the brain-derived neurotrophic factor (BDNF) gene, which promotes (methionine-valine [Met/Val] SNP) or stifles (valine-valine [Val/Val] SNP) plasticity in damaged PFC regions, completed measures of implicit and explicit social bias. Patients and controls demonstrated comparable levels of implicit bias, but patients with Met/Val SNPs exhibited less implicit bias when they had smaller OFC lesions compared with Val/Val patients with similar size lesions and those with large OFC lesions. Both patients and controls demonstrated patterns of explicit bias consistent with hypotheses. Patients with Met/Val SNPs exhibited less explicit bias when they had smaller DLPFC lesions sizes compared with Val/Val patients with similar size lesions and those with large DLPFC lesions. OFC lesion size and BDNF SNP type did not moderate explicit bias; DLPFC lesion size and BDNF SNP type did not moderate implicit bias (nor did other medial or lateral regions). Findings suggest that plasticity within specific PFC regions modulates the type and degree of social bias that individuals' exhibit.

G-19

SOUP FOR THE MIND: SOCIAL INTERACTION WITH EXTREME OUT-GROUP MEMBERS DISRUPTS DEHUMANIZED PERCEPTION

Alexandra Cohen, Duke Institute for Brain Sciences; Lasana T. Harris, Duke Institute for Brain Sciences, Duke University- Social neuroscience research demonstrates that extreme out-group members, such as the homeless, suffer dehumanized perception—people fail to spontaneously infer their mental states. The neural correlates of dehumanized perception in response to images of extreme out-group members like the homeless consist of less activity in the social cognition network—including parts of medial prefrontal cortex (mPFC) and temporal lobe—along with increased activity in the amygdala and insula, subcortical regions implicated in social bias and disgust (Harris & Fiske, 2006). Although the reduced social cognition network response is malleable in the context of preference inferences when viewing the pictures (Harris & Fiske, 2007), the present study aims to explore if actual real life encounters and social interactions can have a similar effect. Social interaction is an integral part of everyday life. However, we may not regularly have the opportunity to interact with individuals in extreme out-groups—spontaneous disgust responses and dehumanized perception encourage

avoiding them all together. In the current study, we adopt a clinical intervention paradigm for use with functional Magnetic Resonance Imaging (fMRI) to examine brain activity of participants in response to the homeless before and after either actively engaging in conversations with homeless individuals at a soup kitchen. We find increased spontaneous mental state inferences after social interaction, and modulation of the social cognition network and amygdala-prefrontal cortical circuitry by social experience. This suggests malleability of neural circuits implicated in the worst kind of prejudice by social experience.

G-20

THE EFFECTS OF STEREOTYPICAL EXPECTANCY VIOLATIONS ON EARLY ATTENTION TO RACE

Cheryl L. Dickter, College of William and Mary; Ivo I. Gyurovski, University of Chicago- Previous research has demonstrated that early attentional components of the event-related potential (ERP) reflect differential attention to race during person perception. Additional psychophysiological work has shown that inconsistency between stereotypic information following impression formation leads to greater neural processing in later ERP components. However, research has not examined how expectancy violations following impression formation affect the early attentional processing of race. Twenty-five White undergraduates performed a novel impression formation task while EEG was recorded. The task involved the presentation of pilot-tested sentences in which a target individual was described to perform behaviors associated with positive or negative stereotypes about Blacks and Whites, with the purpose of creating an expectation of Black or White targets. Following each impression formation sentence, a male face whose race either violated or confirmed this expectancy was displayed. Participants indicated whether this target could have performed the previous behavior. Results demonstrated that early attentional components of the ERP varied as a function of the match between expectancy and the race of target faces, with stereotypic expectancy violating trials yielding greater N1 and N2 amplitudes than expectancy confirming trials. P2 amplitude to the target faces was also moderated by the stereotypic impression formed. Additionally, results indicated that N1 amplitude was only affected by the compatibility of impression valence with the race of the target face, while participants were sensitive to the compatibility of the impression stereotypes with target race in the P2 and N2 components. Taken together, the results of the current study provide compelling evidence that attention to race early in processing as indexed by early attentional ERP components is moderated by the consistency of stereotypic information presented during impression formation. These findings have important implications for person perception.

G-21

AN EVENT-RELATED POTENTIAL ANALYSIS OF MIXED-RACE GROUP MEMBERSHIP

Holly Earls, University of Virginia; James P. Morris, University of Virginia- It has long been known that people are better at recognizing faces of their own race relative to other-race faces (see Meissner & Brigham, 2001 for a review). There has also been neural evidence of differential processing of own- and other-race faces (e.g. Golby, Gabrieli, Chiao & Eberhardt, 2001). Although it was proposed that this recognition bias was due to greater experience with own-race faces, recent evidence has shown an in-group recognition bias for arbitrary groups even when prior exposure is equated (Bernstein, Young & Hugenberg, 2007). Van Bavel, Packer, and Cunningham (2008) assessed the neural substrates of group membership by arbitrarily assigning participants to novel mixed-race groups and measuring brain activation using functional magnetic resonance imaging (fMRI). The authors found many brain areas showing greater activation when processing in-group relative to out-group faces, regardless of race. These findings suggest that the differential brain activation typically associated with own- versus other-race faces could be due to group membership cues rather than perceptual differences associated with race. The current study adopted Van Bavel and colleagues' paradigm using electroencephalography (EEG) to measure event-related potentials (ERPs). Additionally, a baseline measurement of brain activation was obtained while processing mixed-race faces prior to learning team membership. By using ERPs, we were able to examine the time course of processing mixed-race faces both prior to and after learning the group membership affiliation of the target individuals. Results indicated that prior to the group manipulation, differences were seen in the N170 and P300 components based on the race of the target face. These components are associated with facial processing and attention, respectively (Luck, 2005). After learning group membership, differences in the N170 component were again shown for race at multiple electrodes, but were only significantly different based on group affiliation at one electrode site. Differences in brain activation based on group affiliation emerged in the P300 component. These results suggest that although group membership can impact the processing of target individuals, group membership does not completely override the effects of race.

G-22

REPRESENTATION OF VALUE VS. TRAIT INFORMATION IN INTERGROUP SOCIAL JUDGMENTS: DISTINCT ROLES OF ANTERIOR TEMPORAL LOBE AND PREFRONTAL CORTEX

Sam J. Gilbert, University College London; Jillian Swencionis, New York University; David, M. Amodio, New York University- When interacting with a member of a social outgroup, people's responses are often influenced by implicit stereotypic and evaluative associations. Behavioral results suggest that stereotypes and evaluative biases may

operate independently of one another, raising the possibility that they may be mediated by distinct brain systems. We investigated this using fMRI. White participants classified pairs of Black or White faces either according to a friendship judgment (which of these two people would you be more likely to befriend?) or a trait judgment (which of these two people is more likely to be athletic?). These judgments encouraged the expression of evaluative bias and stereotypical associations towards Black faces, respectively. Using multi-voxel pattern analysis (MVPA), we found that a predominantly occipital network represented the race of faces in a context-invariant manner. However, lateral orbitofrontal cortex preferentially represented race during friendship judgments whereas anterior medial prefrontal cortex preferentially represented race during trait judgments. Furthermore, representation of race in left temporal pole correlated with a behavioral measure of evaluative bias during friendship judgments and, independently, a behavioral measure of stereotyping during trait judgments. These results indicate a highly context-dependent representation of race in left temporal pole. Whereas early sensory regions represent race in an apparently invariant manner, representations of race in higher-level brain regions are multi-componential and potentially mutable.

G-23

STEREOTYPES FACILITATE THE VISUAL PROCESSING OF BLACK FACES: EVIDENCE FROM THE N170 EVENT-RELATED POTENTIAL Amy R. Krosch, *New York University*; David M. Amodio, *New York University*- Stereotypes have been shown to shape a perceiver's impressions and behaviors toward members of the stereotyped group. But can they also shape the early visual processing of a stereotyped person's face? In research designed to test this question, we hypothesized that stereotypes facilitate perception of stereotype-relevant faces. Specifically, we predicted that when primed with objects related to the stereotype of Blacks as dangerous (guns), participants would exhibit enhanced encoding of degraded Black faces vs. White faces, as indicated by the N170 component of event-related potential (ERP), compared with stereotype-unrelated primes. ERPs were recorded while participants categorized a series of slightly degraded Black and White faces, houses, cars and chairs as either a "Face" or an "Object". Just before each of these targets appeared, a prime image of either a gun or a tool was presented briefly. As predicted, the N170 amplitude was larger to Black than White faces when participants had been primed with guns, but did not differ when they were primed with tools. Furthermore, differences in N170 amplitude to Black and White faces following gun primes was related to the difference in the speed at which participants categorized these faces; participants exhibiting higher N170 amplitude to Black (vs. White) faces categorized Black (vs. White) faces faster. This suggests that stereotype primes enhanced encoding of faces, facilitating participants' ability to categorize them as

faces. This finding highlights the powerful influence that stereotypes have on even the earliest components of person perception and points to a potential mechanism through which stereotypes affect downstream impressions and behaviors.

G-24

EXPECTANCY MODULATES THE EXPRESSION OF IMPLICIT RACIAL BIAS: EVIDENCE FROM FRONTAL CORTICAL ACTIVITY AND THE P2 ERP Jillian K. Swencionis, *Princeton University*; David M. Amodio, *New York University*- Can a more careful response strategy override the influence of implicit racial bias on behavior? Our prior research shows that expectancy of greater task difficulty is associated with decreased expression of implicit racial bias. Here, we tested whether expectancy is associated with proactive control, as indicated by greater relative left frontal cortical activity measured using EEG, and a shift in early attention to racial cues, as measured by the P2 ERP component. Participants categorized pleasant vs. unpleasant words following White or Black face primes. Expectancy was manipulated by changing the proportion of trials within each block that were incongruent with prevailing racial associations. Task behavior replicated our past findings: in congruent blocks, the typical pattern of racial bias was observed, but in incongruent blocks, race did not influence behavior. We also observed increased left-frontal cortical activity and an attenuated difference in the P2 ERP component between Black and White trials during incongruent vs. congruent blocks. These findings suggest that expectancy is associated with a reduction in implicit bias, and also that expectancy may engage greater proactive control and reduced attention to task-irrelevant race primes.

G-25

THE EFFECTS OF STEREOTYPIC PRIMES ON THE ATTENTIONAL PROCESSING OF RACIALLY AMBIGUOUS FACES Julie A. Kittel, *College of William and Mary*; Cheryl L. Dickter, *College of William and Mary*- Research has demonstrated that attention to race varies based on the race of the target and the perceiver, and is moderated by contextual information. This study aimed to determine how stereotype activation affects the early attentional processing of racially ambiguous faces in Black and White participants. Another goal of this study was to examine how this early attentional processing is moderated by individual differences. Participants saw positive and negative racial stereotypic primes followed by unambiguous monoracial or racially ambiguous faces. Participants categorized the race of the target while EEG data were collected. After the categorization task, participants completed the Need for Closure scale and an index of familiarity with racial outgroup members. Results indicated that White participants showed evidence of greater attention, as indexed by larger amplitudes in the P200 ERP component, to racially ambiguous targets preceded by Black relative to White stereotypes. White participants also showed greater attention to racially

ambiguous targets preceded by negative compared to positive stereotypes. Black participants, however, did not show these effects. These findings indicate that the processing of racially ambiguous target faces is affected by the context in which those faces are viewed, but that racial minority group members may not be affected by contextual information. To examine the moderating effects of individual differences, bias scores were calculated for the P200 and P300 components by subtracting the amplitude when responding to a racially ambiguous face preceded by a Black stereotype prime from the amplitude when responding to a racially ambiguous target preceded by a White stereotype prime. There was a significant positive correlation between P200 and P300 bias scores and the ambiguity subscale of the Need for Closure measure. This finding suggests that participants with a lower tolerance for ambiguity showed a greater sensitivity to the effects of the stereotypes on their attentional processing. Furthermore, regression results indicated that this trend was stronger for Black participants than for White participants. White participants also showed a significant positive correlation between childhood contact with racial outgroup members and the P300 bias score. Taken together, the results of this study provide insight into how the neural processing of racially ambiguous individuals may be moderated by stereotypic information differently for individuals varying in race and other individual differences.

G-26

STRUCTURAL FACE ENCODING AND THE OTHER-RACE EFFECT: HOW DIFFERENCES IN EARLY PROCESSING AFFECT MEMORY FOR OWN- AND OTHER-RACE FACES

Keith B. Senholzi, University of Colorado Boulder; Tiffany A. Ito, University of Colorado Boulder- The other-race effect (ORE) refers to a robust tendency for people to better remember and recognize own- as compared to other-race faces. This effect is assumed to result from superior encoding of ingroup relative to outgroup faces. An ERP component that is likely related to the ORE is the N170, a face-specific component that is larger to human faces than to objects and nonhuman faces. Its amplitude has been linked to the structural encoding of faces, but has also been shown to differ as a function of face race. Given that the ORE is thought to result from differential ingroup and outgroup processing during encoding, and the N170 is thought to index the structural encoding of faces, N170 amplitude may relate to subsequent memory for own- and other-race faces. More specifically, increased N170 responses to outgroup faces may reflect increased recruitment of structural encoding, which in turn should predict better memory. To empirically address this question, ERPs were recorded while White participants viewed Black and White faces and were required to remember them based upon their race or unique identity. N170 amplitudes to Black and White faces varied as a function of subsequent memory when encoded at the level of identity, with bigger amplitudes to Black faces that were later remembered and

smaller amplitudes to Black faces that were later forgotten, relative to subsequently remembered and forgotten White faces. These findings suggest that the N170 and ORE are related, and more specifically that early neural responses can differentially influence subsequent short-term memory for faces depending upon their race when processed at the subordinate level.

G-27

FUNCTIONAL CONNECTIVITY BETWEEN AMYGDALA AND FACIAL REGIONS INVOLVED IN RECOGNITION OF FACIAL THREAT

Motohide Miyahara, National Institute for Physiological Sciences, Okazaki, University of Otago; Tokiko Harada, Nagoya University; Ted Ruffman, University of Otago; Norihiro Sadato, National Institute for Physiological Sciences, Okazaki; Tetsuya Iidaka, Nagoya University- The recognition of threatening faces is important for making social judgments. For example, threatening facial features of defendants could affect the decisions of jurors during a trial. Previous neuroimaging studies using faces of members of the general public have identified a pivotal role of the amygdala in perceiving threat. This functional magnetic resonance imaging (fMRI) study used face photographs of male prisoners who had been convicted of first-degree murder (MUR) as threatening facial stimuli. We compared the subjective ratings of MUR faces with those of control (CON) faces, and examined how they were related to brain activation, particularly the modulation of the functional connectivity between the amygdala and other brain regions. The MUR faces were perceived to be more threatening than the CON faces. The bilateral amygdala was shown to respond to both MUR and CON faces, but subtraction analysis revealed no significant difference between the two. Functional connectivity analysis indicated that the extent of connectivity between the left amygdala and the face-related regions (i.e., the superior temporal sulcus, inferior temporal gyrus and fusiform gyrus) was correlated with the subjective threat rating for the faces. We have demonstrated that the functional connectivity is modulated by vigilance for threatening facial features.

G-28

THE POWER OF PHYSIOGNOMY: A PERCEPTUAL ADVANTAGE FOR UNTRUSTWORTHY FACES

Elizabeth Klobusicky, Temple University; Kevin C. Dieter, University of Rochester; Ingrid R. Olson, Temple University- The faces of members of our own species are one of the most salient classes of stimuli for human beings because they carry a wealth of information critical for social interaction. A useful paradigm for investigating the relative salience of various visual stimuli is binocular rivalry, in which disparate images are presented to the left and right eyes, creating competition for conscious awareness. During rivalry, a more salient image will rise to awareness for longer periods of time than a less salient image (Levelt, 1968). Indeed, one long-standing finding is the tendency of faces to dominate over other types of

visual stimuli even when low-level visual factors are controlled for. Recently, it has been suggested that behavioral relevance is a key component in promoting the relative predominance of an image in binocular rivalry (Dieter & Tadin, 2011). For example, it was shown that faces associated with negative gossip tend to dominate awareness for longer durations than those associated with positive or neutral gossip in a binocular rivalry paradigm (Anderson et al., 2011). In this case, the behavioral relevance of individual faces was modified through associative learning of face-face pairs. In contrast, our present study manipulated behavioral relevance by varying physiognomic features of trustworthiness (Oosterhof & Todorov, 2008). We hypothesized that perceptually untrustworthy faces would dominate visual awareness due to humans' evolved sensitivity to social threat. In the present study, participants viewed competing face and house images presented separately to each eye through a stereoscope. Here, three sets of face images (trustworthy, untrustworthy, and neutral; Oosterhof & Todorov, 2008) were compared against an identical set of house images. Participants recorded their percepts as they occurred via key press. Preliminary results support our hypothesis, demonstrating that untrustworthy, but not trustworthy, faces dominate visual awareness. These findings suggest that sensitivity to social threat, even when inferred from physiognomic features alone, can alter basic visual processing in humans.

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G-29 ★

DAMAGE TO THE VENTROMEDIAL PREFRONTAL CORTEX INCREASES CREDULITY TO EXPLICITLY-LABELED FALSE INFORMATION

Erik Asp, University of Iowa Hospitals and Clinics; Daniel Tranel, University of Iowa Hospitals and Clinics- Recent theoretical and empirical work has indicated that the prefrontal cortex is critical for the psychological process of doubting cognitive representations that are inexorably and initially believed. We have developed the False Tagging Theory (FTT), which proposes that the prefrontal cortex is necessary for somatic "false tags" in the psychological process of doubt. We hypothesize that damage to the prefrontal cortex leads to a disrupted false tagging mechanism and a "doubt deficit," which is accompanied by a tendency toward belief and credulity. Early empirical evidence corroborates the FTT as prefrontal patients tend to have higher social beliefs (and reduced doubt toward these beliefs), such as religious and prejudicial beliefs, relative

to brain damaged and normal comparison participants. Here, we put the FTT to a crucial empirical test by giving prefrontal patients novel beliefs in the laboratory and directly measuring their ability to falsify (or doubt) those beliefs. Participants were given four stories presented sentence by sentence on a computer screen and read the stories aloud. Within each story, a series of explicitly labeled false statements about the protagonist were presented. The explicitly labeled false statements were designed to sway the dispositional opinion of protagonist, if mistakenly believed. After each story, participants judged the protagonist on the critical attribute and performed a recognition memory test for statements in the story. The results show that patients with ventromedial prefrontal cortex damage (vmPFC) tend to misremember more explicitly-labeled false information as true than comparison subjects. Moreover, this failure to falsify truly constitutes a belief, as the explicitly-labeled false information swayed vmPFC patients' dispositional judgments of the protagonist in the designed direction. This is the first study to offer direct evidence that the prefrontal cortex is critical in the psychological process of doubt. The results are in accord with our FTT. Damage to the vmPFC results in an inability to falsify information that is patently false; and these inappropriate beliefs are often used to perform consequential social behavior. These findings indicate that a neural mechanism of credulity and gullibility is disruption in the false tagging mechanism, which is often accompanied by dysfunction or faulty development of the prefrontal cortex.

G-30

AGE DIFFERENCES IN BOLD ACTIVITY RELATED TO JUDGMENTS OF TRUST

Liz Castle, UCLA; Naomi Eisenberger, UCLA; Shelley Taylor, UCLA- This study aimed to identify whether elderly populations show neural differences in trust perception when compared to younger controls, with an eye towards explaining the elderly population's vulnerability to fraud. Previous research has shown that older adults are disproportionately vulnerable to fraud, and age differences in how cues of trustworthiness are processed may partly underlie this effect. To address these questions, 23 older adults (aged 55-80, Mean = 66.39) and 21 younger adults (aged 23-46, Mean 33.24) performed a previously validated trust perception task (Winston et al., 2002) during fMRI scanning. Subjects viewed grayscale images of 60 gaze-forward neutral facial expressions from both male and female faces of an array of ethnicities, presented in an event-related design with a variable ISI fixation displayed between each stimulus. Faces were selected to represent three normed levels of trustworthiness: low (untrustworthy), medium (neutral-trust), and high (trustworthy). There were two runs: a target task run where subjects were asked to make a binary trustworthiness judgment (is this person trustworthy or untrustworthy?), and a control task run where subjects were asked to make a binary gender judgment (is this person male or female?). As hypothesized, we found

bilateral amygdala activation across tasks for all levels of trustworthiness, implicating the amygdala in implicit perceptions of trust ($p < 0.001$, cluster threshold 25 voxels). This finding corroborates previous research implicating the amygdala in obligatory threat-related processing (Whalen et al., 1998; Strange et al., 2000; Vuilleumier et al., 2001). We also found evidence that suggests that there are age-related differences in right insula. When examining the main effect of task, we found that the right insula was significantly activated across both groups when subjects were making trust judgments as compared to gender judgments ($p < 0.001$, cluster threshold 25 voxels). However, when probed for group differences, this effect seemed to be driven by our younger subjects. Using a ROI analysis to investigate the interaction between age group and trustworthiness level, we found that the right insula only responded to untrustworthy and trust-neutral faces (but not trustworthy faces) in the young subjects, and none of the trustworthiness levels reached significance in the older subjects. One suggested function for the insula is that of processing autonomic changes as they affect the body, which might form the basis of 'gut feelings' (Damasio, 1999; Critchley et al., 2001). Related to this, the right insula has also been implicated in the representation of risk (Knutson & Bossaerts, 2007), and linked to risk-avoidance behavior (Paulus et al., 2003). Following this interpretation, both groups might be acknowledging potential for risk while making trust judgments but not gender judgments, an effect that is not only significantly amplified in younger subjects, but is preferentially implemented in untrustworthy and neutral conditions. In other words, it is possible that a diminished 'gut instinct' in older folks hinders their ability to identify untrustworthy faces and consequently avoid risk.

G-31

AMYGDALA REACTIVITY AND ITS RELATIONSHIP WITH CLINICAL COURSE IN ADOLESCENTS AT CLINICAL HIGH RISK FOR PSYCHOSIS Dylan G. Gee, UCLA; Sarah Jacobson, UCLA; Jean Addington, University of Calgary; Scott W. Woods, Yale University; Matthew D. Lieberman, UCLA; Tyrone D. Cannon, UCLA; on behalf of the NAPLS Consortium - Patients with schizophrenia exhibit alterations in the neural circuitry subserving emotion processing, which may underlie core emotion-related features of the disorder (e.g., Kohler et al., 2009). For example, prior work has demonstrated that patients with schizophrenia display hypoactive amygdala activation while matching emotional faces (Fakra et al., 2008). However, the extent to which such deficits are present prior to the onset of overt psychosis, and the role that they might play in its development, remain unclear. The present study aimed to examine amygdala function and its relationship with subsequent clinical outcomes among adolescents at clinical high risk (CHR) for psychosis. Participants consisted of CHR adolescents ($n=95$) and typically developing controls ($n=54$) recruited as part of the multisite North American Prodrome Longitudinal Study (NAPLS). Individuals in the CHR group were

further classified using a clinical course specifier to characterize whether their attenuated positive symptoms worsened ($n=49$), remitted ($n=18$), or remained stable ($n=28$) during the 12 months following a baseline fMRI scan. Participants performed an emotional faces fMRI task, during which they judged which of two linguistic labels best identified a target facial expression (Emotion Labeling) or which of two faces expressed the same emotion as a target face (Emotion Matching). Additional control conditions allowed for isolation of unique effects of emotion processing. Analyses primarily focused on emotion matching, which has elicited robust amygdala activation among healthy adults in prior work (Lieberman et al., 2007). Among CHR patients, comparisons between subgroups revealed differences in amygdala reactivity that related to subsequent clinical course. Specifically, CHR patients whose symptoms later remitted over the course of the next year exhibited increased amygdala activation during emotion matching at baseline, relative to CHR patients whose symptoms remained stable ($z=4.59$, $p < .0001$, corrected), CHR patients whose symptoms worsened (i.e., progression of the prodromal state) ($z=4.19$, $p < .01$, corrected), and controls ($z=3.48$, $p < .01$, corrected). There were no significant differences in amygdala activation between controls, CHR patients whose symptoms progressed, and CHR patients whose symptoms remained stable. Our findings demonstrated increased amygdala reactivity among patients whose clinical presentation improves. It may be that heightened amygdala activation serves a compensatory function among patients whose symptoms later remit. Moreover, baseline measures of amygdala function may aid in predicting future changes in symptomatology related to the onset of psychosis. Longitudinal imaging data will be critical to better understanding developmental trajectories of amygdala function in CHR individuals and how they might relate to clinical outcomes such as conversion to psychosis.

