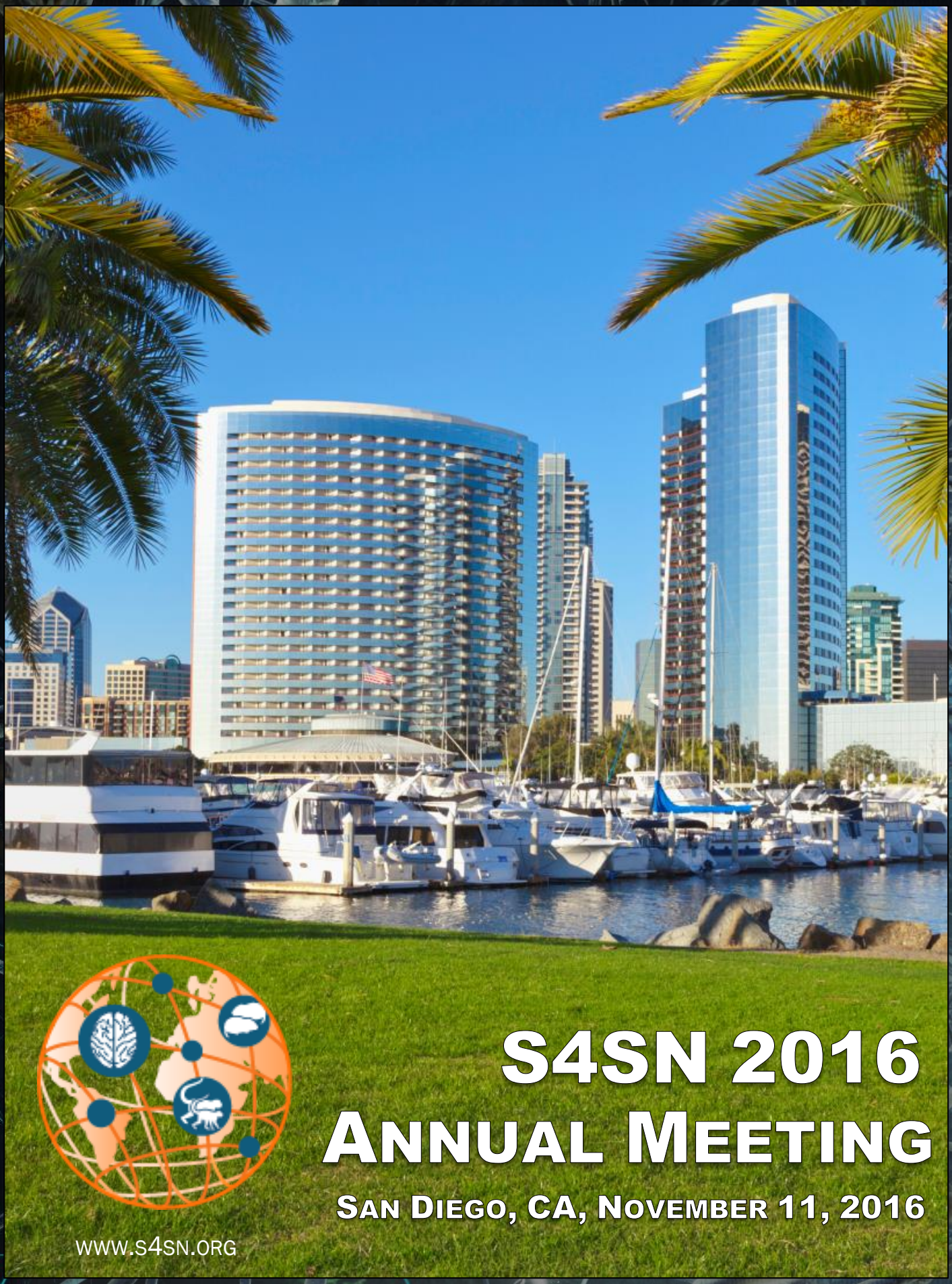

S4SN 2016
Annual Meeting

San Diego, CA, November 11, 2016

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S4SN is happy to announce that our Society is now affiliated with the journal *Social Neuroscience*, published by Taylor and Francis. We believe that this affiliation will benefit our Society and encourage our members to submit manuscripts to Social Neuroscience.

The 2016 Annual Meeting of

The Society for Social Neuroscience

The Society for Social Neuroscience is an international interdisciplinary, non-profit, scientific society established to advance and foster scientific research, training, and applications.

Table of Contents

S4SN 2016 Annual Meeting
San Diego Marriott Marquis and Marina Hotel

S4SN 2016 Annual Meeting I Program Overview

Schedule Friday, November 11, 2016

8:00 am — 6:30 pm	Onsite Registration & Pre-Registration Check In
8:30 am — 7:00 pm	Exhibits on Display
8:55 am — 9:00 am	**Welcoming remarks** by **Larry Young,** President
9:00 am — 10:00 am	**Keynote Address: Michael Platt**, "How We Connect: The Biology of Friendship"
10:00 am — 10:20 am	Coffee Break
10:20 am — 11:35 am	**Symposium 1**: Social signaling facilitating social interaction across the mammalian order: from behavior to the underlying neural mechanisms. Chair: *Anat Perry*
10:20 am — 10:35 am	S1.1 **Yossi Yovel**, "Long-term social foraging bonds in bats"
10:35 am — 10:50 am	S1.2 **Emily Rothwell**, "Coordinated signals: Assessing psychophysiological linkage in a non-human primate model of adult romantic attachment bonds"
10:50 am — 11:05 am	S1.3 **Anat Perry**, "Don't stand so close to me: Preferred interpersonal distance from a social neuroscience perspective"
11:05 am — 11:20 am	S1.4 **Daniel Kennedy**, "Using complex video stimuli to elucidate cognitive and neural dysfunction in individuals with autism"
11:20 am — 11:35 am	S1.5 Panel Q & A
11:35 am — 1:00 pm	Lunch Break (*On your own*)
1:00 pm — 2:00 pm	**Poster Session A**
2:00 pm — 3:15 pm	**Symposium 2:** The Neurobiology of Dynamic Social Interactions. Chair, *Olga Dal Monte*
2:00 pm — 2:15 pm	S2.1 **Laura Harrison**, "Using Live Face-to-Face Functional Magnetic Resonance Imaging to Investigate the Social Brain in Autism"
2:15 pm — 2:30 pm	S2.2 **Aldo Genovesio** , "Neural activity related to the prediction of others' action in the medial frontal cortex of primates in a human-monkey interactive task"
2:30 pm — 2:45 pm	S2.3 **Karen Haroush**, "A Framework for Studying the Neuronal Basis of Interactive Social Behavior"
2:45 pm — 3:00 pm	S2.4 **Olga Dal Monte**, "Coordination of Prefrontal and Amygdala Neurons During Social Decision-making"
3:00 pm — 3:15 pm	S2.5 Panel Q & A
3:15 pm — 3:55 pm	**Novel Approaches and Methodologies**
3:15 pm — 3:35 pm	**John O'Doherty**, "The social computational brain: how the brain learns from and makes inferences about others"
3:35 pm — 3:55 pm	**Kay Tye**, "A cortico-amygdala circuit encodes observational fear learning"

S4SN 2016 Annual Meeting | Program Overview Cont.

3:55 pm — 4:15 pm	Coffee Break
4:15 pm — 5:30 pm	**Symposium 3:** What do we learn about the social brain by adding sex as biological variable? Chair, *Alexa Veenema*
4:15 pm — 4:30 pm	S3.1 **Nirao M. Shah**, "Nature and nurture: modular genetic and social control of sexually dimorphic behaviors"
4:30 pm — 4:45 pm	S3.2 **James Rilling**, "Sex differences in the effect of intranasal oxytocin on human brain activity in social interactive contexts"
4:45 pm — 5:00 pm	S3.3 **Alexa Veenema**, "Sex differences in the brain prevent sex differences in social behavior"
5:00 pm — 5:15 pm	S3.4 **Ragini Verma**, "Sex Differences in the Structural Connectome in Development, Behavior and Pathology "
5:15 pm — 5:30 pm	S3.5 Panel Q & A with **Janine Simmons** (NIMH)
5:30 pm — 6:00 pm	**Early Career Award Talks**
5:30 pm — 5:45 pm	**Jamil Zaki,** "Empathy: Connecting neuroimaging to real-world behavior"
5:45 pm — 6:00 pm	**Steve Chang,** "Supralinearly modulating social gaze dynamics with oxytocin under opioid antagonism"
6:00 pm — 7:00 pm	**Poster Session B & Social Hour Reception**

S4SN 2016 Annual Meeting I Keynote Address

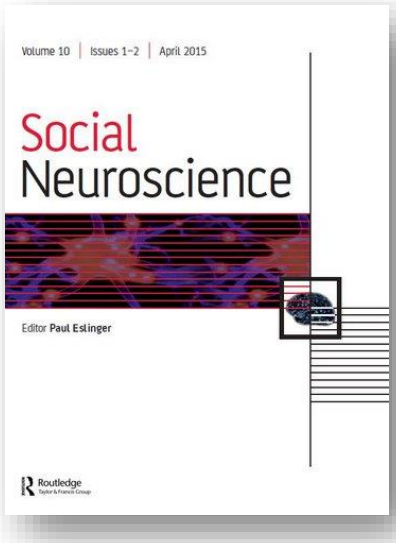
Taylor and Francis *Social Neuroscience* Keynote Address 9:00-10:00 am, Friday, November 11, 2016, San Diego Marriott Marquis and Marina Hotel, Marina Ballroom Salon G

Michael Platt
University of Pennsylvania

"What is Social About Social Neuroscience?"

We all need friends. Deeper and more numerous friendships promote health, well-being, survival, and even financial success. By the same token, social exclusion and the loss of social partners result in feelings similar to physical pain. Impairments in the ability or motivation to connect with others profoundly impact the lives of individuals with disorders like autism and shizophrenia. Yet despite its importance, the formalized scientific study of friendship is relatively new, perhaps due to the perceived difficulty of studying social behavior in the laboratory using the techniques of modern neuroscience. In my talk, I will discuss our work aimed at defining the biological mechanisms that mediate our ability and desire to connect. We directly compare biology and behavior in humans and rhesus macaques, using a complementary suite of brain imaging, eye-tracking, single-unit recording, pharmacological, and genetic techniques, in both the laboratory and the field. Our work has identified specialized circuitry that motivates attention to others, responds to cues to their intentions, and promotes prosocial decisions. The neuromodulators oxytocin and serotonin tune the gain of these circuits to regulate social interactions. In the field, we find that variation in social behavior and cognition has fitness consequences and emerges, in part, from genes that regulate neuromodulatory function. Together, our findings suggest deep homologies in the biological origins of complex social function in human and nonhuman primates.

S4SN 2016 Annual Meeting sponsored by



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S4SN 2016 Annual Meeting I Symposium

SYMPOSIUM 1

SOCIAL SIGNALING FACILITATING SOCIAL INTERACTION ACROSS THE MAMMALIAN ORDER: FROM BEHAVIOR TO THE UNDERLYING NEURAL MECHANISMS.

Friday, November 11, 10:20—11:35 am, Marina Ballroom Salon G
Chair: Anat Perry, PhD.
Speakers: Yassi Yovel, Emily Rothwell, Anat Perry, Daniel P. Kennedy

Social relationships are constantly affected by social signals, such as behavioral cues (e.g. eye gaze, personal space, sounds) or physiological cues (e.g. hormones, heart rate). Both animals and humans use these cues to signal threat in some situations and friendship, attraction, or intimacy in others. With evidence from neuroimaging, lesion studies, pharmacological and physiological measures in controlled laboratory settings as well as realistic real-world situations, this symposium will characterize the neural and physiological mechanisms underlying social communicative signaling across the mammalian order from colonies of fruit-bats and titi monkeys to healthy humans and clinical populations.

ABSTRACTS

Long-term social foraging bonds in bats.
Yossi Yovel, PhD., Department of Zoology and Sagol School of Neuroscience, Tel-Aviv University

Bats are extremely social mammals. They often roost in colonies of thousands of individuals exhibiting vast social communication, but very little is known about their social structure. We studied the social dynamics of two fruit-bat colonies over a full year, observing thousands of interactions. We found that fruit-bats differ in their individual foraging strategies with some bats collecting their own food and others scrounging it from food owners. Bats also exhibited long-lasting social-feeding bonds between specific pairs and long lasting social avoidance bonds between other pairs. We analyzed the social vocalizations of our colony and found that they convey rich information about the sound emitter and the context of the emission. The bat colony is thus a complex social network, with stable and flexible social bonds. We are now using on- board EEG recordings to search for the neural correlates of these behaviors in free-flying bats.

Coordinated signals: Assessing psychophysiological linkage in a non-human primate model of adult romantic attachment bonds
Emily Rothwell, Animal Behavior Graduate Group, University of California, Davis;

High quality relationships reliably promote psychological well-being and physical health, whereas diminished or lack of social support conveys detrimental effects. Cardiovascular regulation via the autonomic nervous system (ANS) is a candidate mechanism by which social relationships can exert these dually beneficial effects. Psychological theories suggest that adults in romantic attachment bonds benefit from a consistent social system for co-regulating and mounting coordinated ANS responses to the environment, represented by interdependent physiological signals, such as linkage across ANS activity in relationship partners. Recent evidence in humans suggests more satisfied couples display stronger ANS linkage. To experimentally evaluate ANS linkage and relationship quality I study titi monkeys (Callicebus cupreus) as non-human primate model of adult romantic attachments. I will present a multifaceted behavioral test that evaluates variability in relationship quality among titi monkey pairs, from which we find that different behavioral components of mammalian social monogamy play differentially important roles across relationship tenure. Further I will present psychophysiological data collected via ambulatory ECG monitors worn by the titi monkey pairs while roaming freely in their captive environment. I will discuss preliminary data that addresses the connection between ANS linkage and relationship tenure and quality. I will further discuss potential implications for individuals suffering neurobiological disorders characterized by social deficits (i.e. autism spectrum disorders, schizophrenia), which may limit patients' abilities to build and maintain enduring social bonds.

Don't stand so close to me: Preferred interpersonal distance from a social neuroscience perspective
Anat Perry, PhD, Department of Psychology and Helen Wills Neuroscience Institute, University of California, Berkeley

The space between people creates and defines the social

dynamics of our interactions with others. Although different between cultures, within each culture interpersonal distance is implicit but clearly felt, especially if one stands closer or farther than expected. To determine the biological and environmental mechanisms that shape interpersonal behavior, I employ an integrative approach combining neuroimaging, pharmacological and behavioral measures in healthy and clinical populations. I will present evidence supporting the idea that interpersonal behavior is influenced by a combination of early sensory mechanisms with high-level understanding of social norms. Behavioral results and EEG data show that early attentional processes, such as sensory sensitivity, affect interpersonal distance preferences in healthy individuals and in individuals with Autism Spectrum Disorder. The contribution of complex social cognition is suggested by a demonstration that patients with lesions to the orbitofrontal cortex demonstrate a lack of interpersonal space, as well as by the modulation of this behavior by social anxiety levels. Implications for clinical populations will be discussed.

Using complex video stimuli to elucidate cognitive and neural dysfunction in individuals with autism

Daniel P. Kennedy, PhD, Department of Psychological and Brain Sciences, Indiana University Bloomington

Neuroimaging studies of psychiatric and neurological disorders have overwhelming adopted reductionist approaches, which use highly simplified experimental conditions to isolate specific cognitive processes and their dysfunctional neural underpinnings. Yet, these reductionist approaches generally fail to capture the inherent and emergent complexity of real-world situations as encountered "in the wild", where stimuli and events are dynamic, unconstrained, unstructured, history-dependent, etc. Recently, we have been using more complex stimuli (i.e., television sitcoms, movie trailers) that better reflect some of these key aspects of the real world, together with neuroimaging methods, in order to investigate which cognitive processes and neural systems are particularly dysfunctional in individuals with Autism Spectrum Disorder (ASD) in more ecologically valid contexts. In this presentation, I will first demonstrate how surprisingly specific neural and cognitive abnormalities can be revealed when using this type of complex and free-flowing stimuli. Second, I will demonstrate how this approach is uniquely positioned to provide important new insight into understanding the biological and behavioral heterogeneity that is characteristic of ASD, and of neurodevelopmental and psychiatric conditions more generally. I will conclude by discussing strengths and limitations of this approach, along with important methodological considerations.

SYMPOSIUM 2

THE NEUROBIOLOGY OF DYNAMIC SOCIAL INTERACTIONS

Friday, November 11, 2:00 —3:15 pm, Marina Ballroom Salon G

Chair: Dr. Olga Dal Monte

Speakers: Laura Harrison, Aldo Genovesio, Keren Haroush, Olga Dal Monte.

This symposium highlights recent work in primates and humans investigating the neural mechanisms involved in social interaction, social attention, and social decision-making. This proposed symposium converges on the same overarching question: What is the neurobiology underlying dynamic and contingent social interaction? The speakers will address this question using novel experimental designs studying several forms of prosocial behaviors and a wide range of methodological approaches, including single-cell electrophysiology, pharmacology, and functional MRI. Together, the proposed speakers will shed new light on the neural mechanisms involved in the neurobiology of complex and dynamic social behaviors.

ABSTRACTS

Using Live Face-to-Face Functional Magnetic Resonance Imaging to Investigate the Social Brain in Autism

Dr. Laura Harrison, University of Southern California Brain & Creativity Institute

A large literature, primarily using picture and video stimuli, documents abnormal processing of faces and gaze in autism. Yet, pictures and real people are likely processed in quite different ways, which may be dissociatively impaired in autism. We investigated how the neural response to gaze in autism changes as a function of the live presence of another person. We employed a novel fMRI paradigm using a live person sitting behind the bore of the magnet as a stimulus. Distinct patterns of neural activation were seen in individuals with autism compared to controls for live but not recorded gaze. In some regions, notably the inferior frontal gyrus, neural activity correlated with autism severity. That visually-matched, but contextually-distinct stimuli only differentially modulated neural activity in controls (1) supports an account of impaired top-down social processing in autism, and (2) highlights the utility

of ecologically valid methods, including interactive paradigms, for social cognitive neuroscience.

Neural activity related to the prediction of others' action in the medial frontal cortex of primates in a human-monkey interactive task
Dr. Aldo Genovesio, Sapienza University of Rome

We studied the representation of other's action using a nonmatch-to-goal spatial task in which the monkeys' task was to choose in each trial the target at a different location than the previously chosen one. The monkeys interacted with human agents and their trials were intermixed. Each agent, when acting as observer, was required to monitor the other actor's choice to switch target location in case it became the actor on the following trial. We found a neural representation in the medial frontal cortex including the dorsomedial prefrontal cortex, the pre-supplementary and supplementary motor areas of the human agent's actions in the delay preceding his action indicating a role of these areas in the prediction of others' actions.

A Framework for Studying the Neuronal Basis of Interactive Social Behavior
Dr. Keren Haroush, Harvard Medical School

Social interactions are a fundamental part of many animal societies, and are increasingly more elaborated and sophisticated in humans and non-human primates. A key aspect of successful social interchange is the ability of individuals to cooperatively interact in order to reach mutually favorable goals such as obtaining and sharing food, defending from predators and building social bonds that benefit future generations. In human societies, cooperation further plays a central role in many interpersonal, economic and political decisions. At the same time, many mental health disorders are characterized by shared substantial deficits in social interactions. Therefore, our ability to understand and treat these various disorders depends on our ability to crack the neuronal coding of basic elements of social interactions in healthy individuals. However, the single neuronal basis, network computations and causal underpinnings of social interactions is largely unknown. A main challenge remains decomposing this complex behavior into a biological problem that could be quantitatively studied. We propose a framework for studying social interactive behavior by using game-theory driven principles. This formal framework allows disentangling neuronal signals that relate to the multiple aspects of social interactions, such as predicting another individual's intentions, weighing previous experiences with others and assessing possible personal profit.

Coordination of Prefrontal and Amygdala Neurons During Social Decision-making
Dr. Olga Dal Monte, Yale University

Social behaviors require complex processing across self and other. Intentions, actions, and outcomes of self and other are represented in various regions of the brain. One important component of social processing is how reward variables of self and other are computed, and recent studies have begun to elucidate how neurons from individual brain regions compute this multidimensional information. Numerous studies have supported that neurons in the basolateral amygdala (BLA) contribute to social processing. More recently, studies in humans and non-human primates have indicated a rather specialized function of the anterior cingulate gyrus (ACCg) in social processing, which has strong reciprocal connections with BLA. However, precise mechanisms of how these regions interact during social behavior remain unexplored at the single neuron level. During a modified dictator game in rhesus monkeys we investigated the neuronal coordination between ACCg and BLA by recording single-unit activity and local field potentials (LFP) simultaneously from both regions in order to test how the signals predominantly tuned for other's reward outcome in ACCg and the value-modulated signals in BLA that are similarly tuned for the rewards to self and other are coordinated to compute social decisions. We observed an enhanced neuronal coherence between ACCg and BLA for decisions leading to other's reward compared to decisions leading to reward to self, endorsing a specialized coordination between ACCg and BLA for prosocial behavior.

SYMPOSIUM 3

WHAT DO WE LEARN ABOUT THE SOCIAL BRAIN BY ADDING SEX AS BIOLOGICAL VARIABLE?

Friday, November 11, 4:15—5:30pm, Marina Ballroom Salon G
Chair: Alexa H. Veenema, PhD
Speakers; Nirao M. Shah, James K. Rilling, Alexa H. Veenema, Ragini Verma.

There is an increased attention and awareness of the importance of sex as a biological variable in basic, preclinical, and clinical research. The goal of this symposium is to generate a discussion whether and how sex as biological variable will gain a better and more complete understanding of how the brain regulates social behavior. This symposium will bring together researchers from various backgrounds in social neuroscience and with diversity in gender and career stage. The speakers will discuss their recent work on sex differences in brain function and behavior. This symposium will be combined with a brief discussion at the end on how to integrate sex as biological variable when applying for NIH funding. Dr. Janine Simmons, program officer of the Affect, Social Behavior & Social Cognition Program at NIMH, will be the discussion leader.

ABSTRACTS

Nature and nurture: modular genetic and social control of sexually dimorphic behaviors

Nirao M. Shah, PhD, Professor, University of California San Francisco

Our research program focuses on the molecular and neural circuit control of sexually dimorphic social behaviors. Sexually reproducing species exhibit developmentally hard-wired sex differences in behaviors that enhance reproductive success of the individual and survival of progeny. Indeed, sexually dimorphic social behaviors such as territorial defense are instinctual in the sense that they can be displayed without prior training. Territoriality is flexible and purposive such that males are territorial in their home range but not when intruding in novel environments, and the territory is defended from intruding males but not females. Previous work from our group has identified a molecularly specified population of neurons in the hypothalamus that is essential for male territorial defense. Here we will present recent findings from our studies that reveal how these hypothalamic neurons control territorial displays.

Sex differences in the effect of intranasal oxytocin on human brain activity in social interactive contexts

James K. Rilling, PhD, Winship Distinguished Research Professor, Emory University

Oxytocin (OT) is a naturally occurring endogenous neuropeptide that is known to modulate social behavior across a wide range of animal species. There is growing interest in whether social behavioral disorders involve dysfunction in this system, and in whether treatment with exogenous OT might improve social functioning. A variety of elegant histological and molecular methods have been used to demonstrate the presence of sex differences in the OT system in rodents. Less invasive methods are needed to investigate OT effects on behavior and brain function in humans. One now common technique is the intranasal administration of OT. We conducted a double-blind, placebo-controlled, pharmaco-functional magnetic resonance imaging (fMRI) study in which healthy normal subjects were randomized to treatment with either 24 IU intranasal OT (n=100) or placebo (PBO, n=104) and imaged with fMRI as they played an interactive social decision-making task known as the iterated Prisoner's Dilemma (PD) game with same-sex partners. Half of all subjects were female. Data analysis focused on the effect of intranasal OT on the BOLD fMRI response to reciprocated (CC) and unreciprocated (CD) cooperation in the PD game, as instances of positive and negative social interactions, respectively. Our results show that 24 IU intranasal OT modulates the neural response to reciprocated and unreciprocated cooperation from human partners very differently in men and women. In men, OT attenuated the response to CD outcomes within areas involved in salience and threat detection, like the anterior insula and the amygdala, and also augmented the response to CC outcomes within areas involved in reward and salience such as the nucleus accumbens and dorsal ACC. In women, on the other hand, OT had no effect on the response to CD outcomes, whereas it actually decreased the neural response to CC outcomes across widespread brain regions (opposite to what was found among men). Although these findings may suggest that the clinical efficacy of intranasal OT may be limited to men, this conclusion is premature until this dose (24 IU) is evaluated in patients, and until the dose-response profile of intranasal OT is characterized in greater detail.

Sex differences in the brain prevent sex differences in social behavior

Alexa H. Veenema, PhD, Assistant Professor, Boston College

Our lab is interested in understanding the neurobiological regulation of the development of social behavior using rats as model organism. We will show that sex differences in the brain (vasopressin, glutamate, dopamine) do not always lead to sex differences in social behavior, but may rather prevent sex differences in social behavior, and that this is already evident at prepubertal ages.

The neuropeptides vasopressin and oxytocin modulate various social behaviors in adult animals. Both systems show sex differences in peptide and/or receptor expression in the brain, most of which are already present in juveniles. Yet, little is known regarding the regulation of social behavior by these neuropeptide systems in juveniles and whether this regulation differs between sexes. In addition, social behavior is often shaped by social contexts, but how this affects the regulation of social behavior by vasopressin and oxytocin is less clear. First, data will be presented showing that pharmacological manipulations of the vasopressin and oxytocin systems induce neuropeptide-specific sex differences in the duration and frequency of social play behaviors in juvenile rats. Second, using a combination of microdialysis and retrodialysis in freely moving juvenile rats, we will show evidence that vasopressin may regulate social play differently in males versus females through sex-specific modulation of glutamatergic, but not GABAergic, neurotransmission. Lastly, we will discuss data indicating that the regulation of social play behavior by vasopressin and oxytocin strongly depends on the social context (exposure to conspecific in either home cage or novel cage), suggesting that subtle differences in the context in which a social stimulus is presented modifies the neural circuitry mediating social play behavior. These findings illustrate that sex and social context are important factors to consider when studying how vasopressin and oxytocin modulate social play behavior and, most likely, other social behaviors as well.

Sex Differences in the Structural Connectome in Development, Behavior and Pathology
Ragini Verma, PhD, Associate Professor, University of Pennsylvania

Investigation of sex differences in brain connectivity is necessitated due to observed behavioral and structural differences in several disorders like autism, schizophrenia, psychopathology and trauma. Identifying and quantifying such differences in the brain network, and studying its link with behavior, is expected to greatly aid in personalized medicine. The talk presents results from the state of the art investigation of sex differences in the structural connectome of the brain, at the macro and meso levels, from the perspective of connectivity and integrity; and subsequently the relationship of network structure and behavior.

S4SN 2016 Annual Meeting I Novel Approaches and Methodologies

Friday, November 11, 3:315 —3:55 pm,
Marina Ballroom Salon G

The social computational brain: how the brain learns from and makes inferences about others
John O'Doherty, California Institute of Technology

Considerable progress has been made in understanding the neural computations underlying the capacity of the human brain to learn from experience and in making decisions to maximize future rewards. Much less is known about how the brain is able to learn and make decisions in a social context. In this talk I will outline a computational model-based approach in which we combine computational modeling with fMRI experiments in order gain insight into how it is that the brain is capable of learning from and about other people, as well as to ascertain how it is the brain can make use of the knowledge acquired about or from others in order to make good decisions in a social context. Our findings point to the involvement of multiple mechanisms in social learning and decision-making. Some of these are domain general i.e. involved in both social and non-social contexts, while other brain mechanisms may be more domain specific, i.e. with a relatively more specialized involvement only in social contexts.

A cortico-amygdala circuit encodes observational fear learning
Kay M. Tye, Ph.D., Assistant Professor, Dept. of Brain & Cognitive Sciences, Whitehead Career Development Professor Picower Institute for Learning and Memory, Massachusetts Institute of Technology

Observational fear learning is a powerful survival tool, allowing an individual to learn about environmental stimuli that predict specific threats without direct experience. This ability has been conserved from rodents to humans, and has been linked to the anterior cingulate cortex (ACC) and the basolateral amygdala (BLA)1–5. However, little is known about the processes that occur within this circuit, and the degree of specificity to observational learning. To investigate how

information is encoded and transmitted through this network, we performed electrophysiological recordings from neurons identified as part of the ACC-BLA network by optogenetic-mediated phototagging to reveal that this network encodes information obtained through observational learning. We also demonstrate that selective inhibition of the ACC-BLA projection impairs observational fear conditioning and other social behaviors, but not classical fear conditioning. Finally, inhibition of the ACC input to the BLA alters the amygdalar representation of a cue that predicts shock to another mouse. Together, we show that information sourced from observing the experience of another mouse is transmitted from the ACC to the BLA and that this routing of information is necessary for observational fear learning.

S4SN 2016 Annual Meeting I Early Career Contribution Awardees

Congratulations to the 2016 Early Career Award Winners

Jamil Zaki, Ph.D., Stanford University
Steve Chang, Ph.D., Yale University

The Early Career Contribution Award Talks will take place on Friday, November 11, 5:30PM - 6:00PM in the Marina Ballroom Salon G, San Diego Marriott Marquis and Marina Hotel.