G-32

OXYTOCIN'S IMPACT ON BRAIN FUNCTION IN CHILDREN WITH AUTISM SPECTRUM DISORDERS

Ilanit Gordon, Yale University; Randi H. Bennett, Yale University; Brent C. Vander-Wyk, Yale University; James F. Leckman, Yale University; Ruth Feldman, Bar-Ilan University; Kevin A. Pelphrey, Yale University- Social dysfunction is a core deficit in individuals with Autism Spectrum Disorders (ASD) and yet the underlying neural mechanisms remain unclear. Novel avenues of translational research come from recent discoveries regarding the effects of the neuropeptide Oxytocin (OT) on a wide range of social behaviors in humans, especially increased sociability, empathy and theory-of-mind. Additionally, variations in the OT receptor gene (OXTR) have been linked to ASD in several studies. Considering the known social deficits in ASD, it is important to seek a deeper understanding of the mechanisms underlying OT's effects using functional magnetic resonance imaging (fMRI). This study aims to identify the impact of OT on

brain regions linked to social motivation, social perception, and social cognition. We hypothesize that on fMRI tasks requiring processing of social information, OT administration will result in increased activity in regions who play a key role in reward circuitry (such as the striatum, caudate and nucleus accumbens) as well as key nodes of the social brain (specifically, the anterior cingulate and prefrontal cortex, superior temporal sulcus, amygdale). We also expect increased connectivity between these brain regions due to OT's impact. We are currently performing a double blind, crossover, and randomized controlled study, in which 20 children and adolescents (ages 7-18) with ASD are randomly assigned to OT and placebo nasal sprays on two consecutive visits. After administration, we are testing participants' ability to detect biological motion and read others' emotions from the eye region using well-validated fMRI paradigms: Reading the Mind in the Eyes (RMET-R) and Biological Motion Detection. Preliminary results are indicating that in children and adolescents with ASD intranasal administration of OT results in enhanced activation of the Superior Temporal Sulcus (STS) region during perception of biological motion compared to placebo. When going through RMET-R, OT seems to improve the ability to accurately define and describe other's mental states as well as enhance brain activation in medial Prefrontal cortex, STS, temporal parietal gyrus and fusiform - all regions previously implicated in their involvement in social perception and cognition, mentalizing, and theory of mind abilities. These initial results are currently being expended, but they provide a very promising and exciting indicator of the neural mechanisms' underlying OT's impact on social perception and cognition in ASD. At IMFAR, final results will be presented and discussed. Should this study show that modulating OT levels can induce specific effects on brain functioning in tasks linked to the social world; it would be possible to explore novel more optimal treatment strategies in ASD.

G-33

EFFECTIVE CONNECTIVITY BETWEEN SUPERIOR TEMPORAL SULCUS AND NEOCEREBELLUM IS ASSOCIATED WITH SOCIAL FUNCTION IN YOUTH WITH AUTISM Allison Jack, University of Virginia; James P. Morris, University of Virginia- Autism spectrum disorders (ASDs) have been associated with a variety of social perceptual deficits, including in biological motion perception and imitation. Such deficits have, in turn, been linked to atypicalities in the superior temporal sulcus (STS), an important site for the processing of human actions. However, ASD symptomatology has also been related to neural connectivity deficits and to abnormalities across many brain sites, including the cerebellum. Having previously found that healthy typical adults show task-specific effective connectivity between the posterior STS and lobule VII of the neocerebellum during simple manual imitation and biological motion perception (Jack, Englander, & Morris, 2011), we hypothesized that this interaction might be disrupted in individuals with ASDs.

In particular, because connectivity between the STS and neocerebellum appeared to be related to efficient processing and relay of information about observed human actions, we predicted that the degree to which individuals with ASDs utilized this pathway during observation and imitation of others' movements would be related more broadly to their ability to understand and interact with others. To test this prediction, we collected fMRI scans from 13 youth (11 male) with ASDs while they completed a simple manual imitation task, as well as measures of IQ, theory of mind, communication skill, and social behavior. All youth were high-functioning and completed the imitation task accurately. Effective connectivity between the right STS and the left neocerebellum (specifically, Crus I), was strongly associated with a variety of measures (assessed both via parent report, in the Social Responsiveness Scale and Theory of Mind Inventory, and by a trained observer, in the Autism Diagnostic Observational Schedule) of social communication, reciprocal social interaction, and advanced theory of mind skill. Youth with more advanced theory of mind skills and more intact social and communicative functioning showed greater imitation-specific effective connectivity between STS and neocerebellum. These associations held after controlling for age, IQ, laterality, and for the overall intensity of activity in the right STS. These data suggest that that while the degree to which STS is recruited during social perceptual processes may indeed be an important predictor of social outcomes, it is not enough to assess localized activity to understand these processes; rather, evaluating the coherence of activity across multiple key regions is also a critical component of understanding deficits in social perception and behavior. In particular, communication between sites important for biological motion perception and often understudied neocerebellar regions may be important for social functioning. Exploring the degree to which individuals utilize these connections while executing basic social perceptual functions could potentially help to explain variability in presentation and in social outcomes among persons on the autism spectrum.

G-34

BASOLATERAL AMYGDALA CELL SUBTYPES MAY MEDIATE JUVENILE SOCIABILITY IN MOUSE MODELS Arati S. Kreibich, Perelman School of Medicine at Univ. Pennsylvania; Matthew Torre, Perelman School of Medicine at Univ. Pennsylvania; Ruben C. Gur, Perelman School of Medicine at Univ. Pennsylvania; Hongzhe. Li, Perelman School of Medicine at Univ. Pennsylvania; Ted Abel, University of Pennsylvania; Edward S. Brodtkin, Perelman School of Medicine at Univ. Pennsylvania- Reduced sociability starting in childhood is among the most disabling and treatment-refractory symptoms of autism spectrum disorders (ASD). Therefore, there is a strong need to better understand the neurobiology of juvenile sociability. Relative to C57BL/6J (B6) mice, BALB/cJ mice show low levels of sociability during prepubescence. To

elucidate the neural circuitry underlying sociability, we mapped Fos expression following social interaction in juvenile male B6 vs. BALB/cJ mice. We hypothesized that B6 and BALB/cJ mice would show differential activation of amygdala nuclei following social interactions. We compared Fos expression in amygdala nuclei among B6 and BALB/cJ mice exposed to a stimulus mouse in a social choice test (S) or not exposed to a stimulus mouse (NS). We also co-labeled Fos stained nuclei in BLA of B6 mice with either Parvalbumin (PV), a marker of GABAergic cells, or CaMKII, a marker of glutamatergic cells. Social exposure increased Fos staining in the basolateral amygdala (BLA) specifically in B6 mice, but not in BALB mice. In the BLA, the proportion of Fos cells co-labeled with CaMKII or PV cells was similar in B6 mice (S) when compared with B6 mice NS. Therefore, a circuit involving both glutamatergic and GABAergic BLA neurons is activated during social interaction. The BLA mediates salience and emotional valence of external stimuli, and its output includes brain regions regulating motivation, reward and motor output. Further elucidation of underlying BLA mechanisms may lead to novel approaches for rescuing sociability in ASD.

G-35

YOUTH WITH DISRUPTIVE BEHAVIOR DISORDERS AND CALLOUS-UNEMOTIONAL TRAITS SHOW IMPAIRED NEURAL REPRESENTATION OF EXPECTED VALUE

Stuart F. White, National Institute of Mental Health, NIH; Katherine A. Fowler, National Institute of Mental Health, NIH; Stephen Sinclair, National Institute of Mental Health, NIH; Daniel S. Pine, National Institute of Mental Health, NIH; R.J.R. Blair, National Institute of Mental Health, NIH- Background: In previous work, we have shown that youth with Disruptive Behavior Disorders (DBD: Conduct Disorder and Oppositional Defiant Disorder) and callous-unemotional (CU: reduced guilt and empathy) traits show impaired decision-making that is coupled with dysfunctional responding within the amygdala and orbitofrontal cortex (OFC; Finger et al., 2008). However, this work has not distinguished between dysfunction during decision-making vs. feedback, nor has it examined decision-making with respect to environmental reinforcements (e.g., appetitive stimuli, physical threats, or contamination threats). Methods: Using a novel affective decision-making paradigm, fMRIs were conducted on 15 youth with DBD+CU and 15 matched controls. Results: Regions showing a diagnosis by choice by emotion interaction included right orbital frontal cortex, right middle frontal gyrus, two areas in the right insula, left cingulate cortex, left caudate and thalamus. When making poor decisions (choosing to open disgust/threat doors, choosing not to open positive doors), healthy controls showed increased activation relative to DBD+CU youth. Contrary to predictions, dysfunction during feedback was not observed. Conclusions: Youth with DBD+CU traits do not appear to be generating the same warning signaling that the healthy youth do when choosing to make poor decisions. These

data support previous suggestions that the neural representation of expected value is disrupted in youth with DBD+CU.

G-36

YOUTH WITH CONDUCT DISORDER AND CALLOUS-UNEMOTIONAL TRAITS SHOW HIGHLY ATYPICAL PREDICTION ERROR SIGNALING IN CAUDATE AND ORBITAL FRONTAL CORTEX

W. Craig Williams, National Institute of Mental Health, NIH; Stuart F. White, National Institute of Mental Health, NIH; Kayla Pope, National Institute of Mental Health, NIH; Stephen Sinclair, National Institute of Mental Health, NIH; Christopher Adalio, National Institute of Mental Health, NIH; Daniel S. Pine, National Institute of Mental Health, NIH; R.J.R. Blair, National Institute of Mental Health, NIH- Background: Previous research has associated abnormalities in reversal learning and reinforcement signaling in youth with Conduct Disorder and callous-unemotional traits (CD+CU) with atypical orbital frontal cortex (OFC) and caudate responsivity (Finger et al., 2008; 2011). However, previous work with this population has not disentangled BOLD responses during decision making as opposed to feedback. As such it remains unclear whether patients with CD+CU show atypical reinforcement expectancy guided decision making or impairments in prediction error signaling or both. The present study addressed this issue. Methods: 20 CD+CU youth and 24 healthy comparison youth completed a passive avoidance task while undergoing fMRI. Cue regressors were weighted by expected value (the degree to which the cue predicted reward/ punishment). Feedback regressors were weighted by prediction error (the degree to which the feedback received corresponded to expected value). Results: A 2 (CD+CU vs. control) x 2 (weighted reward vs. punishment) ANOVA conducted on the BOLD responses to feedback revealed significant interactions within the amygdala, OFC, caudate and posterior cingulate cortex (PCC). Within these regions, healthy individuals showed typical positive prediction errors (increased activity) to unexpected rewards and negative prediction errors (decreased activity) to unexpected punishments. Youth with CD+CU showed a significantly different pattern with atypically increased responses to unexpected punishments. Conclusions: These findings support previous evidence for atypical amygdala, OFC and caudate activity in patients with CD+CU. Importantly, these data suggest that rather than showing simply reduced prediction error signaling relative to comparison youth, as had been previously suggested, youth with CD+CU may be showing a very atypical prediction error signaling with augmented activity to unexpected punishment.

G-37

EARLY DISTURBED CAREGIVING, AMYGDALA REACTIVITY AND COGNITIVE ENGAGEMENT IN ADULTHOOD: RESULTS FROM A 20- YEAR PROSPECTIVE STUDY

Pia Pechtel, Harvard Medical

School; Carl Andersen, Harvard Medical School; Martin H. Teicher, Harvard Medical School; Karlen Lyons-Ruth, Harvard Medical School- According to the US Health and Human Services Department, 3.7 million children were investigated by Child Protective Services in 2008, with 25% under the age of 2 and a majority experiencing parental neglect. Research has indicated that such disturbed care early in life is a significant risk factor for subsequent affective disorders and amygdala hyperreactivity. However, retrospective studies have limited capacity to characterize the type and timing of adversity during the earliest years of life. To address this methodological limitation, the current study administered an Amygdala Reactivity Paradigm (Hariri, 2009) to participants recruited from a 20-year prospective study of infants at social risk, whose aim was to investigate the long-term sequelae of disturbed early care. At the age of 18 months, comprehensive family risk assessments were conducted of the quality of infant care, including videotaped observations of the degree of disturbance in parent-infant interactions. Half of the participants were referred for clinical services because of the degree of caregiving disturbance. Participants were also assessed at later developmental periods. In the present wave of assessment, 16 adults who experienced early disturbed caregiving at 18 months of life (EDC; 11 female, 5 male, Mage= 29.3yrs) and 21 adults without childhood adversity (14 female, 7 male, Mage=23.4yrs) participated in the Amygdala Reactivity Paradigm consisting of 13 blocks of geometrical shapes or emotional facial expressions (anger, threat, neutral). The goal of the task is to match two different stimuli to a target face on the top of the screen. Reaction time and accuracy were used as behavioral indices of emotion reactivity. Based on previous research, we hypothesized that, relative to controls, adults who experienced EDC would show heightened emotion reactivity indexed by (1) higher number of errors, (2) shorter reaction times, and (3) increased amygdala activation in response to negative faces compared to neutral faces or shapes. Whole-brain contrasts focused on responses to negative faces compared to neutral faces or shapes between EDC and controls. Region-of-interest analyses tested amygdala activation in response to negative faces compared to neutral faces and shapes between the groups. Results indicated that, compared to controls, individuals who experienced EDC committed significantly more errors when matching negative faces than neutral faces or shapes, and showed faster reaction times in matching faces compared to shapes. In contrast to hypotheses, both groups showed similar activation in the amygdala when contrasting negative faces to neutral faces or shapes. However, in cortical regions implicated in cognitive control and sustained attention (e.g., superior frontal gyrus), controls showed significantly greater signal increases in response to negative faces relative to shapes than did the EDC group. The pattern of findings suggests that, by adulthood, amygdala hyperreactivity associated with early life adversity (e.g. Tottenham et al., 2011) may be affected by the development of

compensatory attention strategies that involve disengaging from the task during trials containing arousing stimuli but not during trials containing neutral information.

G-38

ABNORMAL SOCIAL PAIN PROCESSING IN CHILDREN WITH EARLY SEPARATION EXPERIENCES – A FMRI STUDY WITH CHILDREN IN CARE

Vanessa Puetz, Aachen University; Nils Kohn, Aachen University, JARA Translational Brain Medicine, Aachen & Jülich; Beate Herpertz-Dahlmann, Aachen University, JARA Translational Brain Medicine, Aachen & Jülich; Kerstin Konrad, Aachen University, JARA Translational Brain Medicine, Aachen & Jülich- Introduction: Early separation experiences can disrupt the child's attachment process and interfere with the psychosocial development of an infant. The current study therefore aims to investigate the neural mechanisms by which attachment to and early separation from the primary caregiver influences structural and functional brain development in children. Specifically, early separation experiences are hypothesized to render these children more susceptible to social exclusion and rejection, as reflected in differential activation of the social-pain network including fronto-limbic structures (anterior cingulate, mPFC and hippocampus). Methods: 25 children that grew up with their biological parents (mean age 10.38 ± 1.7 ; mean IQ= 104.52 ± 9.3) and 23 children with an early parental separation experience (mean age 10.4 ± 1.82 ; mean IQ= 103.17 ± 9.3 ; mean age of separation= $1.5 \text{ years} \pm 1.07$) underwent a social-exclusion paradigm (Virtual ball tossing game 'CyberBall', Williams et al., 2000) in an 3T-MRI scanner to investigate the neural correlates of social exclusion. Data-analysis was conducted with SPM8. To test for differential activation in response to social pain (social exclusion condition vs. non-social exclusion condition) whole-brain analyses were carried out ($p .05$, Monte Carlo corrected). For a-priori anatomical and functional region-of-interests (ROIs), small volume corrections were applied across each respective region ($p < 0.05$, voxel-level FWE-correction). fMRI results: The comparison between exclusion due to social reasons vs. non-social reasons in control subjects revealed strong neural activation in the ACC, left and right insula and rmPFC, replicating previous research on social pain. Further analysis revealed greater activation in the ACC and superior frontal cortex in the control group compared to the early-separation (ES) group in response to social pain. A significant interaction between condition x group was found in the superior temporal sulcus (STS) and tempo-parietal junction (TPJ), which were active during the Social Pain condition only in the ES group. ROI-analysis revealed differences in neural activation between groups also in the right hippocampus. These differences were due to increased neural activation during Social Pain in the ES group. Conclusion: Preliminary analysis of the fMRI data revealed robust differences in neural activation in response to social exclusion between the groups. In line with previous research, the typical "pain matrix"

consisting of the ACC, left and right insulae and rmPFC was active in our control children. Interestingly, activation in the ACC, which has been implicated in signalling situations that require cognitive control was absent in the ES group, suggesting an abnormal pain response when facing ostracism. Rather, when facing social threat children with ES experience activated brain areas that are involved in mentalizing, theory of mind and action understanding (STS/TPJ), as well as episodic memory (hippocampus). These results suggest abnormal social brain functioning in children with an early parental separation experience that could be mediated by impaired PFC-regulation, confirming our hypothesis that early separation has a long-lasting effect on children's brain activation in social situations.

G-39

NEURAL RESPONSES TO MATERNAL CRITICISM IN HEALTHY YOUTH: IT'S BETTER IF YOU DON'T REALLY LISTEN

Kyung Hwa Lee, University of Pittsburgh School of Medicine; Jennifer S. Silk, University of Pittsburgh School of Medicine; Ronald E. Dahl, University of California, Berkeley; Greg J. Siegle, University of Pittsburgh School of Medicine- Maternal criticism is an important factor in emotional and social development during childhood and adolescence that is characterized by increased parent-child conflict (Steinberg, 2005). Children and adolescents show heightened emotional reactivity in social contexts and often have difficulty regulating these emotions (Steinberg, 2006; Dahl, 2004). Imaging studies demonstrate that such heightened reactivity is associated with greater activity in emotion brain networks in the contexts of face processing and peer relationships (Burnett et al., 2011). However, despite the ubiquity of maternal criticism and its association with vulnerability to disorders such as depression (Hooley et al, 2004; Sheeber et al., 2001), relatively little is known about neural mechanisms associated with maternal criticism in youth. Understanding these mechanisms could suggest pathways from maternal criticism to psychopathologies associated with expressed emotion such as depression. We hypothesized that youth would show increased activity to maternal criticism in brain regions not only involved in processing social and emotional information but also emotion regulation. To examine neural responses to maternal criticism in ecological social contexts, we adapted an experimental paradigm previously used with adults (Hooley, et al., 2009). Twenty-five healthy children and adolescents with no axis I disorder (18 female, age 9-17) were scanned while they listened to their own mothers' critical, praise, and neutral remarks. Each mother was asked to produce two 30 second audio clips describing things that bother her about her child, two 30 second audio clips describing things that she especially likes about her child and two 30 second neutral clips. Participants reported more intense negative emotions to their own mother's criticism than neutral remarks. Significant condition (criticism vs. neutral)-by-time (i.e., scans within trials of a given condition) interactions were

identified in emotional and social brain networks all suggesting increased reactions to maternal criticism compared to neutral statements, including the anterior insula (AI; involved in perception and evaluation of emotional information), medial prefrontal cortex (MPFC; involved in social information processing, associating emotional information with the self, and emotion regulation), and dorsolateral PFC (DLPFC; involved in executive control and initiation of emotion regulation) ($p < .001$, 21 voxels contiguity). There were no activation differences in the same brain regions between praise and neutral remarks. These results provided evidence that maternal criticism provoked increased/sustained activity in brain regions associated with not only social and emotional information processing but regulation. This present study suggests that it is normal to show negative reactivity to maternal criticism and regulate it in healthy youth. Possibly not fully internalizing critical comments from one's parents as one way to regulate reactivity to criticism is a critical feature of healthy development. More vulnerable youth may fail to regulate their responses, effectively taking their parents comments too much to heart.

G-40

INTERACTIONS BETWEEN RISK TAKING, SOCIAL EXCLUSION, AND PEER INFLUENCE IN ADOLESCENCE: AN FMRI STUDY

Shannon J. Peake, Department of Psychology, University of Oregon; Tom J. Dishion, Child & Family Center, University of Oregon, Department of Psychology, Arizona State University; Beth A. Stormshak, Child & Family Center, Department of Counseling Psychology, University of Oregon; Jennifer H. Pfeifer, Department of Psychology, University of Oregon- Risk behavior is known to peak in adolescence, resulting in negative outcomes for teens from activities including substance use, unsafe sex, careless driving, smoking, and antisocial behavior. Most of the time, adolescents engage in these risky activities in social contexts with peers. The increased importance of peer acceptance versus social exclusion during adolescence may, therefore, play a prominent role in decision-making in social contexts. While previous neuroimaging studies have identified brain regions involved in social exclusion and risk taking separately, the effect of social exclusion on subsequent risk decisions remains unclear. This study investigated neural activation in adolescents during risk taking in a social context, before and after an episode of social exclusion by peers. Twenty-six adolescents (14-16 years old) completed two computerized tasks in one fMRI session. The Stoplight task (Gardner and Steinberg, 2005) measured risk-taking as participants played a driving game in the presence of two hypothetical peers (implied to be watching the participant via the Internet). Next, subjects completed the Cyberball task (Williams, Cheung, and Choi, 2000), which creates the subjective experience of social exclusion via a ball-toss game in which the participant played with the same two implied peers. Afterward, participants played the Stoplight task again while their performance was

ostensibly being watched by the same peers that just excluded them during the Cyberball task. Participants also completed a several self-report measure that assessed resistance to peer influence. Changes in risk taking following social exclusion were negatively correlated with resistance to peer influence ($r(22) = -.44, p < .05$). In other words, teens that had less resistance to peer influence took significantly more risks after being socially excluded. This study focused specifically on decision-making processes in the two rounds of Stoplight only, one “before” and one “after” social exclusion. Using SPM8, we modeled “decisions” (choosing to go or stop at yellow lights) and “feedback” (finding out if they crashed or safely crossed the intersection). During Stop decisions after social exclusion, greater neural responses were found in medial orbitofrontal cortex and medial posterior cingulate cortex – areas associated with reward valuation and social cognition. During Crash feedback after social exclusion, greater responses were also found in subgenual anterior cingulate cortex and ventrolateral prefrontal cortex, regions associated with negative affect related to social pain and self-regulation. Resistance to peer influence was negatively correlated to right temporoparietal junction (rTPJ) during Go compared to Stop decisions after social exclusion – an area associated with mentalizing, or thinking about what other people are thinking. After being socially excluded, teens with lower resistance to peer influence showed more activation in the right TPJ region, when deciding to Go instead of Stop. Results suggest that after social exclusion, teens that are more susceptible to peer influence take more risks and place more value on performance while peers are watching – including feeling more social pain when their performance is low. Further, these teens may devote more effort to controlling their feelings and to thinking about what peers are thinking while making risk decisions.

G-41 ★

NEURAL TRAFFIC SIGNALS DRIVE BEHAVIOR: ADOLESCENTS' RISKY DECISION-MAKING IN AN FMRI DRIVING SIMULATION

Lauren E. Kahn, University of Oregon; Shannon P. Peake, University of Oregon; Beth Stormshak, University of Oregon; Tom Dishion, Arizona State University; Jennifer H. Pfeifer, University of Oregon- During adolescence, teenagers are faced with many decisions involving risk. These choices often include a trade-off between a risky option involving immediate or more reward, versus a safer option involving delayed or less reward. Although paradigms using monetary incentives accurately model this type of trade-off, the actual risky decisions made by adolescents have very different outcomes, many of which can be life-altering even after a single bad decision (e.g., having unprotected sex, speeding through a red light, or drinking and driving). The present study was designed to assess decision-making and feedback processing in a situation that more closely modeled those which adolescents face every day. Participants ($N = 27$, ages 14-16 years)

underwent fMRI while playing a driving game known as the “Stoplight Task” (Gardner & Steinberg, 2005). The goal is to reach the destination as fast as possible. As each stoplight turns yellow, participants must decide whether to stop or go. Stops result in a 3-sec delay. Choosing to go through the light may result in no delay, but may also result in crashing and a 6-sec delay (as well as experiencing a startling simulation of a car crash). Adolescents completed five distinct games, each consisting of ten stoplights. Using SPM8, we modeled neural activity at yellow lights (representing the onset of the decision-making period) according to the decision ultimately made at that intersection: “go” or “stop.” We also modeled responses to feedback immediately following the intersection: “crash” or “safe crossing” (no crash). Ventral striatum (VS) showed more activation preceding “go” versus “stop” decisions, whereas activation in the right inferior frontal gyrus (rIFG) was greater preceding “stop” versus “go” decisions. In addition, the magnitude of VS activity during “go” decisions was positively correlated with self-reported sensation-seeking (SSS-V; Zuckerman, Eysenck, & Eysenck, 1978). This suggests neural responses during decision-making, observed in regions associated with reward processing and prediction error, contribute to individual differences in factors affiliated with adolescents’ tendencies to engage in actual risky behavior in their everyday lives. Finally, we observed changes as a function of playing the game over time (entered as a parametric modulator in the single subject models). Both decision-related and feedback-related activation changed as a function of time. Specifically, as the games progressed, “go” decisions were associated with decreasing activity in the rIFG, and “safe crossings” were associated with increasing caudate and thalamus activity. In other words, during decision-making periods in early games, adolescents tended to exhibit a mixture of VS and rIFG activity, perhaps reflecting indecision between taking a risk or playing it safe. The observed refinement of responses, to more sharply distinguish between “stop” and “go” decisions, may suggest that adolescents became progressively more decisive as they played the five games, perhaps related to the increase in response to positive feedback. These changes support the idea that both rewarding and regulatory influences on decision-making processes crystallize as adolescents learn about risk-reward trade-offs.

G-42

NEURAL CORRELATES OF SOCIAL PAIN PREDICT CHANGES IN DRIVING RISK IN THE PRESENCE OF PEERS

Christopher N. Cascio, University of Michigan; Matthew O'Donnell, University of Michigan; Joshua Carp, University of Michigan; Francis Tinney, University of Michigan; Ray Bingham, University of Michigan; Jean Shope, University of Michigan; Marie-Claude Oimet, NICHD, Université de Sherbrooke; Anuj Pradhan, NICHD; Bruce Simons-Morton, NICHD; Emily B. Falk, University of Michigan- Motor vehicle crashes are the leading cause of

death in adolescents. This phenomenon is not explained solely by inexperience of teen drivers; teens are at normal risk when driving in the presence of an adult, and at substantially increased risk when driving in the presence of peers. Understanding the factors that lead teens to be more susceptible to peer influence in the driving context both addresses a key question of social development, and may also aid in creating interventions that reduce teen driving fatalities. The present study used a brain-as-predictor approach to examine whether activity in neural regions associated with emotion processing during social exclusion can predict future increases in driving risk in the presence of a peer. More specifically, 42 newly licensed male drivers, aged 16-17, were recruited to participate in a two part study, consisting of an initial neuroimaging session, followed one week later by a driving simulator session. During the fMRI session participants completed a well-validated social exclusion task, Cyberball, in which participants are excluded, ostensibly by two other players. In addition to neuroimaging data, self-report measures of susceptibility to peer pressure and self-reported distress in response to the exclusion were gathered. One week following, participants took part in the driving simulator portion of the study, completing drives in a state-of-the-art, full-cab driving simulator, alone and in the presence of either a risky or safe confederate. We found that neural activity in one hypothesized, anatomically defined region associated with emotion regulation -- rostral anterior cingulate cortex (rACC), significantly predicted increased risk-taking between alone and peer drives. Neural activity in this region predicted change in risk behavior above and beyond the amount of behavior change explained by the behavior of the confederate (risky versus safe), driving order, self-reports of susceptibility to peer pressure, and self-reported feelings of distress following exclusion. Additionally, hypothesized regions associated with social pain in adolescents (subgenual cingulate, anterior insula) significantly predicted increased risk-taking in the presence of peers. The present study demonstrates that neural activity in regions associated with social pain predicts adolescent behavior change in the presence of peers, beyond what is explained by self-reports of susceptibility to peer pressure and other factors. These results suggest that adolescents most responsive to social exclusion are more likely to alter their normal behavior in the presence of peers. More generally, these findings also demonstrate and extend the beneficial use of examining neural mechanisms in order to understand real world behaviors.

G-43

PROCESSING EMOTIONS ACROSS THE LIFE SPAN: INVESTIGATING LATERALIZATION AND DYNAMIC EXPRESSIONS *Ishabel M. Vicaria, University of Miami; Dr. Thomas H. Bak, The University of Edinburgh; Dr. Sarah E. MacPherson, The University of Edinburgh-* The ability to perceive emotions is an enduring human trait that facilitates social interaction throughout the life span. Due to the three-dimensional quality of authentic

communication, dynamic portrayals of emotions are a more ecologically valid tool for research settings. However, the majority of studies have used static portrayals of emotion instead. Moreover, the human brain itself may be organized in a unique manner to process emotion; this organization has been particularly examined in terms of the lateralization of functions amongst the left and right hemispheres of the brain. Furthermore, recent findings in neuroscience revealing that the human brain undergoes significant age-related changes in anatomy and physiology suggest that a reorganization of strategies and activation patterns may underlie some basic cognitive functions, including emotion perception. The current study investigated two fields of emotion research in a cognitive aging context, namely the identification of emotions from body movements and the hemispheric lateralization of emotion perception. In Experiment 1, 50 participants (25 younger and 25 older adults) were presented with emotion stimuli depicting anger, disgust, fear, happiness, and sadness portrayed by actors in grey full body suits with the facial features and expressions masked. All participants viewed videos of the actors portraying these emotions through body movements (e.g. advancing forward and shaking fists in anger), and static images which were captured from the videos. After each stimulus presentation, participants indicated which emotion they thought was represented. The results revealed a significant main effect for presentation type (static vs. dynamic) and age (younger vs. older), and a significant interaction between emotion and presentation type. Post-hoc analyses revealed that each of the emotions was significantly more accurately recognized from dynamic than static presentations across age groups. In Experiment 2 we investigated hemispheric specialization for identifying dynamically expressed emotions. The same 50 participants viewed the video stimuli again, which were randomly presented to either the right or left visual fields while participants maintained gaze on a central fixation point. Participants then selected which emotion had been presented. The results demonstrated a significant main effect of hemisphere, indicating that participants across both age groups correctly identified more emotions when they were presented to the left visual field (i.e. right hemisphere). Overall, the current study suggests that although emotion perception abilities generally decline with age, the advantage for recognizing emotion from dynamic than static stimuli is an enduring ability throughout the life span. Furthermore, the results support the idea that right hemispheric superiority for emotion processing remains constant with age.

G-44 ★

EMOTIONAL AWARENESS ACROSS DEVELOPMENT: DORSAL ANTERIOR CINGULATE CORTEX MEDIATES THE RELATIONSHIP BETWEEN AGE AND TRAIT ALEXITHYMIA *Jocelyn Shu, Columbia University; Jennifer A. Silvers, Columbia University; Jiahe Zhang, Columbia University; Jochen Weber, Columbia*

University; Kevin N. Ochsner, Columbia University- Alexithymia is a trait characterized by difficulty identifying and expressing one's emotions. In adult populations, alexithymia has been associated with a multitude of disorders, including autism and depression. The prevalence of this trait amongst clinical populations points to the importance of understanding how emotional awareness develops across the life span. While prior research has demonstrated age-related increases in knowledge and understanding of one's emotions, no work has yet investigated the underlying neural mechanisms that may be supporting these changes across development. The present study sought to fill this gap in the literature by scanning 44 participants ranging from 10-22 years of age ($M = 16.09$, $SD = 3.77$) on a task that involved taking an immersed perspective while looking at aversive and neutral images and rating one's emotional experience. Emotional awareness was assessed in participants by administering the adult version of the Toronto Alexithymia Scale to participants 15 years and older and the children's version of the scale to participants 14 years and younger. Age was negatively correlated with trait alexithymia scores, suggesting that alexithymia decreases with maturation. Across all ages, aversive picture stimuli recruited dorsal anterior cingulate cortex (dACC), a brain region believed to support emotional awareness, to a greater degree than did neutral stimuli. A single-level mediation analysis further revealed that dACC activity increased with age and, when controlling for age, predicted less trait alexithymia. These results suggest that dACC may be involved in facilitating enhanced emotional awareness as one transitions from childhood to adulthood.

G-45

EVIDENCE FOR DEVELOPMENTAL CHANGE IN AMYGDALA RESPONSE TO MASKED EMOTIONAL EYE-WHITES AND EYE-BLACKS Angela Tseng, New York State Psychiatric Institute, Columbia University; Kathleen M. Thomas, University of Minnesota- Existing adult human and animal literature has specified the amygdala's participation in the decoding of facial expressions and thus, emotional face stimuli has been consistently employed as an efficacious probe of amygdala activity. Yet, there is a dearth in the understanding of the development of the ability to readily recognize and interpret faces and facial expressions of emotion. There is a basic consensus that face recognition accuracy improves from childhood to adulthood but less accord on the particular components of face recognition that alter with development. Prior research in adults has also shown that the amygdala is activated not only by the eye components of an emotional face (Morris et al., 2002) but also low-level perceptual features such as eye-whites (sclera) (Whalen et al., 2004). In particular, Whalen and colleagues (2004) showed that the amygdala is more responsive to masked fearful eye-whites than to masked happy eye-whites. However, it is unclear whether this effect develops with experience or if it is present from birth. In the present

study, 32 8-year-old children were presented with backward masked fearful and happy eye-whites and eye-blacks while brain activity was measured by functional magnetic resonance imaging (fMRI). Contrary to adult findings, results did not show amygdala modulation by emotional eye-whites or eye-blacks in child participants. However, other brain areas (bilateral visual cortex, left thalamus, the left insula, the anterior cingulate, left orbitofrontal cortex) showed differentiation by emotion, indicating that the eye-white and eye-black probes were being processed despite lack of explicit awareness of these stimuli. These findings not only identify brain regions that are selectively activated by these stimuli in children but they also indicate changes in the fast amygdala pathway tapped by backward-masking paradigms. It is posited that these changes are associated with the development of children's processing of face emotion and spatial frequency information.

G-46

PRETTY, POPULAR, SMART? UNIQUE NEURAL ACTIVATION WHEN COMPARING EARLY ADOLESCENT AND ADULT APPRAISALS OF SELF AND OTHER Kathryn F. Jankowski; Junaid S. Merchant; William E. Moore; Lauren E. Kahn; Jennifer H. Pfeifer- Previous research on the neural substrates of self-processing has primarily focused on adult samples, yet few studies have investigated the developmental trajectory from adolescence to adulthood. Given the major changes in brain structure development, perspective-taking abilities, peer social interaction, and self-concept refinement, it is expected that the neural mechanisms underlying self-processing change during this transition. While past studies have primarily capitalized on psychological traits, developmental research shows that physical self-appraisals are the single strongest predictor of adolescent global self-worth (Harter, 1999), suggesting the important contribution of using physical traits to explore adolescent self-processing. The current study investigated the differential neural correlates for making direct self-appraisals, reflected self-appraisals, and direct-other appraisals across development, and is the first study to use both psychological and physical traits within a developmental sample. In a mixed design, fMRI task, 19 young adults ($M = 25.7$, 9 males) and 18 early adolescents ($M = 12.44$ years, 10 males) read short phrases describing academic, physical, and social traits and evaluated if the phrase accurately described oneself (from one's own perspective or from one's best friend's perspective), one's best friend, or traits that, in general, could change (control condition). While previous studies typically use political figures as "other" targets and semantic control tasks (such as counting syllables), this study includes a personally-relevant, close peer for multiple appraisal conditions, and an evaluative control task. Data were preprocessed and analyzed in FSL, SPM, and NeuroElf. At the fixed effects level, reaction time was included as a parametric modulator, and motion parameters and scans characterized by significant artifacts were included as

nuisance regressors. At the random effects level, a 2 (age group) \times 4 (target) \times 3 (domain) repeated measures ANOVA was conducted. Parameter estimates were extracted using MarsBaR based on functionally-defined regions of interest from the current study, as well as independent regions of interest typically recruited during self-appraisal tasks (Dodell-Feder, Koster-Hale, Bedny, & Saxe, 2011). Results demonstrated that neural activity within cortical midline structures was influenced by target type, converging with previous research (Pfeifer et al., 2009; Ochsner et al., 2005), as well as varied by age group and trait domain.

G-47

LONGITUDINAL CHANGES IN BRAIN CONNECTIVITY BETWEEN CHILDHOOD AND EARLY ADOLESCENCE DURING APPRAISALS OF SELF AND OTHER

Kim Veroude, VU University Amsterdam; Mirella Dapretto, University of California, Los Angeles; Matthew D. Lieberman, University of California, Los Angeles; Jennifer H. Pfeifer, University of Oregon- The transitional period from childhood to adolescence is a developmental phase during which self-concepts become more differentiated and peer relations become more important. Research in adults demonstrates that the anterior rostral medial prefrontal cortex (rmPFC; including rostral anterior cingulate cortex, rACC) is relatively more engaged when thinking about self than others. Meanwhile, the medial posterior parietal cortex (mPPC) is frequently more engaged when thinking about others than self (Qin et al., 2012). Compared to adults, children and adolescents show stronger activation of the mPFC (including both anterior rostral and dorsal aspects) during self-appraisals (Pfeifer et al., 2007, 2009). In addition, adults typically show stronger activation of dorsomedial prefrontal cortex (dmPFC) during other-appraisals, also in comparison to children. In this study, we were interested in task-dependent functional connectivity during appraisals of self and other, specifically how this changed over time as children transitioned into early adolescence. Twenty-seven children (18 girls, 9 boys) participated in this longitudinal fMRI study. They performed an appraisal task in the fMRI scanner at 10 (T1) and 13 (T2) years of age. During this task, short phrases from the social domain (e.g. 'I have many friends') or the academic domain (e.g. 'I like going to the library') were presented. Participants indicated by button press whether the phrases described the Self or a familiar fictional Other (Harry Potter). We conducted Psychophysiological Interaction (PPI) analyses in SPM8 to investigate differences in brain connectivity for appraisals of Self and Other, as they changed over development. Seed regions of interest were derived from the main effect of target (Self and Other) across T1 and T2 (Pfeifer et al., in prep). These areas were differentially activated for Self and Other, across timepoints, and included the ventral striatum, the rACC and a region of mPPC/retrosplenial cortex (RSC). Timecourses from those regions were extracted and convolved with the experimental factors Self

and Other for T1 and T2. Neither ventral striatum nor rACC displayed an interaction effect between target (Self versus Other) and age (T1 versus T2). However, in the mPPC/RSC there was a significant interaction between target and age, in three regions: two clusters in dmPFC and one cluster in a more anterior region of posterior cingulate than the mPPC/RSC seed region (uncorrected, $p < 0.005$, $k > 20$). Analyses conducted to interrogate this interaction effect indicated that connectivity in all three regions was stronger for Self than Other at T1 (age 10), but reversed by T2 (age 13). Greater connectivity between mPPC/RSC and dmPFC during appraisals of Other than Self in adolescence may ultimately be related to the development of a more mature pattern of responses in dmPFC (typically greater during other- than self-appraisals in adults). Additionally, the longitudinal increase in connectivity between the two posterior midline regions was correlated with an increase in knowledge about Harry Potter. Together, our results suggest that there are important differences in brain connectivity supporting appraisals of self and other between childhood and early adolescence.

G-48 ★

NEURAL CORRELATES UNDERLYING COGNITIVE REGULATION OF APPETITIVE RESPONSES TO FOOD ACROSS DEVELOPMENT

Catherine Insel, Columbia University; Jennifer A. Silvers, Columbia University; Natalie Porter, Columbia University; Jocelyn Shu, Columbia University; Alisa Powers, Weill Cornell Medical College; Natasha Mehta, Weill Cornell Medical College; B. J. Casey, Weill Cornell Medical College; Walter Mischel, Columbia University; Kevin N. Ochsner, Columbia University- Behavioral and neuroimaging experiments have suggested that children and adolescents show exaggerated responses to appetitive cues, and those prone to obesity exhibit higher reactivity to images of caloric food. However, no prior work has examined how the ability to regulate cravings for unhealthy food changes across development. In the present two studies, we examined the neural and behavioral bases of emotion regulation of appetitive impulses in children and adolescents using a food reappraisal task. These studies included a pilot behavioral study ($n=15$, ages 7-22) and a functional magnetic resonance imaging (fMRI) study ($n=10$, ages 6-18). In both studies, participants were trained to use two different strategies while looking at pictures of appetizing foods. On "Close" trials, participants imagined that the food they saw was directly in front of them and focused on its appetitive features (e.g., taste, smell). On "Far" trials, participants imagined that the food was further away and focused less on its appetitive features and more on its basic visual features (e.g., color, shape). After viewing the stimulus while applying the instructed strategy, participants made a rating on a 1-5 scale to indicate how much they wanted to eat the food that they had just viewed. Results of the pilot study confirmed our hypotheses that 1) across all participants, Far trials were

associated with less self-reported craving than Close trials ($p=0.02$), and 2) older individuals were better at regulating craving impulses through the use of cognitive strategies (age positively correlated with the percent decrease in craving observed on Far trials in comparison to Close trials, $p=0.008$). Behavioral results from the fMRI study have shown that again, participants report less craving on Far trials than Close trials ($p=0.04$). Neuroimaging results reveal that decreased amygdala response in the Close condition as compared to the Far condition is associated with improved reappraisal success. Taken together, these findings suggest a potential mechanism for the development of effective appetitive regulation.

G-49

PIECE OF CAKE: COGNITIVE REAPPRAISAL OF FOOD REWARDS *Nicole Giuliani, University of Oregon; Rebecca Calcott, University of Oregon; Elliot Berkman, University of Oregon-* A common emotion regulation strategy, cognitive reappraisal, involves altering the meaning of a situation so that the emotional response to the situation is changed. Most of the research on reappraisal has focused on the down-regulation of negative emotion; few studies exist on the reappraisal of positive emotion. Furthermore, no studies have yet examined the cognitive reappraisal of primary rewards such as that associated with approaching craved high fat, high calorie foods. In the present study we developed a new event-related paradigm with which to examine the neural underpinnings of this form of cognitive reappraisal. The paradigm consisted of three picture types: neutral (images of vegetables piloted to be rated as not very desirable), idiosyncratically craved high fat/calorie foods, and matched, not-craved high fat/calorie foods. The foods included in the latter two categories were chosen by each subject from a list of seven categories (chocolate, cookies, donuts, French fries, ice cream, creamy pastas, and pizza) matched for mean desirability by a pilot sample (pair-wise t-tests all $p > .05$). Subjects were instructed either to look at the stimulus or to reappraise the stimulus so as to make them want to eat the food less. Subjects were trained extensively in reappraisal strategies, all of which were applicable to real-world food situations (e.g. negative consequences of eating the food (weight gain, upset stomach), imagining that the food had been dropped on the floor or was touched by someone with unclean hands). There were 20 trials for each condition (look neutral, look crave, look no crave, regulate crave, regulate no crave). Each trial began with a 2s instruction cue, followed by a 5s presentation of the picture, 4s to rate food desirability on a 5-point Likert scale, and a 2s fixation period. A sample of undergraduate students at the University of Oregon ($N = 33$, 10 male, mean age 20.6) performed the task. A repeated-measures ANOVA found a significant main effect of picture type ($F = 131.1$, $p < .001$) and instruction ($F = 125.4$, $p < .001$), as well as a significant picture type \times instruction interaction ($F = 71.9$, $p < .001$). Pairwise t-tests confirmed that the reappraisal instructions did indeed significantly reduce

self-reported desirability of both craved and not craved foods ($ps < .001$). In addition, reappraised craved foods were not significantly different than passively viewed not-craved foods ($p = .23$). Neuroimaging results of a scanner-compatible version of this task will be discussed.

G-50

NEUROIMAGING OF THE REGULATION OF CRAVING IN COCAINE-DEPENDENCE

Cameron M. DeLeone, Yale University School of Medicine; Dan Marino, Yale University School of Medicine; Kathleen M. Carroll, Yale University School of Medicine; Hedy Kober, Yale University School of Medicine- Cocaine is an illicit drug commonly abused in the United States: in 2009, 787,000 individuals reported seeking treatment for cocaine abuse or dependence (SAMHSA, 2010). Unfortunately, long-term abstinence is not achieved by the majority of those that enter treatment (Knapp et al., 2007). Drugs users frequently cite craving as the cause of drug use and relapse. Consistently, previous research has demonstrated that craving predicts treatment outcomes (e.g., Rohsenow et al., 2007). Given the central role of craving in cocaine use, Cognitive Behavioral Therapy (CBT), which is one of the most effective therapies available, includes a regulation of craving component. In contrast, it is a commonly held view that substance-dependent individuals have a brain-based deficit in inhibitory control and regulation (e.g., Jentsch & Taylor, 1999; Volkow et al., 2004). We have previously shown that cigarette smokers can regulate their craving for cigarettes using a cognitive strategy, and that a set of prefrontal regions is implicated in this ability (Kober 2010a; Kober 2010b). In this study, we sought to investigate whether cocaine-dependent (CD) individuals can regulate their craving for cocaine using a cognitive strategy similar to one taught in CBT, and to identify the neural correlates of this ability. Therefore, a treatment-seeking sample of cocaine dependent (CD) individuals completed the Regulation of Craving (ROC) task while undergoing functional Magnetic Resonance Imaging. Participants were presented with pictures of food and cocaine, and on each trial instructed to think about either (a) the immediate sensory experience of consuming the item (i.e., the “good” things about it; “NOW”) or (b) the long-term negative consequences of consuming the item (i.e., how it will affect them negatively later on; “LATER”). Self-reports suggested that these individuals were able to reduce their craving for cocaine when they focused on the long term, negative consequences of using cocaine, compared to when they thought about immediately consuming it. Furthermore, using the LATER strategy resulted in relative deactivation in a distributed network of subcortical/limbic regions associated with craving, including the ventral striatum and amygdala. The LATER strategy also resulted in increased prefrontal activity in regions previously associated with cognitive control and regulation of emotion, including dorsolateral prefrontal cortex (dlPFC). Results are consistent with an association between dlPFC recruitment and “regulation of craving” skills learned

during CBT. Further research could delineate whether and to what degree a patient's ability to recruit dlPFC during treatment contributes to treatment success and long-term abstinence.

G-51

NEURAL OVERLAP OF BEHAVIORAL INHIBITION AND AFFECTIVE REGULATION *Kathryn S. Gilliam, University of Oregon; Junaid S. Merchant, University of Oregon; Lauren E. Kahn, University of Oregon; Elliot T. Berkman, University of Oregon-* Recent findings indicate that self-control may share a common neural substrate across the behavioral, cognitive, and affective domains. The aim of this project is to test hypotheses generated by this view. Specifically, if there exists such a common neural substrate, then tasks involving different domains of self-control would be expected to correlate and also recruit similar neural networks. We conducted a functional neuroimaging study assessing affective regulation and behavioral inhibition in the same individuals to elucidate potential behavioral correlations and areas of neural overlap. Twenty-two college-aged participants performed the stop-signal task (SST), a measure of behavioral inhibition, and a standard reappraisal task to assess affective regulation while in the scanner. The SST required participants to establish a prepotent 'go' response and then to selectively inhibit this response following an auditory stop cue. The stop signal response time (SSRT) measure from the SST correlated with level of emotion regulation (i.e., reduction in distress levels on 'decrease emotion' conditions compared to 'just look' conditions), such that faster behavioral inhibition was associated with greater affective regulation. Conjunction analyses revealed the right inferior frontal gyrus (rIFG) to be active above threshold during regulation of both the motor response and emotion. Preliminary analyses indicate that activity in the rIFG mediates the correlation between performance on the behavioral inhibition and affective regulation tasks. These results provide support for the view that the rIFG serves as a common neural substrate and explains the associations among different domains of self-control.

G-52

FATIGUE-RELATED DIFFERENCES IN EMOTION REGULATION: AN FMRI STUDY *Sarah C. Plukaard, VU University Amsterdam; Lydia Krabbendam, VU University Amsterdam; Dick J. Veltman, VU Medical Centre Amsterdam; Jelle Jolles, VU University Amsterdam-* Fatigue is a common complaint in the general population, which, even in the absence of serious disease, can have great adverse effects on the quality of life. For instance, fatigued individuals perceive much higher effort for executed mental and physical tasks than non-fatigued individuals and they may fail to complete successive or ongoing activities. Although fatigue has been associated with altered mood as well as declines in cognitive control, no study has examined the direct effects of fatigue on the cognitive control of emotions. In the current study, neuroimaging was used to study fatigue-related changes in brain activity

during emotion regulation (reappraisal of negative emotion-inducing images). The study was designed to answer the following questions: Does fatigue affect the ability to regulate emotional experiences? And how is brain activity, associated with emotional control, affected by fatigue? To answer these questions, 25 female medical students with fatigue complaints longer than 4 months (age 19 - 25) were compared to 25 female medical students, matched on age, without fatigue complaints. Both groups were tested after a fatigue inducing session (1.5 hours of cognitively demanding activity, such as mental arithmetic's and N-back tasks) and after a control session (1.5 hours of less demanding activity, such as watching nature documentaries). The order of the sessions was counter-balanced within each group. In the scanner, the participants viewed neutral as well as negative emotion-inducing images and were instructed to either view or reinterpret (reappraise) the images. It was expected that fatigue, induced by a period of cognitively demanding activity, is associated with (i) smaller reduction in negative emotion experience after emotion reappraisal and (ii) increased and more dispersed PFC activity during emotion reappraisal showing an increase in exerted effort to accomplish the task. Furthermore, it was expected that the effects of induced fatigue are greater for individuals with long-term fatigue complaints compared to matched controls. The findings (that will be presented at the conference) will show how activities in neural systems involved in the cognitive control of emotions can be modulated by differences in fatigue state between as well as within individuals. Moreover, the results of this study will contribute to knowledge about fatigue related changes in brain activation, which is necessary in order to develop effective interventions for the cognitive component of fatigue problems.