The purpose of the award is to recognize outstanding contributions by scientist early in their careers. Two awardees, one for human research and one for animal research, are named by the Awards Committee, and are honored at the S4SN 2016 Annual Meeting.

Empathy: Connecting neuroimaging to real-world behavior
Jamil Zaki, Ph.D., Stanford University

Empathy, the ability to share and understand each other's emotions, scaffolds countless social behaviors, from prosociality to relationship maintenance. In the last 20 years, neuroscientists have made important strides in characterizing brain mechanisms that support empathy. In this talk, I will focus on two studies that connect brain "markers" of empathic processes to social behavior outside the lab. In the first study, participants were scanned with fMRI while either winning monetary prizes themselves (personal reward) or viewing a friend receiving prizes (vicarious reward). We replicate a common "neural resonance" finding: at the group level, both personal and vicarious rewards engaged ventral striatum. However, the magnitude of striatal responses to each reward type was uncorrelated across people, suggesting that some individuals are relatively sensitive to personal but not vicarious reward, and visa versa. Sensitivity to vicarious, but not personal, reward further tracked individuals' levels of prosocial behavior outside the lab. In a second study, we conducted social network analysis of emerging social communities—freshman dormitories—and scanned individuals from these communities while they viewed images of other dorm residents. At a behavioral level, individuals high in empathy took on central roles in their networks, in that others identified them as sources of social support. During face viewing, images of individuals rated by the network as empathic, versus less empathic, engaged brain areas associated with mentalizing, including medial prefrontal cortex and temporoparietal junction. Together, these data demonstrate that individuals' real-world empathic behavior tracks their own brain activity, and also brain activity of those with whom they interact.

Supralinearly modulating social gaze dynamics with oxytocin under opioid antagonism
Steve Chang, Ph.D., Yale University

Dynamic and contingent gaze interaction between individuals is a hallmark of social behaviors. However, there is a significant knowledge gap in our understanding of social processing with respect to contingent gaze dynamics. Despite the known impact of certain neuromodulatory systems, including the oxytocin (OT) and opioid systems, on "time-averaged" social cognition, the potential role of neuromodulation in contingent social interactions also remains unclear. We recently developed a highly quantifiable paradigm to assess social gaze dynamics between pairs of monkeys and modeled these dynamics using an exponential decay function to investigate sustained attention following mutual eye contact. When interacting with real partners (versus static images and movies of the same monkeys), we found a significant increase in the proportion of fixations to the eyes and a smaller dispersion of fixations around

the eyes, indicating enhanced focal attention to the eye region. Notably, dominance and familiarity between the interacting pairs induced separable components of gaze dynamics that were unique to live interactions. Our results endorse the idea that key aspects of social cognition are only captured during interactive social contexts and are dependent on the elapsed time relative to socially meaningful events. Capitalizing on this finding, we investigated the role of OT in causally modulating social gaze dynamics while also developing novel ways to boost the efficacy of OT in promoting social processing. We found that OT co-administered with an opioid blockade, naloxone (NAL), more strongly promotes attention to the conspecific's face, and particularly to the eyes, compared to either drug administered alone. Notably, the combination of OT and NAL invoked a supralinear enhancement of prolonged social attention following mutual eye contact compared to OT or NAL alone, such that administering the two agents together produced a significantly larger effect than the summation of the effects observed when the drugs were administered separately. Such supralinearity between OT and NAL was absent following non-mutual eye contact, supporting that the neuropharmacological interactions act specifically on mutual social interactions. Furthermore, we found that the effects of both OT alone and OT administered with NAL were negatively correlated with baseline looking time, such that these administrations had bigger effects in monkeys who displayed less social attention to the conspecific to begin with. Our findings are supported by the known regulatory relationship between the OT and opioid systems, in which attenuated opioid processing is associated with stronger OT release from the posterior pituitary. Overall, we provide the first evidence that the OT and opioid systems interact to modulate social attention and exploration following contingent social interactions. Applying OT under opioid antagonism may help improve the efficacy of OT therapies for psychiatric conditions with social deficits.

Supported by: Simons Foundation Autism Research Initiative (SFARI) 365029

S4SN 2016 Annual Meeting | Poster Session

The Poster sessions are scheduled for Friday November 11th in the Marina Ballroom Salon G of the San Diego Marriott Marquis and Marina Hotel. All attendees must present their S4SN 2016 name badge to enter the Marina Ballroom Salon G. Please do not leave personal items in the poster room. The presenting author must be present during the assigned session. You may post your materials on the board assigned to you at any time after the time listed below in "Set-up Begins", but before the beginning of the assigned poster session. You must remove your poster promptly no later than the time listed below in "Take-down Complete." Any posters left after take-down complete will be removed and discarded.

Poster Session	Date & Time	Set-up Begins	Session Begins	Session Ends	Take-down Complete
A	Friday, November 11	8:30 AM	1:00 PM	2:00 PM	2:30 PM
B	Friday, November 11	2:30 PM	6:00 PM	7:00 PM	7:15 PM

To view full abstracts please visit: http://www.s4sn.org/poster-schedule-2016

Poster Session A

Friday, November 11, 2016, 1:00 - 2:00 pm, Marina Ballroom Salon G

A1 Involvement of dopamine and noradrenaline in the sex-specific regulation of social play by vasopressin

Remco Bredewold[1], Nara Nascimento[1], Alexa Veenema[1]; [1]Neurobiology of Social Behavior Laboratory, Department of Psychology, Boston College, Chestnut Hill, MA, USA

Social play is an affiliative and rewarding behavior displayed by nearly all mammals and peaks during the juvenile period. We recently showed that arginine vasopressin (AVP) acting via the V1a receptor (V1aR) within the lateral septum (LS) regulates social play in opposite directions in male and female juvenile rats. The LS receives dopaminergic input from the ventral tegmental area and adrenergic input from the locus coeruleus. Therefore, we sought to determine whether AVP interacts with dopamine (DA) and/or noradrenaline (NE) to regulate social play behavior in sex-specific ways. Using retrodialysis combined with microdialysis in awake and freely moving juvenile rats, we found that exposure to social play increased DA release in the LS of females, but not of males. Interestingly, V1aR blockade in the LS abolished this sex difference in DA release during social play. In contrast to DA release, exposure to social play did not alter NE release in the LS of either sex. However, V1aR blockade in the LS caused an increase in NE release in the LS of females but not of males. These findings suggest that the sex-specific regulation of social play by the LS-AVP system involves differential monoaminergic neurotransmission in the LS of male and female juvenile rats. Using pharmacological manipulations, we currently determine the causal involvement of DA and NE released in the LS in the sex-specific regulation of social play by AVP.

Keywords: sex differences, social reward, vasopressin, dopamine, noradrenaline, septum, microdialysis

A2 How social coordination emerges and changes among multiple heterogeneous agents: An experimental 'human firefly' study

Mengsen Zhang[1], J. A. Scott Kelso[1,2], Emmanuelle Tognoli[1]; [1]Florida Atlantic University, Boca Raton, FL, USA, [2]Ulster University, Derry ~ Londonderry, N. Ireland

People's behavior, emotion, mental and physical health reflect the social milieu in which they are embedded. Social structures are essentially dynamic: their evolving characteristics depend on the coordinative stability between people's behavior. Dyadic social coordination has been well studied experimentally and mathematically at both component and collective

levels. It uncovered metastability as an informationally-rich mix of integration and segregation that depends on coupling strength and differences between people's intrinsic behavior. Whereas the science of coordination (social, neural or physical) tends to polarize toward either systems of 2 or 3 components or systems composed of very many degrees of freedom, much of reality may lie in between. In an attempt to uncover laws and mechanisms of social coordination at this intermediate scale, we introduce a paradigm involving the coordination of rhythmic movement among 8 people. Subjects were seated in obscurity at booths around an octagonal table. Each subject signaled his/her tapping behavior to the group with a touchpad and watched others' taps via a ring of 8 LEDs. Each LED lit up when its assigned individual contacted the touchpad. Subjects were instructed to tap rhythmically to a visual metronome shown at the beginning of each trial (10 s) and to maintain that frequency throughout the following 50s, when they saw each other's tapping via the flashing LEDs. The pacing metronomes were parametrically manipulated to divide the subjects into 2 groups of 4 participants, with frequency differences δf = 0, 0.3 or 0.6Hz. We investigated whether subjects' behavior would persistently follow their initial group or if they would shift to the behavior of the other group. Preliminary data show that subjects tended to persist within their initial frequency groups, yet cross-group switching also occurred. The analyses of phase-locking stability reveal that as the frequency difference δf decreases, the correlation between cross-group and within-group phase-locking changes gradually from negative to positive – a zero-correlation marked the critical frequency difference δf* where original groups begin to merge into one. Our findings suggest that relevant variables to metastable coordination dynamics in dyadic situations still plays an important role in 8 people coordination, but multiagent coordination gives rise to social complexity with formation of groups at multiple scales. The present work opens a new behavioral paradigm for identifying neuromarkers of multi-agent coordination dynamics that may be relevant to clinical populations where social stability and instability are at stake.

Keywords: social interaction, dynamics, group, complexity

A3 Dopamine D2-type receptors in the dorsal hippocampus mediate social learning in female but not male mice

Richard Matta[1], Emily A. Underwood[1], Zoe K. Leach[1], Alex C. Vertes[1], Victoria Atabakhsh[1], Mayara B. da Silva[1], Elena Choleris[1]; [1]Department of Psychology and Neuroscience Program, University of Guelph, Guelph, ON, Canada, N1G2W1

Dopamine (DA) is involved in mediating motivationally relevant behaviors such as drug/alcohol addiction, food intake, and social behaviors. Previous work in our lab using systemic treatments has shown that D1-type (D1/D5) DA receptors are involved in social learning, whereas D2-type (D2/D3/D4) DA receptors are involved in feeding behavior in the social transmission of food preferences (STFP) in mice (Choleris et al, 2011). The ventral tegmental area (VTA) has DAergic projections to numerous limbic sites, including the septum, amygdala, nucleus accumbens, and hippocampus. In particular, the hippocampus has been previously established as an important structure in mediating the STFP. Work in our lab has shown that blocking D1-type DA receptors in the dorsal hippocampus impairs social learning in the STFP in both male and female mice (Matta and Choleris, 2014). In this study, we investigated the role of D2-type DA receptors in the dorsal hippocampus in the STFP. We microinfused the D2-type DA receptor antagonist Raclopride (at 10, 14, 18 or 20 µg/µL) directly into the dorsal hippocampus of male and female CD-1 mice (young adults) 10min before a social interaction (where social learning occurs) with a same-sex conspecific. We found that Raclopride at 10, 18 and 20 µg/µL blocked social learning in female, but not male mice. Furthermore, the social learning impairment could not be explained by any secondary effects on feeding, since total food intake was unaffected by drug treatment. Moreover, an olfactory discrimination task using the two highest doses of Raclopride that also blocked social learning (at 18 and 20 µg/µL) showed that the social learning impairment could not be directly explained by any changes in olfaction. Thus, the female effects of dorsal hippocampal D2-type DA receptor blockade may have been specific to social learning. Our study is also attending to effects of drug treatment on various social and nonsocial behaviors during the social interactions, and possible effects of gonadal hormones. Thus, DA in the hippocampus promotes social learning differently in males and females: in males it acts through only D1-type DA receptors, whereas in females it acts through both D1-type and D2-type DA receptors. Supported by NSERC.

Keywords: social learning, dopamine D2-type receptors, hippocampus

A4 Rapid Effects of 17beta-Estradiol in the Paraventricular Nucleus on Social Recognition in Female Mice

Pietro Paletta[1], Kirstyn Ali[1], Elena Choleris[1]; [1]University of Guelph

Essential for social species is being able to identify others based on information obtained from previous encounters. This ability is referred to as social recognition and is important for the development of social bonds,

dominance hierarchies, and various other aspects of social life. Both estrogens and oxytocin (OT) facilitate social recognition. When the estrogen receptor alpha (ERa), OT, and the oxytocin receptor (OTR) are each knocked out social recognition is impaired. In addition, estrogens can rapidly facilitate social recognition (Phan, et al., 2012). This suggests that both estrogens and OT are needed for social recognition. A model was developed (Choleris, et al., 2003) that suggests that estrogens bind to the estrogen receptor beta (ERb) located on OT neurons in the paraventricular nucleus (PVN) of the hypothalamus and facilitates the production and release of OT. OT reaches the medial amygdala where estrogens bind to ERa to facilitate the production of OTRs. OT-OTR binding in the medial amygdala then facilitates social recognition. The purpose of this research is to determine whether this model accurately depicts estrogens/OT regulation of social recognition within the rapid time frame of estrogen effects. First we need to determine whether 17b-estradiol in the PVN can facilitate social recognition. This is tested by ovariectomizing (OVX) female, CD-1 mice, to control circulating estrogens and inhibit social recognition, then infusing 17b-estradiol (25nM, 50nM, and 100nM) in the PVN through implanted bilateral cannulae prior to testing in a "difficult" social recognition paradigm where social recognition in OVX mice is typically not found. The paradigm begins 15 minutes after the infusion of 17b-estradiol. The mice are presented with two stimulus mice (habituation phase) and, after a delay, with two mice again (test phase), one from habituation and a novel stimulus mouse. This "difficult" paradigm with low performance in the control mice allows for the detection of enhancing effects of treatment. In addition, the paradigm takes place within 40 minutes of treatment to assess the rapid effects estrogens have on social recognition. Since mice have a natural inclination to investigate novelty, if at test they investigate the novel mouse more than the familiar mouse, it would suggest that they recognize the previously encountered familiar mouse. It is expected that 17b-estradiol infused into the PVN will recover social recognition while the control mice will still be impaired. This would prove that estrogens in the PVN facilitate social recognition and we can next determine if this facilitation occurs through an interaction with OT. Funded by NSERC.

Keywords: Social Recognition, Estradiol, Paraventricular Nucleus

A5 The role of membrane-bound estrogen receptors in the rapid estrogenic enhancements of learning and memory within the hippocampus

Talya Kuun[1], Elena Choleris[1]; [1]University of Guelph

It has become increasingly well established that estrogens play a role in various types of learning and memory. The binding of estrogen to its receptors often mediates long-term genomic actions (Nilsson et al., 2001). It has more recently been reported that estrogens also mediate rapid actions, requiring only minutes to hours (Woolley, 2007). Specifically, systemic treatment with 17β-estradiol (E2) was shown to rapidly improve object recognition, social recognition and object place learning in ovariectomized mice within a timescale of 40 minutes after treatment (Phan et al., 2012). Recent studies have further identified the dorsal hippocampus as one site of these estrogenic enhancing effects on learning and memory (Phan et al., 2015). Whether or not these rapid estrogenic effects are mediated solely by membrane-bound estrogen receptors is unknown. The current research seeks to determine the role of membrane estrogen receptors in the rapid effects of E2 in the hippocampus. By conjugating E2 to a large bovine serum albumin molecule (BSA-E2), the estradiol is prevented from passing through the cellular membrane and thus, from binding to intracellular receptors (Taguchi et al., 2004). Therefore, the use of BSA-E2 allows for the investigation of the role of membrane-bound estrogen receptors in the rapid nongenomic effects of estrogens on learning and memory, while ruling out the intracellular mechanisms of estrogen action. The methodology will then use the rapid versions of social recognition, object recognition and object placement paradigms (Phan et al., 2012) to test the rapid effects of intrahippocampal BSA-E2 infusions on these types of learning and memory within 40 minutes post-administration. BSA-E2 or a vehicle control, are infused via previously implanted bilateral hippocampal cannulae, 15 minutes prior to the initiation of the testing procedure. The paradigms involve two 5 minute habituations where two stimuli are presented, and one 5 minute test phase where one of the now familiar stimuli is replaced by a novel one. An investigation ratio of the preference for novel stimulus is calculated. Due to the innate inclination for mice to investigate novel stimuli over familiar ones, mice that remember the habituation stimuli show a preference for the novel stimulus at test. We expect the BSA-E2 treated mice to show investigation ratios at test that are significantly different from the those during habituations, thus demonstrating that these rapid effects of E2 are not impeded by the conjugation with BSA, suggesting the involvement of hippocampal membrane-bound estrogen receptors in these types of learning and memory. Supported by NSERC.

Keywords: Estrogens

A6 Perceived Social Isolation is Associated with Altered Functional Connectivity in Neural Networks Associated with Tonic Alertness and Executive Control

Elliot Layden[1], John Cacioppo[1], Stephanie Cacioppo[1], Stefano Cappa[2,3], Alessandra Dodich[3], Andrea Falini[3,4],

Nicola Canessa[2,3]; [1]The University of Chicago, [2]Istituto Universitario di Studi Superiori, [3]San Raffaele Scientific Institute, [4]Vita-Salute San Raffaele University

Perceived social isolation (PSI), colloquially known as loneliness, is associated with selectively altered attentional, cognitive, and affective processes in humans, but the neural mechanisms underlying these adjustments remain largely unexplored. Behavioral, eye tracking, and neuroimaging research has identified associations between PSI and implicit hypervigilance for social threats. Additionally, selective executive dysfunction has been evidenced by reduced prepotent response inhibition in social Stroop and dichotic listening tasks. Given that PSI is associated with pre-attentional processes, PSI may also be related to altered resting-state functional connectivity (FC) in the brain. Therefore, we conducted the first resting-state fMRI FC study of PSI. Five-minute resting-state scans were obtained from 55 participants (31 females). Analyses revealed robust associations between PSI and increased brain-wide FC in areas encompassing the right central operculum and right supramarginal gyrus, and these associations were not explained by depressive symptomatology, objective isolation, or demographics. Further analyses revealed that PSI was associated with increased FC between several nodes of the cingulo-opercular network, a network known to underlie the maintenance of tonic alertness. These regions encompassed the bilateral insula/frontoparietal opercula and ACC/pre-SMA. In contrast, FC between the cingulo-opercular network and right middle/superior frontal gyrus was reduced, a finding associated with diminished executive function in prior literature. We suggest that, in PSI, increased within-network cingulo-opercular FC may be associated with hypervigilance to social threat, whereas reduced right middle/superior frontal gyrus FC to the cingulo-opercular network may be associated with diminished impulse control.

Keywords: Perceived Social Isolation, Resting-State fMRI, Attention, Functional Connectivity, Loneliness

A7 Lateral Septum Vasopressin System Interacts With Nucleus Accumbens and Prefrontal Cortex to Regulate Social Play in Sex-Specific Ways

Nara F. Nascimento[1], Grace S. Ro[1], Christina J. Reppucci[1], Remco Bredewold[1], Alexa H. Veenema[1]; [1]Boston College

Social play is a highly rewarding and motivated behavior, which peaks at the juvenile period and facilitates the development of social skills needed throughout the lifespan. We recently showed that the AVP system in the lateral septum (LS) modulates social play behavior in juvenile rats in sex-specific ways. Specifically, blockade of the AVP V1a receptor (V1aR) in the LS increased social play in males but decreased social play in females. Here, we aimed to determine the neural pathway by which the LS-AVP system modulates social play behavior in sex-specific ways. To study this, single-housed juvenile male and female rats were exposed in their home cage to an age- and sex-matched unfamiliar juvenile for 10 min ("play") or placed similarly without the introduction of a play partner ("no play"). In addition, all rats were given either a vehicle or a V1aR antagonist injection into the LS 20 min prior to the play or no play session. Rats were killed 80 min after the play test, and brain tissue was processed using immunohistochemistry to detect the expression of c-Fos, an early marker of neuronal activation. Preliminary results show a higher number of c-Fos positive cells in vehicle-treated females exposed to play compared to their male counterparts in the anterior shell of the nucleus accumbens (NAcc) and in the anterior prelimbic and infralimbic divisions of the prefrontal cortex (PFC). Interestingly, V1a receptor antagonist-treated rats did not show this sex difference. Together, this suggests that social play is associated with sex differences in neuronal activation in NAcc and PFC subregions and that these sex differences are eliminated by LS-V1aR blockade. Because the LS projects directly to the NAcc, future studies will investigate the causal involvement of the anterior shell of the NAcc in the sex-specific regulation of social play by the LS-AVP system.

Keywords: Vasopressin, Social Play, Sex Differences

A8 Activation of CRF receptor type 1 in the medial preoptic area severely impairs maternal behavior and increases anxiety-related behavior in lactating rats

Stefanie M. Klampfl[1,2], Barbara M. Gaßner[1], Doris S. Bayerl[1], Oliver J. Bosch[1]; [1]University of Regensburg, Regensburg, Germany, [2]University of British Columbia, Vancouver, Canada

The survival and proper development of the offspring is ensured by the adequate expression of maternal behavior, the most important pro-social behavior of lactating female mammals. Maternal behavior is strongly disturbed by an elevated activity of the major stress neuropeptide system, the brain corticotropin-releasing factor (CRF) system, as shown for the lateral septum (D'Anna & Gammie 2009 Behav Neurosci) and the bed nucleus of the stria terminalis (Klampfl et al. 2014 J Neurosci, 2016 PNEC). In this line, the medial preoptic area (MPOA) is a promising brain area; it is a major maternal brain region and shows broad expression of most CRF family members. To test our hypothesis, we fitted pregnant Sprague-Dawley rats bilaterally with guide cannula targeting the MPOA. On lactation days (LD) 1 to 7, we acutely infused the CRF-R1 agonist human/rat CRF, the CRF-R1 specific antagonist CP-154,526, the CRF-R2 specific agonist stresscopin, the CRF-

R2 specific antagonist astressin-2B or vehicle bilaterally into the MPOA every other day and subsequently monitored maternal and anxiety-related behaviors. Under non-stress conditions (LD1), activation of CRF-R1 or -R2 immediately decreased the occurrence of arched back nursing and overall nursing; interestingly, the behavioral effect of CRF-R1 activation was stronger and longer-lasting (120 min versus 60 min). Under stress conditions (LD7), i.e. immediately after exposure to the maternal defense test, all groups showed an acute decrease in overall nursing. This decrease was even longer-lasting after CRF-R1 activation, which in turn increased licking/grooming the pups at the same time. During the maternal defense test (LD7), CRF-R1 inhibition more than doubled the number of attacks and the sum of aggressive behavior against a female intruder while CRF-R1 activation had no behavioral effect. CRF-R2 manipulations had no effect on maternal aggression. Maternal motivation to retrieve pups was not altered by any treatment (LD3). When testing anxiety-related behavior on the elevated plus-maze (LD5), CRF-R1, but not -R2, activation increased the percentage of time on and full entries into open arms whereas entries into closed arms were decreased. In summary, CRF-R1 in the MPOA are crucially involved in controlling maternal care, maternal aggression and anxiety. Interestingly, the latter two have rarely been linked to the MPOA so far. On the contrary, the MPOA is well known for its prominent role in facilitating maternal motivation to retrieve pups in which the intra-MPOA CRF system is seemingly not involved. To conclude, we identified the CRF-R1 in the MPOA as an interesting and promising target with respect to treatment of maladaptations in maternal behavior. Supported by DFG BO 1958/8-1 to OJB.

Keywords: anxiety; corticotropin-releasing factor; maternal behavior; medial preoptic area;

A9 Role of opioids and endocannabinoids on the expression and motivational properties of social play behaviour in rats

E.J.M Achterberg[1], M.M.H. van Swieten[1], D.J. Houwing[1], M. Aalderink[1], N.V. Driel[1], V Trezza[2], L.J.M.J. Vanderschuren[1]; [1]Div. Neurobiology of Behavior, Dept. of Animals in Science and Society, Faculty of Veterinary Medicine, Utrecht University, Utrecht, The Netherlands, [2]3Science, Section of Biomed. Sci. and Technologies, Univ. Roma, Rome, Italy

Social play behaviour a characteristic form social behaviour displayed by the young of many mammalian species, including rats and humans, which is thought to be important for social and cognitive development. Being a rewarding activity, the performance of social play depends on its pleasurable and motivational properties. Opioids and endocannabinoids have an important role in social play behaviour, through modulation of reward processes. However, it is unknown whether opioids and endocannabinoids are also involved in the motivation for social play behavior. Therefore, we assessed the effects of opioid and cannabinoid (ant)agonists in an operant conditioning setup in which rats responded for social play under a progressive ratio schedule of reinforcement. This setup allowed for the parallel measurement of the performance of social play. Treatment with the opioid receptor agonist morphine increased the performance of play behavior but did not affect operant responding. Blocking opioid receptors with naloxone reduced both responding for play and its performance. Enhancing endocannabinoid levels with the anandamide-hydrolysis inhibitor URB597 modestly reduced operant responding, without affecting social play performance. Treatment with the cannabinoid-1 receptor antagonist rimonabant non-specifically reduced operant responding, due to its pruritic effect, without affecting social play performance. Consistent with previous work implicating opioid neurotransmission in social play behaviour, these data demonstrate an important role for opioids in the motivational properties of social play. However, although endocannabinoids are known to be involved in social play behaviour, they have only a minor role in the motivation for social play.

Keywords: Social play, reward, motivation, opioids, cannabinoids

A10 The effects of sex and gonadal hormones on anxiety behaviour in mice

Colin Howes[1], Cameron Wasson[1], Emily Martin[1], Anthony Giuga[1], Hailey Katzman[1], Angela Tiessen[1], Elena Choleris[1], Neil MacLusky[1]; [1]University of Guelph

Women exhibit a much greater prevalence of anxiety disorders than men. Animal models have examined the potential role for gonadal hormones as an underlying mechanism driving sex differences in anxiety behaviour. In female rodents, estrogen receptor alpha has been shown elevate anxiety behaviour, while estrogen receptor beta activation appears have an anxiolytic effect. In male mice, testosterone rapidly reduces anxiety behaviour, pointing at an activational role for gonadal hormones in mediating anxiety. However, little is known about how gonadal hormones may impact anxiety behaviour developmentally. Given the importance of testosterone for the masculinization of the male fetus, we hypothesize that sex differences in anxiety behaviour may be driven in part by the developmental action of testosterone. Thus, we administered either 10µg testosterone propionate or sesame oil control to pregnant CD1 mice 12, 14, and 16 days following conception. This dosage is at the low end of a range of doses which have been shown to produce

behavioural effects, and administration was timed to coincide with prenatal sexual differentiation of the male fetus. Animals underwent a series of behavioural tests prior to the onset of puberty, including a dark-light test for anxiety-like behaviour. Following the prepuberty set of behavioural tests mice underwent one of three surgical interventions sham surgery, gonadectomy, or gonadectomy with hormone replacement via implantation of a capsule containing either crystalline testosterone (males) or 17-beta-estradiol dissolved in sesame oil (females). 10 days following hormone replacement, mice underwent the behavioural test battery again in adulthood, at 9 weeks of age. Prior to puberty, we found that mice treated with testosterone prenatally exhibited greater anxiety-like behaviour than control animals. This effect was observed only in male mice on some of the behaviours we measured, suggesting that males may be more vulnerable to the effects of elevated testosterone during development. We are in the process of examining the effects of our prenatal treatment and surgical interventions on anxiety-like behaviour in adulthood. Acknowledgements: supported by OMHF and OGS

Keywords: hormones, testosterone, development, anxiety

A11 Neurocomputational mechanisms of prosocial learning and links to empathy

Patricia Lockwood[1,2], Matthew Apps[2], Vincent Valton[3], Essi Viding[3], Jonathan Roiser[1]; [1]Department of Experimental Psychology, University of Oxford, [2]Division of Psychology and Language Sciences, University College London, [3]Institute of Cognitive Neuroscience, University College London

Reinforcement learning theory powerfully characterises how we learn to benefit ourselves. In this theory, prediction errors – the difference between a predicted and actual outcome of a choice – drive learning. However, we do not operate in a social vacuum. To behave prosocially we must learn the consequences of our actions for other people. Empathy, the ability to vicariously experience and understand the affect of others, is hypothesised to be a critical facilitator of prosocial behaviours, but the link between empathy and prosocial behaviour is still unclear. During functional magnetic resonance imaging (fMRI) participants chose between different stimuli that were probabilistically associated with rewards for themselves (self) another person (prosocial) or no-one (control). Using computational modelling we show that people can learn to obtain rewards for others, but they do so more slowly than when learning to obtain rewards for themselves. fMRI revealed that activity in a posterior portion of the subgenual anterior cingulate cortex (sgACC) drives learning only when we are acting in a prosocial context, and signals a "prosocial" prediction error that conforms to classical principles of reinforcement learning theory. However, there is also substantial variability in the neural and behavioural efficiency of prosocial learning, which is predicted by trait empathy. More empathic people learn more quickly when benefitting others, and their sgACC response is the most selective for prosocial learning. We thus reveal a novel computational mechanism that drives prosocial learning in humans. This framework could provide new insights into atypical prosocial behaviour in those with disorders of social cognition.