G-54

THE ROLE OF EXECUTIVE FUNCTIONS IN THE REGULATION OF IMPLICIT RACIAL BIAS: AN EXAMINATION OF ERPS AND INDIVIDUAL DIFFERENCES IN CONTROL *Geoffrey T. Kerr, University of Colorado- Boulder; Lee J. Altamirano, University of Colorado- Boulder; Naomi P. Friedman, University of Colorado- Boulder; Akira Miyake, University of Colorado- Boulder; Joshua Correll, University of Chicago; Bruce D. Bartholow, University of Missouri; Tiffany A. Ito, University of Colorado- Boulder-* Implicit measures of racial bias are often interpreted as reflecting only automatic racial associations, but recent studies show that controlled processes dramatically affect task performance. This study investigates the relationship between individual differences in executive function (EF) and implicit racial bias. Participants completed a variety of EF and racial bias tasks. Higher EF was associated with the implementation of greater control on the racial bias tasks. We also examined the error-related negativity (ENR) during the racial bias tasks, a neural measure of conflict monitoring that is informative when a participant's control fails and they make a race-biased mistake, ERN amplitudes were associated with increased

implementation of control such that the larger one's ERNs after a racially biased mistake the more control implemented during the task. Our data also show that EF mediates the relationship between race-biased ERNs and the implementation of control. Larger race-biased ERNs result in the recruitment of greater control only for those with high levels of EF. Taken together, these results indicate that EF has an important function in the expression of implicit racial bias.

G-55

LOSS OF INHIBITORY CONTROL IN INDIVIDUALS WITH POSTTRAUMATIC STRESS DISORDER (PTSD): AN ELECTROPHYSIOLOGICAL AND BEHAVIORAL STUDY.

Lemons, P., The City College of New York, CUNY; Bibi, R., The Graduate Center, CUNY; Hien, D., The City College of New York, CUNY; Fertuck, E.A., The City College of New York, CUNY; Ruglass, L., The City College of New York, CUNY; Yoon, P., The Graduate Center, CUNY; Garcia, E., The City College of New York, CUNY; Kiriakos, G., The City College of New York, CUNY; McGiffin, J., The City College of New York, CUNY; Bornstein, R.Z., The City College of New York, CUNY; Skiba, R., The City College of New York, CUNY; Melara, R.D., The City College of New York, CUNY- A key feature of PTSD involves enhanced selective attention to threat cues and a bias toward processing stimuli as threatening, leading to heightened emotional reactivity. We used a modified version of the Eriksen Flanker Task, comparing neutral faces with faces expressing fear, to explore inhibitory control of threat-related processing in patients diagnosed with PTSD, people who have been exposed to a traumatic event(s), and healthy controls. Our use of an attention task in which distractors (flankers) were separated in time from targets enabled us to collect electrophysiological measurements separately to each type of stimulus. Our preliminary results indicate that patients with PTSD evince deficits in inhibitory control, as indexed by loss of slow-wave positivity in a selective attention (filtering) condition relative to baseline. Group differences were observed even when face stimuli were neutral, but predominated when viewing threatening stimuli. The electrophysiological measures were significantly associated with several clinical screening and self-report indices. Our results suggest that patients with PTSD suffer general deficits in executive control that are especially disrupted under conditions of social threat.

G-56

NEURAL CORRELATES OF FOCUSED ATTENTION DURING A BRIEF MINDFULNESS INDUCTION

Janna Dickenson Elliot Berkman; Matthew Lieberman- Mindfulness—the practice of attending to present-moment experience and allowing emotions and thoughts to pass without judgment—has shown to be beneficial in clinical populations across diverse outcomes. However, the basic neural mechanisms by which mindfulness operates and relates to everyday outcomes in novices remain unexplored. This study explored the neural

mechanisms of focused attention (a brief mindfulness induction commonly taught in healthy and clinical populations where practitioners focus on specific physical sensations, typically the breath) among novice practitioners. Relative to the control condition (mind wandering), focused breathing recruited an attention network including parietal and prefrontal structures, and trait level mindfulness during this comparison also correlated with parietal activation. Results suggest that the neural mechanisms of a brief mindfulness induction are related to attention processes in novices and that trait mindfulness positively moderates this activation. These data are currently published in a special issue on mindfulness in the journal SCAN. Future directions for clinical populations will be presented.

G-57

FRAME OF MIND: FRAMING A LEARNING TASK AS FOCUSED ON PERFORMANCE OR MASTERY YIELDS A DOUBLE DISSOCIATION OF THE NEURAL PROCESSES PREDICTING SUBSEQUENT MEMORY.

Guerra-Carrillo, Belen., Baruch College, CUNY; Rodriguez, Sylvia, Baruch College, CUNY; Mangels, Jennifer, Baruch College, CUNY- Two achievement goals have been identified to influence students' educational outcomes: performance and mastery. A performance orientation stresses the importance of proving one's abilities to achieve in comparison to others. Traditionally, this goal has been associated with poorer academic outcomes and processing information at a superficial level. Conversely, a mastery goal emphasizes the seeking out of learning opportunities, and the investment of effort in learning, and correspondingly, has been linked to positive academic outcomes. Past research has primarily examined these relationships only using individual difference measures. The current study extends this work by investigating how framing a challenging general knowledge task as either an opportunity to demonstrate ability compared to others (performance framing) or as an opportunity to learn new things (mastery framing) influences students' abilities to use feedback to correct memory errors on an immediate retest. Although we found no behavioral difference in error correction, event-related potentials (ERPs) recorded to performance (accuracy) and learning (correct answer) feedback after each trial revealed different ventral stream mechanisms by which people learned. From 200-800ms post-learning feedback, performance framing was exclusively associated with different due to memory (Dm) effects over parieto-occipital sites, whereas mastery framing was associated with Dm effects exclusively over inferior fronto-temporal sites. The spatiotemporal distribution of the ERPs in the mastery framing is characteristic of deep semantic processing, whereas the distribution for the performance framing is more typical of a shallow, more perceptual level of encoding. The extent to which participants in the mastery framing exhibited an ERP pattern indicative of semantic encoding was also related to their personal achievement goals measured prior to the study. The more that students endorsed the

goal of gaining proficiency in the learning material (mastery-approach goal) the more negative-going the fronto-temporal Dm effects were over the left hemisphere, particularly from 400-800 ms. In contrast, endorsement of the goal to do better in classes than others (performance-approach goal) was related to reduced negative-going Dm activity over these sites. There were no significant relationships between individual goal differences and neural activity under performance framing. The overall double disassociation in the spatiotemporal pattern of the subsequent memory effects across frame suggests that even relatively subtle changes in a task's motivational emphasis can significantly influence the processes a person uses to encode information. Furthermore, these effects can be further enhanced or reduced by individual differences in achievement goals.

G-58

RESISTING THE DEFAULT ACCOUNT OF MIND WANDERING

Jonathan Smallwood, Department of Social Neuroscience, Max Planck Institute for Human Cognitive Brain Sciences - Almost half of mental life is spent being engaged in imaginative thoughts and feelings that are unrelated to the events taking place in the here and now, such as when we daydream about an upcoming vacation or ruminate about a romantic liaison that went badly. In the last decade, research has converged on the assumption that these experiences are produced through the coordinated action of a constellation of brain regions that are collectively known as the default mode network. Although this network undoubtedly plays a role in imaginative thought, recent experience sampling and neurocognitive evidence indicate that the process of executive control can also facilitate such experiences. Not only does this evidence challenge the notion that daydreaming can be equated with the action of a single neural system, but data implicating the application of control processes during mind wandering suggest that a productive imagination could be a contributory factor to success and psychological well-being throughout an individual's life.

Poster Session I

I-02

THE INFLUENCE OF REPEATED SOCIAL FEEDBACK ON DECISION-MAKING UNDER RISK: FRAMING MONETARY CHOICES IN A SOCIAL CONTEXT

Kamila E. Sip, Rutgers University; Anthony J. Porcelli, Marquette University, Rutgers University; Benedetto De Martino, University College London, California Institute of Technology; Mauricio R. Delgado, Rutgers University- The decisions people make are often influenced by the input of others. One way that such input can manifest is through approval or disapproval offered by another person, referred to as social feedback (SFB). Recent research indicates that social approval in the form of a positive reputation with others affects decision-making, and may be equally rewarding as earning money [Izuma et al., 2008]. Additionally, a growing body of evidence suggests that economic choices are influenced by social contexts [e.g. Fehr & Camerer, 2007; Safney et al., 2008; Tabibnia & Lieberman, 2007]. However, less is known about how SFB affects financial decisions and its neural correlates. Therefore, the aim of this study was two-fold. We investigated whether a) SFB would modulate behavioral and neural signals associated with reward processing and risky decision-making, and b) whether there are gender differences in the way SFB is processed that can lead to changes in decision-making? We adapted a well-documented paradigm where decision options were presented as an opportunity to win or lose money (gain and loss frames respectively) [adapted from DeMartino et al., 2006]. During the task, participants were observed by a gender-matched confederate who provided occasional positive (e.g., "Nice!") or negative (e.g., "Lame!") feedback about the choices participants made. Participants (N=32, 16F) responded to the framing manipulation, replicating previous research using this task; that is, they were more conservative in the gain frame and riskier in the loss frame with respect to decisions made. Neurally, the receipt of Positive versus Negative SFB recruited corticostriatal circuits previously implicated in differential responses to positive and negative monetary outcomes suggesting affective processing of the feedback. Interestingly, after participants received positive SFB on a series of choices patterns of risk-taking in females and males diverged. Specifically, we observed a significant interaction between gender and SFB such that females became more conservative after receiving positive feedback in the Loss frame. A 3-way ANOVA (Decision Frame x SFB x Gender) revealed a significant 3-way interaction in the left ventromedial prefrontal cortex (vmPFC, BA32/11; $x,y,z=-4, 30, -9$), a region typically involved in valuation and decision-making (Rangel et al., 2008). In females, decreases in BOLD signals in the vmPFC were observed after Negative SFB for Loss as compared to Gain frame trials, with the reverse observed in males. We speculate that vmPFC integrates SFB-related information with the

expected value of subsequent decisions, and that this process varies as a function of gender. The effect specifically manifests in the context of Negative SFB, which may represent incongruency in how participants perceive their own choices related to receipt of Negative SFB.

I-03

MOTIVATION AND TASK DIFFICULTY EXPECTATIONS INFLUENCE LEARNING AND STRIATAL RESPONSE TO PERFORMANCE-RELATED FEEDBACK

Samantha Swanson, Rutgers University; Elizabeth Tricomi, Rutgers University- Research on reinforcement learning has revealed a key role for the striatum in learning from rewards, punishments, and feedback about one's performance. However, striatal responses to rewards and punishments are not purely driven by objective properties of the stimuli; they are also modulated by the context in which these outcomes are received. This study pairs a novel learning task with functional magnetic resonance imaging to explore the way that task difficulty expectations modulate the striatal response to performance-related feedback. Participants learned to categorize novel figures through trial-by-trial feedback. The task was designed with four conditions: two levels of actual difficulty and two levels of expected difficulty. Before each block of trials, an arbitrary difficulty label instructed the participant that the following trials would be EASY or HARD. The labels were independent of actual difficulty, but influenced the participants' expectations. Following the scan, participants completed questionnaires to assess individual differences in achievement motivation. Accuracy was significantly higher for actually easy blocks that were labeled "HARD" relative to those labeled "EASY." Normative outcome goals, which reflect a desire to outperform others, were positively correlated with these expectation-based performance differences. These results could reflect a magnification of the effort and attention that participants dedicate when anticipating a more challenging task, especially for those who are high in normative outcome goals. In the brain, the striatal signal was greater in response to positive feedback relative to negative feedback across all conditions. The effect of the difficulty label on negative feedback signals in the putamen (expected "EASY" - expected "HARD") was correlated with normative outcome goals. In the same region of the putamen, striatal response to negative feedback was inversely related to task performance. The fMRI results suggest that task difficulty expectations interact with preexisting motivational orientations to produce subtle differences in the processing of negative feedback, which may in turn contribute to performance differences across conditions.

I-04

THE MOTIVATION TO BE MORAL

Félice van Nunspeet, Leiden University; Naomi Ellemers, Leiden University; Belle Derks, Leiden University; Sander Nieuwenhuis, Leiden

University- Previous research has shown the importance of morality (compared to competence or sociability) for people's identity, identification with an ingroup and positive evaluation of ingroup members. However, it has remained unclear whether people are also implicitly motivated to behave according to moral norms. In two ERP studies, we examined whether the motivation to be moral (vs. competent) affected behavior and neural markers of task effort. While the first study compared people's intrinsic motivation to be moral vs. competent, the second study examined whether people are more motivated to behave morally when they are judged by ingroup or by outgroup members. To test whether people are more motivated to adjust their task performance when this is said to measure their morality (rather than their competence), in Study 1 we framed an Implicit Association Test (IAT) as either a test of people's morality or as a test of people's competence. In the IAT, non-Muslim participants had to associate pictures of women with and without a headscarf with positive and negative pictures. In Study 2, we added a social situation: Participants were told that they were being evaluated by someone selected from a group of participants with the same personality style (an ingroup member) or another personality style (an outgroup member). In both studies we recorded event-related brain potentials while participants were performing the IAT. Behavioral results of Study 1 confirmed that participants were more motivated to influence their performance on the moral rather than competence IAT: Participants who read the moral implications of the test showed a smaller IAT effect (i.e., a negative implicit bias towards women with a headscarf) than participants who read the test implications concerning their competence. Behavioral results of Study 2 showed that the motivation to be moral is especially important for self-presentation towards the ingroup: Compared to participants who thought they were being evaluated by an outgroup member, participants who thought they were being evaluated by an ingroup member showed a smaller IAT effect when the test was said to measure their morality than when the test was said to measure their competence. ERP results of both studies gave insight into how participants succeeded in reducing their bias in the IAT: They more strongly distinguished outgroup from ingroup targets in the N1 and P150 components. Moreover, for participants in the morality conditions, N450 amplitudes more strongly distinguished between incongruent and congruent trials. Finally, examination of the ERN revealed that compared to competence instructions, morality instructions resulted in increased performance monitoring. As such, the current two studies reveal how focusing people on the moral implications of their behavior, and giving them feedback from ingroup members, changes their effort and performance on the IAT by improving early attentional as well as conflict monitoring processes.

I-05

CORRELATIONS BETWEEN IMPULSIVENESS AND MORAL JUDGMENTS

M. Carmona-Perera, University of Granada; J. E. Theriault, Boston College; L. Young, Boston College; X. Sumarroca-Hernández, Hospital Nostra Senyora de Meritxell; A. Santolaria-Rossell, Hospital Nostra Senyora de Meritxell; A. Verdejo-García, University of Granada; M. Pérez-García, University of Granada- Impulsivity is a central feature of substance abuse disorders, including alcoholism (Moeller, Barratt, Dougherty, Schmitz & Swann 2001; Gerald & Higley, 2002; Mitchell Howard, Fields, D'Esposito & Boettiger, 2005). Impulsivity is often associated with impairments in decision-making, including the discounting of future benefits (Bechara, Damasio & Damasio, 2000; Barkley, 2001; Verdejo-García, Pérez-García & Bechara, 2006). Here, we investigate the impact of impulsivity on moral decision-making, in alcoholics and non-alcoholics. We tested 31 alcoholics and 34 non-alcoholics matched in age and gender. Participants completed a moral judgment task developed by Greene and colleagues (Greene, Sommerville, Nystrom, Darley & Cohen, 2001) and the Barratt Impulsivity Scale-11 (BIS, Patton, Stanford & Barratt, 1995). We probed the relationship between impulsiveness (i.e., cognitive, motor, non-planning and total) and moral decision-making (e.g., endorsement of a harmful action for the greater good). We found that motor impulsiveness, specifically, was associated with utilitarian moral decisions for personal moral dilemmas ($r = 0.244$; $p = 0.049$). These findings reveal an association between motor impulsivity and utilitarian moral decision-making. People who are high in motor impulsivity are more likely to endorse immediate actions that cause harm in the context of moral dilemmas.

I-06

ARE PSYCHOPATHIC TRAITS ASSOCIATED WITH DIMINISHED NEURAL RESPONSES TO OWN MORAL VIOLATIONS?

Ana Seara Cardoso, University College London; Jonathan Roiser, University College London; Catherine Sebastian, University College London; Eamon McCrory, University College London; Essi Viding, University College London- Adults with high levels of psychopathic traits appear to have intact moral knowledge, but damaged moral emotions; they seem to be able to distinguish right from wrong, but not care about hurting others. For example, individuals with high levels of psychopathic traits show typical permissibility judgements in response to standard moral dilemmas, but report having less difficulty in making their judgements than those with low levels of psychopathic traits. They also show atypical brain function during moral decision making, showing less activity in the emotion processing areas and more reactivity in areas associated with cognitive control and abstract reasoning. These findings have led to the conjecture that these individuals would rely less on emotional inputs and more on abstract reasoning to make moral judgments. Thus, it has been suggested that psychopathic traits are not associated with cognitive impairments in moral knowledge, i.e. the

'knowing' what is wrong, but rather with impairments on affective components of morality, i.e. the 'feeling' of what is wrong. Previous research on the association between psychopathic traits and moral processing has focused mainly on the study of moral judgement and moral decision-making, rather than moral emotion. Moral emotion may be critically important in understanding behavioural adherence to the moral rules, as they provide immediate and salient feedback on behaviour, and thus exert a strong influence on moral choice. In the present study, we will use event-related fMRI to investigate the association between psychopathic traits in the general population and moral emotion. Thirty adult males, with varying levels of psychopathic traits, will be tested on a vignette task consisting of ecologically valid everyday scenarios. Experimental scenarios portraying a moral violation (where the subject intentionally causes harm to another person in order to achieve a personal goal) will be contrasted with morally neutral ones (where the subject causes harm to himself in order to achieve the same goal). Subjects are instructed to imagine themselves in the situation and make online ratings of how guilty they would feel following the action described. Conditions are matched in terms of emotional valence and arousal, presence of a critical other and ToM recruitment. We predict greater activation of the amygdala, ACC, dMPFC and lateral OFC in response to moral violation scenarios relative to neutral ones, and expect the activation to be positively correlated with guilt ratings on the scenarios. We predict that levels of psychopathic traits will be associated with overall diminished magnitude of response, especially in the amygdala and OFC regions. An association between diminished neural responsivity in these regions and psychopathic traits would provide a clearer comprehension of possible impairments in affective components of morality, and thus of the lack of adherence to moral rules manifested by the tendency to antisocial behaviour often associated with these traits.

I-07

HOW YOU REGULATE AFFECTS YOUR BENEFIT: THE DYNAMIC EMOTIONAL EXPERIENCE DURING INTERACTIVE REPEATED ULTIMATUM BARGAINING EXPLAINS SOCIAL DECISION MAKING

Gadi Gilam, Tel-Aviv University, Tel-Aviv Sourasky Medical Center; Gal Raz, Tel-Aviv Sourasky Medical Center, Tel-Aviv University; Tamar Lin, Tel-Aviv University, Tel-Aviv Sourasky Medical Center; Rakefet Sela-Sheffy, Tel-Aviv University; Talma Hendler, Tel-Aviv University, Tel-Aviv Sourasky Medical Center- Emotions interact with social decision making. This has been demonstrated in ultimatum games (UG) where unfair-offers result in more rejections and elicit more negative emotions than fair-offers. However, the emotional experience in real-life bargaining in which we verbally communicate back-and-forth with the same partner has not yet been investigated, particularly in the brain. This study aimed to investigate how the differential experience of negative emotions elicited by repeated UG-offers influences the process of

social decision making. We assumed that the on-going inter-personal interaction may reveal different strategies of emotion regulation. We further proposed that individuals exhibit different patterns of neural activity (specifically in DLPFC and Insula), depending on the dynamic of their emotional experience during the game. While undergoing fMRI scanning, sixty healthy male participants played the responder in a game of 10 repeated UG-offers which were predefined to include mostly unfair-offers. The proposer was a collaborator instructed to negotiate aggressively and thus further intensifying the negative emotional experience. Upon completion of the game, outside the scanner, emotions were reported using the Geneva Emotion Wheel, marked for each offer, outcome and negotiation periods of the game. Decisions made by responders extend classic results of UG; rejection rate of unfair-offers increased to 77% and acceptance rate of fair-offers decreased to 73.5%. High-control negative (HCN) emotions (disgust, contempt, hostility and anger) were the dominant category of emotions experienced during the game. Indeed, participants who reported higher average HCN emotions ended with a lower total gain. This was not found for the category of high-control positive (HCP) emotions (pride, elation, happiness and satisfaction). To further investigate this relation, we divided the participants into three groups based on percentiles of total gain and focused on the two groups with highest and lowest gain. Interestingly, these results were apparent also when looking at the offer-by-offer time-course of these emotional categories indicating a possible difference in emotional regulation strategy along the game. When investigating the inter-offer dynamics, both offer and negotiation periods induced stronger HCN than HCP ratings. However, compared to both these periods, rating of the outcome showed a decrease in HCN and an increase in HCP emotions. This pattern was significantly different between the two gain-groups: the high-gain-group had a much stronger increase in HCP during the outcome period compared to the low-gain-group, in such a way that HCP was significantly higher than HCN. This may possibly indicate that the increase in HCP emotions in the low-gain-group (which was still lower than HCN ratings) reflects reciprocity and/or retribution towards the proposers' unfair-offers, while in the high-gain-group the pattern of emotions reflects their general satisfaction from increasingly gaining more money. Our novel design of a repeated bargaining UG enabled to examine the dynamic experience of emotions within an ecologically valid setting. The emotional experience as it unfolded during the on-going interaction may explain how people make decisions in a complex social context. Furthermore, different patterns of such experiences may reflect underlying unique neural mechanisms of emotional regulation during decision making (still under analysis).

I-08

LADY JUSTICE CAN SEE: HOW DISGUST AND ATTRIBUTION AFFECT RESPONSIBILITY

JUDGMENTS AND PUNISHMENT DECISIONS

Beatrice Capestrany, Duke University; Lasana Harris, Duke University- The future of a criminal defendant on trial relies on the judgments of impartial, objective decision-makers. How are responsibility and punishment judgments—decisions that should be linked—affected by the morality of the crime and the explanation of the defendant's behavior? We use functional magnetic resonance imaging to examine how purity violations and dispositional attributions affect responsibility judgments and punishment decisions, and the corresponding neural networks. Participants read criminal dilemma vignettes matched on severity using the Federal Sentencing Guidelines, and were asked to rate the responsibility of the actor and assign punishment. The vignettes depicted a crime in either a disgust-related moral domain or not, and a sentence describing behavior using either personality or scientific language. Preliminary results indicate that participants are punishing more harshly when the crime falls into a disgust related moral domain, and are attributing less responsibility when the actor's behavior is characterized using a scientific explanation. Moreover, neuroimaging results suggest modulation of neural regions implicated in deductive reasoning (Monti et al., 2007) and third-party punishment (Buckholtz et al., 2008) by both disgust and dispositional attribution, suggesting different affective and social factors bias neural mechanisms implicated in legal decision-making.

I-09 THE IMPACT OF TESTOSTERONE ADMINISTRATION ON TRUST, RISK, BETRAYAL, AND RECIPROCITY

Maarten A.S. Boksem, Erasmus University Rotterdam, Radboud University Nijmegen; Pranjal H. Mehta, Erasmus University Rotterdam, Radboud University Nijmegen; Bram van den Bergh, Erasmus University Rotterdam; Veerle van Son, Radboud University Nijmegen; Alan Sanfey, Radboud University Nijmegen; Ale Smidts, Erasmus University Rotterdam- Testosterone has been associated with increased preferences for risk, while it is also proposed to play an important role in social interactions. Because trust is often regarded as 'social risk', we examined whether Testosterone differentially affects the decision to trust and the decision to take risks, by comparing a binary-choice Trust Game with a structurally identical, binary-choice Risk Game offering a good or a bad outcome. We elicited subjects' minimum acceptable probabilities (MAPs) of receiving the good outcome such that they would prefer the gamble to the sure payoff. Of our 49 participants (all females), 24 received Testosterone, while 25 received Placebo (double blind). In the Testosterone condition, first movers state higher MAPs in the Trust Game than in situations where nature determines the outcome, while subjects in the Placebo condition showed no such difference. In addition, subjects completed a series of lottery choices and played a one-shot Trust Game. The results revealed no difference in risk-attitude. In contrast, subjects in the Testosterone condition invested significantly less in their partners as a first-mover

in the Trust Game, while they actually reciprocated more when they played as a second-mover. These results suggest that for subjects with high Testosterone, a trust-decision entails an additional risk premium to compensate for the potential costs of trust betrayal, leading to diminished trusting behaviour. At the same time, however, Testosterone enhanced reciprocity of revealed trust. We suggest that the impact of Testosterone on the drive to obtain and maintain social status may explain the present findings.

I-10 EQUALITY VERSUS SELF-INTEREST IN THE BRAIN: DIFFERENTIAL ROLES OF ANTERIOR INSULA AND MEDIAL PREFRONTAL CORTEX

Claudia Civali, CNS sector, SISSA, Italy; Cristiano Crescentini, Azienda Ospedaliero-Universitaria Santa Maria della Misericordia; Aldo Rustichini, University of Minnesota; Raffaella I. Rumiati, CNS sector, SISSA, Italy- The tradeoff between equality, defined as an equal share of resources between two similarly deserving parties, and efficiency, considered as the maximization of the resources available, is crucial consideration in policy decisions. Even though an equal outcome is generally preferred (Skitka et al, 2003), sometimes the realization of an equitable allocation is possible only by sacrificing the total amount of resources available. Moreover, efficiency often overlaps with self-interest, which competes with equality for making decisions (Messick, 1995). In this study, we have investigated the neural basis of individual preferences by employing a task in which an allocation of a fixed amount between two couple of players is randomly determined. Specifically, the participant had to accept or reject monetary divisions, established by a device, between: a) the participant himself and another person A (myself - MS- condition); b) D and E, two uninvolved third parties (third party -TP- condition). In both conditions, players A, D and E were not responsible for the outcome, but they were all affected by the participant's decision over the outcome. Acceptance of unequal outcomes revealed a preference for efficiency over equality; vice versa, rejection of unequal allocations, which meant the loss of total amount, indicated a preference for equality over efficiency. Furthermore, in MS condition, efficiency overlaps with self-interest in competing with equality. Behavioral results, as expected, showed that very unequal allocations in TP were rejected, whereas a smaller rejection rate in MS was found when the allocation was favorable to the subject. The first result supports the idea that individuals prefer equal outcomes, everything else being equal, and the second is the consequence of the moderating effect of self-interest. As far as the neural bases are concerned, on the one hand, anterior insula (AI), traditionally related to negative feelings (Sanfey et al, 2003), but implicated also in more complex tasks, such as perceptual decision making, cognitive control, performance monitoring (Craig, 2009, for a review), and, importantly, in norm violations (Spitzer et al, 2007; King-Casas et al, 2008), was active for unequal outcomes, in

both TP and MS, irrespectively their advantageousness. On the other hand, for MS unequal outcomes and consequent MS rejections, we found an activation of a cluster involving anterior cingulate cortex (ACC) and medial prefrontal cortex (mPFC), already known in literature for being implicated in self-referential operations and in processing integration between cognitive, emotional and social aspects (see Amodio & Frith, 2006 for a review); in particular, the anterior part of the mPFC was more active for disadvantageous outcomes as compared to advantageous. Here, we confirmed that equal treatment is the default norm to be applied when no other cue triggers different principles, such as self-interest; we propose that, as a default norm, equal treatment can also be considered the implicitly expected outcome, and its violation is signaled by the activation of AI. The ACC/mPFC activation, negatively correlated to rejections, reflects the effort to overcome the default rule of equal split, integrating cognitive, emotional and motivational paths in favor of a self-advantageous efficiency.

I-11

STICKING WITH THE NICE GUY: WARMTH INFORMATION INCREASES FICTIVE ERROR DEPENDENCE FOR DECISIONS WITH PEOPLE NOT COMPUTERS *Victoria Lee, Duke University; Lasana T. Harris, Duke University*- Prior research suggests mental state attributions to people and objects rely on separable neural mechanisms—people activate the social cognition network, including regions of medial prefrontal cortex and temporal lobes (Harris, Todorov, & Fiske 2005), while dispositional attributions to objects activate other brain regions such as the amygdala (Harris & Fiske 2008). The current study looks at fictive error signals in the brain during person and computer program agent selection—agents are selected to invest in the stock market on behalf of participants. Participants choose an agent to invest on their behalf based on the primary dimensions of person perception—the ability of the agent to make a profit in the stock market (agent competence) or the agents’ generosity in returning a profit (agent warmth). Using a perseverance index—the amount of time participants relied on fictive error signals—we observed a significant interaction between agent and person perception dimension. Specifically participants depended on fictive error signals more when investing with warm human agents compared to ability or computers. The striatum and pACC, neural regions implicated in fictive error processing, were modulated by the identity of the investor, suggesting that these signals are sensitive to the primary dimensions of person perception. Furthermore, the separate social cognition systems described above for humans and non-humans were modulated by fictive error signals to people and computers respectively. We discuss these results in the context of an integrative theory of social cognition and decision-making.

I-12

FUNCTIONAL CONNECTIVITY BASED CLASSIFICATION OF THE PRIMARY SOMATOSENSORY CORTEX

Filippo Migliorati, Netherlands Institute for Neuroscience; Leonardo Cerliani, Netherlands Institute for Neuroscience; Valeria Gazzola, Netherlands Institute for Neuroscience; Christian Keysers, Netherlands Institute for Neuroscience- Several fMRI studies report activation in human parietal cortex consequent to action observation and execution (Rizzolati et al., 1996; Gallese et al., 1996). A possible explanation could rely on the discovery of a mirror neuron system located in macaque ventral premotor cortex (area F5) (Di Pellegrino et al., 1992). Neurons belonging to this system not only fire during action execution but also during the observation of goal directed actions performed by other individuals (Rizzolati et al., 1996; Gallese et al., 1996) as well as the listening of the corresponding sound (Théoret & Pascalleone, 2002; Gazzola et al., 2006). So far, the location of mirror activation in the parietal cortex has been assessed by means of anatomical landmarks or with the help of post-mortem cyto-architectonic atlases, identifying the centres of this activity both in the Inferior Parietal Lobule and the Somatosensory cortex (Gazzola & Keysers, 2009; Keysers et al., 2010). It is still uncertain, though, whether the location of the observed mirror activity in SI reflects the actual situation or whether it is due to a mislocation following the high inter-subjects variability in the morphology of the parietal lobe. In a first attempt to clear up this doubts we aimed at identifying sub-regions of the Primary Somatosensory cortex that are functionally connected with regions usually involved in both observation and execution of goal directed actions, like the dorsal and ventral premotor cortices, BA44. Our results show that SI can be subdivided in three sub-regions showing different pattern of preferential functional connectivity with the chosen target ROIs, supporting the idea that SI actually plays a role during action observation and execution and the location of the mirror activity in SI is not due to issues in the registration fMRI images across subjects.

I-13

USING THE BRAIN TO PREDICT REAL-WORLD TRENDS IN MAINSTREAM FILM RELEASES

Benjamin C. Gunter, University of California, Los Angeles; B. Locke Welborn, University of California, Los Angeles; I. Stephanie Vezich, University of California, Los Angeles; Martin M. Monti, University of California, Los Angeles; Matthew D. Lieberman, University of California, Los Angeles- fMRI-based estimates of neural activity in medial prefrontal cortex (mPFC) and posterior cingulate cortex (PCC) during the presentation of persuasive and advertising stimuli have been previously shown to predict future behavioral change in the participants more accurately than self-report (Falk et al., 2010). Accordingly, the utility of “neural focus groups” as a medium for enhanced estimates of population-level effectiveness in advertising campaigns has been of increasing interest (Falk et al., under review).

We sought to use neural focus group methodology to predict future trends in a market and patterns of reception among consumers and critics. We scanned 29 participants while they watched trailers (previews) advertising unreleased mainstream films. Afterward, participants provided their own liking ratings and estimates of the film's success in the mainstream. After extracting subject-level BOLD estimates for each film from regions of interest (including mPFC and PCC), we correlated both neural and behavioral estimates with the mainstream success of the films (as indexed by box office returns) and with critical reception (as indexed by online aggregations of critical reviews). We hypothesize that mPFC signal change will predict the box office success of the films more accurately than self-report alone. Analyses will continue as the tested films are released and critical reviews appear. Results will contribute to a framework for neural models predicting a variety of real-world events beyond the capacity of self-report by laymen and even experts.

I-14

TASK-IRRELEVANCE AND STIMULUS REPETITIONS REVEAL INDIVIDUAL DIFFERENCES IN THE LATE POSITIVE POTENTIAL

Helen Uiho, University of Tartu, Estonia; Andero Uusberg, University of Tartu, Estonia; Kairi Kreegipuu, University of Tartu, Estonia; Jüri Allik, University of Tartu, Estonia- The Late Positive Potential (LPP) differentiates emotional especially highly arousing evolutionary significant stimuli from neutral ones. This modulation seems to be a robust index of affective processes. It is insensitive to various physical stimulus characteristics (color, brightness, figure-ground relationships etc) and also appears to be resistant to habituation. Even after excessive repetitions LPP reliably differentiates emotional stimuli from neutral ones with only a small overall attenuation. Finally, the affective amplification of LPP amplitudes does not depend on task-relevance. The aims of the present study are a) to explore the combined effects of task relevance and stimulus repetition on affective modulation of LPP amplitudes and b) to study their interactions with state (subjective affective picture ratings) and trait (Big Five personality) level individual differences. 79 participants (32 males) viewed affective images (IAPS) from five different categories (aversive, negative, neutral, positive and erotic) in a direct (making affective evaluations) and an indirect (making non-affective evaluations) task condition. For each task 60 pictures were presented in randomized order within three blocks. LPP mean amplitudes over central-parietal region were analyzed between 320 and 1500 ms. Task-relevance increased LPP amplitudes uniformly across affective as well as neutral images, but only if affective task was completed after non-affective. This carryover effect suggests that once attention has been drawn to affective content, analysis of emotional meaning will continue on the same level even without explicit task requirements. We observed a gradual rise of mean amplitudes from first to third repetition block, which to our knowledge is a novel result. This amplification was

not moderated by task-relevance, valence or arousal. However, the repetition effect was largest between the very first and second picture presentation of the experiment. Psychometric personality traits had no systematic effect on LPP amplitudes. However, an interesting interaction emerged between state level individual differences, task-relevance and affective content. Participants who reported being more aroused by all images had a more pronounced rise in mean amplitudes from first to third repetition block in the indirect task condition in response to aversive stimuli. Meanwhile participants giving lower arousal ratings showed no increase at all ($r = .37, p < .01$). The repetition effect found in this study can be speculatively related to the well-documented enhancement of late posterior ERP-s by conscious recollection. The gradual increase in LPP amplitudes may therefore reflect memory processes being activated by recognition of previously presented stimuli. Viewed in this framework it can be speculated that in a situation where affect is task-irrelevant participants with higher affective sensitivity show enhanced memory for threatening stimuli while their less sensitive counterparts somehow attenuate recollection, possibly by effectively down-regulating their affective reactions. If future research validates this explanation, repetitions of affective stimuli with an indirect task may become a useful tool for studying individual differences in affective memory as well as emotion regulation.

I-15

AN FMRI STUDY ON ATTITUDINAL AMBIVALENCE: THE MICROSOFT PARADOX

Sarah Henderson, Dartmouth College; Catherine J. Norris, Dartmouth College- The experience of co-occurring positive and negative emotions (i.e., ambivalence) is a complex and poorly understood aspect of the human experience. One barrier towards understanding the underlying mechanisms of ambivalence is the difficulty in producing and manipulating this phenomenon in a laboratory setting when individuals differ greatly on what they experience as ambivalent. The current study, therefore, sought to understand the cognitive and emotional processes that underlie ambivalence by utilizing a paradigm that allowed for idiographic analyses of individual differences in attitudes towards well known company brands. Using functional magnetic resonance imaging (fMRI), participants viewed Interbrand's 2009 Best Global Brands ($n = 100$) for 4 sec each and indicated whether they liked or disliked each brand. Following the fMRI task, participants rated their positive and negative feelings about each brand. We calculated ambivalence scores for each brand and used each participant's ratings to create an ideal time series based on the amount of reported ambivalence. We conducted a whole-brain analysis to find areas of the brain in which the time series of neural activity correlated with the ideal time series. We found a high correlation between the real and ideal time series in the medial prefrontal cortex (MPFC; BA 10) and medial orbitofrontal cortex (MOFC; BA 11). MPFC activity has

been suggested to support attention to one's own emotions and mental states (i.e., self-processing), and MOFC is implicated in affective decision making. Therefore, results suggest that attitudinal ambivalence correlates with activation of these regions, indicating that greater levels of ambivalence may require more processing resources. We also found correlated activity in bilateral ventrolateral prefrontal cortex (VLPFC; BA 47), posterior cingulate cortex, and left parahippocampal gyrus, all regions that have been suggested to support memory retrieval. This could suggest that the resolution of ambivalence (i.e., deciding whether a brand is liked or disliked) either requires greater memory retrieval, or that perhaps a greater quantity and variety of memories gives rise to greater ambivalence. Finally, we found that greater ambivalence correlated with activity in bilateral visual cortex and precuneus, suggesting greater visual and attentional processing for ambivalent brands. Overall, these findings shed light on the processes and mechanisms underlying not only consumer ambivalence towards well-known brands, but also the overall experience of ambivalence and how it ultimately impacts decision-making.

I-16

HARNESSING VISUAL ERP-S FOR AFFECTIVE CHRONOMETRY *Andero Uusberg, University of Tartu, Estonia; Helen Uibo, University of Tartu, Estonia; Riti Tiimus, University of Tartu, Estonia; Kairi Kreegipuu, University of Tartu, Estonia; Jüri Allik, University of Tartu, Estonia-* With the hallmark advantage of high temporal resolution, event-related potentials (ERP) seem perfect for the investigation of affective chronometry. However, discerning the temporal structure of visual affective ERP-s is far from trivial. On a larger scale, clear definitions of affective ERP components remain to be agreed upon. Meanwhile on a smaller scale the traditional peak latency measure is both conceptually questionable and unreliable on slow processes such as the Late Positive Potential (LPP). As a result the functional correlates of affective waveform sections remain vague. Here we test two strategies for harnessing the temporal sensitivity of ERP-s in affective neuroscience – identification of component from affective difference waves and measuring their latencies using fractional area estimates. EEG was recorded while 80 subjects viewed two sets of 60 IAPS images from five affective categories (aversive, negative, neutral, positive and erotic) with direct and indirect tasks. While the former task required participants to rate the valence and arousal of each picture, the latter involved evaluating brightness and object numerosity thus rendering affective content task-irrelevant. A maximum difference envelope was used to define three affective components: dipolar Early Posterior Negativity (EPN) and unipolar P3 and Slow Wave (SW). Component amplitudes were analysed using windowed averages from representative electrode pairs. Fractional area latencies were defined for the uniformly positive P3 and SW as points in time when the area under the waveform reaches

50% of total. Only participants with positive area estimates were included in the relevant analyses. The mean amplitudes were most sensitive to erotic stimuli. Significant enhancements compared to the neutral waveform were generated by erotic images in EPN, erotic followed by aversive in P3 and these two followed by negative in SW. Meanwhile the affective modulation of component time courses was quite different. The P3 peaked sooner for both high arousal positive as well as negative categories. By contrast the SW dynamics were prolonged for aversive as well as moderately arousing negative stimuli followed by erotic ones. These findings suggest that latency (i.e. waveform shape) can be used to differentiate the P3 and Slow Wave processes even if amplitudes cannot. Doing so might complement the theoretical distinction between the EPN reflecting pre-attentive prioritisation of motivationally relevant information and the LPP reflecting the actual prioritized processing. The findings of this study suggest the P3 and SW may index distinct phases of the latter such as initial deployment of capacity-limited resources and prolonged processing including cognitive appraisals and emotion regulation, respectively.

I-17

THE UNCERTAINTY BIAS: BRAIN EVIDENCE THAT AMBIGUITY IS MORE CAPTIVATING THAN THREAT OR REWARD *Shona M. Tritt, University of Toronto; Jordan B. Peterson, University of Toronto; Michael Inzlicht, University of Toronto-* A large body of research has focused on the types of stimuli that most capture and sustain human attention. Much of this work has concentrated on preferential processing of negatively compared to positively valenced motivationally-relevant stimuli. Here, however, we suggest that valence may be less motivationally-relevant than certainty, and predict that uncertain stimuli will attract more attention than either positive or negative stimuli. We test this by examining the late positive potential (LPP), which is an evoked brain potential that varies in amplitude with emotional arousal. Undergraduate participants (N = 41) viewed images of smiling (positive stimuli), frowning (negative stimuli), or smiling and frowning facial expressions of the same individual morphed together (uncertain stimuli). Results indicate that uncertain images yielded significantly greater LPP amplitudes than positive and negative images; all of which are greater than neutral non-face images. The results suggest that humans have an evolutionary-based attentional bias that is greater to uncertainty than to threatening or pleasant information.

I-18

FACING YOUR FEARS: A BEHAVIORAL AND NEUROIMAGING EXPLORATION OF THE ROLE OF TRAIT ANXIETY IN IGNORING IRRELEVANT FEAR EXPRESSIONS. *Nook, E., Columbia University; Satpute, A. B., Columbia University; Narayanan, S., Columbia University; Weber, J., Columbia University; Ochsner, K. N., Columbia University-* Anxiety can be an adaptive psychological state

that facilitates one's responses to affective information in the environment. However, in its extremes, anxiety is a debilitating illness that allows such information to undermine cognitive control. This occurs whenever affectively salient information that is irrelevant to the task at hand is not effectively ignored, allowing it to interfere with one's current goals. In this study, we used a parametric design and functional magnetic resonance imaging techniques to investigate the behavioral and neural correlates of the ability to ignore increasing levels of irrelevant affective information and to explore how trait anxiety affects this ability. Twenty participants were scanned while they viewed faces that were morphed to vary in affective intensity (five levels, from calm to fearful), and to range on a non-affective perceptual dimension (five levels, from centered to tilted). Participants judged either the amount of affect or tilt of the faces. Even though the fearfulness of the expression was irrelevant to judging the tilt, participants on average took longer to judge a face's tilt as the fearfulness of the face increased, suggesting that affectively salient information interfered with task goals. Moreover, the degree to which individuals' response times slowed correlated significantly with their trait anxiety scores, suggesting that one's ability to exert cognitive control to ignore affective information was more disrupted for individuals with high trait anxiety. Tracking the behavioral effects, neuroimaging results showed that increasing fearfulness while judging tilt elicited activation of the prefrontal cortex and deactivation of the insula and that regions of the prefrontal cortex were less active for individuals with high trait anxiety when completing this task. These results support current themes in the field suggesting that ignoring salient affective information may rely on prefrontal regions to down-regulate the responses of affective sensitive regions and that anxiety interferes with this regulation.

I-19

NONCONSCIOUS FEAR IS RAPIDLY ACQUIRED AND FORGOTTEN Candace Raio, *New York University*; David Carmel, *New York University*; Marisa Carrasco, *New York University*; Elizabeth A. Phelps, *New York University*-Threatening stimuli can gain preferential access to affective processing, eliciting fear-related physiological and neural responses even when presented outside of awareness. It remains unclear, however, whether an entirely new fear association can be acquired without awareness of the conditioned stimuli. Here, two groups of participants underwent classical fear conditioning. One group was aware of the conditioned stimuli, while the other had the same conditioned stimuli suppressed from awareness using a technique called continuous flash suppression (CFS), in which images presented to one eye are rendered invisible by salient dynamic stimulation of the other eye. One suppressed stimulus (CS+) was occasionally paired with a mild shock, whereas the other (CS-) was never paired with shock. We found significantly greater responding to the CS+ in both groups, although

the temporal pattern of this learning differed. Robust differential fear learning was observed early in the acquisition session for unaware participants, but only during late acquisition for aware participants. A second experiment investigated whether this nonconscious learning would persist one day later. We found that fear associations can develop outside of awareness, and that the magnitude of this learning does not differ significantly from that of conscious fear learning, but unlike conscious conditioned fear that develops and is known to persist over time, nonconscious conditioned fear is acquired rapidly and quickly diminishes. Thus, the initial orienting response that allows a stimulus to be associated with threat may not require awareness, but the formation of a stable association that endures over time does.

I-20 ★

THE ANXIETY-REDUCING POWER OF BELIEF: CONTEMPLATING BELIEF SYSTEMS IS ASSOCIATED WITH LOWER ERN AMPLITUDE Alexa

Tullett, *The University of Toronto*; Aaron Kay, *Duke University*; Michael Inzlicht, *The University of Toronto*-Uncertainty makes us anxious. It is often suggested that belief systems are adaptive because they provide an explanation for the events that occur in our lives – they assure us that the world is not a random place. In three studies, we explored the link between belief systems and neuroaffective markers of anxiety. In the first study, religious participants were brought into the lab and were asked to either write about what their religion means to them, or to write about their favorite season (a pleasant but non-religious control condition). Afterwards, participants completed a computerized reaction-time task while their brain activity was monitored using electroencephalography (EEG). In particular, we focused on a brainwave known as the error-related negativity (ERN), which occurs when people make mistakes. The amplitude of the ERN reflects, in part, people's emotional reactions to their errors, and can thus be seen as an index of anxious reactivity. We found that participants who wrote about their religion had significantly smaller ERNs than those who wrote about a season, suggesting that religious beliefs can have anxiety-reducing effects. In a second study, we investigated whether implicit religious primes would have the same effects, and also whether these effects would extend to non-religious people. Participants completed a word-scramble task that included either religious words (i.e. "divine" or "prophet") or neutral words. For religious participants, the results replicated our findings from Study 1, showing that implicit religious primes were associated with reduced ERN amplitudes compared to control primes. For non-religious subjects, however, the religious primes had the opposite effect, causing greater ERN amplitude relative to control primes. These findings suggest that religious belief systems may be comforting, but only for those who subscribe to them. In our third study, we aimed to explore whether belief systems that are not explicitly

religious might also have anxiety-reducing effects. Participants read one of three passages expressing the following ideas: 1) things happen for a reason that we are capable of comprehending, 2) things happen for a reason that is beyond our comprehension, and 3) things happen randomly. Subsequently we assessed ERN amplitude during a computerized reaction-time task. We found that when participants were told that events in the world happen randomly they had higher ERNs relative to participants who read about an orderly world. Taken together, these findings suggest that belief systems, whether religious or not, that enforce the orderliness of the world we live in can shield us from anxiety.

I-21

GUM CHEWING INHIBITS THE PROPAGATION OF STRESS-RELATED INFORMATION IN A BRAIN STRESS NETWORK

Hongbo Yu, Peking University; Xi Chen, Peking University; Jinting Liu, Peking University; Xiaolin Zhou, Peking University- Stress is prevalent in human life and threatens both physical and mental health. Coping with stress therefore is of great importance in survival and well-being. Gum chewing has been proven by both behavioral and physiological studies to be an effective way of mitigating stress. Two kinds of mechanism have been proposed for this function: gum chewing improves attention and cognitive functions and thus helps the chewers to concentrate on the task and ignore the stressor; alternatively, gum chewing has positive influences on mood regulation during the processing of stressor, alleviating the experienced stress (Scholey, 2008; Scholey et al., 2009; Smith, 2009a, 2009b). However, the neural basis of the anti-stress functions of gum chewing is not clear. Here we used loud noise as an acute stressor and investigated how stress is relieved by a popular coping behavior, namely, gum chewing. In a functional magnetic resonance imaging study, we presented participants with noise and asked them to rate their feeling of stress under gum chewing and no chewing conditions. The participants generally felt more stressful when hearing noise, but less so when they were chewing gum. The bilateral superior temporal sulcus (STS) and the left anterior insula (AI) were activated by noise and the activity showed a positive correlation with participants' self-report of stress feeling. Critically, gum chewing significantly reduced the noise-induced activation in these areas. Psychophysiological interaction (PPI) analysis showed that the functional connectivity between the left AI and the bilateral STS and that between the left AI and the anterior cingulate cortex (ACC) were increased by noise to a less extent when the participants were chewing gum than when they were not chewing. Dynamic causality modeling (DCM) analysis demonstrated that gum chewing inhibited the connectivity from the STS to the AI. These findings demonstrate that gum chewing relieves stress by attenuating the sensory processing of external stressor and by inhibiting the propagation of stress-related information in the brain stress network.

I-22

STUDY OF SEX DIFFERENCE TO A PSYCHOSOCIAL STRESS RESPONSE:

A NEUROPSYCHOPHYSIOLOGICAL PERSPECTIVE

Annie Duchesne, McGill University; Cory Cooperman, McGill University; Jens C Pruessner, McGill University- Background: An important condition of health and well-being is determined by our adaptability. Physiologically, adaptation can be characterized by the synchronized and coordinated activation of endocrine and autonomic stress systems. Sex and gender are preponderant modulating factors of the stress response. Differences between men and women's stress response have been reported at the neural, physiological and psychological levels, however the directionality of these differences often varies according to paradigm use, menstrual cycle assessment and varying stress biomarkers. The main goal of the current study was to assess sex and gender differences in stress responses by systematically looking at neural, physiological and psychological measures. Methods: Men (n=16) and groups of women in either the follicular (n=21) or luteal (n=14) phase of their menstrual cycle (mean age 20.5 years) were exposed to the Montreal Imaging Stress Task (MIST). The MIST consisted of two sessions of 12 minutes of challenging arithmetic tasks in which the success rate is maintained at 25–40%, while the subject is told to expect 80 a 90% correct answers. The perception of failure to the task was supplemented by direct evaluative feedback provided by an investigator in between the two sessions. Salivary cortisol and alpha amylase (AA, a biomarker of the autonomic nervous system) were measured throughout the experiment, together with pre and post task self esteem. All subjects were scanned in a 3 T Siemens Magnetom scanner. Results: Neuroimaging results will be presented at the conference. Endocrine stress response revealed a significant effect of time ($F(2.349,112.738) 9.789 p < 0.01$) where cortisol levels 15, 30 and 45 min after task initiation were significantly higher compared to baseline levels (all $p < 0.05$). Levels of AA revealed a significant time by group interaction ($F(5.837,140.099) 2.447 p = 0.029$) where men had decreased levels of AA as opposed to the two groups of women who showed an increase in AA levels 15 min after task initiation (all $p < 0.05$). Analysis of the area under the increase (AUCi) for AA levels revealed a significant effect of group ($F(2,51) 6.285 p = 0.004$); pairwise comparisons demonstrated that women in their luteal phases produced larger increase in AA levels in response to the stress paradigm compared to both groups (all $p < 0.05$). A significant reduction in perceived social self esteem was also observed following task exposure ($F(1,27) = 13.139, p = 0.001$). Interestingly, a significant correlations emerged between physiological and psychological stress variables only in the group of men, where AA AUCi was negatively related with social self esteem scores following the task exposure ($r = -.622 p = 0.01$). Conclusions: The current study will provide insightful information on the relation between physiological and psychological stress processing at the neurological levels. To this point, physiological and

psychological variables revealed that all groups were significantly stressed by the procedure. While moderate group differences were found between groups, significant relation between psychophysiological stress measures seemed to be strictly observed in men. This systematic approach allows a better understanding of sex differences on the stress response.