Keywords: Prosocial behaviour, empathy, reinforcement learning, prediction error, reward, subgenual anterior cingulate cortex, ventral striatum

A12 Exploring the potential of oxytocin for enhancing interpersonal motor resonance upon direct eye gaze: A transcranial magnetic stimulation study

Prinsen Jellina[1], Brams Stephanie[1], Alaerts Kaat[1]; [1]KU Leuven

Among different social cues from the environment, the eyes constitute a very salient source for initiating social interaction or communication. Interestingly, previous work from our and other labs demonstrated that direct eye contact between two individuals can readily evoke an increased propensity to 'mirror' other peoples' actions. Particularly, using transcranial magnetic stimulation (TMS), we showed that mirror-motor mapping at the level of the primary motor cortex (M1), also known as "interpersonal motor resonance" (IMR), is significantly increased upon the observation of actions accompanied by direct eye contact, compared to the observation of actions accompanied by averted eye gaze. With the present study, we aimed to investigate the role of eye contact on IMR further, and in particular, explored whether administration of the 'prosocial' neuropeptide oxytocin (OT) can influence eye-contact induced IMR. OT is known to play an important role in promoting prosocial behavior and the perception of socially-relevant stimuli, such as eye gaze. To date however, the link between OT and IMR is less clear. Twenty-seven neurotypical adult males (18-31y) participated in a double-blind placebo-controlled cross-over design including two sessions, separated by one week. They were randomly assigned to receive a single dose of OT (24 IU) or placebo nasal spray at the first and second session. In each session, TMS was used to measure changes in cortico-motor excitability at the level of M1 while participants observed video stimuli of an actress performing simple hand movements combined with either direct or averted gaze. Additionally, eye tracking was performed to evaluate potential changes in spontaneous viewing behavior of the participants. Preliminary results replicated previous

findings indicating IMR-modulations by the gaze direction of the actor, such that IMR during movement observation was enhanced when combined with direct eye contact. These effects were tentatively more pronounced after administration of OT. Interestingly, participants that failed to display eye contact-induced IMR enhancements at baseline, were shown to significantly increase eye contact-induced IMR after a single-dose of OT. Our results provide indications that a single-dose of OT can promote motor-mirroring of others' movements upon direct eye contact. OT may thus increase the saliency of social cues originating from the eye regions of others, which in turn may promote the propensity of an individual to automatically 'mirror' the actions and behaviors of surrounding others.

Keywords: Mirror-motor system

A13 Ghrelin receptor mutation leads to deficits in social behavior & food-seeking behavior in a stressful environment

Su-Bin Park[1], Anne Wilson[2], Myddryn Ellis[3], Barbara Woodside[4], Alfonso Abizaid[1]; [1]Department of Neuroscience, Carleton University, [2]Department of Psychology, Carleton University, [3]Department of Biochemistry, University of Ottawa, [4]Center for the Study of Behavioral Neurobiology, Concordia University

Ghrelin, a gut derived peptide hormone contributes both to energy balance and the stress response. Results of some previous studies using animal models have also suggested that ghrelin has anxiolytic effects although other studies have reported anxiogenic effects of ghrelin. To further explore the role of ghrelin in anxiety behavior we compared ghrelin receptor knock-out (GHSR-KO) mice and their wild type (WT) counterparts, on a battery of behavioral tests designed to examine different facets of anxiety behavior. Open field and light/dark preference tests were used to measure general anxiety and no significant differences between the GHSR-KO and WT mice were observed in these tests. By contrast, both the latency to approach a palatable food in a novel environment and to approach a strange mouse in the home cage was increased in GHSR-KO mice compared to WT mice. In a subsequent study, the effects of acute blockade of the ghrelin receptor on these measures were examined. The ghrelin antagonist JMV2959 (0.3mg/ml) or saline (0.1ml/10g) were administered i.p. to C57/BL6 before testing. As in the previous study, we observed no effects on the tests of general anxiety but did observe increased latency to approach both food in a novel environment and a strange mouse in the home cage. The aforementioned results of these studies suggest that the anxiolytic effects of ghrelin may be most apparent in tests of goal-directed behavior.

Keywords: Ghrelin, Stress, Social Anxiety, Goal-directed behavior

A14 INVOLVEMENT OF MU OPIOID RECEPTORS IN THE REGULATION OF JUVENILE SOCIAL NOVELTY-SEEKING BEHAVIOR: BRAIN REGION-SPECIFIC EFFECTS AND MODULATION BY SOCIAL SEPARATION

Caroline J. Smith[1], Aarane M. Ratnaseelan[1], Sara Li[1], Alexa H. Veenema[1]; [1]Neurobiology of Social Behavior Laboratory, Boston College, Chestnut Hill MA

The drive to approach and explore novel conspecifics is inherent to social animals and may promote optimal social functioning. Juvenile animals seek out interactions with novel peers more frequently and find these interactions to be more rewarding than their adult counterparts. We have previously shown that juvenile rats spend more time interacting with a novel conspecific than a cage mate (sex and age matched). However, the underlying neural mechanisms have yet to be determined. Given their role in the regulation of rewarding juvenile social behaviors, we hypothesized that μ-opioid receptors (MORs) might play an important role in the facilitation of juvenile social novelty-seeking behavior. Using the MOR antagonist CTAP, we show that central (intracerebroventricular) MOR blockade reduces social novelty-seeking behavior in juvenile male rats. This effect appears to be specific to the opioid system as oxytocin, vasopressin V1a, or dopamine D2 receptor blockade had no effect. Moreover, this effect appears to be brain region-specific as local MOR antagonism in the anterior nucleus accumbens, but not the basolateral amygdala, reduces social novelty-seeking, despite the fact that both brain regions display dense MOR binding in juvenile rats. Finally, an acute period of social separation (3 hours) reduces juvenile social novelty-seeking behavior, an effect that can be rescued by central MOR agonism (using DAMGO). Taken together, these results demonstrate that MOR activation facilitates juvenile social novelty-seeking behavior by acting on the nucleus accumbens and restores juvenile social novelty-seeking behavior following social separation.

Keywords: oxytocin, vasopressin, opioid, juvenile, social, novelty

A15 Gender stereotype processing in people of opposite political ideologies: Behavioural and Event-Related Potential Differences

Adam Baker[1], Travis Baker[2], Mario Liotti[1]; [1]Simon Fraser University, [2]Montreal Neurological Institute

Recent research has begun to utilize event-related potentials (ERPs) to investigate social phenomena, such as stereotyping. Here, we continue this work by using event-related brain potentials (ERPs) and behavioral

assays of gender stereotyping, together with questionnaires about political orientation, to examine the cognitive mechanisms of gender stereotype processing between groups of people (e.g. liberals and conservatives). Our investigation revealed subjects (n=30) produced greater neural activity, as revealed by the N400 ERP, in response to gender stereotype word-pair incongruities (Female + Mechanic), compared to congruities (Male + Beer). To highlight automatic and controlled processing between groups, a short (150ms) and long (700ms) stimulus-onset asynchrony (SOA) was utilized. Our results revealed a significant 3 way interaction between Congruency x SOA x Group interaction $F(1, 28) = 4.55$, $p < .05$, $\eta 2 = .04$. Post-Hoc contrasts indicated that in the 150ms SOA condition, the N400 amplitude for incongruent word pairs was significantly larger compared to congruent word pairs in both groups $t(14) = 5.42$, $p<.001$. Importantly, in the 700ms SOA condition, the N400 amplitude for congruent word-pairs contrast, for the N400 amplitude did not reach significance for liberal group $t(14) = 1.82$, $p >.05$, but did for the conservative group. Our study effectively showed when more time was allowed to decide about gender associations (700 ms SOA), only liberals were able to bypass stereotypical gender associations by displaying slower RT responses to incongruent words, and less voltage of the N400 indexing an unexpected violation of social expectations. Taken together, our results highlight important neurocognitive mechanisms of stereotyping processing; bolstering the utility of ERPs to investigate differential processing of social groups and examine inter-group bias (e.g. partisan bias).

Keywords: ERP, N400, Stereotyping, Social Neuroscience, Ideology

A16 Effects of social housing on measures of stress in male and female Syrian hamsters

Amy Ross[1], Alisa Norvelle[1], Dennis Choi[1], James Walton[1], H. Elliott Albers[1], Kim Huhman[1]; [1]Georgia State University

In recent years, there has been some debate as to whether group housing of Syrian hamsters is stressful to these animals. Although Syrian hamsters are thought to be naturally solitary, research from our laboratory suggests that hamsters prefer social interaction and that this interaction can induce a conditioned place preference. We have also demonstrated that social defeat stimulates stress-induced hyperphagia in male hamsters; however, other labs have suggested that singly housing female hamsters leads to stress-induced anorexia. The purpose of this study was to compare a variety of stress endpoints in singly housed and group housed males and females. Therefore, male (n = 20) and female (n = 20) hamsters were housed singly (n = 20) or in groups of 5 (n = 20). After 4 weeks, the hamsters were euthanized by rapid decapitation and trunk blood was collected at lights on (12:00 am). Fat pads, thymus and adrenal glands were extracted and weighed. Serum cortisol was measured using a radioactive immunoassay. Results showed that group housed females weighed more than any other group. In addition, group housed females and males had more fat than did singly housed animals. Interestingly, there was no effect of housing on serum cortisol or adrenal gland weights. There was, however, an effect on thymus gland weights, such that the thymus glands of group housed animals weighed less than the glands of singly housed hamsters, but this effect was only significant when thymus weight was normalized to body weight. These results suggest that group housing animals might be stressful to Syrian hamsters, but given that cortisol and adrenal weights were not affected by housing condition and thymus weights were only significant when normalized to body weight, the data are overall inconclusive as to whether socially housing these animals is stressful.

Keywords: cortisol, thymus, social stress

A17 The effects of dorsal hippocampal MEK/ERK inhibition on rapid 17β-estradiol facilitated social recognition in female mice

Paul Sheppard[1], Katherine Sellers[2], Iain Watson[2], Deepak Srivastava[2], Elena Choleris[1]; [1]University of Guelph, [2]King's College London

In addition to the delayed and long lasting gene-transcription regulation of steroid hormones, very rapid actions have also been described. The rapid effects of estrogens on learning and memory have been repeatedly shown. In female mice, facilitation of social recognition was found within 40 minutes of systemic administration of 17β-estradiol (E2), as well as estrogen receptor a (ERa) and G-protein coupled estrogen receptor (GPER) selective agonists (PPT and G-1 respectively), but not an estrogen receptor β (ERβ) selective agonist (DPN) (Phan et al, 2011; 2012; Gabor et al, 2015). The dorsal hippocampus mediates these effects as intrahippocampal administration of E2, PPT, or G-1 facilitates social recognition (Phan et al, 2015; Lymer, 2015). Furthermore, systemic administration of E2, PPT, or G-1 increases dendritic spine density in the dorsal hippocampus (Phan et al, 2011; 2012; Gabor et al, 2015). The mechanisms of action by which these rapid effects occur are not well understood; however, estrogenic actions on cell signaling cascades affecting synaptic plasticity and dendritic spine dynamics are thought to play a role. One candidate cascade is the extracellular signal-regulated kinase (ERK) pathway as blocking the phosphorylation (activation) of the ERK protein has been shown to block estrogen facilitated increases in dendritic spine density in cultured neurons (Sellers et al, 2015) and rapid estrogen-induced enhancements in

object memory consolidation (Fernandez et al, 2008). Whether the ERK pathway is also involved in rapid estrogenic facilitation of social recognition in the hippocampus is unknown. First we infused (0.5µL/side, 0.2µL/min) MEK/ERK inhibitor U0126 (0.1, 0.5, or 1.0µg/side) in the dorsal hippocampus of ovariectomized female mice 15 min prior to testing for social recognition. Preliminary results suggest doses of 0.1 and 0.5µg/side do not block social recognition whereas 1.0µg/side does. Then, we infused into the dorsal hippocampus the highest dose of U0126 that did not block social recognition to investigate only the ERK-dependent effects of 50nM E2 – a dose shown to rapidly facilitate social recognition in a difficult version of the social recognition paradigm. These paradigms consist of habituation trails where two female conspecifics are presented and one test trial where one conspecific is novel and the other is familiar. The paradigms are completed within 40 minutes of drug administration, thus enabling the investigation of rapid effects of estrogens.

Keywords: social recognition, estrogens, ERK, hippocampus

A18 From agents to actions to interactions: Uncovering multiple social networks in the primate brain

Julia Sliwa[1], Winrich A Freiwald[1]; [1]The Rockefeller University, New York, NY

Our brain continuously decodes the complex visual scenes unwinding in front of us: both the nature of material entities we perceive, such as objects and individuals, and their immaterial interactions. Interactions are recognize quickly and effortlessly by primates: They understand fights, grooming and plays, but also colliding objects that exchange forces following physical laws of classical mechanics. Interactions are fundamental in that they reveal hidden properties of objects, e.g. their weight or material, and of individuals, e.g. their dominance status or relationship, and by doing so they determine and teach the observer about its own position and prospects regarding those entities. However little is known about the brain regions that track and process social and physical interactions. In order to chart these regions, videos of three types of interactions 1) social interactions between monkeys, 2) interactions between monkeys and objects or their environment and 3) physical interactions between objects, were projected to four rhesus monkeys being scanned for fMRI acquisition with contrast agent. Whole-brain activity for watching blocks of interactions was compared to the activity for watching control videos of monkeys making no actions, objects moving with no interactions, landscapes and scrambled motion videos using Fixed Effects (FFX) Generalized Linear Model (GLM) group analysis and conjunction analyses. We show that watching interactions over-activates the STS, but engages also two sets of regions located outside: 1) it activates the fronto-parietal mirror neuron system (mapped independently using a classic localizer) more than watching non-interactive goal directed behaviors that define the system; 2) in the case of social interactions, it additionally exclusively activates the medial-prefrontal cortex (mPFC), a putative temporo-parietal junction homolog and the temporal pole (TP) that appear to correspond to the human mentalizing network. These two networks are fed differentially by patches of STS cortex (mapped independently using a classic Face-Object-Body patch localizer): face patches co-activate with the social brain, while body patches co-activate with both the mirror neuron system and the social brain. These results demonstrate that combining individuals or objects into evocative units modulates basic mechanisms of object and individual perception in the STS, they reveal the mirror neuron system's nature of node of convergence between the social and non-social brain, and suggest that human unique and sophisticated mind-reading ability evolved from the faculty shared with our monkey kin to read social interactions.

Keywords: MEDIAL PREFRONTAL CORTEX ; MIRROR NEURON SYSTEM ; FACES

A19 Social Behavior and Immune Function of Mice Born to Maternally Immune Activated Dams

Kenneth Onishi1, Leah Malamut1, Jennifer Novo1, Aashna Mukerji1, Mary Claire Tuohy1, Brian Prendergast1; 1University of Chicago

Appropriately-timed immune activation (MIA) in rodents dams results in abnormalities resembling schizophrenic- and autistic-like behaviors. The mechanisms by which MIA induces such changes in the developing brain remain to be fully characterized. In these experiments, pregnant C57BL/6 mice were injected with saline or the viral mimic, polyinosinic : polycytidylic acid (PIC) on gestational day 12.5. In study 1, anxiety-like and social behaviors were evaluated in male and female offspring in an open field test and a social interaction test. In study 2, cytokine expression was quantified in the developing brain at ages ranging from postnatal day 1 – 60. MIA did not affect anxiety-like behavior but resulted in sex-specific changes in in social behavior/motivation; MIA also resulted in idiosyncratic and in some cases persistent upregulation of multiple cytokines in the hypothalamus during development. Changes in brain cytokine expression during development may participate in MIA-induced alterations in behavior in adulthood.

Keywords: PIC, Maternal Immune Activation, Behavior, Cytokine

A20 Sex differences in neural activation following different routes of oxytocin administration in awake adult rats

Kelly M. Dumais[1], Praveen P. Kulkarni[2], Craig F. Ferris[2], Alexa H. Veenema[1]; [1]Boston College, [2]Northeastern University

The neuropeptide oxytocin (OT) regulates social behavior in sex-specific ways in humans and rodents. OT has been found to have promising effects on alleviating social deficits in patients with sex-biased neuropsychiatric disorders, however little is known about potential sexually dimorphic effects of OT on brain function. Therefore, using the rat as our model organism, we aimed to determine whether OT via central administration (most common in animal studies) or via peripheral administration (most common in human studies) induces sex differences in neural activation. Functional magnetic resonance imaging was used to examine blood oxygen level-dependent (BOLD) signal intensity changes in the brains of awake male and female rats over a period of 20 min after intracerebroventricular (ICV; 1µg/5µl) or intraperitoneal (IP; 0.1mg/kg) administration of OT. Following ICV OT administration, sex difference in BOLD activation were observed in 26 brain regions, with 20 regions showing higher activation in males, and 6 regions showing higher activation in females. Among these were the nucleus accumbens and insular cortex showing higher activation in males, and the lateral and central amygdala showing higher activation in females. Interestingly, compared to ICV OT, IP OT elicited fewer sex differences in BOLD activation (12 brain regions), but in the same overall direction as ICV OT, with all regions showing higher activation in males compared to females. Furthermore, sex differences in BOLD activation in response to IP OT were found in different brain regions than in response to ICV OT. Overall, these results indicate that exogenous OT modulates neural activation differently in males and females, and that the pattern and the magnitude of sex differences in BOLD activation depends on the route of administration. These results highlight the need to include both sexes in basic and clinical studies to fully understand the role of OT on brain function. This research is supported by NIMH F31MH100891 to KMD, NIMH R15MH102807 to AHV, and NICHD P01HD075750 to CFF.

Keywords: oxytocin, sex differences, fMRI

A21 Oxytocin (OT) in the Ventral Tegmental Area (VTA) has Sex Specific Effects on Social Reward in Syrian Hamsters

Johnathan Borland[1,2], Lauren Aiani[1,2], Kymberly Grantham[1,2], Eric Song[1,2], H. Elliott Albers[1,2]; [1]Neuroscience Institute, Georgia State University, [2]Center for Behavioral Neuroscience, Atlanta, GA, USA

Many forms of social interaction are highly rewarding. Previously we have shown that activation of OT receptors in the VTA are essential for the rewarding properties of social interaction in male Syrian hamsters. In this study we tested the hypothesis that the effects of OT in the VTA on social reward differ in male and female hamsters. Social reward was quantified using a conditioned social preference (CSP) test. In both male and female hamsters OT was injected into the VTA just prior to social interaction training in each hamsters non-preferred chamber. After three 10-minute training sessions hamsters were tested again to measure the amount of time spent in the chamber where social interactions took place. Both males (p=0.028) and females (p=0.008) showed an increase in time spent in the social interaction chamber compared to no social interaction controls (male no social -6.3 +/-67.0 sec, male social 75.0 +/-73.5 sec, female no social 36.1 +/-59.0 sec. female social 13! 7.0 +/-97.7 sec). OT-treated males (115.5 +/-45.6 sec) did not show a change in time spent in social interaction chamber compared to saline treated (75.0 +/-73.5 sec) subjects (p=0.226), while OT-treated females (58.4 +/-99.9 sec) showed a decrease in time spent in social interaction chamber compared to saline treated (137.0 +/-97.7 sec) subjects (p=0.017). These data demonstrate that OT in the VTA has opposite effects in males and females, decreasing the rewarding properties of social interaction in females, while increasing it in males.

Keywords: Oxytocin, Social Reward, Sex Differences, Ventral Tegmental Area

A22 Divergent facial scanning patterns in behavioural-variant frontotemporal dementia and semantic dementia

Rosalind Hutchings[1,2,3], Romina Palermo[3,4], Jason Bruggemann[1,2], John Hodges[1,2,3], Olivier Piguet[1,2,3], Fiona Kumfor[1,2,3]; [1]Neuroscience Research Australia, Sydney, Australia, [2]University of New South Wales, Sydney, Australia, [3]ARC Centre for Excellence in Cognition and its Disorders, Sydney, Australia, [4]University of Western Australia, Perth, Australia

Faces offer an incredible wealth of information for social interactions. Emerging evidence suggests that some clinical groups (e.g., autism) with impaired emotion recognition do not appropriately attend to parts of the face that display emotion (e.g., eyes). Two variants of frontotemporal dementia (FTD): behavioural-variant frontotemporal dementia (bvFTD) and semantic dementia (SD), have frontal and/or temporal atrophy, which overlaps with brain networks involved in face and emotion processing. Existing evidence has shown that

both bvFTD and SD patients have behavioural deficits in labelling facial expressions. Whether this impairment is due to inappropriate facial scanning, however, is unknown. This study investigated facial scanning in 20 bvFTD, 12 SD and 21 control participants. Eye tracking was recorded while participants passively viewed faces across 72 trials (3 blocks of 8 fearful, 8 happy, 8 neutral faces). Results revealed a significant group difference in the number of fixations to the eyes during the first block ($p = 0.04$). Specifically, bvFTD participants showed more fixations to the eyes than controls in both the happy ($p = 0.046$) and fearful ($p = 0.023$) condition. Furthermore, bvFTD patients showed more fixations to the eyes in the fearful condition than the SD group ($p = 0.048$). This difference diminished over repeated exposure to stimuli (i.e., across blocks), with all groups looking less at the eyes with repeated viewings of the face ($p < 0.005$). These results indicate that despite evidence of emotion labelling deficits, both bvFTD and SD are looking at emotionally relevant face regions. In particular, bvFTD participants look more at they eyes than healthy controls when viewing emotional faces, which may be suggestive of an attempt to compensate for deficits. Differences in facial scanning between these subtypes of FTD suggest distinct underlying processes influencing facial emotion decoding. Future analyses will identify the neural correlates of facial scanning patterns in these dementia syndromes. Overall, our results provide impetus for further investigation into the mechanisms of face and emotion processing in these FTD syndromes, which will, in turn, inform our knowledge of the face-processing network.

Keywords: eye tracking; expression recognition; dementia

A23 Dissociation of the Contributions of Orbitofrontal Subregions on Social Attention in Rhesus Macaques

Lauren Murphy[1,2], Jocelyne Bachevalier[1,2]; [1]Emory University, Atlanta, GA, [2]Yerkes National Primate Research Center, Atlanta, GA

Speedy and accurate processing of social information is essential for group living primates and is supported by interconnected regions such as the limbic, temporal, and frontal lobes (Leopold, 2010). Within the frontal lobe, damage to the orbitofrontal region may result in impaired emotional processing, poor affect regulation, and inappropriate social behavior (Tsuchida & Fellows, 2012; Hornak, et al. 2003). Subregions of the orbitofrontal cortex may be differentially involved in the regulation of social behavior in primates, however, damage in human studies is rarely confined to specific subregions. Thus, we prepared 13 adult rhesus macaques with damage restricted to subregions of the orbitofrontal cortex, including Brodmann's area 12 (n=4), areas 11/13 (n=5), areas 14/25 (n=4), as well as sham-operated controls (n=4). Once recovered, subjects were seated in a primate chair and placed in a darkened testing booth to freely view 10-second social and nonsocial movies containing positive, neutral, or negative valence. During viewing, gaze position was tracked using a 60Hz infrared eye-tracking system (ISCAN), which was calibrated at the start of each testing session. Regions of interest (ROI) were hand drawn on each movie for the following pre-determined regions: eyes, mouth, and main figure. For nonsocial movies, only main figure was created and analyzed. To quantify patterns of looking behavior, percent of looking time was calculated for each ROI as a proportion of total looking time to that movie, using a custom MATLAB script. Finally, total looking time was summed for each movie. All values were averaged for each subject across each valence category (positive, neutral, negative). A repeated-measures ANOVA was performed for each ROI with valence as the within-subjects factor and lesion group as the between-subjects factor. Irrespective of valence, damage to BA12 and BA11/13 significantly decreased the proportion of time subjects spent looking at the eyes of social stimuli compared to controls and BA14 ($F_{3,13}=6.08$, $p<0.01$), yet had no significant effect on other ROIs. Overall, when viewing negative social stimuli, all subjects looked more at the mouth (Mouth: $F(1.5,19)=3.97$, $p=0.05$) but less at the eyes and entire monkey stimulus (Eyes: $F(2,26)=13.78$, $p<0.01$; Monkey: $F(1.9,24.5)=5.55$, $p=0.01$), and accrued more total looking time ($F(2,26)=3.81$, $p=0.04$) compared to more positively valenced stimuli. When viewing negative nonsocial stimuli, subjects looked less at the objects in the scene compared to objects in positive nonsocial scenes ($F(2,24)=7.07$, $p<0.01$). No interactions reached significance. Thus, damage to BA12 and BA11/13 appear to elicit similar social deficits, characterized by decreased attention to highly salient social regions (i.e. the eyes). These findings are supported by research in humans suggesting that the ventral orbitofrontal network is highly involved in social attention (Wolf, et al. 2015), but less so in emotional processing. While the small sample size may have hindered our ability to detect any interactions between orbitofrontal damage and valence, future analyses will attempt to elucidate the impact of valence by examining changes in pupil diameter as a measure of autonomic arousal.

Keywords: social attention, orbitofrontal cortex, emotion, rhesus macaques

A24 Oxytocin alters excitatory synaptic transmission in rat insular cortex

Juan Varela[1], Vikram Krishna[1], John Christianson[1]; [1]Boston College

The neuropeptide oxytocin (OT) is a highly conserved neural modulator and is known to contribute to social,

feeding, and fear behaviors. OT positive axons and OT receptors (OTR) are found in the insula of rat but little is known regarding the physiological consequences of OT acting in this region. We sought to describe the effects of OT on synaptic transmission in layer 5/6 pyramidal neurons of the insular cortex. Studies were done using visualized whole cell patch clamp recordings and extracellular field potentials from 300µm slices taken from 6 to 9 week old male Sprague Dawely rats; data were included for analysis if they were found in the deep layers of Agranular or Granular insular cortex 2.8mm (+/-.5mm) caudal to bregma and appeared to have pyramidal morphology (confirmed by biocytin staining with patch-clamp experiments or by visual inspection on field potential experiments). Bath application of OT (500 nM) decreased of the mEPSC amplitude and increased the inter-event intervals (IEI), ps < 0.05. Spontaneous inhibitory post-synaptic currents (sIPSCs) were unchanged. OT did not influence evoked excitatory post-synaptic potentials (fEPSPs) per se, but OT applied during low frequency stimulation (LFS, 900 stimulations at 1Hz) appeared to promote long term depression (N=3) when compared to control (N=3); data collection is ongoing. Together these data suggest that OT may alter both presynaptic glutamate release probability and postsynanptic AMPA receptor kinetics to promote LTD-like neuroplasticity.

Keywords: plasticity, insula, rat, oxytocin, empathy

A25 The Insular Cortex is Necessary for Social Affective Behavior in Rat

Morgan Rogers[1], Katherine Gribbons[1], Morgan McGoey[1], John Christianson[1]; [1]Boston College

Psychiatric conditions including autism and schizophrenia are characterized by aberrant social cognition. An elementary component of social cognition is the ability to detect the emotional state of another individual and use that information to coordinate the appropriate social behaviors. We report on a set of experiments which sought to explore the neural basis of social affective behavior. In a Social Affective Preference (SAP) test, an adult male rat is presented two unfamiliar male juvenile conspecifics (PN28), one exposed to stress (2x 5 s, 1mA footshocks) and the other naïve to treatment. Adult test rats prefer to interact with the stressed juvenile ($p<0.01$) which we interpret as evidence for social affect. The insular cortex (IC) is a site of multisensory integration and is implicated in both healthy and disordered social cognition. To test the role of IC in the SAP test, we inactivated the IC by bilateral injection of muscimol (50ng/side) prior to testing or optogenetic silencing of IC projection neurons with halorhodopsin (CamKII-eNpHr3.0). Both manipulations abolished the preference for the stressed juvenile. The IC contains oxytocin receptors (OTR) and bilateral infusion of an OTR antagonist (10µg/side) in this region prior to testing also abolished SAP preference behavior ($p<0.01$). OTR signaling involves protein kinase C (PKC). Consistently, intra-insula inhibition of the PKC signaling cascade by Gö-6893 (500ng/side) prevented the display of social affective preference for the stressed juvenile ($p<0.05$). These data suggest that social affective behaviors can be studied in rat, and they depend upon activation and OTR signaling in the IC.

Keywords: insula, rat, empathy, oxytocin

A26 Neural and behavioral effects of incentives on cooperative decision-making in gain and loss context

Xu Gong[1,2], Tengxiang Tian[1], Yuejia Luo[3]; [1]National Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China, 100875, [2]Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, The Netherlands, 6525 EN, [3]Institute of Affective and Social Neuroscience, Shenzhen University, Shenzhen, China, 518060

Objective: Cooperative behaviors, large-scale existed among non-kin individuals underlying nonbinding agreements, are essential for the functioning of human societies, which are affected by both social norms and economic incentives. However, few study has been engaged in how gradient quantified incentives interact with a given social norm can affect human cooperative decision-making and the underlying relevant neural mechanisms. The present study aims mainly to investigate how incentives influence human cooperative decision-making in gain and loss social context. Methods: Thirty-seven participants recruited from Beijing Normal University (17 female, mean age = 21.75 ± 2.41 years). Subjects were scanned using 3T fMRI while they played a modified public goods game (PGG), a standard experimental measure of cooperation, in gain and loss context with a varying level of incentives. Specifically, a gradient variation of thresholding of the public-goods (defined as the sum of contribution from all players in PGG) that leads to the incentive of reward or punishment, were symmetrically manipulated in both gain and loss context. The percentage of contribution in PGG is our dependent variable across different manipulated conditions. The neuroimaging data was analyzed by using a general linear model with trail-wise parametric modulation analysis. Results: Behaviorally, incentives gradually modulated the individuals' contribution in PGG, especially in loss context. However, non-proportionately gradual reversed effects were found in the gain context, which indicated that individuals were more sensitive to the incentives in the gain than the loss context. In terms of neural activation, cooperative decision in gain context versus non-cooperative decision in loss context

was positively correlated with the activation in the brain area of the bilateral ventral striatum (VS), anterior cingulate cortex (ACC) that extending to medial prefrontal cortex (mPFC), and temporal parietal junction (TPJ). Conclusions: In summary, the present research first shows that discrepant effects of the gradual threshold of incentives on cooperative behavior in gain and loss context, and that the motivation to cooperate may be associated with both reward processing as well as with theory of mind mechanisms.