I-23

THE EFFECT OF ACUTE STRESS EXPOSURE ON NEURAL CORRELATES OF PAVLOVIAN CONDITIONING

Andrea H. Lewis, Rutgers University; Anthony J. Porcelli, Marquette University; Meredith P. Johnson, Rutgers University; Mauricio R. Delgado, Rutgers University- While much is known about the neural circuitry associated with Pavlovian conditioning, there is some ambiguity as to how this pattern of activation changes when learning occurs under stress. Past research suggests that stress may enhance (e.g. Shors et al., 1992) or impair (e.g. Wolf et al., 2009) conditioning, and its effect may vary as a function of gender (Stark et al., 2006; Wood & Shors, 1998). The current study was designed to examine the effect of acute stress exposure on Pavlovian conditioning using secondary reinforcers. The task utilized a between-subjects design, such that half of the participants were exposed to cold stress and the remaining participants were exposed to a no-stress control procedure. Cortisol samples were obtained immediately prior to each stress or control procedure application. During the task, participants were shown four different geometric shapes (conditioned stimuli, CS), each of which was paired with a specific financial outcome. Outcomes varied with respect to valence (i.e. monetary gain or loss) and magnitude (i.e. high or low magnitude). A partial reinforcement procedure was used such that participants received a financial outcome on 50% of the trials; in the remaining 50% of trials the CS was paired with no outcome. At the end of each of each block, participants rated their liking of each CS on a 4-point Likert scale. Behavioral ratings provided confirmation that participants correctly learned the valence and magnitude of the CS-outcome contingencies, although rate of learning did not differ between the stress and no-stress groups in an initial sample. Preliminary neuroimaging data suggest that BOLD signal differs as a function of acute stress exposure when processing CS associated with monetary gain and loss. A magnitude effect was also present such that acute stress led to an increase in BOLD signal in affective learning regions of the brain including ventral striatum and amygdala when viewing a CS associated with high monetary gain as compared to low monetary gain. Future analyses will focus on temporal changes in BOLD signal as a function of learning and acute stress exposure.

I-24

NONCONSCIOUS ORIENTING OF ATTENTION TO THREAT IS ASSOCIATED WITH VARIATION IN THE SEROTONIN TRANSPORTER GENE *Joshua M. Carlson, State University of New York at Stony Brook; Lilianne R.*

Mujica-Parodi, State University of New York at Stony Brook; Eddie Harmon-Jones, Texas A&M University; Greg Hajcak, State University of New York at Stony Brook- The capture of spatial attention by environmental threat is a central component of the fear response. This attention bias to threat is so strong that it occurs even when awareness has been restricted through the use of backward masking. However, research suggests that unrestricted/unmasked and restricted/masked threat cues modulate spatial attention through different mechanisms: disengagement and orienting, respectively. The serotonin transporter gene polymorphism (5HTTLPR) has been linked to one's allocation of attention to unmasked threat signals. Yet, the association between the 5HTTLPR gene and nonconscious biases to masked threat is unknown, and it is unclear if such biases might be driven by facilitated orienting or delayed disengagement. Fifty-one participants were genotyped (41 Short allele carriers and 10 homozygous long individuals) and performed a dot-probe task with backward masked fearful and neutral faces. Fearful-neutral, neutral-fearful, or neutral-neutral faces were simultaneously presented (33ms) to the left and right of fixation and immediately masked by happy faces (100ms). A dot then appeared either on the left or right of the screen and participants responded to the location of the dot. This dot could either be spatially congruent or incongruent with the fearful face. Average reaction time differences between congruent and incongruent trials reflect participants' overall capture of attention by nonconscious threat. Differences between congruent and neutral-neutral trials reflect orienting effects, while differences between incongruent and neutral-neutral reflect disengagement effects. A post-task awareness check confirmed that processing of these faces was below the level of conscious awareness. Fifty out of 51 participants performed at chance in this task. Only those performing at chance we used for dot-probe analysis (40 S-carrier and 10 LL). Dot-probe results suggest that backward masked fearful faces captured spatial attention in short-allele carriers of the 5HTTLPR and this capture of attention was driven by a nonconscious orienting to threat. Conversely, homozygous long individuals tended to direct attention away from masked fearful faces. Thus, the short allele of the 5HTTLPR appears to be a mechanism in which spatial attention is automatically shifted toward nonconscious threat signals. This rapid shifting of attention to threat is adaptive; however, excessive negative attention bias is associated with anxiety. In contrast, the long allele may act to promote resilience to stress and anxiety by biasing one's attention away from nonconscious threats.

I-25

TAKING ACTION IN THE FACE OF FEAR: INDIVIDUAL DIFFERENCES IN HUMAN ACTIVE AVOIDANCE *Katherine A. Collins, Mount Sinai School of Medicine; Michael A. Canete, Mount Sinai School of Medicine; Christopher K. Cain, Nathan Klein Institute for Psychiatric Research, New York University; Daniela Schiller, Mount Sinai School of Medicine-* Background: Active avoidance learning

(AA) is the acquisition of behavior that minimizes exposure to danger. Most rodents exhibit AA, but some display only automatic fear reactions (freezing). AA deficits are associated with an “anxious” phenotype in animals. Patients with anxiety disorders often exhibit excessive inhibitory avoidance behavior, but the relationship between anxiety and AA in humans is unclear. To understand why some people can take action while others are “paralyzed” when faced with fear, we aimed to create a task that permitted observation of inter-individual variability in human AA. **Methods:** During the experiment, participants moved a marker within a virtual game-board divided into two compartments by a narrow “bridge”. Every three seconds, a lightening bolt image would appear if the player had not crossed the “bridge” in that time period. The bolt was paired with mild electric shock in one third of trials. To avoid all bolts and shocks, a participant had to cross the “bridge” two times per trial. **Results:** Our task successfully identified “good” and “poor” performers in a sample of 28 healthy volunteers. “Good” performers made significantly more avoidance responses than “poor” performers, who evinced slower reaction times in late versus early trials. “Poor” performers reported significantly higher levels of state and trait anxiety. **Conclusions:** We developed a novel probe of human AA that is the first to identify a subset of poor performers who report significantly higher levels of anxiety. Future studies may elucidate the neural mechanisms of both AA and anxiety disorders.

I-26

THE NEURAL CORRELATES OF PERSONALITY BASED MOTIVATED BEHAVIOR. *Tal Gonen, Tel Aviv Sourasky Medical Center, Tel Aviv University; Eran Eldar, Princeton University; Talma Hendler, Tel Aviv Sourasky Medical Center, Tel Aviv University-* Motivation is a psycho-behavioral concept regarding the drive to facilitate or inhibit behavior in response to environmental incentives and threats. Basic motivation tendencies were theorized to be mediated by specific brain nodes including the Nucleus Accumbens (NAc), facilitating response to gains; and the Peri Aqueductal Grey (PAG) and amygdala, facilitating response to threat and losses. These behavioral tendencies were further conceptualized as core personality traits of Sensitivity to Reward (SR) and to Punishment (SP). However, since reinforcements (both appetitive and aversive) carry the hedonic value of pleasure (i.e. ‘liking’), along with motivational value of incentive (i.e. ‘wanting’), it is not fully clear which of these reinforcing attributes is reflected by the corresponding personality traits. This study aimed to extract the neural correlates of intentional motivated response to reinforcements (i.e. incentive motivation) and elucidate the relation between the neural activation of key regions related to these motivational processes and the SR/SP personality traits. We conducted an fMRI study among healthy participants, using a novel competitive computer game which was constructed to manipulate approach and avoidance tendencies. The goal of the game is to catch money coins (reward), and to avoid

of red balls (punishment). Additionally, uncontrolled events of random rewards and punishments allowed for separation of intentional, incentive motivational processes from unintentional (hedonic) neural response to random rewards and punishments. Following the scan, subjects filled the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). In order to functionally identify our pre-determined regions of interest (ROIs): PAG, amygdala and NAc; a whole brain General Linear Model analysis including four regressors (controlled and uncontrolled reward and punishment events) was conducted. Spearman correlation was calculated between regressors of controlled reward/punishment and SR/SP trait scores. We found that the activation of the key motivational ROIs during controlled events was differentially related to the motivational personality traits: for the PAG, during rewarding events activation increased with higher SP scores ($r=0.593$, $p=0.033$), whereas during punishment, increased activation was associated with lower scores in SR ($r=-0.649$, $p=0.016$). For the NAc, increased activation during rewarding events was associated with higher RS scores ($r=0.526$, $p=0.0325$), while at the same time these higher RS scores were also associated with decreased activation of the amygdala during punishing events ($r=-0.845$, $p<0.001$). Our results suggest that personality traits of motivation differentially relate to neural responses to the ‘wanting’ attribute of reward and punishment in previously indicated motivation systems. As expected, the PAG correlated with sensitivity to punishment, even during rewarding events, supporting the idea that activity in a threat system mediates such tendency. However, an opposite relations were observed for Nacc and Amygdala, presumably nodes of different motivation systems, with regard to sensitivity to reward. This suggests that the balance between these regions determine the overall personality tendency toward potential gains. Our results unveil the neural underpinnings of individual differences by applying a mechanistic rather than a descriptive approach.

I-28

ENDOCRINE, NEURAL, AND PSYCHOLOGICAL RESPONSES TO SOCIAL EVALUATIVE THREAT IN A SUBCLINICAL DEPRESSION SAMPLE *Katarina Dedovic, University of California, Los Angeles; Veronika Engert, Max Planck Institute Leipzig; Annie Duchesne, McGill University; Sonja Damika Lue, McGill University; Julie Andrews, McGill University; Simona I. Efanov, McGill University; Thomas Beaudry, McGill University; Jens C. Pruessner, McGill University-* Depression has been associated with maladaptive psychological and endocrine responses to social stressors. However, it is unclear whether this pattern of dysregulation is present prior to onset of clinical depression. The present study aimed to investigate whether healthy young adults with varying levels of depressive tendencies, at a subclinical level, may already show dysregulation of the subjective and endocrine stress response and the corresponding regulatory neural networks, when exposed to a mild

psychosocial challenge. Based on depression scores derived from standard questionnaires, healthy young adults were sorted into a control (N=27), a subclinical (N=23), or a high-risk subclinical group (N=9). The subjects completed two runs of the modified Montreal Imaging Stress Task (MIST), which combines mental arithmetic task with social evaluative threat (SET). The participants also completed state social and performance self-esteem measures pre- and post-MIST, and provided saliva samples for cortisol analysis throughout the testing session. Analysis of self-esteem data revealed that, in all participants, performance self-esteem levels significantly decreased following the MIST ($F(1,53)=15.2, p<.001$). With respect to cortisol, there was a tendency for a time x group interaction, $F(4.6, 121.05)=2.08, p=.08$, and a significant group effect ($F(2,53)=3.63, p=.03$). Analysis of group differences in endocrine and neural data showed that the subclinical group had an overall lower cortisol output during the testing session ($p=.046$), and a greater change in signal intensity in the right occipital lobe in response to SET (cluster thresholded, $p<.05$ corrected), compared to the control group. Furthermore, the control and the subclinical group showed significant deactivation in the medial orbitofrontal region in response to SET processing (cluster thresholded, $p<.05$ corrected), which was absent in the high-risk subclinical group. The present findings suggest that while all subjects internalized negative feedback (by showing a decrease in performance self-esteem), subclinical and high-risk groups did show differential endocrine and neural patterns compared to the control group and to each other in response to the MIST session. Although the lack of cortisol stress response in controls limits interpretation of findings, the results seem to suggest that dysregulation of both the endocrine profile and neural networks involved in processing of SET may be present even prior to onset of clinical levels of depression.

I-29

CONTRIBUTIONS OF SOCIAL ANHEDONIA AND SOCIAL ANXIETY TO IMPAIRED SOCIAL ADJUSTMENT IN THE PUTATIVE SCHIZOPHRENIA PRODROME Victoria Cressman, Columbia University; Scott Schobel, Columbia University; Sara Steinfeld, Columbia University; Shelly Ben-David, Columbia University; Scott Small, Columbia University; Holly Moore, Columbia University; Cheryl Corcoran, Columbia University-
BACKGROUND: Poor social function is a core characteristic of schizophrenia and its risk states, yet it is poorly understood and refractory to treatment. In this study, we examined trait anhedonia as assessed with the Chapman scale, as well as social anxiety, as processes potentially contributing to social impairment in the schizophrenia risk syndrome. We also explored potential neural correlates of social adjustment and its affective component processes. **METHODS:** In 50 patients at clinical high risk (CHR) for psychosis and 29 age- and sex-appropriate healthy controls, we measured social adjustment (Social Adjustment Scale Self-Report Scale;

Weissman et al, 1976), social and physical anhedonia (Chapman Revised Physical and Social Anhedonia Scales; Chapman et al., 1976) and social anxiety (Social Anxiety Scale for Adolescents; LaGreca et al., 1998). In a subgroup of 14 CHR patients from whom high spatial resolution functional magnetic resonance imaging data was available, we assessed correlations between these psychological measures and basal metabolic activity (as indicated by cerebral blood volume) in striatal subregions, the amygdala and related basal forebrain, and the orbitofrontal and subcallosal cingulate cortices, all nodes of circuits hypothesized to mediate reward processing and/or learned and generalized fear. **RESULTS:** Relative to healthy controls, CHR patients showed significantly poorer social adjustment, higher social and physical anhedonia, and higher social anxiety, exhibiting levels comparable to those observed in schizophrenia patients. Regression models revealed total anhedonia predicted social adjustment impairment. Anhedonia was significantly and negatively correlated with basal metabolic activity states within orbitofrontal cortex and the anterior caudate. **DISCUSSION:** Both anhedonia and social anxiety are prominent in patients at high clinical risk for schizophrenia. Trait anhedonia may be a particularly informative core phenotype which, independent of symptoms, predicts social impairment. The current study provides a rationale for targeting these processes and activity in related paralimbic frontal corticostriatal circuits in interventions for the psychosis risk syndrome. Drs. Holly Moore and Cheryl Corcoran are joint senior authors for this presentation.

I-30

AFFECT REACTION TIME AND RESTING STATE ANTERIOR CINGULATE CORTEX ACTIVITY LEVEL IN VETERANS WITH AND WITHOUT POST TRAUMATIC STRESS DISORDER (PTSD) Francis Stevens, Emmanuel College; Cortney McCormick, W. G. (Bill) Hefner Veterans Affairs Medical Center; Robin Hurley, W. G. (Bill) Hefner Veterans Affairs Medical Center; Courtney Haswell, Durham Veterans Affairs Medical Center; Rajendra Morey, Durham Veterans Affairs Medical Center; Katherine Taber, W. G. (Bill) Hefner Veterans Affairs Medical Center-
 Previous research has shown that anterior cingulate cortex (ACC) appears to be under activated in PTSD (Etkin & Wager, 2007). The anterior cingulate cortex lies in the medial wall of each cerebral hemisphere, beneath the frontal lobe and considered to be part of the limbic lobe positioned above amygdala and adjacent to the corpus callosum. The ACC is considered to be involved in the regulation of emotion generated in limbic system areas (Etkin, et al 2006; Ochsner, et al 2002). Individuals with PTSD show difficulty maintaining sustained attention (Vasterling, et al 2002), and this inability maintain constant attention has been seen across most all PTSD studies (Bremner, 2004). The ability to attend and focus is considered to be a primary function of the ACC (Weissman et al, 2005). Research further suggests that ACC is specifically important in attending to and

processing of emotional stimuli (Pannu-Hayes et al 2009). It is hypothesized that Veterans with PTSD will show marked deficits in reaction time to emotional stimuli, when general reaction time is controlled for. The study consists of forty-nine VA enrolled OEF/OIF combat Veterans deployed after September 11, 2001. Subjects completed The Structured Clinical Interview for DSM-IV Diagnoses-I (SCID-I), a Reaction Time (RTI) test of simple response speed, and the Affective Go-No Go (AGN) a task in which words of positive, negative or neutral valence are rapid presented and the subject must respond to the word valence. Positron Emission Tomography and Magnetic Resonance Imaging data were acquired for a future region of interest analysis of the ACC. Results hope to show that PTSD not only inhibits attention, but the ability to process and respond to emotional stimuli as marked by a deficit in overall ACC activity.

I-31 ★

FUNCTIONAL BRAIN NETWORKS IN AUTISM SPECTRUM DISORDER IN DIFFERENT ATTENTIONAL STATES

P. Barttfeld, Laboratorio de Neurociencia Integrativa, Buenos Aires; B. Wicker, Aix-Marseille University; S. Cukier, FLENI, Buenos Aires; S. Navarta, Laboratorio de Neurociencia Integrativa, Buenos Aires; J. Calvar, FLENI, Buenos Aires; R. Leiguarda, FLENI, Buenos Aires; M. Sigman, Laboratorio de Neurociencia Integrativa, Buenos Aires- Background: Interoception is our sensitivity to stimuli originating inside of the body. As humans, we perceive feelings from our bodies that relate our state of well-being, our energy and stress levels, our mood and disposition, all of which seem to be impaired in ASD. Anatomical and functional brain studies have converged to the hypothesis that ASD is associated with atypical connectivity, producing a system that is ineffective for integrating complex information at the neural and cognitive level. For instance, task positive (TPN) and task negative (TNN) functional brain networks of ASD and normal subjects have qualitatively different intrinsic organization, with abnormal connectivity in the TNN but not in the TPN in ASD. It remains however unexplored if the TPN differentiates whether the task involves directing attention internally (interoception) or externally. Objectives: We reasoned that brain network organization during interoceptive states may show more pronounced differences between groups and hence constitute a precise physiological signature of ASD. To examine this hypothesis we measured functional connectivity in three different mental states varying the focus of attention of the subjects. Methods: Participants included 12 individuals with high-functioning autism or Asperger's Syndrome matched to a group of 12 typically developing individuals. Whole brain fMRI data were acquired with a GE HDx 3T scanner. Rest run : subjects lie eyes closed in the scanner. Introspective run : subjects had to count the number of their breathing cycles. Exogenous Run : subjects had to detect and count beeps (target) with a little higher pitch among others. Classic functional

connectivity and network characterization using graph theory metrics were performed. Using graph theory metrics as characteristics of ASD and Control groups, we further performed a classification analysis, based on ROC curves. Results: Network changes between groups in the interoceptive and exteroceptive states showed opposite effects, revealing that inferences about connectivity in ASD are state-dependent. ASD functional networks largely vary across conditions: in the exogenous run, the analysis of ASD brain network reveals sub-optimal metrics, suggesting that it is badly suited for this kind of task. As attention shifts to self, ASD brain networks improve their metrics - even surpassing those of Controls'- suggesting that ASD networks reaches its optimum capabilities in those cognitive states related to introspective tasks and body perception. While network measures decode whether a patient belongs to the ASD or normal group at a modest performance of 60%, comparing how network parameters change with state achieves very accurate decoding performance (90%). Conclusions: Connectivity analysis revealed consistent and organized differences in functional connectivity between ASD and control groups, suggesting that a distinct pattern of dynamical connectivity may be related to the physiopathology of ASD. ASD process interoceptive information just as they process external information, without adapting information processing to the fact that the signal comes from their own body, possibly caused by an altered capacity to self awareness. This results may have important behavioural consequences : ASD individuals may exaggeratedly focus on internal physical sensations that tend to automatically elicit anxiety and panic, leading to inappropriate emotional reactions.

I-32

ENHANCED ELECTROCORTICAL RESPONSES TO FACIAL EXPRESSIONS OF EMOTION IN PSYCHOPATHY

Pedro R. Almeida, University of Porto; Fernando Ferreira-Santos, University of Porto, UCL Institute of Child Health; Joana B. Vieira, University of Porto, Georgetown University; Pedro Moreira, University of Porto; Fernando Barbosa, University of Porto; João Marques-Teixeira, University of Porto- Psychopathy has been related both to impairments in processing of facial affect and amygdala dysfunction. However, self-report findings have not clearly established the relation between degree of psychopathy and ability to process facial expressions of emotion. In the present work we have characterized the early event related responses (N170 and Early Frontal Positivity- EFP) to pictures of facial emotion, according to degree of psychopathy. Participants viewed angry, disgusted, fearful and happy expressions matched in arousal, plus low arousing neutral faces. We controlled for the use of magno-/parvocellular-based processing by manipulating the spatial frequency in which stimuli were displayed. Participants with a higher degree of psychopathy showed enhanced N170 and EFP responses. Effects of emotional category were found on the N170 and the EFP, but these effects were not dependent on the

degree of psychopathy. These findings question the assumption of facial emotion processing impairments in psychopathy. Given the well documented association between psychopathy and abnormalities in amygdala function, these results suggest the presence of a modulation of cortical activity by facial expressions of emotion, independently of amygdala functioning. We consider the role of such mechanisms in the aetiology of the psychopathic phenotype.

I-33

EFFECTS OF SUBTHALAMIC DEEP BRAIN STIMULATION IN THE RECOGNITION OF EMOTIONAL PROSODY: A PET STUDY IN PARKINSON'S DISEASE

Julie Péron, University of Rennes, University of Geneva; Florence Le Jeune, University of Rennes, Centre Eugène Marquis; Florent Lalys, University of Rennes; Pierre Jannin, University of Rennes; Sascha Frühholz, University of Geneva; Jean-François Houvenhagel, University of Rennes, Hôpital Pontchaillou, CHU de Rennes; Thibaut Dondaine, University of Rennes, Hôpital Pontchaillou, CHU de Rennes, CH Guillaume Rognier; Sophie Drapier, University of Rennes, Hôpital Pontchaillou, CHU de Rennes; Paul Sauleau, University of Rennes, Hôpital Pontchaillou, CHU de Rennes; Claire Haegelen, University of Rennes, Hôpital Pontchaillou, CHU de Rennes; Bruno Millet, University of Rennes, CH Guillaume Rognier; Didier Grandjean, University of Geneva; Marc Vérin, University of Geneva, Hôpital Pontchaillou, CHU de Rennes- The recognition of emotions is impaired following subthalamic nucleus (STN) deep brain stimulation (DBS) in Parkinson's disease (PD) [1-3]. These changes have been linked to a disturbance in the STN's limbic territory, which is thought to be involved in emotional processing. In the facial modality, this was confirmed by PET studies where these emotional modifications were correlated with changes in glucose metabolism in different brain regions, including the amygdala and the orbitofrontal regions [4]. Recently, it has been shown, at the behavioural level, that these emotional changes induced by STN DBS in PD were also present in the vocal modality [2]. Nevertheless, the brain region sustaining these emotional prosody recognition modifications has yet to be identified. Accordingly, the aim of the present study was to investigate the effects of STN DBS on emotional prosody recognition of PD patients and to correlate emotion modifications with changes in glucose metabolism. To this end, we conducted 18FDG-PET scans in 30 PD patients in pre- and post-STN DBS conditions and correlated changes in their glucose metabolism with modified performances on an original emotional prosody paradigm [2, 5]. Two different patterns of emotional performances were identified in post-operative condition. A first sub-group of PD patients (N=17) showed increase of their emotional judgement in post-operative whereas the second sub-group (N=13) decreased their performances in post-operative condition. Regressions showed that the best predictors explaining these two patterns of results was the depression score in the "increase" sub-group, and the location of the contact

electrodes in the "decrease sub-group". As far as the metabolic results are concerned, in the "increase" sub-group on the one hand, there were correlations between decreased cerebral glucose metabolism and increase of emotional prosody recognition performances in the left fusiform gyrus (BA 20) ; there were correlations between increased cerebral glucose metabolism and increase of emotional prosody recognition performances in the left insula (BA 13), and the left inferior frontal gyrus (BA 47). On the other hand, in the "decrease" sub-group, there were correlations between decreased cerebral glucose metabolism and impairment of emotional prosody recognition in the right gyrus temporal superior (BA 22) and the left cerebellum; there were correlations between increased cerebral glucose metabolism and impairment of emotional prosody recognition in the right inferior frontal gyrus (BA 47), the right orbitofrontal cortex (BA 10) but also in the right somatosensory cortex (BA 6). These results confirm that the impaired recognition of emotions after STN DBS is not specific to the visual modality but may also be present when emotions are expressed through the human voice, and STN DBS modulates a distributed network known to subtend emotional prosody processing, implying the involvement of STN in this network.