Keywords: social decision-making; social neuroscience, fMRI, neuroeconomics

A27 Hypersocial behavior in mice associated with the heterozygous deletion of GTF2i, a gene deleted in Williams Beuren Syndrome and duplicated in some cases of Autism Spectrum Disorder

Erica Iceberg[1], Loren Martin[1]; [1]Azusa Pacific University

Williams Beuren Syndrome (WBS) is a disorder caused by a deletion at human chromosome 7q11.23, with symptoms including mild to moderate intellectual disability and hypersocial behavior. Autism Spectrum Disorder (ASD) is a behaviorally-defined collection of syndromes of known and unknown etiology that share a common phenotype including impairments of social motivation. The hypersocial behavior associated with WBS appears opposite to the hyposocial behavior observed in ASD and, interestingly, duplications of 7q11.23 have been associated with ASD. The social phenotype of WBS has recently been linked to deletion of a single gene: GTF2i, or general transcription factor IIi (TFII-I). Duplication of GTF2i has also recently been associated with ASD, suggesting that it works in a dosage-type response in its effects on social behavior. In this study, we characterized the specific aspects of social behavior that are modulated by GTF2i by comparing mice having either a deletion (GTF2i+/-) or duplication (GTF2i+/Dup) of GTF2i to wildtype (WT) littermate controls in a series of social behavior tasks. Results from tests comparing GTF2i+/- mice to WT sibling controls have been completed but tests on GTF2i+/Dup mice are ongoing. In the social choice task, GTF2i+/- mice showed a significant preference for a stimulus mouse that was not observed in WT siblings. GTF2i+/- mice spent significantly more time in nose-to-nose contact compared to controls during social encounters and also demonstrated a significantly heightened preference for urine over water scents. To assess social motivation, test mice were trained to press a lever for a social reward in the form of 15s access to an unfamiliar stimulus mouse. The number of lever presses achieved in the final trial of a testing session was used as an index of social motivation (breakpoint). GTF2i+/- mice demonstrated significantly higher breakpoints than controls. The mice were then tested in an operant task involving a choice between food and social rewards. The percentage of total lever presses that were made for a social reward was significantly higher for the GTF2i+/- mice. Overall, GTF2i+/- mice consistently demonstrated increased social behavior across multiple testing paradigms supporting a role for this gene in the hypersocial phenotype of WBS. Preliminary tests of GTF2i duplication mice do not support a role for this gene in the hyposocial phenotype of ASD, however.

Keywords: genetics of social behavior, autism, williams syndrome

A28 Dopaminergic mechanisms of vocal communication in prairie voles

Morgan L. Gustison[1], Natalie Nevárez[1], Matthew Sehrsweeney[1], Minna Wybrecht[1], Isabella K. Wohl[1], Erin E. Wright[1], Brandon J. Aragona[1]; [1]University of Michigan

The two distinct families of dopamine (DA) receptor systems within the nucleus accumbens (NAc) shell, the D1- and D2-like receptor systems, differentially mediate the formation of pair bonds in prairie voles. Specifically, activation of D2-like receptors facilitates pair bond formation whereas D1-like activation prevents this behavior. Functionally, however, it remains unclear how activation in these different receptor systems influence the complex social behaviors important for social bonding. One of the key ways that humans and other mammals engage in social interaction is through vocal communication. In prairie voles, for instance, adult male virgins show a robust increase in the frequency and complexity of ultrasonic vocalizations (USVs) when exposed to novel females, especially if they are in estrous. Here, our objective was to determine whether D2-like activation (i.e. the receptors that promote pair bond formation) promote the production of USVs in male prairie voles when exposed to a novel female, whereas D1-like activation (the receptors that prevent pair bond formation) reduce USV production upon exposure to a female. Specifically, we peripherally administered either a D1 agonist (SKF 38393) or a D2 agonist (quinpirole) and quantified changes in USVs upon being exposed to a female. Remarkably, we found that males treated with the D2-like agonist showed both higher rates of USVs, as well as showed a significantly larger repertoire of USV types, compared to males given the D1-like agonist. This is especially significant because, in a separate group of animals, we show that call repertoire size during the first several minutes of exposure to a novel female predicted how strongly the pair eventually bonded and showed associated neuroplasticity within the DA system within the NAc shell. Moreover, follow up choice experiments suggest that females may prefer males that have been treated with the D2-like agonist (but not D1), potentially indicating that adult USVs function to attract mates and

that this is mediated in a DA receptor specific manner. Our results strongly suggest that USVs serve to advertise the ability/motivation to form a long-term social bond, making this behavior a key signal in the facilitation of partner choice.

Keywords: communication, prairie vole, dopamine, USV

A29 Event-Related Desynchronization in The Mu Frequency During Action Observation Predicts Goal Imitation in 7-Month-Old Infants: A Partial Least Squares Analysis

Carlos Cardenas-Iniguez[1], Courtney A. Filippi[1], Nathan A. Fox[2], Amanda L. Woodward[1], Marc G. Berman[1]; [1]The University of Chicago, [2]The University of Maryland, College Park

Desynchronization of activity in the mu frequency (6-9 Hz in infants) has been previously associated with action imitation in children, suggesting a relationship between motor system activation and social behavior (Filippi et al., 2016). The current study investigates this finding further by using Partial Least Squares (PLS), a multivariate analysis approach, to investigate the relationship between electrical brain activity during action observation in 7-month-old infants and subsequent imitation behavior. More specifically, we used Electroencephalography (EEG) to measure Event-Related Desynchronization (ERD) in the mu frequency (6-9 Hz) in thirty-five 7-month-old infants as they observed and responded to experimenters reaching for one of two toys. Event-Related Desynchonization (ERD) for a trial was calculated as 10 times the log ratio of power during the test interval (1s from onset of experimenter action) to power during the baseline interval (1s period before the experimenter's action began). We implemented a Partial Least Squares (PLS) analysis to uncover significant relationships between signal changes in electrode regions and experimental variables (e.g., behavioral responses or experimental contrasts; Krishnan, Williams, McIntosh, & Abdi, 2011). Initial analyses revealed a number of electrodes in parietal, occipital and frontal sites showing a reliable difference in ERD during action observation for trials that resulted in goal responses (i.e. the child imitated the actions of the experimenter) compared to trials with non-goal responses (i.e. the child did not imitate the actions of the experimenter). Consistent with prior literature, electrodes in parietal and occipital sites (PO4, P6, POz) showed greater ERD during action observation trials preceding a goal response, while electrodes in frontal regions (F5, Fp1) showed greater Event-Related Synchronization (ERS) during action observation trials preceding a non-goal response. The results from this multivariate and data-driven approach are a first step in understanding the contribution of a network of brain regions during action understanding in infants.

Keywords: social cognition, action understanding, eeg, ERD, PLS, infants

A30 Ideal affect modulates neural predictors of giving

BoKyung Park[1], Jeanne Tsai[1], Elizabeth Blevins[1], Brian Knutson[1]; [1]Stanford University

Can brain activity predict decisions to share resources with others, and if so, is this moderated by how people ideally want to feel (Ideal Affect)? In the Dictator game, European Americans, who value high-arousal positive states (HAP; e.g., excitement, enthusiasm), give more to targets with excited smiles, whereas Koreans, who value low-arousal positive states (LAP; e.g., calm, peacefulness), give more to targets with calm smiles. We explored the neural mechanisms underlying how ideal affect influences giving. 18 European Americans and 18 Koreans played the Dictator Game while undergoing fMRI. On each task trial, subjects chose how much of their endowment (i.e., $12) they would give to different targets, whose avatars varied with respect to positive expression (excited versus calm), ethnicity (Caucasian versus Asian), and sex (male versus female). One randomly selected trial was realized at the end of the experiment. Consistent with previous findings, the more the givers valued HAP vs. LAP, the more they offered to excited vs. calm targets, Estimate = .29, $z = 6.86$, $p < .001$. Analyses of neuroimaging data focused on neural circuits implicated in reward (Nucleus Accumbens; NAcc) and mentalizing (dorsomedial prefrontal cortex; dmPFC, temporo-parietal junction, TPJ). The more people valued HAP, the less they activated mentalizing circuits while viewing excited targets vs. calm targets (Estimate = -.02, $z = -2.07$, $p = .039$). Moreover, decreased activity in mentalizing circuits predicted increased giving ($z = -2.21$, $p = .027$). These findings suggest that people may give more to targets that match their ideal affect because they assume shared mental states. Increased activity in reward circuits predicted increased giving to all targets ($z = 2.08$, $p = .037$) – but this was not associated with ideal affect. These effects did not vary by target ethnicity and target sex. Together, these results indicate that while NAcc and mentalizing area activity predict willingness to give to others, givers' ideal affect modulates mentalizing area in response to varied expressive targets. These findings may have implications for the cultural specificity of appeals for charitable giving and policy related to the distribution of resources.

Keywords: Culture, Emotion, Ideal affect, Prosocial behavior

A31 Social information foraging obeys the marginal value theorem in rhesus macaques

Courtney Turrin[1], Nicholas Fagan[1], Olga Dal Monte[1], Steve W.C. Chang[1]; [1]Yale University

Like food, water and other essential resources, animals aggregate in clumped distributions based on specific landscape and biotic features of an environment. It has been demonstrated across a variety of taxa that animals forage for patchily distributed resources according to an energy-maximizing strategy, balancing the tradeoff between the benefits of obtaining energetic gain and the costs of searching. For social species, seeking out conspecifics and effectively attending to and interpreting the social signals of others are critical to reproduction and survival. However, it remains unknown how animals forage for social information. To determine whether social information foraging behavior resembles nonsocial resource foraging behavior, we investigated how rhesus macaques (Macaca mulatta) forage for social information conveyed by conspecific faces. Monkeys completed a virtual social foraging task in which they explored environments containing patches of such social information. While foraging, monkeys could explore and exploit specific social information by selecting targets mapped onto emotional valence of conspecific faces that were revealed upon selection. Monkeys could choose to leave the current patch for a new patch at any time by selecting a travel bar, which indicated randomly varied travel delay length (time to a new patch). Monkeys had a consistent preference for negative-valence targets, selecting them substantially more and earlier within a given environment, suggesting an intrinsically greater informational value of negative-valence images relative to non-negative (affiliative and neutral) images. We used the Marginal Value Theorem (MVT; Charnov, 1976, Theor Popul Biol), an optimality model that has been shown to describe the behavior of animals foraging among patches of resources, to assess whether monkeys foraged for social information using an optimal strategy. Patch residence times during social foraging increased with longer travel delay times, which is consistent with MVT. Our results indicate that social information foraging obeys MVT, suggesting that some of the neural computations used for nonsocial resource foraging (Hayden et al., 2011, Nat Neurosci) may underlie decisions concerning the tradeoff between the benefits of obtaining social information and the search costs.

Keywords: social behavior; information seeking; foraging

A32 Effect of behavioral development and social experience on visually-mediated conspecific interaction in Japanese medaka fish (Oryzias latipes)

Yasuko Isoe[1], Yumi Konagaya[1], Saori Yokoi[1], Takeo Kubo[1], Hideaki Takeuchi[1,2]; [1]the University of Tokyo, School of Science, [2]Okayama University, School of Natural Science and Technology

Forming a group with conspecifics plays an important role in foraging, predator avoidance, and mating in some species. In zebrafish, the ability of conspecific recognition develops during larval stage and shoaling preference can be affected by their early experience. To clarify molecular mechanism underlying the behavioral development, we have focused on medaka fish (Oryzias latipes), because adult medaka fish exhibit complex social behaviors mainly based on visual cues from conspecifics. The ontogeny of visually-mediated social behaviors from larval/juvenile to adult medaka fish, however, is still unknown. In the present study, we established a simple behavioral paradigm to evaluate the swimming proximity to conspecifics based on visual cues in an inter-individual interaction of two medaka fish throughout life. When two fish were placed separately in a cylindrical tank with a concentric transparent wall, the two fish maintained proximity to each other. An intact fish inside the tank maintained proximity to an optic nerve-cut fish outside of the tank, while the converse was not true. Thus, the behavioral paradigm enabled us to quantify visually-induced motivation of a single fish inside the tank. The proximity was detected from larval/juvenile to adult fish. Larval fish, however, maintained proximity not only to conspecifics but also to heterospecifics. As the growth stage increased, the degree of proximity to heterospecifics decreased, suggesting that shoaling preferences toward conspecifics and/or visual ability to recognize conspecifics is refined and established according to the growth stage. Furthermore, the proximity of adult female fish was affected by their reproductive status and social familiarity. Only before spawning, adult females maintained closer proximity to familiar males rather than to unfamiliar males, suggesting that proximity was affected by familiarity in a female-specific manner. This simple behavioral paradigm will contribute to our understanding of the neural basis of the development of visually-mediated social behavior using medaka fish.

Keywords: social motivation, approaching behavior, teleost

A33 Oxytocin Receptors Regulate Social Cognition and Arc and Their Response to Social Stress

Hailian Xiao[1], Jeff Sanders[1]; [1]Emory University

The oxytocin receptor (Oxtr) plays influential roles in social cognition and in resilience to social stress. We studied the Oxtr regulation of social cognition and of activity regulated cytoskeleton-associated protein (Arc) within a social stress paradigm. Male C57Bl/6J mice (WT) and Oxtr knockout mice (Oxtr-KO) were divided into 'socially housed' or 'socially stressed' experimental

groups. Socially stressed mice were isolated for 6 weeks. During this period they were tested for social investigation and discrimination at week 5, and repeatedly exposed to an intruder during week 6. The brains of these socially stressed mice were removed 2 hrs after their last intruder encounter and assayed for Arc mRNA with in situ hybridization. Socially stressed WT mice had impaired social investigation and discrimination and decreased Arc mRNA within many brain regions. Oxtr deletion created many of these social stress-induced alterations within socially housed animals. Socially housed Oxtr-KO had impaired social discrimination and decreased Arc mRNA within several brain areas. Social stress decreased the social investigation of Oxtr-KO to a greater extent than WT, but it did not alter their baseline social discrimination impairments. Moreover, in contrast to decreased Arc mRNA found in socially stressed WT, socially stressed Oxtr-KO either showed no change in Arc mRNA or displayed increases from its baseline level. These data show that the Oxtr is critical for regulating baseline levels of social cognition and Arc mRNA. Furthermore, these data indicate that the Oxtr plays a crucial role in organizing both behavioral and brain plasticity in response to social stress.

Keywords: oxytocin, social stress, plasticity, Arc

A34 Developmental changes in emotional neurocircuitry and cellular aging in nonhuman primates: Effects of early maternal care

Elyse Morin[1], Brittany Howell[1,2], Eric Feczko[1], Eric Earl[3], Kyle Esteves[4], Martin Styner[5], Stacy Drury[4], Damien Fair[3], Mar Sanchez[1]; [1]Emory University, [2]University of Minnesota, [3]Oregon Health & Science University, [4]Tulane University, [5]University of North Carolina

Childhood maltreatment is associated with increased risk for psychopathology, and social and cognitive deficits. This is in part due to alterations in cortico-limbic circuits (e.g. prefrontal cortex (PFC) and amygdala connectivity) critical for emotional and stress regulation, which are sensitive to early social experience and stress due to their protracted development. How these effects unfold during early development is not well understood and difficult to study in humans. This study utilized a well-established nonhuman primate model of infant maltreatment (MALT), which consists of comorbid physical abuse and rejection, leading to infant distress. In this macaque model, the highest rates of abuse and rejection take place during the first three months of life, co-occurring with rapid brain development and maturation of PFC-amygdala circuits. MALT leads to long-term effects on emotional reactivity and social behavior, as well as alterations in amygdala and white matter development. To disentangle the effects of experience from inheritance we used a unique cross-fostering design with random assignment of infants to control or maltreating foster mothers at birth. This study delves into the effects of MALT on the developmental trajectory of PFC-amygdala functional connectivity (FC) throughout the infant and juvenile periods. Structural and resting state (rs) fMRI scans were collected at ages 2 weeks, and 3, 6, 12, 18 months in 13 animals with history of MALT (7 male, 6 female) and 13 controls (6 male, 7 female). RsfMRI findings indicate reduced PFC-Amygdala FC in MALT animals and an accelerated switch to negative coupling than in controls, between amygdala and medial, dorsolateral and orbitofrontal PFC. The reduced PFC-amygdala FC during infancy and the juvenile period in MALT subjects could underlie the emotional and cognitive alterations they exhibit during development. To test the hypothesis that the developmental alterations in FC are linked to accelerated biological aging we explored the association between the trajectory in leukocyte telomere length (TL) measured at birth, 2 weeks and 3 and 6 months and FC fMRI data. TL is an established marker of cellular aging that reflects cellular allostasis and is sensitive to a range of factors including psychosocial stress, oxidative stress and DNA damage. Accelerated decline of TL has been associated with MALT in adults and children, however limited data exists on the neurobiological correlates. Our preliminary findings indicate a complex interaction between MALT, sex and the trajectory of TL shortening, which predicts some of the maturational effects of maltreatment on PFC-amygdala FC, particularly in females.

Keywords: socioemotional development, stress, trauma, amygdala, PFC, rsFMRI

A35 Do rhesus macaques show the same visual preference for average faces as humans?

Olivia Tomeo[1], Leslie Ungerleider[1], Ning Liu[1]; [1]Laboratory of Brain and Cognition, NIMH, Bethesda MD

In humans, facial attractiveness is a long-standing topic of active study in both neuroscience and social science, motivated by its positive social consequences. Non-human primates share similar social behaviors related to face processing and their underlying neural mechanisms with humans. For example, like humans, non-human primates can read information from conspecific faces about another's identity, mental state, and emotional state. However, it is unclear in non-human primates whether faces might also play a role in attraction as in humans and, if so, what kind of facial characteristics make a face preferred. To address these questions, we investigated the effect of averageness, a well-accepted factor that influences judgments of facial attractiveness in humans, on face preferences in monkeys. We tested three adult male rhesus macaques using a visual paired comparison task design in which

they viewed pairs of faces (both individual faces, or one individual face and one average face). We found that monkeys looked longer at certain individual faces than other individual faces. However, unlike humans, monkeys did not prefer the average face over individual faces. Interestingly, looking times to individual faces reflected the norm-based face space, in which faces are encoded by their deviation from the average face: the more the individual face differed from the average face, the longer the monkeys looked at it. Taken together, our study provides new information about visual preferences for facial characteristics and behavioral evidence for the norm-based face space theory in monkeys.

Keywords: Facial, macaque, average

A36 Role for androgen receptor in the development of the sex differences in the brain oxytocin system

Nicholas B. Worley[1], Kelly M. Dumais[1], Jingying C. Yuan[1], Laura E. Newman[1], Andrea G. Alonso[1], Alexandra H. Veenema[1]; [1]Boston College

The neuropeptide oxytocin (OT) often regulates social behavior in sex-specific ways. This may be due to sex differences in the brain OT system. In support, our lab has recently demonstrated that adult male rats have higher OT receptor (OTR) binding density than females in various forebrain regions, including the posterior bed nucleus of the stria terminalis (BNSTp). Understanding the origin of this sex difference may advance our understanding of the sex-specific development and regulation of social behavior. Sex differences in the brain are organized by testosterone (T), primarily via actions of its metabolite estradiol during critical periods (perinatal and pubertal) in development. The BNSTp is a sexually dimorphic region of the rodent brain in which males have a larger volume than females. This sex difference is dependent on perinatal testosterone and can be eliminated by early postnatal castration. While the sexual dimorphism in size doesn't appear until postnatal day 12, we find that the sex difference in OTR binding density in the BNSTp appears at postnatal day 5. This suggests that the sex difference in OTR binding density is also organized during the perinatal critical period. We hypothesized that the sex differences in pBNST size and OTR binding density are regulated by androgen and/or estrogen receptor signaling during the early postnatal period. To test this, we determined whether masculinization of BNSTp size and OTR binding density is dependent on androgen receptor or estrogen receptor activation. We predicted that blockade of endogenous neonatal testosterone-dependent signaling would decrease the pBNST size and OTR binding density in the of males to the level seen in females. We find that neonatal androgen receptor antagonism in males decreased OTR binding density in the pBNST as well as pBNST volume, but neither to the point of female levels. Furthermore, we find that estrogen receptor antagonism did not significantly alter OTR binding density or pBNST size. These findings suggest that the sex differences in BNSTp size and OTR binding density are partially mediated by testosterone-induced AR activation during the postnatal period.

Keywords: oxytocin receptor, sex differences, androgen receptor, bed nucleus of the stria terminalis

A37 Prenatal anxiety and neural responses to infant affective cues

Helena Rutherford[1], Grace Austin[1], Jonathan Lee[1], Linda Mayes[1]; [1]Yale Child Study Center

Women may be especially vulnerable to anxiety during pregnancy and the postpartum period. However, little is known regarding the potential impact of anxiety on the neural processing of infant-relevant information during this critical period for mothers and their developing child, and how early associations between anxiety and responding to infant affective cues may occur. One prior event-related potential (ERP) study reported that recent mothers with higher levels of anxiety had increased LPP responses elicited by unfamiliar neutral infant faces, as compared to mothers with lower levels of anxiety (Malak, Crowley, Mayes, & Rutherford, 2015). However, whether this relationship was present prior to delivery and represented a truly infant-specific effect was not known. Therefore, in the current study, women were recruited from the local community during their second and third trimester of pregnancy to participate in an ERP study of socio-emotional face processing. We examined the N170, P300, and LPP amplitudes elicited by infant and adult neutral and distress faces (and also by house images, acting as a non-social control stimulus). We also examined prenatal levels of anxiety and depression. All facial stimuli were pre-tested to determine their emotional quality and were randomly presented. The N170 was comparable across face conditions, and was not associated with prenatal anxiety or depression levels. However, for both the P300 and LPP, we found a statistically significant interaction between face type (infant, adult), face emotion (neutral, distress), and prenatal anxiety. For both ERP components, increasing prenatal anxiety level was associated with a larger neural response elicited by infant neutral faces, with no associations between the other face conditions or the neural responses elicited by houses. Notably, prenatal depression was not associated with neural responses to any social or non-social cues. Furthermore, general measures of stress, intentions and planning for pregnancy, maternal age, and prior reproductive experience did not contribute to these findings. Taken together, prenatal anxiety may result in increased attention to, and processing of,

neutral infant faces, consistent with prior postpartum research (Malak et al., 2015). This finding appears infant-specific in the absence of any prenatal anxiety associations with adult faces and our non-social control condition. Heightened processing of neutral infant cues may be understood within an intolerance of uncertainty framework, wherein ambiguous infant affective states may be more negatively-valenced, requiring additional processing of these cues – although this requires further investigation. Our study is in progress and women are continuing with postpartum visits. We plan to assess the associations between prenatal anxiety and infant-relevant neural responses to caregiving in the postpartum period.

Keywords: anxiety, pregnancy, face perception, EEG/ERP

A38 Oxytocin increases the reward value of interpersonal touch in romantic relationships

Ann-Kathrin Kreuder[1], Dirk Scheele[1], Lea Wassermann[1], Michael Wollseifer[1], Brigitte Stoffel-Wagner[1], Juergen Hennig[2], Wolfgang Maier[1], René Hurlemann[1]; [1]University of Bonn, [2]University of Giessen

Interpersonal touch in romantic relationships functions is a signal of intimacy and affective support that has a beneficial influence on multiple stress-sensitive systems. The hypothalamic peptide oxytocin (OXT) has been implicated in modulating pair bonding behavior and the sensation of interpersonal touch, but whether these effects extend to the unique experience of a romantic partner's touch remains unknown. Here we present preliminary data from an ongoing randomized placebo (PLC)-controlled parallel-group study involving 47 heterosexual couples. We administered 24 IU of synthetic, intranasal OXT to either the man or woman. Subsequently, we employed functional magnetic resonance imaging to scan the subjects while they assumed they were being touched by their romantic partners. In fact, however, the touch was always applied by the same experimenter thereby keeping the intensity and type of cutaneous stimulation constant. On the behavioral level, OXT selectively enhanced the subjective pleasantness of the partner's touch and concomitantly reduced the hedonic quality of a stranger's touch compared to PLC. On the neural level, these effects were paralleled by an increased neural response to the partner's touch in reward-associated regions such as the striatum and the orbitofrontal cortex. Collectively, our results provide further support for the notion that social OXT effects fundamentally depend upon the perceived context. By increasing the reward value of a partner's touch, OXT may contribute to the maintenance of monogamous relationships. As such, intranasal OXT could be used for the pharmacological augmentation of touch-based support interventions.

Keywords: Interpersonal touch; fMRI; oxytocin; pair bonding

A39 Supralinear effects of combined oxytocin administration and opioid blockade on contingent social gaze dynamics

Matthew Piva[1], Olga Dal Monte[2], Marios Tringides[2,3], Steve Chang[1,2,3]; [1]Interdepartmental Neuroscience Program, Yale University, [2]Department of Psychology, Yale University, [3]Department of Neuroscience, Yale School of Medicine

Upon encountering other people in daily life, we initiate interactions, observe reactions, and respond using our own gaze behavior. This dynamic and contingent gaze interaction between individuals is a hallmark of social attention. However, there is a significant knowledge gap in our understanding of social attention with respect to contingent gaze dynamics. Moreover, the potential role of neuromodulation in social interaction remains unclear, despite the known impact of certain neuromodulatory systems, including the oxytocin and opioid systems, on social cognition. Here, we utilized a live gaze interaction paradigm in pairs of rhesus macaques to explore how the oxytocinergic and opioidergic systems interact to modulate contingent gaze dynamics between two individuals. In this paradigm, two monkeys were placed in front of each other while eye positions were recorded from the two animals simultaneously. Monkeys freely explored the face of a conspecific following inhaled administration to one of the two monkeys of either oxytocin or naloxone, an opioid antagonist, or both. We found that oxytocin co-administered with naloxone more strongly promoted attention to the conspecific's face, and particularly to the eyes, compared to either drug administered alone. This increase was strongest approximately 50 to 70 minutes following administration, indicating a time course for the behavioral effects. Additional analyses revealed that the effects of oxytocin and naloxone were supralinear for these looking behaviors such that the effect of oxytocin and naloxone administered together exceeded the added effects of oxytocin and naloxone alone, although these values were still positively correlated. We also found that the effects of both oxytocin alone and oxytocin administered with naloxone were negatively correlated with baseline looking time, such that drug administration affected monkeys who displayed less social attention to the conspecific more than monkeys who displayed higher baseline social attention. Our findings also indicated that the combination of oxytocin and naloxone invoked a supralinear enhancement of prolonged social attention following mutual eye contact compared to oxytocin or naloxone alone, such that administering the two agents together produced a significantly larger effect than the summation of the effects observed when

the drugs were administered separately. Interestingly, these effects were specific to the time period following mutual eye contact and were not observed following non-mutual eye contact. Our findings are supported by the known regulatory relationship between the oxytocin and opioid systems, in which attenuated opioid processing is associated with stronger oxytocin release from the posterior pituitary. We provide the first evidence that the oxytocin and opioid systems interact to modulate social attention and exploration following contingent social interactions based on the observed supralinearly summed effect patterns.

Keywords: Oxytocin, naloxone, eye movement

A40 Ucn3 and CRF-R2 in the medial amygdala regulate complex social dynamics

Yair Shemesh[1,2], Oren Forkosh[1,2], Alon Chen[1,2]; [1]Department of neurobiology, Weizmann Institute of Science, Rehovot, Israel, [2]Department of stress Neurobiology and neurogenetics, Max Planck Institute of Psychiatry, Munich, Germany.

In social environments, individual interests may be confronted with the needs and expectations of others. Thus, the ability to respond adequately to social stimuli is important for facilitating adaptive social interactions. Such socioemotional skills reflect how individuals perceive themselves and others. Because of the complexity of social environments, adequate coping with the stress that accompanies social engagements, requires highly adaptive behavior. Such coping is compromised in a variety of psychiatric disorders such as social anxiety disorder (SAD) and autism spectrum disorders (ASDs). Currently, understanding of the molecular mechanisms and neurobiological circuits that regulate the socioemotional balance is limited and the ability to intervene and treat maladaptive social stress is poor. The central corticotropin-releasing factor (CRF) system plays a key role in mediating the neuroendocrine and behavioral responses to stressful challenges. CRF plays a well-established role in the regulation of the hypotalamic-pituitary-adrenal (HPA) axis under basal and stress conditions, and is proposed to integrate the autonomic, metabolic, and behavioral responses to stressor. In addition to CRF, the mammalian CRF-peptide family contains Urocortin 1 (Ucn1), Ucn2 and Ucn3, and their effects are mediated, with different affinities, through activation of two known receptors, CRF receptor type 1 (CRF-R1) and CRF-R2. The MeA, in which both CRF-R2 and Ucn3 are expressed, is a central hub in the rodent's social brain network. It is the first site where signals from the olfactory bulb and vomeronasal system converge, thus positioning the MeA to recognize, analyze, and categorize incoming chemosensory information. This makes the MeA a critical center for processing pheromonal signals that regulate social behavior. We hypothesized that manipulating the MeA Ucn3/CRF-R2 system would affect the way mice cope with the challenges of interacting with either novel or familiar conspecifics. We found that mice deficient in CRF-R2 or Ucn3 exhibit abnormally low preference for novel conspecifics. We also found that MeA specific knockdown of Crfr2 in adulthood recapitulates this phenotype. In contrast, pharmacological activation of MeA CRF-R2 or optogenetic activation of MeA Ucn3 neurons increase preference to novel mice. Furthermore, chemogenetic inhibition of MeA Ucn3 neurons elicits pro-social behavior in freely behaving groups of mice without affecting their hierarchal structure. These findings collectively suggest that the MeA Ucn3/CRF-R2 system modulates the ability of mice to cope with social challenges.