1. Péron et al., *Neuropsychology*, 2010. 24(1): p. 1-8.
2. Péron et al., *Neuropsychologia*, 2010. 48(4): p. 1053-62.
3. Péron et al., *PLoS One*, 2010. 5(3): p. e9919.
4. Le Jeune Péron et al., *Brain*, 2008. 131(Pt 6): p. 1599-608.
5. Péron, J., et al., *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 2011. 35: p. 987-996.

I-34

EMOTION REGULATION STRATEGIES PREDICT SYMPTOM FLUCTUATIONS IN SCHIZOPHRENIA

Beverly E. Pozuelos, Harvard University; Elizabeth Langer, Boston University; Laura M. Tully, Harvard University; Christine I. Hooker, Harvard University- Social functioning impairments are well documented in schizophrenia, yet the mechanisms by which they contribute to the exacerbation and maintenance of symptoms remain unknown. Research indicates that effective emotion regulation strategies are mediated by lateral prefrontal cortex (LPFC) function. While LPFC deficits are well documented in schizophrenia, it is unclear how these deficits might relate to self-reported emotion regulation strategies and response to social conflict. The present study examines the relationship between trait-related emotion regulation strategies, daily social interactions, mood and symptoms in a sample of individuals with schizophrenia and matched healthy controls. We used standard self-report questionnaires of emotion regulation strategies including the Dysfunctional Attitudes Scale (DAS) and Cognitive Emotion Regulation Questionnaire (CERQ) and a novel daily diary. In the daily diary, participants reported on interpersonal conflict, mood and symptoms each day for 21 days. Analysis thus far indicates response to conflict relates to symptom level in participants with schizophrenia: high conflict distress and high DAS scores related to worse negative symptoms, and

high conflict distress with lower rumination scores relate to increased auditory hallucinations after conflicts. Future analysis will examine how 1) interpersonal stressful events influence affect and symptoms the same day, and 2) whether LPFC dependent neurocognitive skills predict the influence of social conflict on symptoms. This study could provide valuable insight into the nature of social impairments in schizophrenia.

I-35

COGNITIVE REAPPRAISAL OF EMOTION: A META-ANALYSIS OF HUMAN NEUROIMAGING STUDIES

Jason Buhle, Columbia University; Jennifer A. Silvers, Columbia University; Tor D. Wager, University of Colorado, Boulder; Richard Lopez, Dartmouth University; Chukwudi Onyemekwu, Columbia University; Jochen Weber, Columbia University; Kevin N. Ochsner, Columbia University- Recent years have seen an explosion of neuroimaging studies on the cognitive regulation of emotion. The bulk of these studies have examined the neural bases of cognitive reappraisal, a form of emotion regulation that involves changing the way one thinks about an emotional stimulus in order to change its affective impact. An important but still unresolved question is whether reappraisal relies on cognitive control regions, such as dorsomedial, dorsolateral, and ventrolateral prefrontal cortex (dmPFC, dlPFC, and vlPFC), or emotion-specific control circuits, such as ventromedial PFC (vmPFC), an area associated with fear extinction and emotional learning. Previous work has typically emphasized the amygdala as the primary target of reappraisal, but it is unclear if different reappraisal strategies, affective stimuli and regulatory goals similarly modulate amygdala activity. We performed a meta-analysis of 45 neuroimaging studies of cognitive reappraisal in order to identify common activity across paradigms that differed in terms of strategies (reinterpret or distance), stimuli (positive or negative), and goals (increase or decrease). The implementation of reappraisal consistently activated cognitive control regions (dmPFC, dlPFC, vlPFC), but not emotion-specific control circuits (vmPFC). The amygdala was a primary target of reappraisal across strategy types, but only when decreasing negative emotion. Ventral striatum was a primary target of reappraisal across strategies, stimuli and goals. Taken together, these findings suggest that the cognitive reappraisal of emotion relies upon dynamic interactions between cortical and subcortical networks involved in emotional processing and cognitive control.

I-36

THE NEURAL EFFECTS OF DIVIDED ATTENTION ON COGNITIVE REAPPRAISAL

John A. Morris, Boston College; Elizabeth A. Kensinger, Boston College; Christina M. Leclerc, State University of New York at Oswego - Cognitive reappraisal is an effective emotion regulation strategy that is used to alter one's interpretation of a situation's meaning. Reappraisal is thought to rely on cognitive control to provide flexible interpretation of a situation, a process demonstrated to involve both medial and lateral

prefrontal (PFC) brain regions. Little is known about how cognitive reappraisal processes are affected by the extent of attentional resources available, and how dividing attention may tax prefrontal regions also important for cognitive reappraisal. We analyzed fMRI data from 34 adults (ages 18-35) on a cognitive reappraisal task utilizing positive, negative, and neutral images from the International Affective Picture System (IAPS) database. 16 adults completed the task with full-attention devoted to task performance, and 18 completed the task with divided-attention, using an auditory monitoring task to divide attention. When examining the viewing of emotional images, regardless of regulation condition, there was more recruitment of lateral PFC in the full-attention group and more recruitment of medial PFC in the divided-attention group. When specifically comparing regulation conditions to the view condition, there was an interaction between image valence (positive or negative image) and regulation instruction (increase or decrease emotion) that was present in the full-attention and divided-attention groups: hedonic regulation (i.e., increasing positive or decreasing negative emotion) displayed greater amygdala and visual attention activation than nonhedonic regulation. However, there also was a three-way interaction of valence, instruction, and condition (full or divided attention). This three-way interaction displayed a greater difference between hedonic and nonhedonic reappraisal in the full-attention group than in the divided-attention group in regions of the lateral PFC; preferential lateral PFC recruitment for hedonic regulation occurred in the full attention condition but not in the divided attention condition. Taken together, these results provide evidence of a neural distinction between hedonic and nonhedonic reappraisal, but suggest that this differentiation may be stronger when full attention can be devoted toward reappraisal than when attention is divided by performance of a secondary task. The results also suggest a more lateral-to-medial PFC shift in processing of emotional images as attention is divided, suggesting that lateral PFC recruitment may demand resources that cannot be engaged when attention is divided.

I-37

COMMON NEURAL MECHANISM FOR EMOTION REGULATION AND MOTOR INHIBITION

Torre, J. B., University of California, Los Angeles; Inagaki, T. I., University of California, Los Angeles; Mulvenna, C. M., University of California, Los Angeles; Haltom, K. E. B., University of California, Los Angeles; Stanton, A. L., University of California, Los Angeles; Lieberman, M. D., University of California, Los Angeles- Higher activation in right ventrolateral prefrontal cortex (RVLPFC) has been consistently implicated in emotion regulation processes such as reappraisal, altering the meaning of a stimulus to make it more or less emotionally evocative, and in affect labeling, an unintentional form of emotion regulation that involves applying an affective label to an emotional stimulus. Activation in this region is often found to

correlate inversely to activation in the amygdala, suggesting an inhibitory relationship between these regions corroborated by a reduction in self-reported levels of negative affect. Other domains of inhibition have shown activation in this same region, most notably in studies investigating motor inhibition in a 'Go/No-Go' motor task. Further, there is previous evidence of 'inhibitory spillover' where inhibiting a motor response to stimuli has incidentally inhibited an emotional response. This mounting evidence suggests RVL PFC may play a central role in inhibitory self-control across numerous domains, though to date no systematic research has directly contrasted these multi-domain inhibition tasks. A conjunction analysis between these three tasks (Reappraisal, Affect Labeling, and motor Go/No-Go) in 90 subjects suggests the possibility of RVL PFC as a multi-domain neural inhibitory mechanism.

I-38

REAPPRAISAL OF PERSONAL MEMORIES VIA 'NEUTRALIZING' AND 'POSITIVIZING': IMMEDIATE AND LONG-TERM EFFECTS

Dore, B., Columbia University; Ochsner, K. N., Columbia University- Separate literatures emphasize the importance of coping with negative personal experiences by decreasing negative affect (e.g., via 'self-distancing') or by increasing positive affect (e.g., via 'benefit-finding'). In a behavioural study directly comparing the effects of these two reappraisal strategies, participants (n=96) recalled memories of personal events and then appraised the meaning of these events by focusing on their positive aspects and consequences ('positivize' group), by focusing on their neutral aspects and consequences ('neutralize' group), or by reflecting on the events and their consequences regardless of valence ('reflect' control group). Participants made ratings of positive affect, negative affect, and memory vividness immediately after applying these reappraisal strategies and again in an online follow-up completed at least 1 week after the initial lab session. Confirming our hypotheses, both the 'positivize' and the 'neutralize' strategies led to changes in the immediate affective impact and subjective vividness of personal memories. Results from the 1 week follow-up suggest that, for negative memories, the 'positivize' strategy leads to a lasting increase in positive affect and the 'neutralize' strategy leads to a lasting decrease in negative affect. Additionally, both immediate and long-term effects of the 'positivize' strategy on positive affect ratings were correlated with individual differences in 'promotion focus', as assessed by the Regulatory Focus Questionnaire. These findings shed light on the immediate and long-term impact of these two reappraisal strategies for memories of life experiences and suggest a connection to chronic self-regulatory orientation.

I-39

INCREASES IN FRONTAL CONTROL REGION ACTIVATION DURING EMOTION REGULATION FOLLOWING A MINDFULNESS INTERVENTION

Rebecca D. Calcott, University of Oregon; Lisa M. May, University of Oregon; Jessica M. Tipsord, Lewis and Clark College; Joshua C. Felver-Grant, University of Oregon; Elliot T. Berkman, University of Oregon- Mindfulness meditation practice has been shown to improve emotion regulation abilities, which, in turn are linked to tangible improvements in psychological well-being. A fundamental component of mindfulness training involves learning to maintain a non-judgmental attentional focus in the present moment. The present pilot study examines the neural mechanisms by which mindfulness practice translates into improved emotion regulation, by looking at mindfulness-related changes in neural activation during an emotion regulation task. Sixteen adults (1 male) ages 29-52 completed an 8-week Mindfulness Based Stress Reduction (MBSR) class. Participants took part in weekly 90-minute sessions that included a body scan, sitting meditation practice, and yoga, and were also assigned to practice at home. At baseline and after the final class, participants completed separate experimental sessions in a neuroimaging laboratory, in which they performed an emotion regulation task while their brains were scanned using functional magnetic resonance imaging (fMRI). In the task, participants are instructed to either just look, label, or reappraise neutral and aversive picture stimuli, and rate how much distress they experienced while viewing each item. We examined the change in participants' neural activity during the emotion regulation task from the baseline to the endpoint scanning sessions. Preliminary analyses suggest that activation in frontal control regions during emotion regulation increased as a function of the intervention. This study could lead to a better understanding of the mechanisms by which mindfulness meditation improves emotion regulation abilities and leads to other positive health outcomes.

I-40

SHORT-TERM MEDITATION INDUCES THE FRONTAL CEREBRAL BLOOD FLOW ASYMMETRY

Yi-Yuan Tang, Texas Tech University, University of Oregon- Asymmetry in frontal electrical activity has been reported to be associated with positive emotion. One form of meditation based-intervention, integrative body-mind training (IBMT) improves positive emotion and neuroplasticity. The purpose of this study is to determine whether short-term IBMT induces frontal asymmetry. Brain imaging results showed that five-day (30-min per day) IBMT significantly enhanced cerebral blood flow (CBF) in subgenual/adjacent ventral anterior cingulate cortex, medial prefrontal cortex and insula, and also increased left frontal asymmetry. Our results suggest 2.5 h IBMT changes left frontal CBF at resting state, which may underlie the promotion of positive emotion.

I-41 ★

THE JOYFUL AMYGDALA: THE MOTIVATIONAL SALIENCE OF POSITIVE STIMULI IN TRAIT HAPPINESS

William A. Cunningham, The Ohio State

University; Tabitha Kirkland, *The Ohio State University*- Research in positive neuroscience seeks to understand the neural bases of positive experience. Happiness is not simply the absence of sadness, but rather reflects a positive worldview and a set of motivated processes to foster and maintain positive experience. Indeed, happy people are thought to live their lives wearing “rose colored glasses,” perceptually attending to opportunities and experiences that others may simply miss. To the extent that trait-happy people have an automatic tuning toward positive opportunities, we predict that participants high in trait happiness may not only show reduced amygdala activation to negative stimuli (as they are less sensitive to negativity), but, more critically, will also show the greatest amygdala response to positive stimuli, reflecting a tuning towards positivity. In early work, the amygdala has been understood as a threat detector and amygdala sensitivity has been shown to be associated with individual differences in constructs associated with threat, such as neuroticism and anxiety disorders. Yet, the narrow understanding of the amygdala’s affective function as simply reflecting threat/fear has been expanded, and we have recently proposed the motivational salience hypothesis, which states that the amygdala is sensitive to motivational relevance. According to this view, a primary function of the amygdala is to signal what is important in any particular situation, and then modulate appropriate perceptual, attentional, autonomic, and cognitive/conceptual processes to deal with the challenges or opportunities that are present. To the extent that this is true, the “rose colored glasses” of happy people should result in an increased attention to positive stimuli and an enhanced amygdala response to these stimuli. 50 participants viewed 10-second blocks of positive, negative, and neutral IAPS stimuli during fMRI scanning. Following scanning, participants completed the Subjective Happiness Scale along with several control measures. As expected, participants high in trait happiness showed the greatest amygdala response to positive blocks. These data demonstrate that the amygdala is not simply the origin of negative feeling, but may also help contribute to positive experience and subjective well-being.

I-42

SUBJECTIVE COGNITIVE EFFORT MODULATES ACTIVITY OF THE VENTRAL STRIATUM Ekaterina Dobryakova, *Rutgers, The State University of New Jersey* - Newark; Elizabeth Tricomi, *Rutgers, The State University of New Jersey* - Newark- Goal-directed behavior is driven by reward desirability and by amount of effort required to obtain the goal. Previous neuroimaging work points to a role of the ventral striatum (VS) in coding for reward value, but it is unclear how cognitive effort required to achieve a goal may influence subjective reward value and activity in the VS. Effort-discounting theory states that humans prefer low effort actions that result in high reward; this theory predicts decreased VS activity for rewards acquired with more effort. However, contrast

theory states that an outcome of a more effortful action would be preferred due to a greater contrast between the aversive action and the rewarding nature of the outcome; this theory predicts increased VS activity for rewards acquired with more effort. To test these alternative hypotheses, we used functional magnetic resonance imaging (fMRI) as participants engaged in feedback-based learning that required low (LE) and high cognitive effort (HE) to obtain positive feedback while the objective amount of information provided by feedback remained constant. No significant difference in accuracy was observed between the effort conditions but all participants indicated that the HE condition was more difficult. Increased VS activation was associated with feedback presented during the HE condition relative to the LE condition, when controlling for activation from corresponding control conditions for which feedback was random, rather than based on performance. These results suggest that increased cognitive effort produces corresponding increases in VS activity, in line with the predictions made by contrast theory.

I-43

ROLE OF ENDOGENOUS OPIOIDS FOR HEDONIC CAPACITY TOWARDS SOCIAL AND NON-SOCIAL REWARDS Siri Leknes, *University of Oxford*, *University of Oslo*; Chantal Berna, *University of Oxford*; Irene Tracey, *University of Oxford*-

The enjoyment of everyday rewards such as eating a tasty meal or seeing other people’s smiling faces, is central to mental health. Anhedonia, the inability to experience pleasure from social and non-social rewards, likely reflects dysfunction of the brain’s reward system. Anhedonia is a key symptom of psychiatric disorders such as depression, schizophrenia and drug addiction. Recent neurobiological theories on reward system function parse reward into hedonics and motivation, thought to be based on preconscious ‘liking’ and ‘wanting’. A dissociation between ‘liking’ and ‘wanting’ has been found on the level of neurotransmitter systems, with opioids mediating hedonic ‘liking’ and dopamine underpinning motivational ‘wanting’. The endogenous opioid system has been shown to mediate ‘liking’ of both social and non-social rewards in rodents and primates. However, less is known about the role of endogenous opioids in human reward processing. According to the brain opioid theory of social attachment, opioids may play a greater role for social rewards in primates than in other mammals (Machin and Dunbar, in press, Behaviour). Interestingly, opposite effects of opioids have been reported for motivation of social and non-social rewards. Whilst systemic opioid antagonist treatment decreases ‘wanting’ of non-social rewards such as food, in primates opioid antagonism has been shown to increase wanting of social rewards. Here, we used an opioid antagonist, naloxone, to investigate the role of endogenous opioids for social and non-social hedonic capacity in humans. In a double-blind, placebo-controlled crossover study, we tested hedonic function in twenty healthy volunteers (11 females) using a state visual

analogue scale version of a validated anhedonia questionnaire, the Snaith-Hamilton Pleasure Scale (SHAPS). After treatment with high-dose intravenous naloxone (bolus 0.15 mg/kg followed by infusion 0.2 mg/kg) or placebo, participants rated how much they would enjoy a series of everyday primary rewards (e.g. a cup of tea, a warm bath) or social rewards (e.g. other people's smiling faces). We hypothesised that naloxone treatment would disrupt the normal function of the reward system in humans and cause reduced hedonic capacity. Our results confirm this hypothesis. Although we found no significant effects of naloxone on mood, blockade of endogenous opioid neurotransmission significantly reduced ratings of hedonic capacity (paired t-test, $p=0.006$). This reduction was significant for both primary, non-social rewards ($p=0.02$) and for items relating specifically to social rewards ($p=0.004$). These findings support the idea that human hedonic capacity may be based on preconscious 'liking', which in rats is mediated via opioid-rich 'hedonic hotpots' in the ventral pallidum and nucleus accumbens. Our results also suggest that disruptions in endogenous opioid signalling may underpin anhedonia associated with mental illness. The role of endogenous opioids for social and non-social rewards 'wanting' in humans is investigated in a subsequent, ongoing study.

I-44

NEURAL MARKERS OF INCENTIVE ANTICIPATION ARE ASSOCIATED WITH AFFECTIVE TRAITS

Charlene C. Wu, Stanford University; Gregory R. Samanez-Larkin, Stanford University, Vanderbilt University; Brian Knutson, Stanford University- Early studies using functional magnetic resonance imaging (fMRI) to examine incentive processing in humans identified increased blood oxygenated level-dependent activation in the nucleus accumbens (NAcc) during gain anticipation and the anterior insula during loss anticipation (Knutson et al., 2001). These incentive processing neural responses have recently been linked to individual differences in impulsivity and psychopathy (Buckholz et al., 2010). However, the test-retest reliability of incentive processing activation has been questioned (Fliessbach et al., 2010), implicitly raising concerns about the robustness of links to individual differences. Furthermore, investigations of psychometric validity, or how these neural signals are related to established measures of individual differences, have been limited. All participants ($n = 53$) completed one fMRI session of a monetary incentive delay (MID) task and measures assessing individual differences in emotion and motivation (NEO-5F, AVI, BIS/BAS). Two years later, a subset of these participants ($n = 14$) completed a second fMRI session of the MID task. During the MID task, participants anticipated and experienced the outcomes of six cue types signaling varying amounts of potential monetary gains and losses (± 0.00 , $\pm \$0.50$, $\pm \$5.00$). To examine test-retest reliability of activation, peak individual responses were extracted from both NAcc and anterior insula volumes of interest across the two sessions.

Test-retest reliabilities during gain anticipation in the NAcc and loss anticipation in the anterior insula demonstrated significant test-retest reliability ($ICC \sim 0.6$) for the highest levels of gain and loss ($\$5.00$). Validity analyses examined whether these incentive processing neural signals index general affective factors. Principal components analyses identified two affective factors - "Positive Arousal" and "Negative Arousal" - from individual difference measures. NAcc activation was associated with Positive Arousal but not Negative Arousal ($r = 0.24$), whereas anterior insula activation was associated with Negative Arousal but not Positive Arousal ($r = 0.28$). These findings suggest that incentive paradigms that employ a range of incentives may better establish test-retest reliability of elicited neural activity, that this incentive-elicited neural activity correlates with emotional traits, and that fMRI can be used to index individual differences in incentive processing with potential relevance to decision making.

I-45

THE NEURAL BASIS OF GRATITUDE Qiang Cai,

Peking University; Hongbo Yu, Peking University; Xiaolin Zhou, Peking University- Gratitude is defined as "a positive emotional reaction to the receipt of a benefit that is perceived to have resulted from the good intentions of another" (Tsang, 2006). On the one hand, gratitude is arose from "the admiration of a praiseworthy action (intention) and the joy experienced when that action is desirable (or valuable) to the self" (Ortony et al., 1988) and thus it may function as a social reward; on the other hand, gratitude may function as a buffer against stressful circumstance, mitigating the unpleasant feeling therein (Lyubomirsky et al., 2005). One possible consequence of gratitude is prosocial behavior toward one's benefactor (Tsang, 2006). This study investigated the neural basis of gratitude in social exchange through fMRI. We presented participants with either mild or moderate painful stimulus in each trial. The intensity of the pain stimulus was ostensibly dependent upon whether one of three anonymous confederates shared the pain with the participants. In half of the trials, participants were informed that the Share/NoShare decision was voluntarily made by a partner, while in the other half they were informed that the decision was made by the computer. Following the pain delivery, participants were asked to distribute an amount of money between themselves and their partner for the current trial, with the knowledge that the partner was not informed of this procedure. This served as a measure of the participants' prosocial behavior. Behaviorally, participants allocated significantly more to the partner when the latter voluntarily shared pain than when the decision was made by the computer. When the decision was not to share, not only the amount of money allocated to the partner was significantly reduced, the difference between the two decision makers was also absent. For the neuroimaging data, we focused on the neural processes related to the decision outcome (i.e., Share/NoShare). We found that the

activation in the bilateral caudate was higher when the partner voluntarily decided to share than when the decision was forced. When the decision was not to share, the difference between the two decision makers was absent, indicating that this activation reflects the positive emotion elicited by the intentional helping bestowed by the partner. Moreover, this differential effect in the bilateral caudate correlated with participants' trait gratitude as measured by a questionnaire. Furthermore, the intention-modulated differential effect of BOLD signal extracted from an a priori region of interest within the left caudate (Izuma et al., 2008) predicted the difference in monetary allocation. In contrast, the left insula showed a reversed pattern of interaction, such that less activation was observed when the "share" decision was made by a partner than by the computer. To conclude, we demonstrate that gratitude is encoded in the brain reward circuitry and can reduce the neural responses to unpleasant events in brain structures responsible for processing pain and negative emotions. The neural activity in the reward circuitry may drive the prosocial behavior of the help receivers.

I-46

REMINDER OF DEATH DECREASES ANTERIOR CINGULATE RESPONSES TO THE SUFFERING OF OTHERS

Siyang Luo, Zhenhao Shi, Xiangyu Zuo, Shihui Han - Death-related thoughts influence human behaviors tremendously. However, whether and how reminder of death modulates brain activity underlying human behaviors remains unknown. The current study tested the hypothesis that mortality salience inductions influence the neural activity involved in empathy - a capacity that mediates prosocial behaviors. Using functional MRI we scanned two groups of healthy adults during perception of others in pain before and after priming procedures that induced mortality salience or negative affect. We found that perceived pain in others activated the anterior cingulate/supplementary motor cortex (ACC/SMA), bilateral anterior insula/frontal cortex, bilateral secondary somatosensory cortex, and left middle temporal gyrus. However, mortality salience priming decreased ACC/SMA activity to perceived pain whereas negative affect priming did not influence empathic neural responses. Moreover, subjective ratings of fear of death induced by the mortality salience priming mediated the modulation of ACC/SMA activity and moderated the covariation of ACC and left insular activity in the pre- and post-priming sessions. Our findings indicate that reminder of death decreases human empathic neural responses to perceived pain and this effect is mediated by the fear of death induced by mortality salience.

I-47 ★

ERPS REVEAL RAPID EFFECTS OF THE SELF-POSITIVITY BIAS DURING THE PROCESSING OF SOCIAL VIGNETTES

Eric C. Fields, Tufts University; Camila Carneiro de Lima, Tufts University; Rohan Natraj,

Tufts University; Erich Tusch, Tufts University; Gina R. Kuperberg, Tufts University; Massachusetts General Hospital- People tend have positive associations with their own self-concept: for example, we tend to expect more good things to happen to ourselves than to others and to think that we have more positive traits than others. Most previous work has examined this self-positivity bias using questionnaire methods. It is less clear whether it influences online processing of incoming stimuli. Event-related potentials (ERPs), a direct neural measure with excellent temporal resolution, are an ideal technique to investigate this question. We recorded ERPs while subjects read two-sentence social vignettes in 2nd person (self condition) or 3rd person (other condition) with a positive, negative, or neutral critical word in the second sentence (e.g., 'A man knocks on Sandra's/your hotel room door. She/you see(s) that he has a gift/tray/gun in his hand.'). ERPs time-locked to the critical word showed an interaction between self-relevance and emotional valence due to a reduced negativity within the N400 time-window to positive critical words in self-relevant contexts. This suggests that the self-positivity bias is available online and influences the processing of words at the earliest stages of computing their meaning.