Keywords: Molecular and behavioral social neuroscience

A41 Oxytocin interacts with gender and social order

Yaoguang Jiang[1], Michael Platt[1]; [1]University of Pennsylvania

The neuropeptide oxytocin (OT) is known to influence social functions in a wide array of mammals. In humans and non-human primates demonstrating complex social behaviors, OT delivered intranasally enhances trust, relaxes social vigilance, and promotes prosocial behavior. The precise neural mechanisms underlying these effects, however, remain unclear. Here we show that treating one male macaque monkey with intranasal OT relaxed his social interaction with another male. OT treatment simultaneously suppressed the threatening behavior of dominant males and increased the boldness of submissive males, effectively flattening the pre-existing social hierarchy. Additionally, OT also enhanced the effectiveness of social communication by increasing the behavioral synchrony between the pair. Notably, OT altered the behavior of not only the treated monkey but also his non-treated partner, consistent with the idea of enhanced feedback through reciprocal social interactions. These effects were largely recapitulated when OT was injected focally into the anterior cingulate gyrus (ACCg), a brain area previously linked to empathy, self-control, and other-regarding behavior. Finally, OT administration in female macaque monkeys resulted in significantly different behavioral patterns when compared with males. These findings bear potentially important implications for the use of OT in both basic research and as a therapy for social impairments in autism, schizophrenia, and other disorders.

Keywords: oxytocin dominance gender

A42 Oxytocin (OT) and Arginine-Vasopressin (AVP) Cell Bodies and Fibers in the Social Behavioral Neural Network in Rhesus Macaques, Chimpanzees, and Humans

Christina Rogers[1,4,6], Amy P. Ross[7,6], Jeromy Dooyema[5,6], Mary Ann Cree[5,6], Shweta P. Sahu[4,6], Ethan Siegel[4,6], E.G. Stopa[8,6], James K. Rilling[1,2,3,6,4], H.E. Albers[7,6], Todd M. Preuss[5,9,6,3]; [1]Anthropology, [2]Psychiatry and Behavioral Sciences, [3]Center for Translational Social Neuroscience, Emory University, [4]Yerkes National Primate Research Center, Atlanta, GA, [5]Division of Neuropharmacology and Neurodegenerative Diseases, [6]Center for Behavioral Neuroscience, [7]Neuroscience Institute, Georgia State University, Atlanta, GA, [8]Pathology (Neuropathology) and Neurosurgery, The Warren Alpert Medical School, Brown University, Providence, RI, [9]Pathology and Laboratory Medicine, Emory University School of Medicine, Atlanta, GA

The neuropeptides OT and AVP are strongly implicated in the regulation of social behavior in mammalian species. While oxytocin- and vasopressin-producing cells are consistently located in the hypothalamus across species, less is known about variation in the distribution of extra-hypothalamic cell bodies and processes. Moreover, the anatomical distribution of these neuropeptides in great apes, such as chimpanzees, the animals most closely related to humans, has not been studied to date. We used immunohistochemistry to identify cell bodies and fibers containing OT and AVP within the social behavioral neural network in fixed, postmortem tissue from humans (n= 3), chimpanzees (n=3), and rhesus macaques (n=3). All three species showed labeling for OT and AVP cell bodies in the hypothalamus. Rhesus macaques showed a wider distribution of labeling for AVP than chimpanzees or humans, with cell bodies and fibers in the BNST as well as fibers in the lateral septum, amygdala, and periaqueductal gray of the midbrain. Across the three species, labeling for OT cell bodies was more restricted, being mainly localized to the hypothalamus. Our results suggest that primates differ from many rodent species (e.g., mice, rats, and voles), which have prominent AVP-containing cell bodies in the medial amygdala that send dense fiber projections to several forebrain areas. Our results also suggest that the distribution of AVP cell bodies and fibers may have been reduced over the course of evolution in great apes and humans.

Keywords: evolution, limbic system, primate

A43 Medial prefrontal cortical thinning mediates shifts in other-regarding preferences during adolescence

Sunhae Sul[1], Berna Güroğlu[2,3], Eveline Crone[2,3], Luke Chang[4]; [1]Pusan National University, [2]Leiden University, [3]Leiden University Medical Centre, [4]Dartmouth College

Development of complex mental models, such as inferring another's intention, is essential for successful social functioning. Recent neurodevelopment research suggests that cortical changes in the social brain during adolescence might enable sophisticated social computation (Blakemore, 2008). Yet, there is limited evidence directly linking these changes in neural architecture to social behavior. The present study investigated the impact of cortical thinning in areas of the social brain to the development of other-regarding behavior in the context of fairness concerns. We adopted a computational approach combining economic utility models, cross-sectional cortical thickness measure, and meta-analytic decoding of functional implications. Participants aged between 9 to 23 years old performed multiple rounds of a mini-ultimatum game (Falk & Fehr, 2003) as responders. We used formal economic utility models to quantify the degree to which each participant considers fairness of intention (i.e., intention-based reciprocity; Dufwenberg & Kirchsteiger, 2004; Rabin, 1993) vs. outcome (i.e., egalitarianism; Fehr & Schmidt, 1999). For each participant we estimated how well each model explained his/her decision and calculated their relative preference for intention-based reciprocity over egalitarianism. Behaviorally, we found a gradual shift in fairness concerns from simple rule-based egalitarianism to complex intention-based reciprocity, from early childhood to young adulthood. Unlike the relatively stable preference for egalitarianism, the preference for intention-based reciprocity seemed to emerge during adolescence, with the shift occurring around 17-18 years of age. Cortical thickness analysis revealed that this shift was mediated by cortical thinning of social brain including the dorsomedial prefrontal cortex and posterior temporal lobe. Further, meta-analytic reverse-inference analysis using Neurosynth framework showed that these regions are highly likely to be involved in social inference. In summary, the present study demonstrated that structural changes in the social brain during adolescence underlie shifts in other-regarding preferences. Our findings provide an important link between brain and behavior and suggest that cortical reorganization of the medial prefrontal cortex and posterior temporal lobe during adolescence facilitates the emergence of complex mental models of others' mental states, which may ultimately enable large-scale human cooperation at a societal level.

Keywords: other-regarding behavior, cortical thickness, structural development, reciprocal fairness, intentionality, medial prefrontal cortex, computational modeling

A44 From joint attention to mentalization: beta oscillatory activity predicts theory of mind skill in typically developing children and suspected autism spectrum disorder children

Patricia Soto-Icaza[1,2], Lorena Vargas[3], Francisco Aboitiz[2], Pablo Billeke[1]; [1]Universidad del Desarrollo, [2]Pontificia Universidad Católica de Chile, [3]Hospital Luis Calvo Mackenna

Social neuroscience has shown that social skills are crucial for a proper human development. Early social development involves the capacity to share with another person the perception of an object, namely joint attention (JA). This skill precedes to the development of the ability to attribute mental states to others known as "mentalization" or theory of mind (ToM). Nevertheless, the neural mechanism involved in this development is still unknown. Since temporo-parietal region (TPR) in adults participates in both attentional and mentalization abilities, this research tests the hypothesis that functional specialization of this region is involved in the development of mentalization from JA. In a real interactive experimental paradigm, children watched a novel stimulus presented in a screen and looking for the interaction with the experimenter (JA condition) or not (no JA condition, nJA). We assessed the electroencephalographical (EEG) activity during self-initiated JA in typically developing (TD) children (n=24) between 3 and 4 years old and then compared this activity with a well-matched group of suspected autism spectrum disorder (sASD) children (n=17). Autism spectrum disorder shows both impairments in the development of JA and mentalization, and alterations in social brain activity that could serve as neurobiological markers. Since JA with another person requires both uncoupling of the stimuli of interest and refocusing of that attention to the social partner, we expect that attentional networks will be involved. Moreover, if JA is a necessary previous step for the explicit ToM development, then it involves the activation of a neural network whose specialization leads to the appearance of ToM ability (i.e., mentalization network). Event related potential (ERP) analysis in TD children showed a significant difference between JA and nJA conditions in right frontal electrodes (490-560ms after stimulus, $p<0.01$, cluster based permutation test). This difference reveals the Nc component (mid-latency negative component) that suggests attentional orienting. Source analysis shows that this activity is placed in right intraparietal sulcus and right inferior frontal gyrus. Time frequency analysis in TD children demonstrated a significant difference in beta band (15-25Hz) between JA and nJA conditions over right parietal channels in JA condition ($p<0.01$). The source of this oscillatory activity was placed in right TPR. This beta oscillatory activity in right TPR discriminates children who already have mentalization ability. Taken together, these results demonstrated that TD children activate both attentional and mentalization brain networks when they perceive an object which subsequently sharing with another human. By contrast, ERP analysis showed that children with sASD presented an opposing pattern of attention network activity when they perceived an object that evoked JA. Moreover, they did not demonstrated beta activity in TPR as compared to TD children. In summary, typical development of social skills involve the recruitment and the specialization of brain areas associated to the ability to understand other persons' perspective and preferences. This process coincides with the apparition of explicit mentalization in TD children and seems to be altered in sASD children, revealing the neural mechanism by which the acquisition of complex social abilities occurred.

Keywords: Joint attention, share attention, theory of mind, mentalization, temporo-parietal region, social cognition, social neuroscience, childhood, EEG, beta oscillations, social brain, autism spectrum disorder.

A45 Neural correlates of eye-to-eye contact include language and social systems: An fNIRS hyperscanning investigation

Joy Hirsch[1,2], J. Adam Noah[1], Xian Zhang[1], Swethasri Dravida[1], Ilias Tachtsidis[2]; [1]Yale School of Medicine, New Haven CT 06511, [2]University College London, WC1E 6BT, UK

Eye-to-eye contact between two humans is a universal form of natural social interaction. Although it is often speculated that neural effects of eye-to-eye contact engage language and social systems, direct evidence and a theoretical framework are lacking. Conventionally, neuroimaging techniques focus on single subjects and solitary task-related paradigms, and investigations of neural correlates that underlie interpersonal interactions, such as eye-to-eye contact, are not well-studied. This knowledge gap is addressed by hyperscanning using functional near-infrared spectroscopy (fNIRS) to investigate neural systems engaged during natural interactive conditions. We test the hypothesis that eye-to-eye contact between dyads engages language, social, and face-related processes to a greater extent than mutual gaze of a static face picture. In this study, 38 subjects (19 dyads) alternated their gaze between the eyes of their partner and the eyes of a picture-face vs. a crosshair. Blood oxygen level-dependent signals were acquired via a Shimadzu LABNIRS system with 84 channels distributed bilaterally on both heads covering anterior and posterior regions. Temporal resolution was 27 ms and the deoxyhemoglobin signal was used for analysis. Eye-to-eye contact was confirmed by eye-tracking (SMI ETG2) synchronized to the fNIRS acquisitions. General linear model contrasts using global mean removal techniques

(Zhang et al., 2016) revealed an eye-to-eye effect ([eye-to-eye]>[eye-to-picture]) consisting of a cluster centered at (-54, 8, 26) extending over left pars opercularis (40%), part of Broca's Area specialized for speech production; left premotor and supplementary motor cortex (45%), part of the sensorimotor face network; and the left subcentral area (12%), consistent with the language and face-related hypothesis ($p<0.01$). Functional connectivity (psychophysiological interaction) using the eye-to-eye effect cluster centroid as a seed revealed increased connectivity to a cluster including: left superior temporal gyrus (STG, 40%), a canonical node for receptive language processing and a component of Wernicke's Area; left primary somatosensory cortex, a component of the sensorimotor face network (18%); and left subcentral area (35%), $p<0.02$. Right side homologues to Broca's Area also increased connectivity to the eye-to-eye effect seed. These results are consistent with co-engagement of eye-related and language systems during eye-to-eye contact. Wavelet analyses of signals between partners confirmed that cross-brain coherence increased between the STG and the supramarginal gyrus, an area known to be sensitive to social cues, during eye-to-eye contact relative to eye-to-picture gaze ($p<0.03$, Bonferroni-corrected). We conclude that these findings are consistent with pair-specific interactive responses because when the partners are scrambled (i.e., the signals from each person in a dyad are compared with those of every other participant in the study group except the original partner), the effect is lost. Together, our results provide evidence for a neural complex that integrates visual, language, and social systems, and is sensitive to the continuous exchange of socially meaningful face and eye signals across participants during natural eye-to-eye contact. Zhang, X., Noah, J. A., & Hirsch, J. (2016). Separation of the global and local components in functional near-infrared spectroscopy signals using principal component spatial filtering. Neurophotonics, 3(1), 015004. This research was partially supported by NIMH of the NIH R01MH107513 (JH).

Keywords: Eye-to-Eye Contact Effect, Hyperscanning, fNIRS

A46 Role of the cingulate on social influence

Raymundo Báez-Mendoza[1,2,3], Firas Bounni[1,2,3], Ziv M. Williams[2,3,4]; [1]Equal Contribution, [2]Harvard Medical School, [3]Massachusetts General Hospital, [4]Harvard-MIT Health Sciences and Technology

Social groups can have a profound influence on their member's decisions. Groups can bias an individual's behavior in both, positive and negative ways. Here, we explore the neuronal mechanisms through which social groups influence an individual's behavior. We used small groups of mice in a foraging task and introduced covertly biased participants while recording the neuronal activity from neuronal ensembles in the anterior cingulate cortex (ACC). We found that behavioral choices were significantly affected by the behavior of other group members. Whereas one subset of neurons reflected social biases introduced by the group's decisions, a second subset reflected conformity or opposition to the group's decisions. These two ensembles complement each other in reflecting the social pressure that the mice faced but were also insensitive to acquiring rewards and to reward prediction errors. Surprisingly, neuronal responses were most strongly modulated by group consensus, even when decisions were wrong. Moreover, group bias coding was weaker when foraging in less reliable patches and when guided by non-social avatars. Together, these findings reveal a subgroup of cells in ACC that selectively encode social biases introduced by group decisions, and suggest a possible early phylogenetic process that may have allowed social animals to make collective decisions.

Keywords: Influence, Social Bias, Mice, Anterior Cingulate Cortex

A47 Human performance when matching facial expressions in a task designed for nonhuman primates

Molly Flessert[1], Leslie Ungerleider[1], Ning Liu[1], Jessica Taubert[1,2]; [1]Laboratory of Brain and Cognition, NIMH, Bethesda, MD, [2]School of Psychology, The University of Sydney, Sydney, Australia

Humans and non-human primates share similar social behaviors as well as face processing strategies. The ability to extract both emotional and identifying information from conspecific faces is critical to all primate species. There is a widely held belief that in order to successfully navigate complex social interactions, humans must extract detailed information about a person's identity and current affect from their face. In the past, researchers have often used a match-to-sample behavioral paradigm to test whether rhesus monkeys share these same sensitivities with humans, especially in light of potentially homologous neural markers. These behavioral experiments have yielded mixed results. However, because matching is considered a relatively simple task, with a low cognitive load, human subjects have been rarely tested in this way. Here, we first tested whether 10 human subjects could discriminate facial expressions using a match-to-sample task similar to those previously designed for rhesus monkeys. Each trial presented three images of different individuals, but the sample and the target (correct choice) both featured the same expression (either neutral, happy, angry or fearful) whereas the foil depicted a different expression. The experimental stimuli were photographs taken of famous celebrities under

various lighting conditions and made little effort to control viewpoint variation. We found that, given auditory feedback but no instruction other than to "select the stimulus that best matched the sample", human subjects on average only performed at just over 70% (excluding the first 60 trials as 'training'). In light of these results, we designed a second match-to-sample task for human subjects where we either tested expression discrimination (and held identity information constant among the faces in any given trial) or identity discrimination (holding expression information constant). We found that overall performance improved slightly. Subjects found the expression task easier than the identity task and maintained a preference for matching facial expression over facial identity in a subset of "preference trials" scattered throughout the experiment that were not differentially reinforced. These results imply that expression is more salient cue than identity when human subjects were not told what to attend to. This task, with a few procedural modifications, is being used to test four adult rhesus monkeys. Additionally, this task has the potential to be used in future experiments designed to understand how the primate brain extracts information about a face's identity and whether the same mechanisms are responsible for the perception of facial expressions.

Keywords: Facial expression, identity, macaque, match to sample

A48 Social exposure robustly enhances the modulation of oxytocin-sensitive reward pathways by a melanocortin agonist

Kara Kittelberger[1], Hasse Walum[1], Larry Young[1]; [1]Silvio O. Conte Center for Oxytocin and Social Cognition, Department of Psychiatry, Yerkes National Primate Center, Emory University, Atlanta GA, USA

Oxytocin (OT) enhances several aspects of social cognition and the OT system is an important therapeutic target for improving social function in disorders such as autism. Melanocortin 4 receptor (MC4R) agonists stimulate local release of OT in the hypothalamus and potentiate OT release in distal target brain areas in response to a physiological stimulus. Both OT and MC4R agonists rescue social deficits in mouse models of autism and facilitate partner preferences in socially monogamous prairie voles. In the absence of social exposure, Melanotan II (MTII), a selective MC4R agonist, enhances Fos activation in OT neurons, but only evokes detectable OT release in the NAcc in response to hypertonic saline. Given this priming effect of MTII, we predict that MTII will enhance OT release in response to social exposure, thereby modulating neural activity of OT-sensitive brain regions mediating social behaviors, including the nucleus accumbens (NAcc) and prefrontal cortex (PFC). We used Fos immunohistochemistry (IHC) to assess neural activity in female prairie voles in response to central infusion of MTII in two contexts, MTII alone and MTII with exposure to a novel stimulus male. First, ICV MTII (3nmol, 2µL) or aCSF (vehicle control, 2µL) was administered to adult female prairie voles, followed by immediate return to an empty homecage. Ninety minutes later animals were perfused and brains were processed for Fos IHC. In this condition, central MTII infusion resulted in a significant increase in Fos positive cells in the basolateral and central amygdala (BLA and CeA, $p<0.001$). No differences were observed in the NAcc, PFC, lateral septum (LS), medial amygdala (MeA), or paraventricular nucleus of the hypothalamus (PVN). In the second condition, females receiving the same treatments as above received 30 minutes of social contact with a novel stimulus male and brains were collected 90 minutes after the initial social exposure. In the social contact condition, MTII resulted in a significant increase in Fos positive cells, compared to aCSF, in the BLA and CeA, as before, but also in the NAcc, LS and PFC ($p< 0.001$), regions known to be involved in social attachment. Thus social contact, a presumed facilitator of central OT release, changes neural activation in the pair bonding network in response to MC4R stimulation. Future experiments will determine whether OT receptor signaling is necessary for the interaction of MTII and social exposure in these brain regions. These findings have important implications for ongoing clinical studies examining the efficacy of an MC4R agonist in enhancing OT-dependent social cognition in autistic populations.

Keywords: autism, prairie vole, oxytocin, melanocortin

A49 Effect of age and autism diagnosis on oxytocin and vasopressin 1a receptors in the basal forebrain and superior colliculus of the human brain

Sara Freeman[1], Michelle Palumbo[1], Aaron Smith[2], Mark Goodman[2], Karen Bales[1]; [1]University of California, Davis, [2]Emory University

Due to the ability of the neuropeptide oxytocin (OT) to enhance social behavior, it is now one of the most promising therapeutics for the treatment of autism spectrum disorder (ASD), a condition characterized by deficits in social function. Indeed, OT treatment can ameliorate some of the social symptoms of ASD, and genetic studies have implicated the OT system in the etiology of ASD. However, it is unknown whether there are differences in OT receptor (OXTR) expression in the brains of individuals with ASD compared to typically developing individuals. This study used a previously validated method for competitive binding receptor autoradiography to quantify the density of OXTR and the structurally related vasopressin 1a receptor (AVPR1a) in postmortem brain tissue from individuals with ASD (n=17) and matched neurotypical controls (n=24). Patients with

ASD have atypical visual attention to social images and disrupted patterns of eye movement; therefore, our analysis focused on the nucleus basalis of Meynert (NBM), which mediates visual attention, and the superior colliculus, which controls gaze direction. Analyses of the superior colliculus are still underway. In specimens of the human NBM, we also found an adjacent region of receptor binding, which we determined to be the ventral pallidum (VP). We found no association between the postmortem interval of the tissue and the density of radioligand binding in either of these two regions, nor did we find any sex differences. We found that receptor binding is greater in the NBM in ASD compared to controls ($p<0.05$) but is reduced in the VP in ASD compared to controls ($p<0.05$). We found no effect of age on receptor binding in the NBM, but we found a significant negative correlation between age and receptor binding in the VP ($r = -0.4066$; $p=0.01$). This association in the VP was driven entirely by the neurotypical controls ($r = -0.6299$; $p<0.01$) and not by our ASD specimens ($r = -0.0902$; $p=0.73$). Further analysis revealed that neurotypical cases have higher levels of receptor binding in the VP from birth to 7 years of age, and these levels drop between ages 8-10 to match the unchanging levels of receptor binding in ASD cases. From ages 8 to 25, there is no difference in receptor density between ASD and controls in the VP. This pattern suggests a possible critical period in childhood, which is lacking in ASD, where receptor expression is heightened, and the VP is maximally sensitive to neuropeptide binding. Further studies are needed to establish a functional role of OXTR in the etiology of ASD. Human tissue was obtained from the University of Maryland Brain and Tissue Bank, which is a Brain and Tissue Repository of the NIH NeuroBioBank. Funding: NIH R21MH110014.

Keywords: oxytocin, vasopressin, human brain, autism, receptor binding

A50 Similar Modulation of Risk Preferences in Economic and Social Domains by Testosterone and Cortisol

Evan Caldbick[1], Neil Watson[1]; [1]Simon Fraser University

Decision-making under uncertain conditions is affected by evaluations of risk, especially in the social and economic domains. Both of these domains are systematically influenced by basal and dynamic changes in testosterone (T) and cortisol (C) (Coates & Herbert, 2008; Stenstrom et al, 2008), and there are many neurophysiological channels through which these steroid hormones may influence both risk domains. Their modulation of monoamine communication, especially through their influence over the expression of serotonin and dopamine receptors, is an important candidate. For example, T increases 5-HT1A mRNA expression throughout the forebrain, while decreasing 5-HT2A mRNA expression in the ventromedial hypothalamic nucleus (Zhang et al, 1999). T also increases dopaminergic activity (de Souza Silva et al, 2009) in several pathways, including to the striatum and nucleus accumbens (Kuhnen & Knutsen, 2005), which modulates reward sensitivity involved in risk taking. Additionally, some of the social affective effects of T may be mediated by a decoupling between the orbitofrontal cortex and the amygdala (van Wingen et al, 2009). These complex and disparate neural effects of T imply that it should have differential behavioural effects as well, with risk domains being a convenient research vector. We therefore sought to determine whether T, in combination with C, differentially acts on financial and social risk preferences. To answer this question we conducted a gambling experiment controlling for risk type and magnitude over both the financial and social domains. Male undergraduate students (N=52) played a trust game with variable number of trials against an algorithm that generated stochastic payoffs from a distribution centred at their bet each round. Subjects in the first condition were explicitly told that their payoffs would be generated by such an algorithm, while those in the second condition were told that they were playing an equivalent trust game against a concealed confederate in a separate room. Saliva samples were collected to measure both baseline and post-task T and C. Risk propensity was measured through the magnitude of subjects' change in bets given their payoffs in the previous trial. No difference was observed in mean risk propensity between conditions, suggesting that prior work on self-appraisals of risk preferences between the financial and social domains may not translate into behavioural outcomes. Additional analyses did reveal a relationship between steroid hormones and risk propensity, such that those with high levels of basal T, as grouped by a median sample split, were more risk-prone than those with low levels. This relationship was statistically significant ($p<0.05$) only for subjects with low levels of C. Therefore, while T and C were jointly related to behavioural risk in general, we found no evidence for differential risk preferences between the financial and social behavioural domains. This may be because no such difference exists, or because our design precluded relevant social information, such as partner personality traits, perceived social rank, or trust related cues such as facial expressions. Future research will explore these possibilities.

Keywords: steroid hormones, social risk, economic risk

A51 Early life sleep fragmentation impairs social behavior and affects parvalbumin expression in adult prairie voles

Elizabeth A.D. Hammock[1], Carolyn E. Jones[2,3], Jazmine Quintana[1], Rachel D. Champaigne[3], Ryan A. Opel[3], Davelle L. Cocking[3], Alex Q. Chau[3], Jorge Rodriguez

Toro[3], Miranda M. Lim[2,3]; [1]Florida State University, [2]Oregon Health & Science University, [3]Veterans Affairs Portland Health Care System

Consolidated periods of sleep during sensitive time points in development may be necessary for the maturation of the neurobiological systems that underlie species typical cognitive and social behaviors. Rapid eye movement (REM) sleep is critical for parvalbumin inhibitory interneuron expression in basic brain circuits and parvalbumin immunoreactivity is decreased in the prefrontal cortex of human subjects with autism spectrum disorder (ASD), while parvalbumin immunoreactivity is increased in the hippocampus, suggesting region specific alterations in parvalbumin. Prairie voles (Microtus ochrogaster) are a highly social rodent species that form lifelong pair bonds with other individuals, thus providing an ideal rodent model to study how sleep shapes the development of social behavior. We selectively suppressed REM sleep in prairie vole pups during a sensitive post-natal period of development (p14-p21) by fragmenting sleep with gentle orbital shaking. Male and female animals were tested for social functioning both as adolescents (p35) and adults (p75-p90) and underwent parvalbumin immunohistochemistry (IHC) followed by cell counting to quantify parvalbumin neurons in the somatosensory barrel fields, prelimbic, and infralimbic cortices. We demonstrate that a brief period of sleep fragmentation in prairie vole pups results in profound social impairments as adults. Sleep fragmented adult animals showed a behavioral phenotype reminiscent of the social deficits observed in ASD, including a male bias in prevalence of atypical behavioral phenotype. Sleep fragmented males, but not females demonstrated lack of pair bond formation, and hyperactivity. Early life sleep fragmentation did not disrupt social investigation behavior in adolescent prairie voles. Parvalbumin IHC revealed increased parvalbumin-immunoreactive cell number in somatosensory barrel fields of sleep fragmented male adults (but not in adult females) compared to non-sleep fragmented animals. Studies utilizing this unique animal model will enhance our understanding of modifiable risk factors, such as sleep, that may contribute to atypical development of the brain and social behavior.

Keywords: sleep, development, prairie vole, autism, parvalbumin, pair bond

A52 Justice sensitivity impacts neural activity during a three-party distribution game

Keith Yoder[1], Jean Decety[1]; [1]University of Chicago

Self-interest is classically described as a fundamental motivation in human behavior. However, recent research indicates that justice is also a central concern. The current study investigated the role of justice sensitivity using a three-party distribution game, in which monetary equality for the participant and a neutral observer were independently manipulated. Healthy participants choose to accept or reject distributions while undergoing functional magnetic resonance imaging (fMRI). Prior to scanning, participants also completed the Justice Sensitivity Inventory, a questionnaire which assesses dispositional sensitivity to justice for oneself (i.e. victimization) or for others. Other-oriented sensitivity scores predicted increased hemodynamic differentiation (UnfairOther-FairOther) in dorsal anterior cingulate and left dorsolateral prefrontal cortex. Conversely, self-oriented sensitivity scores were negatively associated with signal in thalamus, striatum, anterior insula, and right dorsolateral prefrontal cortex. Neither disposition was significantly related to neural processing of self-focused fairness. These findings suggest that individuals wary of exploitation may not find the plight of others particularly salient. On the other hand, individuals highly sensitive to the injustice of others may be utilizing cognitive representations of justice principles, rather than being driven by affective reactions.

Keywords: Justice sensitivity

A53 Parsing the Behavioral and Brain Mechanisms of Third-Party Punishment

Matthew Ginther[1], Richard Bonnie[2], Morris Hoffman[3], Francis Shen[4], Kenneth Simons[5], Owen Jones[1], Rene Marois[1]; [1]Vanderbilt University, [2]University of Virginia, [3]District Judge, State of Colorado, [4]University of Minnesota, [5]University of California, Irvine

The evolved capacity for third-party punishment is considered crucial to the emergence and maintenance of elaborate human social organization and is central to the modern provision of fairness and justice within society. While it is well established that the mental state of the offender and the severity of the harm he caused are the two primary predictors of punishment decisions, the precise cognitive and brain mechanisms by which these distinct components are evaluated and integrated into a punishment decision are poorly understood. Using fMRI, here we implement a novel experimental design to functionally dissociate the mechanisms underlying evaluation, integration, and decision that were conflated in previous studies of third-party punishment. Behaviorally, the punishment decision is primarily defined by a super-additive interaction between harm and mental state, with subjects weighing the interaction factor more than the single factors of harm and mental state. On a neural level, evaluation of harms engaged brain areas associated with affective and somatosensory processing, while mental state evaluation primarily recruited circuitry involved in

mentalization. Harm and mental state evaluations are integrated in medial prefrontal and posterior cingulate structures, with the amygdala acting as a pivotal hub of the interaction between harm and mental state. This integrated information is used by the right dorsolateral prefrontal cortex at the time of the decision to assign an appropriate punishment through a distributed coding system. Taken together, these findings provide a blueprint of the brain mechanisms by which neutral third-parties render punishment decisions.

Keywords: fMRI, norm-enforcement, punishment, decision-making, judgments

A54 Consolation behavior in prairie vole is predicted by oxytocin receptor density in anterior cingulate cortex

James Burkett[1], Lanikea King[3], Elissar Andari[2], Larry Young[2]; [1]Department of Environmental Health, School of Public Health, Emory University, Atlanta, GA, [2]Center for Translational Social Neuroscience, Yerkes National Primate Research Center, Emory University, Atlanta, GA, [3]Scripps Research Institute, Jupiter, FL

Empathy for the pain and suffering of others is a widespread mechanism among social animals that provides a motivation for prosocial behaviors. Consolation is one such prosocial response that has been observed in a wide range of animals, including a laboratory rodent, the prairie vole (Microtus ochrogaster). Our previous research demonstrated that consolation behavior in the prairie vole is empathy-based and is regulated by oxytocin receptor (OTR) signaling in the anterior cingulate cortex (ACC). OTR density in the ACC varies between individual prairie voles, yet the role of this biological variation in contributing to behavioral variation is unknown. We examined the relationship between OTR density and consoling behavior using data from five experiments, split into a discovery sample (Expt. 1, N=54) and a replication sample (Expt. 2, N=7; Expt. 3, N=12; Expt. 4, N=12; Expt. 5, N=43). Analysis of both samples revealed a negative correlation between consoling response and OTR density in the ACC (p=0.02, r=-0.3, Hedges' g=-0.6) but not OTR density in other brain regions. Voles in both the highest and lowest quartiles of OTR density showed a significant consoling response (high, p=0.003; low, p=0.0002), but voles in the lowest quartile performed more consoling behavior than those in the highest quartile (p=0.03). These results show that the magnitude of the consoling response in individual animals can be predicted by the density of OTR in the ACC, suggesting that OTR density in this region may be behaviorally relevant. High OTR density in ACC may drive an increase in personal distress in response to the distress of others, which is related to lower levels of helping in humans, great apes and rats.

Keywords: empathy, consoling, prairie vole, oxytocin, anterior cingulate

A55 Socially rewarding behavior recruits orexin/hypocretin neurons in juvenile male and female rats

Christina Reppucci[1], Cassandra Gergely[1], Nara Nascimento[1], Grace Ro[1], Remco Bredewold[1], Alexa Veenema[1]; [1]Boston College

Orexins/hypocretins (ORX) are neuropeptides whose central synthesis is restricted to neurons in the lateral hypothalamic area (LHA) and adjacent dorsomedial and posterior hypothalamic nuclei. The ORX system has been shown to modulate many reward-driven and motivated behaviors, but its role in socially rewarding behavior is largely unknown. Social play is a highly rewarding motivated behavior predominately displayed by juveniles, and expressed by nearly all mammalian species. Here we examined whether social play recruits ORX neurons in juvenile male and female rats. Single-housed juveniles were exposed, in their home cage, to an age- and sex-matched unfamiliar juvenile for 10 min ("Play" condition) or received similar handling but no partner ("No Play" condition). Rats were sacrificed 80 min after the test, and brain tissue was later processed using fluorescent immunohistochemistry methods for combined detection of the immediate early gene product Fos and identification of ORX-positive neurons in the LHA. Preliminary analysis showed that social play increased recruitment of ORX neurons in the juxtadorsomedial LHA (LHAjd); a greater percentage of ORX neurons were double-labeled for Fos in the Play compared to the No Play condition. Interestingly, this effect was stronger in males compared to females. These findings suggest a novel role for LHAjd ORX neurons in socially rewarding behavior at the juvenile age. The LHAjd is interconnected with regions that comprise the social behavior and mesocorticolimbic reward networks, and ORX fibers innervate many of these regions. Thus, this neuronal population is well-positioned to coordinate the expression of socially rewarding behavior. Future work will examine recruitment of specific ORX-dependent pathways during social play, and assess whether pharmacological manipulations of the ORX system alter expression of social play in males and females.

Keywords: social play, orexin

A56 Processing of social bonding cues in human perceptual and motor systems – an electrophysiological analysis

Rafaela R. Campagnoli[1,2], Andreas Keil[2], Laura Krutman[3], Isabela Lobo[3,4], Jose M. Oliveira[1], Leticia Oliveira[3], Mirtes G. Pereira[3], Isabel A. David[3], Eliane

Volchan[1]; [1]Universidade Federal do Rio de Janeiro, [2]University of Florida, [3]Universidade Federal Fluminense, [4]Pontifícia Universidade Católica do Rio de Janeiro

Predisposition to form and maintain social groups is one of the core features for preserving survival of social species, especially humans. Social bonding typically refers to the process of attachment that develops between parents and children, close friends, romantic partners or loved ones. Previously, using measures of the readiness potential (RP), we suggested that priming with social bonding cues activates caress-like motor preparatory circuits. The aim of this study was to investigate perceptual and motor processing relative to scenes depicting social bonding. The rationale here is that exposure to social bonding pictures impacts perceptual visual processing and prompts action dispositions towards positive social interaction. To investigate this issue, we recorded EEG and combined the event-related potentials technique and analyses of oscillatory brain activity to elucidate this hypothesized perception-action interaction. Participants (17 women/15 men) viewed social bonding and control pictures in a blocked design. Bonding pictures displayed infant/infant and adult/infant dyads interacting with each other; control pictures, in turn, also displayed dyads with no-direct social interaction. Soon after exposure to pictures, participants were asked to perform a caress-like movement on a soft cloth with their left hand, a movement that is compatible with the designed context. Concerning stimulus onset, event-related potentials analyses showed enhanced amplitude of the N2 component when viewing bonding compared to control pictures at temporo-parietal sensors (P7 and P8), and heightened early ERP amplitudes (e.g., N1, 200 ms latency) at occipital sensors. To identify potential signatures of perception-action interactions at the neural level, a temporal principal component analysis (PCA) was conducted. This analysis identified well-known perceptual components as well as a slow component whose time course and topography (central sensors) was consistent with anticipatory motor processing. Finally, a time-frequency analysis using Morlet wavelets analysis was conducted to corroborate and extend the ERP findings in terms of oscillatory correlates of perception and action related to social bonding. This analysis showed greater alpha reduction in posterior sensors for bonding compared to control stimuli, suggesting participants devote relatively more attention to bonding stimuli. In line with the previous RP study, preliminary analyses showed a selective reduction of oscillatory activity in the mu rhythm range, for the bonding condition compared to control. These findings point at a complex interplay between perceptual and action representations while exposure to social bonding stimuli.

Keywords: Emotion; EEG; social bonds

A57 Postnatal oxytocin production in infant mice.

Radhika Vaidyanathan[1,2], Elizabeth A.D. Hammock[1,2]; [1]Department of Psychology, The Florida State University, Tallahassee, FL, [2]Program in Neuroscience, The Florida State University, Tallahassee, FL

Oxytocin (OXT) signaling through the oxytocin receptor (OXTR) facilitates species-typical social behavior and social recognition of a familiar conspecific. OXTR-/- and OXT -/- mice have similar social deficits. OXT production and OXTR expression in perinatal development is sex-dependent in mice, with females showing earlier onset of OXT production and higher expression of perinatal Oxtr . Further, neonatal OXT manipulations have sex-specific effects, which may be influenced by underlying differences in OXT production and release. Because OXTR can serve as a mechanism to promote OXT release, we hypothesized that it might also serve to enhance OXT production during development. In our experiments, we tested the hypothesis that congenital loss of OXTR would impair the development of OXT production in neonatal C57BL/6J mice in a sex-specific manner. In this study we describe a sexually dimorphic effect of OXTR inactivation on OXT production. Our preliminary results show that at postnatal day 8, male OXTR knockout mice but not female knockout mice, show a 50% decrease in Oxt mRNA levels compared to WT animals determined by qPCR. This further demonstrates that the development of OXT/OXTR signaling is sex-specific and suggests sex-differences in the experience-dependent development of the OXT system.

Keywords: Oxytocin

A58 Serotonin promotes sustained attention to social signals

Hannah Weinberg-Wolf[1], Nick Fagan[1], Olga Dal Monte[1], Steve Chang[1]; [1]Yale University

Rhesus macaques, live in large, complex, societies with strict dominance hierarchies (de Waal and Luttrell, 1985) and rely on highly stereotyped, species specific, social signals that help invididuals know when to engage in aggression, and when to submit (Partan, 2002). Navigating the social domain requires effectively attending to these these social signals, which are largely conveyed by a diverse array of viewer-directed facial expressions. Despite the stereotypy of these signals, individuals vary in their ability to competently interpret and deploy species typical social signals to achieve and maintain dominance status (Higley et. Al 1996). The serotenergic system is thought to be largely responsible for regulating these abilities. For example, non-human primates with low concentrations of cerebrospinal fluid (CSF) 5-hydroxyindoleacetic Acid (5-HIAA), a serotonin

metabolite, are less likely to acquire and maintain social dominance than those with high CSF 5-HIAA concentrations (Higley & Linnoila, 1997). However, it remains unclear whether and how serotonin modulates attention to specific social signals communicated via facial expressions. To address this, we investigated how rhesus macaques explore species typical social signals when their circulating levels of serotonin are increased. Following systemic administrations of serotonin precursor l-5-hydroxytryptophan (5-HTP), subjects were allowed to unconstrainedly explore social and non-social images for 5000 ms each. We tested the effects of a low (20 mg/kg), and high (40 mg/kg) 5-HTP dose, as well as a saline control, over strictly alternating days while their eye positions were tracked at high resolution. We observed both an effect of 5-HTP on overall sustained attention as well as effects specific to the facial expression being presented, particularly facial expressions used to convey subordination. We also observed a reorienting of attention to informative regions of the face. In particular, we observed an increase in attention to the eye region. Once again, the magnitude of this effect was specific to the facial expression being presented. Together, these results support our hypothesis that serotonin promotes attention to diverse social signals and reorients attention towards regions of the face that are particularly informative for decoding intent. Enhanced attention to social signals by way of serotonergic neuromodulation may improve social competency.

Keywords: Serotonin, Social Behavior, Eye Movement

A59 Variation at the OXTR gene predicts individual differences in reward, maternal behavior, and stress response across species.

Driscoll CA[1], Baker MB[1], Lindell SG[1], Miller-Crews I[1], Suomi SJ[2], Barr CS[1], [1]NIH/NIAAA, Section of Comparative Behavioral Genomics, [2]NIH/NICHD, Laboratory of Comparative Ethology

Genetic variation that affects sociality and social cognition is likely under selection in any social species. We have recently also been looking for variation at the Oxytocin Receptor gene (*OXTR*) across species. The oxytocin system, like opioids, plays roles in reward, social attachment, anxious responding and HPA axis/stress response. As has been demonstrated with the *OPRM1* gene, studies performed in primates, including humans, have shown there to be evidence of both positive selection and balancing selection at the *OXTR* gene. As this gene encodes a receptor that confers effects on the behavioral systems listed above in addition to various reproductive and caregiving indices (parturition, and milk let-down) across mammals, this is not entirely surprising. We screened the regulatory region, first exon and first intron of the rhesus macaque rh*OXTR* gene and identified 17 SNPs. SNPs were identified in a location at which there is high interspecific conservation, yet high frequencies of non-synonymous SNPs in humans as well. Based on Manhattan distances weighted by minor allele frequency and marker average LD, haplotypes for rhesus macaque were clustered hierarchically using R (http://www.r-project.org). The ancestral sequences at each SNP site were estimated as described by Pollard et al. [15] with multiple alignments of human (March 2006 assembly), chimp (Mar 2006 assembly), and rhesus macaque (January 2006 assembly) from UCSC Genome Browser (http://genome.ucsc.edu/). The cladograms also demonstrate the existence of alternative (yin-yang) haplotpe clades and may suggest selective pressure for markers 6/7 (in high LD) and marker 8. The persistence of the divergent haplotypes over time may suggest that they have been subject to selection such that at least one allele on each background is being selected. To extend these analyses, we also examined the degree to which *OXTR* variation exists across species and whether variation correlated with behavioral measures that are likely under selection (artificial or natural). Data obtained from domesticated animal species, in which social cognition may have artificially selected (equids, ovids, canids and felids) will also be discussed.

Keywords: primate, macaque, oxytocin, reward, alcohol

A60 Probing the Epigenome of Social Attachment

Jason Ikpatt[1], Alejandro Berrio[1], Mariam Okhovat[1], Steven Phelps[1]; [1]The University of Texas at Austin

In the socially monogamous prairie vole, Microtus ochrogaster, pair bonding behaviors are regulated by the expression levels of a host of neuromodulators in reward-related regions such as the nucleus accumbens and ventral pallidum. Social cognition in this species seems to rely heavily on circuits known for their roles in spatial or episodic memory, such as the hippocampus and retrosplenial cortex. We identified active regulatory regions for a range of major neuromodulatory genes in each of these four brain regions using chromatin immuno-precipitation sequencing (ChIP-seq) targeting H3K27 acetylation – a histone modification that marks active enhancers. Model-based Analysis for ChIP-Seq was used to map DNA reads to a reference sequence in order to determine the location of H3K27 acetylation marks throughout the genome. This analysis reveals H3K27 acetylation patterns relevant to the expression of a suite of major neuromodulatory genes, including receptors for vasopressin, oxytocin, opioids, dopamine, CRF and glucocorticoids (avpr1a, oxtr, oprk1, oprm1, drd1, drd2, crhr1, nr3c1), a group of genes implicated in the formation and maintenance of a pair bond.

Keywords: epigenetics, social attachment, pair bond, gene expression

A61 Hedonic responses to touch from strangers depend on the perceived attractiveness of the caresser

Giovanni Novembre[1], Roberta Etzi[1,2], India Morrison[1]; [1]Center for Social and Affective Neuroscience (CSAN), Department of Clinical and Experimental Medicine, University of Linköping, Sweden, [2]Department of Psychology and NeuroMi, Milan Center for Neuroscience, University of Milan-Bicocca

Social touch is attracting increasing attention as a specific category of touch with typical psychophysical properties and neural underpinnings. Previous research has shown that a special type of C fibers, the C tactile (CT) afferents, are involved in detecting gentle, affective tactile input on the skin and conveying the information to the central nervous system, with the posterior insula as one of the crucial cortical targets. Despite building on such bottom-up information flow, the hedonic perception and the physiological consequences of affective touch are probably influenced by various sources of top-down information, which in turn results in adaptive behavioral strategies. For instance, it has been shown that the pleasantness of gentle caresses is affected by the belief about the gender of who is stroking, and various affective cross-sensory stimuli (e.g., pictures, odors) impact the hedonic quality of touch experiences. In the present study we aimed to build on this research by investigating how perception of affective touch is influenced by the attractiveness of hypothetical caressers. Thirty-five young participants (15 women) were brushed on the skin while seeing photos of more attractive and less attractive opposite-gender faces, and imagining those people being the caressers. Along with the Attractiveness factor, the factorial design included other two within-subject factors: Site (forearm, palm), and Velocity (3 cm/s, 30 cm/s). Participants were asked to rate the pleasantness of each stimulation, while electrocardiogram activity (ECG) was measured throughout the experiment. Results of the repeated-measure ANOVA showed that participants preferred touch stimuli delivered by more attractive people; a preference for the palm and for the slow velocity (3 cm/s) was also found. The degree to which slow stroking is preferred over fast critically depends on the attractiveness of the face stimuli, reflected by an interaction between Attractiveness and Velocity, with a higher difference for more attractive compared to less attractive. Furthermore, ECG data analysis showed that touch stimuli associated with more attractive faces resulted in significantly higher heart rate variability (HRV) than ones associated with less attractive faces. Overall, the present study confirms that contextual social information plays a major role in affective touch experiences, impacting not only the perceived hedonic quality of the experience but also the physiological state of the body.

Keywords: affective touch HRV emotion

A62 Cntnap2 deficiency leads to abnormal resting-state functional connectivity patterns in mice

Katrina Y. Choe[1], Martin Safrin[1], Neil G. Harris[1], Daniel H. Geschwind[1]; [1]UCLA

Neuroimaging studies in individuals diagnosed with autism spectrum disorders (ASD) consistently report aberrant neural connectivity consisting of decreased long-range and increased short-range connections. Understanding the mechanistic basis for these changes warrants the use of animal models with strong construct and face validity. Mice lacking Contactin-Associated Protein-Like 2 (Cntnap2), a highly penetrant gene for ASD, display the two core behavioral phenotypes of the neurodevelopmental disorder including repetitive behavior and social deficits (Penagarikano et al., 2012). As an investigative first step, we used functional neuroimaging to study whether this validated animal model presented patterns of abnormal brain connectivity. Resting-state functional magnetic resonance imaging (rsfMRI) was performed using an ultra high field (7T) MRI scanner with a gradient-echo EPI sequence to measure BOLD contrast in dexmedetomidine-sedated wild-type (WT, n=4) and Cntnap2 knockout (KO, n=5) mice. Correlations in low-frequency (0.01-0.2Hz) BOLD signal fluctuations were computed between 26 regions-of-interest (ROIs), made up of 13 bilateral brain regions. Overall, we observed a marked reduction in the resting-state functional connectivity of KO mice. Reductions in interhemispheric connectivity were consistently observed, and those seen in the basal ganglia, as well as somatosensory, olfactory, and perirhinal cortices were statistically significant ($P<0.05$; 2-sample t-test). In agreement with these results, graph theoretical analysis revealed a strong trend of reduced mean clustering coefficient, global efficiency, and mean local efficiency in the KO, suggesting both global and local decreases in functional connectivity. These results highlight parallels between functional connectivity alterations in this mouse model of ASD and patients. We are now extending the pilot studies to validate the generalizability and reproducibility of these results. In addition, we are currently investigating whether these connectivity deficits are attenuated by oxytocin administration, previously demonstrated to rescue social deficits in these mice.

Keywords: Autism, fMRI, social behavior, functional connectivity, mice

A63 Processing communicative facial and vocal cues in the superior temporal sulcus

Ben Deen[1,2], Rebecca Saxe[1], Nancy Kanwisher[1]; [1]Massachusetts Institute of Technology, [2]Rockefeller University

Facial and vocal cues provide critical social information about other humans, including their emotional and attentional states and the content of their speech. Recent work has identified a region of the human superior temporal sulcus that selectively responds to both face movements and vocal sounds (fSTS). Here, we investigate the functional role of this region by measuring its response profile to a range of face movements, vocal sounds, and hand movements using fMRI (N=15 participants). We find that the fSTS responds broadly to different types of audio and visual face actions, including both richly social communicative actions, as well as minimally socially relevant noncommunicative actions. Strikingly, however, responses to hand movements were very low, whether communicative or not, indicating a specific role in the analysis of face actions (facial and vocal), not a general role in the perception of any human action. Furthermore, spatial patterns of response in this region were able to decode communicative from noncommunicative face actions, both within and across modality (facial/vocal cues), demonstrating sensitivity to an abstract social feature at the level of neural population responses. Taken together, these results point to the fSTS as a mid-level stage of social perceptual inference from faces and voices, involved in perceptual processing of arbitrary facial/vocal cues, but beginning to make explicit high-level, abstract social properties.

Keywords: social perception

A64 Neural and Computational Processes Underlying Dynamic Changes in Self-Esteem

Geert-Jan Will[1], Robb Rutledge[1,2], Michael Moutoussis[1], Raymond Dolan[1,2]; [1]Wellcome Trust Centre for Neuroimaging, University College London, [2]Max Planck University College London Centre for Computational Psychiatry and Ageing Research

Onset of psychiatric disorders is often preceded by a decline in self-esteem, and this is thought to be related to a heightened sensitivity to negative evaluation from peers. The mechanisms through which repeated negative evaluation leads to declines in self-esteem are largely unknown. To characterize the neural and computational processes underlying changes in self-esteem, we asked healthy young adults to perform a task in which they received acceptance and rejection feedback from peers who evaluated them based on an online profile. Participant expectations were manipulated by sorting peers into four groups based on the overall likelihood of giving positive social feedback to other participants. On each trial, participants were provided with a visual cue that indicated which group a peer belonged to and predicted whether the peer would like or dislike them before receiving acceptance or rejection feedback. After every 2-3 trials, participants reported their current level of self-esteem. Using computational modeling, we found that moment-to-moment fluctuations in self-esteem were best explained by the combined influence of: 1) recent expectations about social feedback and 2) social prediction errors arising from those expectations upon receipt of feedback (i.e. the difference between actual and expected feedback). Using functional magnetic resonance imaging, we show that social prediction errors correlate with activity in the ventral striatum and momentary changes in self-esteem co-vary with activity in ventromedial prefrontal cortex. These findings provide insight into the computations performed in the brain during social feedback processing and the likely mechanisms through which social feedback cumulatively impacts on self-esteem. These results are relevant to understanding why volatility in self-esteem is a vulnerability factor for mental health problems.

Keywords: social feedback, acceptance, rejection, self-esteem, psychiatry, fMRI, computational modelling, striatum, ventromedial prefrontal cortex

Poster Session B

Friday, November 11, 2016, 6:00 - 7:00 pm , Marina Ballroom Salon G

B1 A stereological analysis of neuron density in the prefrontal cortex in Williams Syndrome and typically developing controls

Caroline Horton Lew[1], Chelsea Brown[1], Kimberly Groeniger[1], Ursula Bellugi[2], Katerina Semendeferi[1]; [1]University of California, San Diego, [2]Salk Institute for Biological Studies

Williams Syndrome (WS) is a rare neurodevelopmental disorder caused by hemizygous genetic deletion of ~26 consecutive genes on chromosome band 7q11.23. WS is characterized by a hyper-affiliative socio-behavioral phenotype, which includes a strong drive to approach strangers, a gregarious personality, heightened social engagement, and an increased attention to faces compared to typically developing controls. The discrete genotype and distinct behavioral phenotype of WS provides a unique opportunity to link genes, neuroanatomy, and behavior in the social domain. MRI studies have demonstrated structural and functional abnormalities in WS cortex, including the prefrontal cortex (PFC), a region implicated in social cognition, but

little is known about the neuroanatomical phenotype of WS at the microscopic level. Here, we utilized the Bellugi Williams Syndrome Brain Collection, a unique postmortem brain tissue collection, to examine neuron density in layers II/III (supragranular) and V/VI (infragranular) in two prefrontal cortical areas implicated in socio-emotional behavior, BA 10 and BA 11, and three unimodal areas in the neocortex previously examined in human post-mortem studies (motor cortex BA 4, somatosensory cortex BA 3, and visual area BA 18) in the postmortem brains of six adult WS subjects and six matched TD subjects, using unbiased quantitative stereological techniques. We found that neuron density in PFC was lower in WS relative to TD, with layers V /VI demonstrating the largest decrease in density and reaching statistical significance in BA 10. In contrast, BA 3 and BA 18 demonstrated a higher density in WS compared to TD, although this difference was not statistically significant. Neuron density in BA 4 was similar in WS and TD. While other cortical areas were altered in WS, prefrontal areas appeared to be most affected. These results suggest that cytoarchitectonic changes in the cortex are area- and layer- specific, and that altered neuron density in the PFC may underlie the socio-behavioral abnormalities of WS. This research was supported by the National Institutes of Health P01 NICHD033113 to UB and KS (PIs) and 5R03MH103697 to KS (PI). Typically developing human tissue was obtained from the University of Maryland Brain and Tissue Bank, which is a Brain and Tissue Repository of NIH

Keywords: Williams Syndrome; cytoarchitecture; unbiased stereology; prefrontal cortex; social brain

B2 Neuronal metabolic activity predicts the social interaction & spatial-usage of wild prairie voles.

Michael Viacheslavov[1], Zhara Dehghani[1], Lauren O'Connell[1], Steven Phelps[1]; [1]The University of Texas in Austin

An integrative approach to understanding social cognition requires examining how nervous systems contribute to natural behaviors in the wild. We used monogamous rodents, prairie voles (Microtus ochrogaster), to examine whether metabolic activity in brain regions involved in bonding and memory are related to individual differences in social interactions and spatial usage. To measure their social interactions and spatial usage, we released our subjects into a seminatural enclosure, where we manually radiotracked the location of each vole twice a day, for 6 weeks. After that, we recaptured each animal, sacrificed them, extracted their brains, and sectioned the tissue at 20 microns. To measure the metabolic activity of each region of interest, we used a histochemical procedure known as a DAB (diaminobenzidine) reaction to stain for the concentration of cytochrome oxidase (CO) within each section. CO is a mitochondrial enzyme that is used as a marker to measure the oxidative metabolic activity of energy production within a given cell. We quantified CO in the hippocampus and the retrosplenial cortex, regions implicated in spatial navigation, and in the nucleus accumbens and lateral septum, regions important to social bonding. Paired males (n=23) had smaller home ranges than single males (n=7; $p=0.0004$), but paired males did not have lower activity in the spatial memory circuit ($p>0.20$). Paired-male home range size, however, correlated with CO activity in the retrosplenial cortex ($p=0.004$) and the hippocampus ($p<0.01$). Single male home ranges did not ($p>0.20$). All extra-pair encounters experienced by each male positively correlated with the CO activity in the nucleus accumbens (n=31; $p<0.02$) and the lateral septum (n=29; $p<0.009$). However all opposite-sex encounters experienced by each male negatively correlated with the CO activity in the ventral lateral septum (n=29; $p<0.02$), but did not negatively correlate with the CO activity in the dorsal lateral septum (n=27, $p<0.08$) Paired males seem to use space intensively, taxing spatial memory more as home ranges increase. Single males, in contrast, seem to wander widely without increasing costs to spatial memory. Furthermore, males that increase their extra-pair encounters, also increase the metabolic activity in the regions important for social interaction. However, males that increase their encounters with the opposite sex, decrease their metabolic activity in the ventral portion of the lateral septum, but not the dorsal portion.

Keywords: Prairie Voles, Cytochrome Oxidase, Monogamy, Social Interactions, Spatial Memory, Retrosplenial Cortex, Hippocampus, Lateral Septum

B3 Sex differences in the effects of arginine vasopressin (AVP) in the anterior hypothalamus (AH) on resilience to social stress in Syrian hamsters

Joseph Terranova[1,2], Nathan Hardcastle[1,2], Kim Huhman[1,2], H. Elliott Albers[1,2]; [1]Georgia State Univ., Atlanta, GA, [2]Ctr. for Behavioral Neurosci., Atlanta, GA

Syrian hamsters readily establish dominance relationships that are formed and maintained by agonistic behaviors such as aggression and social communication. Hamsters that lose agonistic encounters subsequently abandon territorial aggression and become more susceptible to subsequent social stress, whereas animals that have dominant experience become more resistant to social defeat stress. Dominant male hamsters have increased arginine vasopressin (AVP) 1a receptors, whereas subordinate males have decreased AVP cell bodies in the hypothalamus, a critical brain region that mediates aggressive behavior. Thus, the purpose of this project is to test the hypothesis that neural systems that increase aggressive behavior

promote resistance to social stress, whereas neural systems that reduce aggressive behavior decrease resistance to social stress. Interestingly, AVP microinjection into the anterior hypothalamus (AH) facilitates aggression in male hamsters but inhibits aggression in female hamsters. Therefore, we also tested the hypothesis that there is a marked sex difference in how susceptibility to social stress is mediated. Hamsters were singly housed for two weeks and implanted with unilateral guide cannula aimed at the AH. The week following surgery, hamsters were handled daily and the estrous cycle was monitored in females. During the testing week, hamsters experienced a single 15 min defeat in the home cage of a sex-matched resident aggressor (RA). Females were defeated and tested during diestrus. Twenty-four hours later, hamsters were microinjected with saline vehicle or 0.9 μM AVP and placed in a neutral arena with an unfamiliar RA behind a mesh cage. Time spent avoiding the RA and time spent investigating the RA was quantified. There was a trending interaction of drug treatment and sex on avoidance duration ($p = 0.137$) and a significant interaction of drug treatment and sex for investigation duration ($p < 0.05$). Females who received AVP in the AH spent less time investigating the RA than control females (Controls: 201.37 ± 19.25 seconds; AVP: 108.59 ± 26.49 seconds) and more time avoiding the caged RA than control females (Controls: 55.76 ± 17.70 seconds; AVP: 148.03 ± 26.34 seconds). There was no effect of AVP treatment on male avoidance or investigation. These data support the hypothesis that neural systems that decrease aggressive behaviors increase susceptibility to social stress. Furthermore, there are sex differences in the contributions of these neural systems. (This work is supported by NSF IOS-0923301 and NIH MH062044. The content is solely the responsibility of the authors and does not necessarily represent the official view of the NSF or NIH.)