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STRUCTURAL CONNECTIVITY OF VENTRAL ANTERIOR CINGULATE CORTEX AND NUCLEUS ACCUMBENS PREDICTS TRAIT SELF-ESTEEM.

Robert S. Chavez, Dartmouth College; Katherine E. Powers, Dartmouth College; Todd F. Heatherton, Dartmouth College- Though different areas of the prefrontal cortex have been implicated in various components of self-referential processing, the ventral anterior cingulate cortex (vACC) has been found to be most involved in the affective component of evaluation in self-related stimuli. Self-esteem is an evaluative attitude based on the extent to which a person views themselves as favorable and leads them respond to their social world. By definition, individuals with high self-esteem tend to think of themselves with elevated regard, but little work has been to investigate the underlying neural networks that give rise to these attitudes. In the current study, we used diffusion tensor imaging and probabilistic tractography to investigate whether individual differences in the structural connectivity of vACC and nucleus accumbens (NAcc; a putative reward area) would be related to a trait-level measure of self-esteem. Because of the evaluative nature of self-esteem, we hypothesized self-esteem would be related to greater connectivity of NAcc to vACC, but not other regions involved in self-relevant processing or reward (e.g., MPFC, OFC). In a sample of 75 normal subjects, we found a positive relationship between left-NAcc /vACC connectivity and self-esteem. As hypothesized, there were no significant results for any other brain areas. These results provide evidence that the structural connectivity of brain regions involved in processing the affective component of self-relevant

cognition to reward-related areas contributes to individual differences in trait self-esteem.

I-49 ★

HOW DISGUST AFFECTS SOCIAL DECISIONS *May Yuan, William A. Shine Great Neck South High School; Marianne Reddan, Mt. Sinai School of Medicine; Daniela Schiller, Mt. Sinai School of Medicine*- Recent studies suggest that the basic emotion of disgust is involved in more complex human behaviors, such as judgment of morality. Participants primed with disgust, for example, are prone to make harsher moral judgments. People could also be disgusted of neutral cues when these are associated with disgusting stimuli such as bad odors. In this study, we asked whether such “conditioned disgust” could occur for a social other could affect the way we judge this character’s behavior. To examine this question we designed a two-stage paradigm. In the first stage, subjects underwent disgust conditioning using a picture-picture paradigm. One of two fictional characters was paired with disgust-inducing images (CS+), while the other was paired with neutral images (CS-). To assess subjects’ disgust conditioning we measured skin conductance response (SCR), and electromyography (EMG) activation of the levator labii (a facial muscle activated when one is disgusted). We also asked subjects to give an expectancy rating at the beginning of each trial, to determine how negative they expected the image following the character would be. In addition, we asked them to subjectively rate how disgusting they thought the characters were before and after conditioning. In the second stage we examined how our participants would judge the behavior of the character now eliciting a conditioned disgust response (induced in phase I). Subjects were presented with 32 scenarios, each describing either a positive or a negative behavior of one of the two characters from Phase I. For each scenario they judged the moral appropriateness of the behavior, made an attribution as to what caused the behavior (situational or dispositional factors), and rated how much they liked the character. Verifying that disgust conditioning was successful, the results show significantly higher post versus pre conditioning disgust ratings for the CS+, but not for the CS-. This increase in CS+ disgust evaluation was correlated with the difference in expectancy ratings between the CS+ and CS- during the late phase of conditioning, and the expectancy ratings were correlated with EMG levator labii activation. As for the effect of learned disgust on social decision making, we found that disgust conditioning decreased the character’s likeability and moral scores, which was more pronounced in our female participants as compared to the males. Lastly, when we averaged together all scenarios, we found a positive correlation between moral appropriateness and liking. Positive behaviors that were considered dispositional rather than situational tended to have higher morality and liking scores, while negative behaviors that were considered dispositional tended to have lower morality and liking scores than situational negative

behaviors. These results suggest that a disgust response toward a social other could be acquired by way of association, and could affect the way we judge that person’s behavior. Previous studies have identified a disgust-like response toward stigmatized groups such as drug addicts and homeless people. Our findings might point to a mechanism by which such responses are acquired, but they also propose an opportunity to extinguish conditioned disgust and overturn its bias on social decision making.

I-50

THE SELF, THE OTHER AND THE DISGUST: PROBING THE RELATIONSHIP BETWEEN DISGUST AND SELF IDENTITY WITH IMPLICIT ASSOCIATIONS *Uri Berger, Gonda Multidisciplinary Brain Research Center; David Anaki, Gonda Multidisciplinary Brain Research Center, Bar-Ilan University*- Disgust is an intriguing emotion which plays a prominent role in many psychopathologies and inter-group discrimination. In addition, the neural basis of disgust has been studied extensively indicating that several brain mechanisms (e.g., anterior insula) are involved in disgust processing. However, the origins of disgust remain largely unknown. Specifically, it remains unclear how simple mechanisms of distaste, taste aversion and taste neophobia (all found in nature), were structured into the human subjective emotion. Important information regarding this change may be acquired by examining uniquely human mechanisms and their interaction with disgust. One such unique human quality is the ability to differentiate between the ‘self’ and the ‘other’. Humans are almost the only living organisms with ability to self recognize, and which makes a full use of this ability. This self/other differentiation ability may be one of the human qualities which make subjective disgust a rich emotional experience. One outcome of such a relation is a disgust bias toward self or others. This bias has been studied in the past with results indicating a tendency to view the self as less disgusting in comparison to others. For example, it has been shown that subjects prefer their own body odor compared to odor of others. Similarly, mothers prefer the smell of their own child dirty diaper compared to that of a stranger’s child. However, such studies greatest advantage, namely, their natural setting, is also their shortcoming. That is, these studies designs cannot be modified to allow a full retesting with neuroimaging measures, thus preventing a better examination of disgust. The purpose of our presented study is to develop a new methodology using an implicit task. In Exp. 1 16 subjects have participated in an implicit association task (IAT), containing four types of images; disgusting images, pleasant images, family member pictures, and an unknown and different race person pictures. Four linguistic parallel labels were presented as responses; self (family members), other (strangers), disgusting and pleasant. The task examined the amount of incongruence between labels, evident in reaction latencies. Results indicated a large congruency effect; subjects preferred

pairing disgust with the 'other' and pleasant with the 'self'. In Exp. 2 we estimated the emotional intensities associated with the incongruent pairings of self-disgust and other-pleasant. Sixteen subjects viewed superimposed images comprised of two images from four categories (self/disgust, self/pleasant, other/disgust, other/pleasant) and responded on separate trials to either the image's social (self/other) or valence (disgust/pleasant) features. For example, a participant viewed an image of her mother superimposed over a unflushed toilet and was requested to reply either who is presented (self/other) or what is presented (disgusting/pleasant). Our results indicate that participants found it easier to attribute pleasantness to the other than disgust to the self. These results underscore the magnitude of emotional aversiveness that occurs when the self is contaminated with a disgust provoking stimuli. The current study has both practical and theoretical implications which may constitute a new vantage point of the neural basis of disgust.

I-51

AROUSAL AND VALENCE ARE DIFFERENT COMPUTATIONS OF THE SAME UNDERLYING INFORMATION. *Assaf Kron; Daniel H. Lee; Ariel Goldstein; Violetta Krichovski; Busisiwe Ncube; Cherry Chan; Greta Cosgrove; Samandeep Brar; Aaron Prosser; Adam K. Anderson-* Emotional experience is often mapped onto two separate, independent axes of valence (i.e., pleasant vs. unpleasant) and arousal (i.e., activated vs. calm). This arousal-valence model (AVM) of emotion has become the default assumption for the structure of emotional experience in psychology and neuroscience. In the present work we show that the assumptions of the AVM have been over extended—that valence and arousal are not separate components but different computations of the same underlying information. Empirical support for the AVM of emotion comes from a double dissociation that involves skeletomotor response as indexed by corrugators' Electromyography (EMG) response and sympathetic autonomic response as indexed by electrodermal activity (EDA). Corrugator EMG activity was found to be highly correlated with valence judgments but not with arousal judgments. EDA response to emotional stimuli were found to be correlated with judgments of arousal but not with valence (Lang et al., 1993). In this work we suggest that this dissociation is an artifact of the AVM using bipolar rather than independent valence scales. In two experiments participants viewed emotional pictures while EMG and EDA were measured. In addition participants were rated their feelings according to the AVM and independent pleasant and unpleasant feelings. The two experiments are similar to each other except that different versions of the independent pleasant and unpleasant feelings were used. The results of two experiments demonstrate that (a) bipolar valence and arousal ratings do not reflect different sources of information, rather both can be computed from independent unipolar judgments of pleasant and unpleasant feelings; (b) contrary to previous conclusions that valence is related to corrugator's EMG

response while arousal is related to EDA, when estimated by independent judgments of pleasant and unpleasant feelings, valence alone predicts EMG and EDA to the same degree as separate valence and arousal judgments. These results we suggest valence and arousal are one in the same, or more specifically, arousal and valence are different computations of the same bits of information. The model we proposed claims that every emotional phenomenon that can be explained by judgments of arousal, may be explained by independent judgments of pleasant and unpleasant feelings.

I-52

ROLE OF SUBGENUAL ANTERIOR CINGULATE CORTEX IN SHIFTING AFFECTIVE STATE AND VAGAL TONE *Lane, R.D., University of Arizona; Weidenbacher, H., University of Arizona; Fort, C., University of Arizona; Thayer, J.F., Ohio State University; Allen, J.J.B.-* We tested the hypothesis that subgenual anterior cingulate cortex (sgACC) participates in concurrently regulating shifts in both affective state and vagal tone. Eleven healthy adults (6 women, mean age 23.1 years) performed the Emotional Counting Stroop (counting the number of words on the screen) in alternating 15-second blocks of emotion words and neutral words. We measured the absolute value of change between adjacent 15-second blocks in both high frequency heart rate variability (vagal tone) and the absolute value of change in BOLD signal in specific regions of interest using a 3.0 T GE scanner. Strong positive correlations were observed between changes in vagal tone and changes in BOLD signal in sgACC (BA25) (right: $r=.67$, $p<.02$; left $r=.69$, $p<.02$) and left BA47 ($r=.68$, $p<.02$), key structures in the medial visceromotor network. Correlations with change in vagal tone were not significant in dorsal or rostral ACC or dorsolateral PFC. These data suggest that as exteroceptive stimuli are evaluated for emotional significance by a network of structures including BA25, a change in affective state occurs that is automatically supported by a concomitant change in autonomic tone. These findings may have implications for the unvarying mood and vagal dysfunction associated with depression.

I-53

ADDITIONAL EVIDENCE TOWARD THE CATEGORICAL PERCEPTION OF EMOTIONS IN FACIAL EXPRESSIONS AND ITS DYNAMICS *Fernando Barbosa, University of Porto; Joana B. Vieira, University of Porto, Georgetown University; Pedro R. Almeida, University of Porto; Fernando Ferreira-Santos, University of Porto; João Marques-Teixeira, University of Porto-* In this study we investigated the nonlinear properties of the emotional processing of facial expressions, aiming to obtain additional evidences regarding the continuous Vs. categorical models of emotional processing, and also the bimodal perception of the same facial expressions, depending on the subject's previous experience. Selecting pictures of six models/actors from the NimStim Face Stimulus Set (Totenham et al., 2009) we created six

morphed continua between opposite prototypical expressions (happiness and sadness) and manipulated the order of presentation of the stimuli in each continuum (randomized, from happiness to sadness, and vice-versa). Thirty healthy participants, 15 male and 15 female, performed a forced-choice task, where they were instructed to identify each facial expression as “happy” or “sad”. The response curves of each condition were derived from the participants’ accumulated responses in each picture frame, either for happiness or sadness. The results yielded an effect of the order of presentation on the point of change from one emotion to the opposite, with a sudden shift between emotions (represented by a sigmoid curve), which supports the thesis of categorical processing of emotional information. Moreover, we have verified the phenomenon of bimodality in the identification of facial expressions that are in the vicinity of the turning point between emotional categories. These findings support the presence of nonlinear properties in the processing of emotional information from facial expressions.

I-54

FACIAL EMOTION RECOGNITION AFTER SMOKED COCAINE AND LEVODOPA-CARBIDOPA-ENTACAPONE ADMINISTRATION IN REGULAR COCAINE SMOKERS Gillinder Bedi, NYSPI, Columbia University; Nehal P. Vadhan, NYSPI, Columbia University; Edward V. Nunes, NYSPI, Columbia University; Richard W. Foltin, NYSPI, Columbia University; Adam Bisaga, NYSPI, Columbia University- Facial emotion recognition is altered by drugs that affect serotonergic (5-HT) neurotransmission. For instance, 3,4-methylenedioxymethamphetamine (MDMA; ‘ecstasy’, which acts primarily on the 5-HT system) acutely reduces fear identification in healthy humans; whereas selective 5-HT reuptake inhibitor (SSRI) antidepressants either increase or decrease fear identification, depending on whether dosing is acute or chronic. In contrast to the literature on 5-HT, relatively little is known about the role of dopaminergic (DA) signaling in perception of facial emotion. However, patients with schizophrenia and those with Parkinson’s Disease (PD), disorders characterized by increased and decreased DA function respectively, have impairments in social function and specifically in facial affect processing, suggesting a role for DA in facial emotional recognition. The purpose of this study (part of a broader program investigating the therapeutic potential of DA enhancement for cocaine abuse) was to study the individual and combined effects of two dopaminergic agents, Levodopa-Carbidopa-Entacapone (LCE) and smoked cocaine, on recognition of facial emotion in cocaine users, under controlled laboratory conditions. Eleven healthy non-treatment-seeking cocaine smokers (10 male; 1 female) who reported smoking cocaine on average 3.3 (SD = 2.8) days per week and spending \$176.40 (SD = \$151) on cocaine weekly completed this 10-day inpatient within-subjects study. Participants underwent two 5-day phases in which they were maintained on LCE (400mg/100mg/200mg) or placebo, with the order of

medication condition counterbalanced. On day 4 of each phase, participants completed facial emotion recognition testing without cocaine administration; on day 5 of each phase they completed the facial emotion recognition test after smoking 5 doses of cocaine within 60 minutes. Facial emotion recognition was measured with a variant of the computerized Facial Emotion Recognition (FER) task previously shown to be sensitive to serotonergic drugs. The FER measures accuracy of identifying fearful, angry, sad, and happy faces morphed in 10% gradients from a neutral expression to the full emotion. There was a main effect of LCE on recognition of fear faces ($p = 0.05$), with accuracy decreased on LCE relative to placebo. There was no effect of LCE on recognition of sad, happy, or angry faces, or on reaction times. No main effects of cocaine or interactions between cocaine and LCE were observed. These data indicate that increasing DA neurotransmission by administration of LCE, the direct precursor of DA, decreases accuracy of fear recognition in regular cocaine users. This is broadly consistent with a decrease in bilateral amygdalar response to emotional faces previously reported in both healthy participants and non-depressed PD patients after levodopa. Converging evidence indicates that DA neurotransmission modulates facial emotion recognition. However, these effects appear to be complex, with effects potentially relating to the mechanism and extent of the alteration to DA signaling, and both decreases and increases in DA transmission disrupting optimal function. This research was supported by NIDA grant 09236.

I-55

COMPETITION OF FACIAL EXPRESSIONS AND VISUAL SCENES - FEARFUL FACES BROADEN ATTENTION TO POTENTIAL THREAT Matthias J. Wieser, University of Würzburg; Andreas Keil, University of Florida- Facial expressions are of utmost importance for social interaction as they convey important information about others’ social intentions and emotions. In the laboratory, perception of facial expressions is typically investigated by presenting isolated face stimuli. In everyday life, however, faces are rarely seen without surrounding visual context, which most likely influences perception and interpretation of the facial expression. Indeed, recent research suggests that threatening visual context enhances processing of fearful faces, but might also enhance encoding of faces per se. Moreover, fearful faces seem to lead attention to peripheral cues in order to effectively detect potential threat in the environment. From a competition point of view, faces and surrounding visual contexts also compete for attentional resources. Thus, enhanced attention to faces may come at cost of perception of visual context. In the present study, we used steady-state visual evoked potentials (ssVEP) methodology together with frequency tagging (i.e. simultaneously flickering multiple stimuli at multiple frequencies) to examine competition between facial expressions (fearful, neutral, happy) and affective visual context (pleasant, neutral, unpleasant). By assigning two

different frequencies (12 vs. 15 Hz) to the face and the visual context scene, it is possible to separate cortical activity to competing stimuli and thus disentangle attentional engagement to the face versus the context stimuli. 20 participants watched flickering faces overlaid on visual scenes, while high-density EEG was recorded from 128 sensors. Participants were instructed to attend to the faces, only. In a second run, participants were instructed to rate the valence and arousal of the faces presented in the different visual contexts. SSVEP analysis revealed that happy facial expressions received most attentional resources regardless of the background, and arousing background scenes were generally associated with larger ssVEP amplitudes. However, when fearful facial expressions were shown, unpleasant visual context scenes elicited larger mean ssVEP amplitudes compared to other backgrounds. The face-sensitive N170 amplitude was largest for fearful faces, without any influence of visual context. Independent effects of facial expressions and visual context scenes were found for affective ratings of faces embedded in visual context. Together, these findings suggest that the visual context does not matter when happy faces are attended. In contrast, fearful faces seem to elicit vigilance for potential threat cues and thus enhance processing of unpleasant context. These findings further illustrate the signal character of facial expressions of fear, which leads to enhanced vigilance for potential sources of threat in the environment.

I-56

THE ERP MICROSTATES OF FRUSTRATION Steven R. Green, *Indiana University*; Kevin D. Schwartz, *Indiana University*; Sharlene D. Newman, *Indiana University*- One difficulty in studying affective states in EEG is identifying relevant signals indicative of an emotional state. For example, identifying EEG signals that suggest the presence of a negative affective state, such as frustration, can prove to be very challenging. Recent advances in microstate analysis have provided an avenue to find affective states in the EEG data by revealing topographic states thought to reflect moments of quasi stable processing in the brain (Murray, 2008). The current study employed this analysis to identify microstates related to the processing of frustration. According to frustration theory the omission of an expected reinforcer leads to the transitory aversive experience of frustration (Amsel 1994); thus, to manipulate frustration negative reinforcers were omitted. Subjects performed a task in which they had to identify the correct stimulus in order to avoid having to repeat an aversive task. Since reinforcers represent avoiding the repetition of an aversive task, the omission of them likely elicits frustration. During the experiment we recorded EEG using a high density system and analyzed the resulting data to identify microstates unique to the processing of reward omission. After combining reward omission and reward reception in order to define a topographic map over a 1000 ms period beginning with onset of feedback, segmentation analysis identified 17 unique microstates. Using the topographic template maps,

we derived a measure of global explained variance (GEV) and time duration for each microstate by fitting each subject to the template map according to each condition. Results of the GEV measure revealed three microstates that better fit segments of the subject data during the processing of reward omission while time frame analysis showed four states had a longer duration as compared to the reward reception condition. The GEV analysis also revealed one microstate which significantly better fit data in the reward reception condition while time frame analysis indicated two different microstates with significant longer durations in reward reception as compared to reward omission. Since it has been argued that reward omission leads to frustration, several of the microstates which uniquely fit the reward omission data may reflect neuronal processing associated with frustration. Furthermore, the microstate that uniquely fit the reward reception data may reflect affective processes akin to relief for not having to repeat the aversive task. The current study provides a preliminary attempt at identifying neural markers which reflect processing of negative affect. Future studies should develop effective means of tracking frustration which can then be used in a correlation to better determine which microstates may be involved in processing negative affect.

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THE DEPENDENCE OF FAMILIARITY AND RECOLLECTION PROCESSES ON THE AFFECTIVE PROPERTIES OF STIMULI Hugo Sousa, *University of Porto*; Mariana Pereira, *University of Porto*; Tiago Paiva, *University of Porto*; Pedro R. Almeida, *University of Porto*; Fernando Barbosa, *University of Porto*; João Marques-Teixeira, *University of Porto* - The prioritization of the processing of information with high motivational value has been extensively documented in the literature. Event Related Potential studies tend to demonstrate that both highly arousing and unpleasant stimuli elicit more attentional allocation (e.g., Carretie et al., 2004; Cuthbert et al., 1998; Schupp et al., 2004) at various points in the information processing stream. This allocation of resources is sought to, among other processes, facilitate the storage in memory of information of motivational value (Warring & Kensinger, 2011) and its subsequent recall (Kensinger & Schacter, 2007). However, the influence of the emotional characteristics of the stimuli may operate in distinct modes on the various components of the memory retrieval process. On the present study we have characterized the influence of emotional valence in memory processes, by relying on an ERP protocol. We have characterized the FN400 component, involved in familiarity (e.g., Rugg et al., 1998), and the Late Positive Complex (LPC) that has been related with recollection (e.g., Curran, 2000). Thirty-four young adult male participants were exposed to visual emotional stimuli, rated as Pleasant, Neutral or Unpleasant from the International Affective Picture System (IAPS) and were later asked to identify images that has been displayed, shown among new distracters. The ERP responses to the Old and Distracter stimuli were

analyzed in trials in which correct responses were obtained. For the FN400 there was an effect of novelty ($F(1,33) = 8.22$; $p = 0.007$) on mean amplitude, with Old pictures eliciting higher FN400 than Distracters. For the LPC there was a Valence by Novelty interaction ($F(2,66) = 4.38$; $p = 0.016$), with a novelty effect remaining only for Unpleasant pictures. These results suggest the presence of a mechanisms for familiarity detection operating independently of the emotional valence of the stimuli. In contrast, higher order recollection processes seem to be sensitive to the motivational properties of the material to be recognized.

I-58 ★

EFFECTS OF SLEEP AND TIME OF DAY ON EMOTIONAL MEMORY RETRIEVAL: EVIDENCE FROM FMRI

Kelly Bennion, Boston College; Elizabeth Kensinger, Boston College; Jessica Payne, The University of Notre Dame- Purpose: Emotion has long been known to have an enhancing effect on memory [1]. When emotional objects are presented as part of a scene, they are selectively enhanced, and this enhancement becomes intensified over time [2]. The sleeping brain is thought to provide the optimal neurochemical environment for memory consolidation, preserving memory for emotional objects and resulting in a shift from engagement of a diffuse to a more refined memory retrieval network [2]. With sleep research, it is also important to investigate circadian effects on emotional memory to determine if these contribute to differences in activity and memory performance after a delay spent asleep or awake. The present study examines neural engagement on emotional memory retrieval as a function of the time of testing (morning, evening) and study-test delay length (20-min, 12-hrs). Procedure: Participants viewed 124 scenes consisting of a negative or neutral object on a neutral background, prior to a recognition test during fMRI. Sleep participants studied the images in the evening, prior to

sleep, while Wake participants studied in the morning and were tested in the evening (~12-hour delay for both groups). Circadian control participants were tested on the images in either the morning or evening, after a 20-min delay. Results: A contrast comparing Hits to studied objects to Correct Rejections to novel objects defined several regions of interest (ROI), which were unbiased with regard to the effect of object valence (negative, neutral), delay length (20-min, 12-hr) and time-of-testing (morning, evening). An ANOVA was computed on the parameter estimates extracted from the ROIs, with the dependent variable being the difference in activity between hits and misses to studied objects. ROIs in the anterior and dorsolateral prefrontal cortex (-30 62 6; 52 28 26), inferior and middle temporal gyrus (58 -40 -10; -66 -36 -2), and orbitofrontal cortex (24 42 -12) showed a significant interaction ($p < .05$) between delay length (20-min, 12-hr) and time-of-testing (morning, evening). Keeping time-of-testing constant, activity in the anterior PFC, OFC, and inferior temporal gyrus increased as a function of delay length only when the delay interval included time awake (Wake > Circadian-PM, all $t(28) > 2.33$, $p < .027$); Sleep = Circadian-AM, all $t(26) < 1.60$, $p > .12$). Additionally, activity in the anterior PFC, dlPFC, and OFC differed as a function of time-of-testing after a short delay (Circadian-AM > Circadian-PM, all $t(21) > 2.24$, $p < .035$). Conclusions: These results suggest that after a period of sleep, the memory retrieval network may be refined, consistent with Payne & Kensinger (2011). Additionally, a novel finding is a potential circadian effect on memory, with Circadian-AM participants showing greater anterior and dlPFC and OFC activity than Circadian-PM participants, independent of stimuli valence. This effect is dampened with a long study-test delay, suggesting that circadian effects may contribute to changes in the memory retrieval network for negative and neutral information.

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