Keywords: Dominance, social stress, vasopressin, sex differences

B4 Increased neuron and glia density in the associative and limbic striatum in Williams syndrome, a disorder of social cognition

Kari L Hanson[1,2], Kimberly Groeninger[1], Ursula Bellugi[2,4], Katerina Semendeferi[1,2,3]; [1]Department of Anthropology, UCSD, La Jolla, CA, [2]Institute for Neural Computation, UCSD, La Jolla, CA, [3]Neurosciences Graduate Program, UCSD, La Jolla, CA, [4]Salk Institute for Biological Research, La Jolla, CA

Williams syndrome (WS) is a rare neurodevelopmental disorder caused by a hemizygous deletion of 26-28 genes on the seventh chromosome. Among its most notable behavioral phenotypes is a generalized disinhibition of social engagement, coupled with generalized anxiety, heightened emotional reactivity, and overall deficits in IQ, particularly with respect to visuospatial cognition. A significant decrease in activation is reported in functional imaging studies in frontostriatal regions during go/no-go tasks in individuals with WS, with particular deficits in striatal activation. Given these findings and the specific impairment of basal ganglia systems in a wide variety of other neurodevelopmental disorders affecting behavioral control and response inhibition, such as Huntington's disease and ADHD, we sought to examine the associative and limbic territories of the striatum in individuals with WS. Our sample included five pairs of age, sex, and hemisphere-matched individuals, including three males and two females (ages 18-45) with behaviorally confirmed diagnoses of WS. Coronal sections through the rostral portion of the striatum, consisting of the associative regions of the caudate and putamen, as well as the limbic nucleus accumbens region, were Nissl stained to examine the distribution of neurons and glia using unbiased stereological methods. We found an overall increase in neuronal density, as well as an increase in the ratio of glial cells to neurons in all nuclei of the striatum. These data suggest that deficits in inhibitory behavioral control and regulation of emotional reactivity may be linked to dysfunction of local circuitry within the striatum in WS mediated by imbalance between neuronal and glial cell distribution. Research was supported in part by P01 NICHD 33113 and the Oak Tree Philanthropic Foundation. Control specimens and ongoing material support has been provided by the University of Maryland Brain and Tissue Bank for neurodevelopmental disorders, a repository of the NIH NeuroBioBank.

Keywords: Williams syndrome, neurodevelopmental disorders, genetic disorders, pathology, brain evolution, glia, basal ganglia, chromosomal deletion, human neuroanatomy, comparative neuroanatomy

B5 Development of Socioemotional Attention in Male Juvenile Rhesus Macaques

Olivia Meisner[1], Lauren Murphy[2,3], Jocelyne Bachevalier[2,3]; [1]Massachusetts Institute of Technology, [2]Emory University, [3]Yerkes National Primate Research Center

This longitudinal study seeks to document normative socioemotional development of juvenile male rhesus macaques (n=3) by investigating changes in attention to salient regions of social stimuli during the pre-adolescent period. Eye-tracking technology was used to noninvasively measure visual scan patterns of 3 juvenile male monkeys at 3 pre-pubertal time points (18, 22, and 26) and 1 peri-pubertal time point (36 months). At each time point, subjects viewed novel 10-second videos of conspecifics performing stereotyped positive

(lip-smacks), negative (threats), and neutral facial expressions while seated calmly in a primate chair with moderate head restraint. Hand-drawn regions-of-interest (ROIs) of the eyes, mouth, and body on each video frame were used to quantify attention to social stimuli. Because facial expressions in each video-clip occurred at different times and lasted for different durations, we identified start and end times for portions of the video where the stimulus monkey had either an emotional or a neutral expression for each video. Fixation durations during emotional and neutral components of social videos were summed and compared within each ROI as a proportion of total looking time to that ROI. Male macaques allocated equal attention to emotional and neutral components at all ROIs at 18 (Body: $F(2,34)=0.750$, $p=0.480$; Eyes: $F(2,34)=0.878$, $p=0.425$; Mouth: $F(2,34)=0.483$, $p=0.621$) and 26 months of age (Body: $F(2,46)=0.148$, $p=0.810$; Eyes ($F(2,46)=0.205$, $p=0.815$; Mouth ($F(2,46)=0.365$, $p=0.696$). At 22 months, pre-pubertal macaques looked more at the first neutral component of positive, but not negative, videos within the eye region, but looked equally at emotional and neutral components within the body and mouth regions (Eyes: $F(1,2)=58.043$, $p=0.017$; Mouth: $F(2,40)=0.569$, $p=0.571$; Body: $F(2,40)=0.369$, $p=0.694$). Once juveniles reached the peri-pubertal stage at 36 months of age, they began to rapidly modulate their attention to the eye and mouth regions of social stimuli based on emotional content (eyes: $F(2,50)=4.450$, $p=0.017$; mouth: $F(2,50)=4.362$, $p=0.018$). These data suggest that social attention and emotion processing abilities continue to develop throughout the pre-pubertal period. However, the patterns seen in juvenile males at 36 months are still distinct from adults' viewing patterns tested under similar conditions (Murphy & Bachevalier, personal communication). This experiment complements previous research in humans suggesting that adolescence is a developmental window for socioemotional maturation, and highlights that adult-like patterns of emotional maturation do not begin to emerge until around the onset of pubertal development (Moore et al., 2012; Hare et al., 2008). Future research using this animal model is needed to investigate the role of key brain regions and pubertal hormones associated with the development of emotional processing and to further our understanding of normal and abnormal socioemotional development during adolescence. Supported by NIH grant MH86947 (JB).

Keywords: Social neuroscience, developmental psychology

B6 Excessive association between negative intentionality and immorality is diminished in autism spectrum disorder

Kazuki Iijima[1,2], Yukihito Yomogida[1], Kosuke Asada[3], Kaosu Matsumori[1], Ayaka Sugiura[2,3], Shinichiro Kumagaya[3], Kenji Matsumoto[1]; [1]Tamagawa University, [2]Japan Society for the Promotion of Science, [3]The University of Tokyo

Moral judgment is a highly complex mental process, and the features that drive it have been the center of research in psychology, neuroscience, and philosophy. Classical models assumed that intentionality of an action guides moral judgments on that action. However, recent findings suggest that moral judgment could inversely affect judgment on intentionality. Specifically, most people attribute intentionality to morally bad side-effects, but not to morally good side-effects. In the present study, we focused on this phenomenon, known as 'the Knobe effect', and examined the psychological and neural mechanisms underlying this effect using functional magnetic resonance imaging (fMRI) by comparing adults with autism spectrum disorder (ASD) and neurotypical adults (NT). We prepared various types of scenarios, including not only negative but also positive scenarios, such as intended, attempted, and accidental harms/helps. Furthermore, we prepared two distinct sets of 20 negative and 20 positive side-effects in contrast that previous studies examined the Knobe effect with only few typical scenarios, so that we could quantify the effect and eliminate scenario-specific factors. Thirteen ASD and 11 NT judged the degree of morality and intentionality of the protagonist's action for each scenario in the scanner. We found that both ASD ($P = 0.02$) and NT ($P < 0.001$) showed significant Knobe effects. Interestingly, attribution of intentionality in negative side-effects was significantly smaller in ASD than NT ($P = 0.03$), with no significant difference in positive side-effects, indicating that the Knobe effect is attenuated in ASD. In addition, moral judgments for attempted harms were less severe in ASD than NT ($P < 0.05$). We hypothesized that this decreased dependence of moral judgment on intentionality is related to the diminished Knobe effect in ASD. We quantified how much moral judgment of each individual depends on intentionality (the degree of intentionalism: DOI) by comparing moral judgments for attempted helps to attempted harms. We could derive DOI from these scenarios, since protagonists brought the same morally neutral outcomes with either good or bad intentions there. Interestingly, as with the Knobe effect, DOI was significantly lower in ASD than NT ($P < 0.05$). Moreover, DOI showed a significant positive correlation with the strength of the Knobe effect ($P < 0.001$), that is, those who depends more on intentionality in moral judgment showed stronger Knobe effects. These results suggest that the Knobe effect is subserved by a bidirectional interaction between intentionality and morality, and help to understand the social difficulties in people with autism.

Keywords: fMRI, morality, autism

B7 The paradoxical effect of social incentive to performance

Ayaka Sugiura[1,2], Yukihito Yomogida[3], Kazuki Iijima[2,3], Toshikazu Hasegawa[1], Kenji Matsumoto[3]; [1]The University of Tokyo, [2]Japan Society for the Promotion of Sciences, [3]Tamagawa University

When we are promised with large amount of money as a result of successfully doing a task, we are likely to perform well compared to when we are promised a small amount. However, increasing incentive sometimes result in a paradoxical decrease of performance, which is called as choking under pressure. Similar to increasing money, it can be hypothesized that increasing social incentive may result in choking. In the present study, we examined how an increase in social incentive to succeed in a task will affect performance. In the experiment, a participant was asked to earn money for the three partners who had previously given effort to earn money for the participant. Since the participant felt indebtedness to pay back for the partner, her/his social incentive should increase according to the amount of money that was received from each partner, resulting in the increase of performance, if the subjects did not choke on the pressure to pay back. The participant was instructed that the maximal amount of money that could be received from one partner was 5000 yen (approximately corresponding to $50), and the three partners had earned 4000 yen (Big), 2100 yen (Medium) and 300 yen (Small) for the participant. After receiving the money from each partner, the participant went into the scanner to earn back for each partner in an achievement task, where they had to stop a stopwatch in the range of 5 ± 0.05 sec after it started moving automatically. The amount of money that can be earned back in one trial was either 1000 yen or 100 yen (as control). The control condition was introduced to create a condition where there are no incentives for the subject to succeed since the amount that can be paid back is low, and to control for the effect caused by the simple increase in the amount of money. Forty trials (20 trials each for 1000 yen and 100 yen) were done for each partner and the participants were told that the actual earnings that would be given back to one partner were determined by the result of 5 randomly chosen trials done for that partner, which meant that the optimal strategy is to engage every trial with their best effort. Preliminary data (N = 7) have shown that participants' performance increased for the Medium partner compared to Small partner ($t = 2.00$, $p = .092$), but decreased for the Big partner compared to the Medium partner ($t = 1.98$, $p = .093$), although the incentive to succeed had monotonically increased. This trend was not present in the control (100 yen) condition. The behavioral results suggest that in the Big condition, participants choked on the pressure to pay back to the partner. Subsequent analysis will test for brain regions that will show the effect of performance decrement although there is a rise in incentive.

Keywords: Motivation, fMRI

B8 Neural activation of oxytocin receptor expressing circuits during pre-weaning development.

Manal Tabbaa[1], Elizabeth Hammock[1]; [1]Florida State University

Oxytocin (OXT) regulates species typical social behaviors. Emerging data indicate that OXT interacts with early life experience to influence behavioral development and adult social phenotype. In an effort to further inform how early experience and central OXT signaling affect neural activation and subsequent brain development, we examined the neural response to oral administration of OXT during a sensitive period of cortical development that coincides with peak transient oxytocin receptor (OXTR) expression in the cortex of mice. OXT or vehicle were administered orally to transgenic EGFP:OXTR reporter mice, both males and females, on postnatal day (PND) 14 or PND 21. Two doses of OXT were chosen: a low dose based on the concentration of OXT the offspring would experience from the dam's breast milk and a high dose analogous to concentrations used intranasally in human clinical trials. Animals were perfused 90 minutes after dosing. Immunohistochemistry revealed dense EGFP staining in cortical layers II/III in PND 14 OXTR:EGFP transgenic mice, consistent with our previous OXTR radioligand binding data, as well as in expected brain regions known to express OXTR such as the olfactory bulb, piriform cortex, amygdala, nucleus accumbens, hippocampus, and hypothalamus, among others. As expected, these patterns of EGFP expression were not seen in mice negative for the EGFP transgene. Furthermore, immunostaining for c-Fos revealed dense neuronal activation, including activation of OXTR-EGFP positive cells in several brain regions. These data will identify neural circuits activated by OXT received during maternal-offspring interactions or clinical treatment during development.

Keywords: Oxytocin, Development

B9 GENETIC VARIATION IN PUTATIVE PHEROMONE RECEPTOR VN1R1 IS ASSOCIATED WITH SOCIOSEXUAL BEHAVIOR

Daniel Hovey[1], Susanne Henningsson[1], Kinga Vass[1], Hasse Walum[2,3,4,5], Kenneth Sandnabba[6], Pekka Santtila[6], Patrick Jern[6], Lars Westberg[1]; [1]Department of Pharmacology, Institute of Neuroscience and Physiology at the Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden, [2]Karolinska Institutet, Department

of medical epidemiology and biostatistics, Stockholm, Sweden, [3]Center for Translational Social Neuroscience, Emory University, Atlanta, Georgia, USA, [4]Silvio O. Conte Center for Oxytocin and Social Cognition; Center for Translational Social Neuroscience, Atlanta, Georgia, USA, [5]Yerkes National Primate Research Center, Department of Psychiatry and Behavioral Sciences, Emory University, Atlanta, Georgia, USA, [6]Department of Psychology, Faculty of Arts, Psychology and Theology, Åbo Akademi University, Åbo, Finland

Pheromones regulate social and reproductive behavior in most mammalian species. These effects are mediated by the vomeronasal and main olfactory systems. Effects of putative pheromones on human neuroendocrine activity, brain activity and attractiveness ratings suggest that humans may communicate via similar chemosignaling. Here we studied two samples of younger and older individuals, respectively, with respect to one nonsynonymous polymorphism in the gene encoding the human vomeronasal receptor, VN1R1, and one nonsynonymous polymorphism in the gene encoding the odor receptor OR7D4. Participants in both samples had self-reported their sociosexual behavior using the sociosexual orientation inventory, including questions regarding life-time number of one-night-stands, number of partners last year and expected number of partners the coming five years. In women, there was a significant association between the VN1R1 polymorphism and sociosexual behavior in both samples, driven specifically by the question regarding one-night-stands. Our results support the hypothesis that human social interaction is modulated by communication via chemosignaling.

Keywords: Genetic variation, sociosexual behavior, VN1R1

B10 Connectivity between auditory and visual cortices mediates the impact of argument strength on the efficacy of smoking-cessation videos among low-sensation-seeking smokers

Zhenhao Shi[1], Victoria Fairchild[1], An-Li Wang[1], Catherine Aronowitz[1], Joseph N. Cappella[1], Daniel Romer[1], Daniel D. Langleben[1]; [1]University of Pennsylvania

Televised anti-smoking video ads have been a key component of public health campaigns that seek to advance the movement toward a non-smoking society. Specifically, anti-smoking videos with high argument strength (AS) are shown to be more effective at reducing smoking behavior than low-AS ones. Prior research suggested that the interaction between AS and sensory aspects of the video messages are associated with their overall effectiveness. In addition, studies agree on the importance of the sensation-seeking trait in smokers' sensitivity to smoking-cessation interventions. We hypothesized that integration of visual and auditory (i.e. multisensory) processing would mediate the effectiveness of high-AS smoking-cessation videos on subsequent smoking behavior, and that such mediation would be moderated by smokers' sensation seeking. Using functional magnetic resonance imaging (fMRI), we recorded the brain response of 66 smokers (32 females) randomly assigned to view either 16 high-AS or 16 low-AS smoking-cessation videos. A validated I^2 content analytic measure (Lang et al. 2006) quantified the amount of visual and auditory information in each video, which was matched between high-AS and low-AS videos. Multisensory processing of the videos was indexed by the functional connectivity between sensory cortices. Specifically, such connectivity was assessed by identifying cortical regions whose activity was parametrically modulated by the visual and auditory I^2 scores, and computing the correlation between fMRI signals extracted from these regions. Sensation seeking was measured using the Brief Sensation Seeking Scale (Hoyle et al. 2002). Smoking behavior was assessed with urine levels of nicotine metabolite cotinine immediately before (baseline) and approximately 30 days after (follow-up) the fMRI session. We tested a moderated mediation model using AS as the input variable, follow-up cotinine level (adjusted for baseline) as the outcome variable, multisensory neural connectivity as the mediator, and sensation seeking as the moderator. We found a significant (p=.01) moderated mediation effect: the high-AS videos produced greater connectivity, which in turn negatively predicted follow-up cotinine levels among the low-sensation-seeking smokers. This effect was absent in the high-sensation-seeking group. Our results suggest that 1) audiovisual neural integration underlies the greater efficacy of high-AS smoking-cessation videos, and that 2) high sensation seeking confers resistance to anti-smoking arguments. These findings highlight the importance of accounting for brain connectivity and individual differences in the evaluation of anti-smoking messaging in particular and public health communication in general.

Keywords: Health communication, fMRI, Smoking, Multisensory processing, Sensation seeking

B11 Exome and Whole Genome Sequencing in Domestic Animal Models Exhibiting Individual Differences in Aggression

Driscoll, C. A.[1], Razaquar, S.[1], Roberson, D.[2], Stephens, C.[3], Lindell, S. G.[1], Blackistone, K. [1], Clemente, J. [1], Yuan, Q. [1], Goldman, D. [1], Kukekova, A.[4], Yeager, M.[1], Barr, C. S.[1] , [1] Section on Comparative Behavioral Genomics, Laboratory of Neurogenetics, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, Bethesda, MD, [2] Cancer Genomics Research Laboratory, Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of

Health, Bethesda, MD, [3] Genomics GPS, LLC, Guilford, CT, [4] Department of Animal Sciences, The University of Illinois at Urbana-Champaign, Urbana, IL.

Aggression can facilitate access to resources and mating opportunities across mammals, including domestic species, and appears to be under selection. However, in humans, exaggerated aggression is a hallmark of some psychiatric and personality disorders. One approach to determining genetic factors contributing to variation in aggression is the study of the genetics of domestication. At its most basic, domestication is a suite of heritable traits affecting behavior. Among most domestic animal species, there is decreased aggression and the ability to coexist with humans. The domesticated fox (Vulpes vulpes) and the house cat (Felis silvestris catus) may be good candidates for modeling how genetic variation contributes to aggressive behavior in humans. The house cat, relative to its wild ancestor, manifests a suite of heritable behaviors characteristic of domesticates, and the tame Russian silver fox is recognized as a superior model of domestication. However, few studies have attempted to identify intra- or inter-specific variation among these species. Here, we explore a draft whole genome sequence of a domestic cat (DC), a wild Asian leopard cat (ALC) (Prionailurus bengalensis) and interspecies hybrid offspring (ALC X DC) differing in their levels of tameness. We also explore genetic variation in two lines of fox selected for marked differences in reactivity and temperament (tame vs. aggressive). One domestic cat (DC), one Asian leopard cat (ALC) and interspecies hybrid offspring (ALC X DC) were WGS at approximately 15X. Exploiting the phylogenetically close relationship between the domestic dog and fox, we used a dog –based exon assay (Agilent) to characterize genome-wide protein-coding variation in tame-selected, aggressive selected, and unselected foxes farmed at the Institute of Cytology and Genetics, Novosibersk, Russia and wild-caught foxes from Maryland. In ALC–DC comparisons, SNPs, some of which are predicted to be potentially deleterious by in silico analysis, were found in the transcribed region of 1400 genes and in the coding region of 158 of those. Dog-on-fox exon pulldown resulted in ~80% on-target capture with ~70% of the targets at >20X coverage, successfully resolving >90% of the sequences expected from a dog-on-dog assay. After filtering, ~500,000 SNPs were called in fox as compared to the Broad dog assembly. Filtering dog vs. fox differences, ~50,000 SNPs were novel in fox, as compared to the 2.5 X 10 6 SNPs reported for dog in the Broad database. Domestic animals are generally less aggressive than their non-domesticated ancestors. Systems permissive of domestication and underlying a "tame" phenotype range from those involving fear and impulse control to those driving reward and sociality. Between tame and aggressive animals, we identified damaging SNPs in gene systems influencing anxiety-like behavior, transcription control, DNA repair, epigenetic processes, synaptic plasticity/transmission, reward, and circadian rhythms. As these systems can contribute to vulnerability to, or resilience to, human psychiatric disorders, identification of genetic variation among domesticated animals with exaggerated differences in their degrees of tameness may inform us of the human condition and aid in identifying appropriate models for examining treatment response to compounds being developed for the treatment of various psychiatric disorders.

Keywords: SNP, domesticate, aggression, fox.

B12 Successful Interpersonal Relationships and Threat Detection

Evan L. Eschliman[1], Stephanie Cacioppo[1]; [1]The University of Chicago

Prior research has suggested that feeling socially isolated from significant others is associated with increased self-focus attention and hypervigilance to social threats—a finding in line with the evolutionary model of perceived social isolation that indicates that feeling on the social perimeter of a social network leads to increased attention and surveillance of the social world and an unwitting focus on self-preservation. It is unclear, however, if the opposite is true i.e., Do individuals who feel socially connected and are in a successful relationship with a significant other show less and/or slower attention to social threats than non-social threats? To address this question, we first asked 100 subjects (70 men and 30 women, mean age: 38 years +/-13.4), who did not participate in the behavioral experiment, to rate the valence of ninety words on a 7-point scale. The thirty words (15 social/human threats, such as "rejection", and 15 non-social/natural threats, such as "wildfire") with the highest ratings were then used in a preliminary behavioral study. In this preliminary study, we tested eight pairs of subjects (mean age: 20.81 +/-1.83, 14 women, 2 men), who were in a successful, satisfying relationship (mean success score: 6.06 +/-0.06 on a 7 point-scale; relationship satisfaction: 8.33 +/-1.05 on a 10 point-scale) with a best friend (mean duration of the friendship: 50.69 months +/-51.95; IOS score: 3.96 +/-1.33). A series of 2 x 3 repeated measures ANOVAs with type of threat (social vs. non-social) and subject of threat (self vs. best friend vs. stranger) as within-subject variables indicated that: i) individuals who feel socially connected and are in a successful relationship with a best friend rate non-social threats as being more threatening than social threats ($F(1, 15) = 5.74$, $p = .30$, partial $\eta 2 = .28$); ii) threat ratings are more similar for the self and best friend, compared to the stranger ($F(2, 30) = 19.89$, $p = .00$, partial $\eta 2 = .57$); and iii) reaction times for threat detection are similarly slower for the self and best friend, compared to the stranger ($F(2, 30) = 8.21$, $p = .001$,

partial η 2 = .35). A trend to a significant interaction was also observed for the reaction times between type of threat and subject of threat ($F(2, 30) = 2.99$, $p = .07$, partial η 2 = .17). Finally, a positive correlation was observed between Inclusion-Of-Other-in-the-Self (IOS) scale and reaction times in response to social threats, suggesting that the more there is a self-overlap between the self and the best friend, the slower are the reaction times for social threat detection. These results reinforce the evolutionary model of social connection by revealing that individuals who feel socially connected see other individuals as being less threatening than natural elements. A follow-up study with a larger sample size and the combined use of behavioral and high-density electrical neuroimaging with the Chicago Electrical Neuroimaging Analytics (CENA) will help better understand the mechanism of action and the spatiotemporal dynamics underlying attention to non-social threats in the connected brains.

Keywords: Social Neuroscience, Interpersonal Relationships, Friendship, Self-Expansion, Attention,

B13 Emergence of social behavior deficit is linked to blunted corticolimbic activity and adult depression-like behavior in a rodent model of maternal maltreatment

Millie Rincón-Cortés[1,2,3], Regina Sullivan[1,2,3]; [1]Department of Child and Adolescent Psychiatry, Child Study Center at the NYU Langone Medical Center, New York, NY, USA, [2]Neuroscience and Physiology, Sackler Institute for Graduate Biomedical Studies, NYU School of Medicine, New York, NY, USA, [3]Emotional Brain Institute, Nathan Kline Institute for Psychiatric Research, Orangeburg, NY, USA

Disrupted social behavior is a core symptom of multiple psychiatric and neurodevelopmental disorders. Many of these disorders are exacerbated by adverse infant experiences, including maltreatment and abuse, which negatively affect amygdala development. Although a link between impaired social behavior, abnormal amygdala function and depressive-like behavior following early life adversity has been demonstrated in humans and animal models, the developmental emergence of maltreatment-related social deficits and associated amygdala neural activity are unknown. Here we used a naturalistic rodent model of maternal maltreatment during a sensitive period, postnatal days 8-12 (PN8-12), which is known to produce social behavior deficits that precede adolescent depressive-like behavior and amygdala dysfunction, to examine social behavior in infancy, periweaning and adolescence. Socially-induced neural activity was assessed via c-Fos immunohistochemistry at each of these ages. A separate group of animals was tested for adult depressive-like behavior in the forced swim test (FST). Maternal maltreatment spared infant (PN16-18) social behavior but disrupted periweaning (PN20-22) and adolescent (PN42-48) social behavior. Moreover, maltreated rats exhibited blunted socially-induced neural activation in the amygdala and other areas implicated in social functioning, including the medial prefrontal cortex (mPFC) and nucleus accumbens (NA), at these ages as well as increased adult depressive-like behavior. These findings may suggest corticolimbic involvement in the emergence of maltreatment-induced social deficits that are linked to adult depressive-like behavior, thereby highlighting potential targets for therapeutic intervention. Understanding how infant experiences influence social behavior across development may provide insights into basic neural mechanisms of social behaviors and disease-relevant social dysfunction exacerbated by early life stress.

Keywords: early life stress, development, social behavior, amygdala, prefrontal cortex, nucleus accumbens, depression

B14 Facial responses to experienced and observed affective touch

Leah M. Mayo[1], India Morrison[1], Johan Lindé[1], Håkan Olausson[1], Markus Heilig[1]; [1]Linköping University

Affiliative behaviors such as social touch are believed to elicit rewarding responses that enhance positive social interaction. In humans, one selective feature of social touch is speed of stroking. Stroking to the skin at 3 cm/s robustly activates unmyelinated C tactile (CT) afferents and produces positive subjective ratings of "pleasantness". Here, we aimed to determine whether social touch also elicits positive affective responses as detected by facial muscle movement. We used facial electromyography (EMG) to assess affective responses to experienced or observed social touch in healthy adults (n=30). In one task, subjects received brush strokes to the arm and palm at 3 cm/s (optimal) or 30cm/s (non-optimal speed). In the other task, subjects watched short video clips of touch to the arm, touch to the palm, or non-social touch (i.e. touch to a wooden arm) at 3 and 30 cm/s. After each stimulus, subjects rated how "Pleasant," "Intense," and "Relaxing" they found the stimulus. Affective responses to the stimuli were assessed in real-time via EMG recordings of the zygomatic ("smile") and corrugator ("frown") muscles. Experienced touch at 3 cm/s elicited positive affective responses, including decreased corrugator and marginally increased zygomatic reactivity, while touch at 30 cm/s produced enhanced corrugator reactivity. In addition, participants rated 3 cm/s touch as more pleasant, less intense, and more relaxing. There were no significant differences between touch locations (arm, palm). Observed touch elicited similar patterns of differential affective responding based on velocity, with 30 cm/s videos eliciting increased corrugator reactivity as

compared to 3 cm/s videos. Similarly, videos of social touch at 3 cm/s were rated as more pleasant, less intense, and more relaxing than videos of 30 cm/s. However, videos of non-social touch (to the wooden arm) were not rated as pleasant or relaxing at any velocity. We have shown that CT-optimal stroking velocities elicit positive affective responses as assessed by facial EMG. The differential affective responses based on stroking speed were consistent across modalities (felt, seen), consistent with a common coding framework between experienced and observed touch. Observed touch responses were specific to socially-relevant stimuli, indicating that the social nature of the touch rather than the visual features are relevant in eliciting affective facial EMG responses and hedonic ratings. Together, these findings broaden our understanding of affective, socially relevant touch by demonstrating that affective facial responses track stimulus factors related to the social relevance and valence of touch.

Keywords: affect, social, touch, emotion,

B15 Individual differences in social expectancy biases linked to grey matter volumes in key hubs of the social brain

Bonni Crawford[1], Nils Muhlert[2], Geoff Macdonald[3], Andrew D. Lawrence[1]; [1]Cardiff University, Cardiff, UK, [2]University of Manchester, Manchester, UK, [3]University of Toronto, Ontario, Canada

Social connectedness is one of the most important predictors of mental and physical well-being across cultures and across the lifespan. Differences in individuals' cognitive biases are linked to emotional vulnerability (for loneliness, depression etc.) on one hand, and resilience on the other. Cognitive biases include broad tendencies like dispositional optimism, but, focussing on predictors of social connectedness, we have examined biases in social expectancies - tendencies to expect social situations to be pleasurable or distressing. To measure individual differences in social expectancies, we developed a novel self-report measure, the levels of dispositional expectancies for social threat and reward scale (LODESTARS). The LODESTARS is a 10-item inventory examining the extent to which participants expect to experience social reward and punishment during an imminent vividly imagined social encounter with previously unknown individuals. Data from >800 participants demonstrate that the LODESTARS has a clear two-factor structure and excellent psychometric properties. The brain-structural correlates of dispositional social threat and reward expectancies were examined using voxel-based morphometry (VBM). Regional grey matter volume (GMvol) of 100 healthy participants (mean age 24 years; 26 males) was assessed. High-contrast T1-weighted anatomical images were acquired using a 3-Tesla MRI scanner and analysed using SPM12. To correct for multiple comparisons across the whole brain, non-stationary cluster extent correction was implemented. Age, gender and total brain volumes were accounted for. Higher expectancies of social reward and lower expectancies of social threat were associated with greater GMvol in brain regions implicated in valuation and emotion regulation, particularly right ventromedial PFC (vmPFC). Previous findings suggest that this region may function as a network hub that modulates negative affective responses across a broad range of paradigms. Corroborating this, seed-based structural covariance analysis revealed that vmPFC GMvol covaried negatively with amygdala GMvol in our sample, controlling for age, gender and total brain volume. Further, vmPFC GMvol covaried positively with GMvol in dorsomedial PFC and in left lateral occipital cortex, regions that were associated with higher social reward expectancies and lower social threat expectancies, respectively. Higher social threat expectancies were associated with greater GMvol in brain regions involved in social attention and perception, including the right superior temporal sulcus (pSTS). This may reflect attentional bias and hypervigilance directed towards potential social threat signals in the environment. Supporting this interpretation, pSTS GMvol covaried positively with amygdala GMvol in our sample. Our results are consistent with the idea that individual differences in affective biases are reflected in the structure of key cortical hub regions that implement emotion regulation by modulating the configuration of functional pathways involved in valuation, attention and perception. Our findings may have implications for understanding neurocognitive risk factors for loneliness, as well as brain structural dispositions to mood disorder risk, including social anxiety and social anhedonia.

Keywords: Social cognition, brain structure, loneliness, emotion regulation, individual differences, humans

B16 Neural Pathways Underlying Explore-Exploit Tradeoffs in Social and Nonsocial Contexts

David V. Smith[1], Shaoming Wang[2], Mauricio Delgado[3]; [1]Temple University, [2]New York University, [3]Rutgers University

Many of our decisions require us to tradeoff using existing information (exploitation) and gathering new information (exploration). Previous work has suggested that exploitative decisions involve the ventromedial prefrontal cortex and the ventral striatum whereas exploratory decisions involve the frontopolar cortex and intraparietal sulcus. While these brain regions help shape explore-exploit tradeoffs, it remains unclear whether such decisions are influenced by social context. We therefore created a social variant of a conventional 2-armed bandit task. On each trial, participants were first

presented with a picture of their partner (a confederate or a computer) before choosing one of two bandits where the potential payouts (1-100 points) varied across time according to Gaussian random walks. After selecting a bandit, participants were shown how many points could be won on that trial. Participants were then shown a screen indicating that their partner was playing the card-guessing game. Next, participants were asked to press a button to reveal whether their partner guessed correctly or incorrectly. If the partner guessed correctly, then the participant received the points; but if the partner guessed incorrectly, the participant did not receive the points. We found that the partner's success on the previous trial increased exploitative decisions, despite being independent from the potential payouts of either bandit. Our preliminary neuroimaging analyses (N = 11) revealed two results. First, dorsal anterior cingulate cortex responses encoded the absolute extent to which the potential points deviated from what the participants expected (i.e., unsigned prediction errors). Second, ventral striatal responses to winning points depended on the type of partner, with the confederate partner evoking more activation to winning points compared to the computer partner. Taken together, our results suggest that both behaviors (i.e., tendency to exploit) and neural pathways (i.e., ventral striatum) underlying explore-exploit tradeoffs can be influenced by social context.

Keywords: learning; decision making; fMRI; social context

B17 The role of oxytocin in social exclusion and suicidal behavior.

Carol Chu[1], Elizabeth A. Hammock[1], Thomas E. Joiner[1]; [1]Florida State University

Background: One of the strongest and most reliable predictors of suicidal ideation and behavior across the lifespan is social exclusion (Van Orden et al., 2010). Indeed, according to the interpersonal theory of suicide, the need to belong is so fundamental that the thwarting of this need (thwarted belongingness) is a proximal cause of suicidal desire that contributes to suicidal behavior (Joiner, 2005; Van Orden et al., 2010). However, there is little translational research examining the biological mechanisms by which social exclusion influences suicide risk. Using a translational approach and quasi-experimental design, this study examines how oxytocin, an important modulating neuropeptide in the regulation of social behavior that protects against the negative effects of social exclusion (Alvares et al., 2010; Bartz et al., 2011), may impact the relationship between social exclusion and suicide. Previous studies have reported an association between attenuated basal oxytocin levels, suicide attempt history and suicide intent (Jokinen et al., 2012). Further, there are studies showing decreased oxytocin levels in response to social exclusion among individuals with borderline personality disorder (Jobst et al., 2014) and chronic depression (Jobst et al., 2015), many of whom exhibited suicide-related symptoms. Although these findings suggest that dysregulated oxytocin levels may contribute to the association between social exclusion and suicide, no studies have directly test this hypothesis among individuals with and with a history of suicidal behavior. Aims: Thus, this study aims to examine potential dysregulations in oxytocin levels that may explain the association between social exclusion and suicidal behavior. Methods: Young adults with and without a history of suicide attempts completed a powerful, computerized, social exclusion paradigm (Cyberball; Williams & Jarvis, 2006). Prior to and approximately 10 minutes after this paradigm, blood samples were collected and participants completed self-report measures of their desires to affiliate and feelings of thwarted belongingness. Results: Preliminary results indicated that in comparison to controls, suicide attempters exhibited decreased oxytocin levels in response to social exclusion. Suicide attempters also reported decreased desires to affiliate and increased feelings of thwarted interpersonal belongingness following exclusion. Conclusions: Overall, our findings suggest that dysregulated oxytocin may explain the link between social exclusion and increased suicide risk. However, replication and further work is needed to determine the nature of the biological disruptions affecting oxytocin levels and whether oxytocin injections may contribute to diminished suicidal symptom severity.

Keywords: suicide, oxytocin, psychiatric illness, social exclusion

B18 Social Anhedonia: Are There Domain-Specific Hedonic Deficits Across the Neural and Behavioral Levels?

Ari Feinstein[1], Cristina Abarno[1], Claire Gorey[1], Marina Bornovalova[1], Geoffrey Potts[1]; [1]University of South Florida

The core feature of Schizotypy, the subclinical expression of Schizophrenia, is high social anhedonia (i.e., reduced motivation and excitement toward social rewards). However, recent literature that dissects reward into discrete processes has found that this hedonic deficit underlying Schizotypy may be more circumscribed than once believed. Neurobehavioral models of reward suggest that there are three components of reward that can be distinguished at the neural level: reward anticipation (pleasure before receiving the reward), reward consummation (pleasure after receiving the reward), and reward learning (how quickly the individual is able to pair the US with the CS). When parsing the reward components, individuals with high levels of social

anhedonia have shown a deficit in reward anticipation, not in reward consummation. Interestingly, recent behavioral evidence suggests that this deficit in reward anticipation is domain specific, with deficits being shown to emotional reward stimuli not to general reward stimuli (i.e., money; Xie et al., 2014). Although this shows that the expression of Schizophrenia-related hedonic deficits may be restricted to social rewards, the findings are limited due to the lack of neural evidence; additionally, no research has explored reward learning in relation to social versus general reward deficits in social anhedonia. In the current study, we addressed these gaps using both neural and behavioral data to all three reward components using a sample of 120 college students from the University of South Florida. The participants were administered the Monetary Incentive Delay (MID; general reward) and the Affective Incentive Delay (AID; emotional reward) tasks. Before the task initiates, the subject must learn the US (neutral cue) and CS pairing (picture or money; behavioral and neural learning phase). After the pairings are learned, the subject is presented with the trained cue that signals a monetary amount or picture type (neural anticipation phase). Then, they are presented with a target square and told that the speed at which they press the "1" key will determine whether or not they win the monetary amount or picture (behavioral anticipation phase). After this, they are presented with feedback regarding whether they won or not (neural consummation phase). At the end of the study, participants rated how rewarding the money or picture was (behavioral consummation phase). Electroencephalography was used to collect Event Related Potentials that index the three reward components: 1) reward anticipation (Stimulus Preceding Negativity), 2) reward consummation (Late Positive Potential), and 3) reward learning (Feedback Related Negativity). Preliminary results suggested that higher levels of social anhedonia were related to lower reward anticipation and learning to emotional stimuli but not monetary stimuli. These findings suggest that, like previous behavioral work, the core hedonic deficit underlying Schizotypy could be restricted to social domains, suggesting that the reward system may act differently to individual rewards (e.g., money) compared to social rewards. Results will be discussed in light of the current models of reward processes and Schizotypy (Gard et. al., 2007; Berridge & Robinson, 2003).

Keywords: EEG, Schizotypy, Social Anhedonia, Reward

B19 Might as well face it, we're addicted to love: Endogenous opioid release in the subgenual cingulate cortex influences emotional responses to social acceptance through the nucleus accumbens.

Ashley Yttredahl[1], Benjamin Sanford[2], Kathleen Hazlett[3], Tiffany Love[4], Brian Mickey[4], Robert Koeppe[2], Jennifer Crocker[5], Scott Langenecker[6], Jon-Kar Zubieta[4], David Hsu[1,2]; [1]Stony Brook University, [2]University of Michigan Ann Arbor, [3]Marquette University, [4]University of Utah, [5]Ohio State University, [6]University of Illinois Chicago

We previously found that fMRI BOLD signal in the nucleus accumbens (NAcc) completely mediated the relationship between trait reward responsiveness and changes in feeling "happy and accepted" in response to being liked by a preferred dating partner (Yttredahl et al., 2016). This suggests a critical role for the NAcc in mediating subjective responses to social reward. In the present study, we examined a separate group of healthy participants who were scanned with both PET and fMRI to determine whether μ-opioid receptor (MOR)-mediated neurotransmission (i.e., endogenous opioid release) is related to fMRI BOLD signal during social acceptance in the NAcc. Participants were 9 women and 2 men between ages 20 years to 48 years (mean age ± SD, 36.01 ± 11.00 years), with no history of psychiatric illness, no current physical illness, and no medications at the time of study. Participants created their own dating profile, and then rated profiles of their preferred gender on likeability. The most liked profiles were presented to participants as stimuli during the PET and fMRI scans. The selective MOR radiotracer [11C]carfentanil was administered intravenously during the PET scan while participants received feedback that they were liked (acceptance) or not liked (rejection) by 12 desired potential dating partners. Baseline scans contained a similar visual presentation with no feedback. The participants returned after 3-41 months for fMRI scanning during a similar task. A priori ROI masks were used to extract PET and fMRI data and included the left and right NAcc, and areas with strong input to the NAcc including the subgenual ACC (sgACC), and left and right amygdala. During social acceptance, we found positive correlations between bilateral NAcc BOLD and endogenous opioid release in the sgACC (left $r = .65$, $p = .03$; right $r = .55$, $p = .08$). We found that the NAcc BOLD signal and opioid release were independently correlated with several state emotional changes. Furthermore, both opioid release and BOLD activity in the sgACC were related to several state outcomes. Using Bayesian mediation modeling on the extracted ROIs, we found that opioid release in the sgACC, a region involved in mood regulation, influences emotional responses to social acceptance through mediation by the NAcc. By further illuminating how NAcc BOLD activity is regulated by higher cortical regions in healthy people, we may ultimately identify how neural disruption can lead to inappropriate responses to the social environment in clinical populations.

Keywords: Social feedback, social acceptance, mu-opioid, PET, fMRI, nucleus accumbens, subgenual,

B20 Neural correlates of acceptance and rejection during online interaction in teenagers.

Irene Perini[1], Paul Hamilton[1], Robin Kämpe[1], Zetterqvist Maria[1], Heilig Markus[1]; [1]Department of Clinical and Experimental Medicine, Linköping University, Linköping, Sweden

Negative online social interactions incl. cyberbullying are a growing problem among teens. Here, we investigated the neural correlates of social interaction in a simulated online context. Healthy teenagers (age 15 to 18) engaged in a social online game in which they chose whether they liked or disliked pictures of other young adults. Similarly, their own pictures were judged by others. A picture of a young adult was shown on the screen for 3 seconds, and the subject was instructed to choose whether he or she liked that person or not by pressing a button. Following this choice, a "thumbs up" or a "thumbs down" appeared on the left side of the picture as feedback. The word "calculating" was then displayed over the picture for 2-4 sec, and signaled that other people were also rating the person (anticipation phase). Finally, the collective outcome was superimposed over the picture and shown for 3 seconds (outcome phase). Similarly, participants saw their own picture being rated by others. There were 16 "self" and 16 "other" trials occurring in two consecutive runs in the MR scanner. A within subject t-test for the anticipation and outcome phases and a 2x2 factorial ANOVA with factors Perspective (self and other) and Outcome (like and dislike) for the outcome phase were performed. During anticipation, right anterior insula (rAI) was significantly more active for self versus other conditions. During the outcome phase, bilateral AI and the head of the caudate were significantly more activated when the participant saw themselves as opposed to other people being liked. Significant activations were also found for the main effect (ME) of Perspective and the ME of Outcome. For the ME of Outcome left insula, posterior cingulate cortex (PCC) and dorso-medial prefrontal cortex (dmPFC) were activated. Beta values were higher in insula for the level "like" whereas dmPFC and PCC showed higher values for the level "dislike". For the ME of Perspective, rAI and mid cingulate cortex (MCC) were significantly more active for the condition "self" versus "other." These findings show that areas implicated in salience and goal directed behavior are more engaged when the subject is being judged. This paradigm offers insights about neural substrates of online communication during adolescence and can be used to investigate social interaction in individuals with more vulnerable psychological profiles.

Keywords: fMRI, social interaction, acceptance, rejection, adolescence

B21 Electrophysiological Evidence for Semantic Blocking as a Mechanism of Selective Social Learning

Haykaz Mangardich[1], Mark A. Sabbagh[1]; [1]Queen's University

From a young age, children are selective word learners. They suspend the mechanisms that typically support word learning when speakers provide word-referent links that are likely to be either inaccurate or socio-culturally irrelevant (Koenig & Sabbagh, 2013; Mills, 2013). Though we know much about the conditions under which children demonstrate selective word learning, we have a very limited understanding of the underlying cognitive mechanisms by which children's selectivity manifests. One possibility is that judgments about the prospective relevance of a novel word might affect the strength of the semantic representation that young children create for the new word. Previous work has shown behaviorally that children's word learning is stronger for objects that they were told were purchased nearby (i.e., "downtown) and were thus relevant to them, compared with objects they were told were purchased faraway (i.e., "Japan") and were thus less relevant (in the North American context) (Henderson, Sabbagh & Woodward, 2013). These findings, however cannot tell us about how the usual processes associated with word learning might have varied across conditions. Here, we report findings from a brain electrophysiological (ERP) study designed to determine the extent to which information about objects' origins affect the strength of the semantic representations formed during learning. Following previous work, 20 children (12 girls, mean age = 6.5 years) first experienced novel word training during which they were provided with labels for novel objects that were said to be purchased from either nearby (downtown) or faraway (in Japan). ERPs were subsequently recorded as they heard a recording of the speaker using the novel word, followed by a picture of either the object the word was paired with during training (congruent) or a distractor object that was also present during training (incongruent). EEG was recorded from the scalp using a 128-channel Geodesic Sensor Net, time-locked to the presentation of the picture of the object. We were particularly interested in the N400 component of the ERP, the amplitude of which is sensitive to semantic incongruity. We reasoned that if children formed semantic representations for word-referent links that were said to be purchased from faraway, then they should have a noticeable N400 effect when they later heard those words paired with objects that are different from the initially presented. Results showed a significant condition (nearby vs. faraway) by trial-type (congruent vs. incongruent) interaction $\Psi \hat{} = 2.36$, $p = .024$, 95% CI [-4.35, -0.15], indicating that children in the nearby condition demonstrated a larger N400 congruity effect for the recently trained novel words (Median = - 2.62) in

comparison to children in the faraway condition (Median = -0.25) over the right central region of the scalp between 350 and 450 ms. These results suggest that children differed in the extent to which they created semantic representations for word-referent links based on information about the origins of those objects. More broadly, these findings show that selective learning may be implemented through neurocognitive processes that "gate" the formation of semantic representations based upon considerations of prospective relevance.

Keywords: Language, word learning, selective social learning, ERP

B22 Degu reunion vocalizations increase following extended social isolation but not footshock stress

Navdeep Lidhar[1], Ayushi Thakur[1], Anna-Julia David[1], Kaori Takehara-Nishiuchi[1], Nathan Insel[1]; [1]University of Toronto

The motivation to interact socially increases following isolation, but to what extent is this increase due to social isolation per se rather than a general effect of stress? To investigate this question, pairs of female degus (n = 9) were reunited after being separated for varying amounts of time (1 min, 45 min, 24 hrs), separated for a 45 min interval with rewards (sunflower seeds), and separated for 45 min with an acute stressor (10, 1.0 mA footshocks over 2.5 min). Degus (Octodon degus) were used because of their wide repertoire of social behaviors (e.g., Colonnello et al., 2011), which offer a model to examine more than one dimension of social motivation. During reunions following 24 hrs isolation degus exhibited a marked increase in vocal communication compared with all other conditions. Physical interaction, including face-face, face-body ("allogrooming"), and face-rear contact, also varied across reunion conditions, with highest levels observed after 24 hrs isolation and the lowest after 1 min and reward conditions. In contrast to vocal communication, physical interactions did not significantly differ between the 24 hrs and shock reunions. These data are consistent with the hypothesis that stress increases positive social interactions between adult female conspecifics, but also suggest that extended social isolation differentially influences animals' motivation for vocal communication. To begin disentangling the processes supporting 24 hrs reunion behaviors, we repeated the condition with intraventricular infusion of an oxytocin receptor antagonist (OTR-A) or vehicle control (ACSF). Neural investigations have demonstrated a critical involvement of forebrain oxytocin receptors in social reward; we therefore predicted that a subset of behavioral interactions that directly engage the social-reward system might be attenuated in the OTR-A condition. Preliminary data (n = 4) suggest that OTR-A reduced vocalizing, but did not have pronounced effects on physical interactions. Further examination of the specific types of vocal and physical interactions affected by the behavioral and pharmacological manipulations is ongoing. These preliminary results are consistent with previously reported "tend and befriend" relationships between stress and social motivation in females, while also emphasizing the distinction between effects of social isolation (arguably acting as a chronic stressor) and those of a potent, acute stressor. They further reveal vocal communication in degus as especially modulated by both social isolation and central oxytocin signalling.

Keywords: affiliation, stress, motivation, vocalizations, oxytocin

B23 Oxytocin receptor in peripheral tissues of the neonatal mouse

Maria A. Greenwood[1], Elizabeth A.D. Hammock[1]; [1]Florida State University

Oxytocin (OXT) is an integral part of the neural regulation of social behavior across mammalian species, with a prominent role in maternal behaviors. Maternal OXT acts within the mother to transform her behavior and physiology to be able to deliver, nourish, and nurture her offspring. OXT is found in maternal peripheral fluids such as amniotic fluid, saliva, and breast milk. Is it possible that these maternal sources of OXT can be detected by OXT receptors (OXTR) located in the infant periphery? The aim of this project was to assess peripheral sites of OXTR for potential genotypic and sex differences in the newborn mouse. Receptor autoradiography was performed on 20µm sagittal sections of whole neonatal (PD 0) male and female C57BL/6J mice using the 125iodinated-ornithine vasotocin ([125I]-OVTA) radioligand. A competition binding assay was used to assess the selectivity of [125I]-OVTA for peripheral OXTR. Radioactive ligand (0.05nM [125I]-OVTA) was competed against concentrations of 0nM, 10nM, and 1000nM excess unlabeled OXT. Neonates with a genetic deletion of the OXTR (OXTR KO) were also used as control tissue to determine signal specificity. Autoradiographs demonstrated the high selectivity of the radioligand for infant peripheral OXTR. OXTR were identified in the oronasal cavity, ciliary bodies of the eye, whisker pads, skin, adrenal gland, and anogenital region in the OXTR WT mouse, but were absent in OXTR KO. Nonspecific binding that could not be fully competed away with unlabeled OXT was seen in areas with a high lipid content such as the scapular brown adipose tissue and the liver. In addition, male OXTR KO mice displayed evidence of hyperadiposity in these regions. Collectively, these data confirm OXT targets in the periphery of the neonate and suggest a role for OXT in modulating peripheral sensory inputs and contact-dependent social development.

Keywords: ontogeny, ornithine vasotocin, oxytocin, OT, OXT, oxytocin receptor, OTR, OXTR, OT-R, OXT-R

B24 Characterization of the distribution of oxytocin and vasopressin 1a receptors throughout the neurotypical human brain

Michelle C. Palumbo[1], Sara M. Freeman[1], Aaron L. Smith[2], Mark M. Goodman[2], Karen L. Bales[1]; [1]University of California Davis, [2]Emory University

The neuromodulator oxytocin (OT), as well as the structurally related vasopressin (AVP), can influence complex social behaviors across mammals. In humans, OT effects social bonding, eye contact, affiliation, trust, social memory, and reinforced learning. Recent clinical trials have begun testing OT as a treatment for Autism Spectrum Disorder (ASD), a condition characterized in part by deficits in sociality. However, huge gaps remain in what is known about how OT and AVP affect neural substrates in humans. This study aimed to characterize the locations of the OT receptor (OXTR) and AVP receptor 1a (AVPR1a) in the neurotypical human brain. We used a previously established method for competitive binding receptor autoradiography in more than 20 distinct regions of interest throughout one hemisphere of postmortem brain tissue from one adult male and one adult female. We found binding from the OXTR radioligand but not the AVPR1a radioligand in the following regions of the human brain: nucleus accumbens, putamen, globus pallidus (internal and external subdivisions), nucleus basalis of Meynert, superior colliculus, and the substantia nigra. The existence of OXTR radioligand binding in the human nucleus accumbens matches what is seen in the brains of monogamous prairie voles and highly social marmosets. We detected binding of the AVPR1a radioligand but not the OXTR radioligand in the following areas: central amygdala, the CA2/3 field of the hippocampus, presubiculum, and the primary visual cortex. In rhesus macaques and titi monkeys, binding of the AVPR1a radioligand is also present in the central amygdala and primary visual cortex. We measured binding from both radioligands in the dentate gyrus of the hippocampus and the periaqueductal grey, which may indicate mixed receptor expression in these regions. There was no binding above background from either radioligand in the prefrontal cortex, caudate nucleus, CA1 or CA4 fields of the hippocampus, subiculum, amygdala (remaining nuclei besides the central nucleus), anterior cingulate cortex, and the lateral geniculate nucleus of the thalamus. Midline thalamic and hypothalamic nuclei are still being analyzed. These preliminary results in humans can be compared to previous findings in rodents and nonhuman primates to begin to infer the potential function of these receptor populations, although future research will be needed to more fully characterize and understand how OT and AVP may be acting in the human brain influencing behavior. Although the sample sizes are too small to examine sex differences, the results of this study provide a neuroanatomical foundation for future research on sex differences in OXTR and AVPR1a expression in humans. Furthermore, this preliminary data can inform results from previous human neuroimaging studies of intranasal OT and AVP, and it can also inform the design of future research in clinical populations in order to better understand the possible role that OXTR and AVPR1a may play in the etiology of human conditions like ASD.

Keywords: oxytocin, vasopressin, receptor binding, human brain

B25 Distinct brain systems mediate social influence and conditioned cue effects on pain

Leonie Koban[1], Marieke Jepma[1], Tor D. Wager[1]; [1]University of Colorado Boulder

Both social information and experience-based learning can drive expectations and experience of affective stimuli, such as pain. Yet, it is not known whether these different sources of expectations modulate pain via different brain mechanisms. The present study compared how experience-based learning (classical conditioning) and social information (other people's pain ratings) affect pain-related brain responses and pain experience. In each trial of a learning task, participants were presented with one of two visual cues, serving as conditioned stimuli (CS). One cue (CSlow) was followed by low (50%) or medium (50%), the other (CShigh) by medium (50%) or high (50%) painful thermal stimulation. These CS were crossed with a social information manipulation, which involved presenting lines that participants were told reflected the pain ratings of other individuals. We measured expectation and pain ratings, as well as brain responses (fMRI) to painful heat. Our results showed significant effects of both CS and social information on pain, which were both mediated by self-reported expectations. Brain mediation analyses revealed that learned cue effects were mediated by activity in more posterior regions, including cerebellum and visual areas, whereas social influences on pain were mediated by activity in fronto-parietal regions. Overlapping mediation effects were found in the dorsomedial prefrontal cortex. In conclusion, our results demonstrate strong social influences on pain, and partially distinct brain mechanisms underlying learned versus socially instructed pain regulation.

Keywords: social influence; pain; emotion; learning

B26 Evaluating Activities According to Values Theory: An fMRI Study of Social Values

Adam Teed[1], Daniel Mark[1], Jelena Rakic[1], Daniel Krawczyk[1,2]; [1]University of Texas at Dallas, Richardson, TX, United States, [2]University of Texas Southwestern Medical Center at Dallas, Dallas, TX, United States

Social neuroscientists frequently use the word "values" to describe the degree of worth a person assigns to social behaviors or outcomes observed in a variety of neuroimaging tasks. Terms such as cooperation, fairness and generosity are often used to describe results of such studies but such interpretation often remains disconnected from the social psychological subfield of values theory in which these terms have a long history of study. In the current study, we have compared the blood-oxygen level dependent (BOLD) response to descriptions of activities related to concepts drawn from a well-established theory of values, the Basic Human Values Theory (BHVT), in order to investigate potential differences in brain activity related to both similar and different values within one study. Each stimulus consisted of a single sentence description presented in experimental blocks relating to one of four core values described by the BHVT: two prosocial values (Universalism and Benevolence) and two self-interested values (Achievement and Power). Participants responded to each activity with separate ratings for how worthwhile they perceived an activity to be in principle and how likely they would be to participate in it. Regional activation elicited during consideration of the two prosocial values versus the two self-interested was driven by frontal areas, particularly the frontal pole and anterior cingulate cortex. Contrasting the two self-interested values versus the two prosocial values revealed cerebellar and posterior cingulate gyrus activity. When contrasting the prosocial values, the bilateral superior temporal was elicited for Universalism as opposed to Benevolence stimuli. Contrasting the self-interested values, bilateral angular gyrus, bilateral middle occipital gyrus and the left inferior frontal gyrus were observed for Power but not Achievement. We also analyzed what regions tracked across participation and worthiness rating scales for each value. For Achievement, activity in the right supramarginal gyrus and right superior parietal lobe varied with ratings. The brain regions tracking ratings of stimuli pertaining to the other values were more evident when worthiness and participation judgments were separated. Worthiness ratings for Power activities were driven by the right insula, thalamus and left caudate while the middle frontal gyrus tracked worthiness ratings of Universalism stimuli. When separated this way the only brain region observed to track ratings of participation likelihood was the posterior and mid-cinculate gyrus in response to Universalism activities. This study presents early evidence that concepts proposed by the BHVT are relevant for categorizing brain areas involved in different social processes. The results reveal differences in elicited brain activity between both theoretically opposed (i.e. self-interested versus prosocial values) and theoretically similar values (e.g. Power versus Achievement) values.

Keywords: Values Theory, Judgment, fMRI

B27 The interaction of hormones and experience in the noradrenergic response to social vocalizations is not simply due to auditory processing: a c-fos study

Amielle Moreno[1], Ankita Gumaste[2], Geoff Adams[3], Robert Liu[1]; [1]Emory University Neuroscience Program, [2]National Institute of Health, [3]Center for Translational Social Neuroscience Yerkes Primate Center

Maternal response to infants requires sensitivity and attention to infant-specific social cues, such as infant vocalizations. Shortly after the influx of hormones associated with parturition, mother mice rapidly begin responding to behaviorally relevant pup isolation calls. Non-mothers can reach the same level of maternal responsiveness to these cues after sufficient pup experience, a process that can be enhanced in the presence of the hormone estrogen. The ability for pup vocalizations to elicit maternal responses depends on the auditory cortex (AC), where neural plasticity in the encoding of pup calls is thought to enhance their salience. The underlying molecular mechanisms enacted by estrogen and social pup experience to enhance AC processing are currently unknown. Of particular interest is the neuromodulator norepinephrine (NE), whose main cortical source derives from activity in the locus coeruleus (LC). A functioning NE system is necessary for normal maternal behavioral responses to infant cues. Moreover, both the LC and AC express estrogen receptors, providing a potential substrate in both brain areas for estrogen's effects on experience-dependent changes in the responsiveness to pup calls. We therefore tested the effects of estrogen exposure and pup care experience using a 2x2 design in virgin female mice. Mice were given either 17-beta estradiol (E2) or vehicle implants, and cohoused either with a dam and litter (co-carer, CC) or with adult female littermates. We examined the response to playback of pup calls in the LC, primary AC, and secondary AC using the expression of the immediate early gene c-fos (c-fos-ir) as a measure of neural activity. The c-fos-ir in the primary AC, the site of initial cortical sound processing, was highly correlated ($r = 0.91$) with that of the secondary AC, a higher order associative sound processing area. In both the primary and secondary AC we observed a main effect of pup experience (primary: $F(1,11) = 7.7041$, $p = 0.024$; and secondary: $F(1,11) = 17.0148$, $p = 0.033$), which reduced call-evoked c-fos-ir. In the LC, we found an interaction between estrogen and pup experience in response to pup call playback ($F(1,29) = 8.308$, $p = 0.0078$). Interestingly, while the primary AC's activity was not correlated with that of the LC ($r = 0.06$), the secondary AC and LC were negatively

correlated (r = -0.47) suggesting an association between higher order auditory processing and noradrenergic activity. While the pattern of LC response across animal groups could not be simply explained by the pattern of AC activation, it was notable that E2-CC mice showed a particularly large LC c-fos-ir, despite having the lowest relative AC response (i.e., greatest plasticity). These results support the hypothesis that the specific conjunction of pup experience under the influence of estrogen heightens the NE system's response to pup calls, enabling greater plasticity in AC and making those vocalizations more salient.

Keywords: Hormones, Social Auditory Processing, Maternal Behavior, Locus Coeruleus

B28 Resting state functional networks in major depression: relationship to social and divine sources of self-worth

Anjali Sankar[1], Ashley A Yttredahl[1], Benjamin J Sanford[2], Erin McRobert[2], Jennifer K Crocker[3], David T Hsu[1,2]; [1]Stony Brook University, [2]University of Michigan, Ann Arbor, [3]Ohio State University

There is considerable evidence to suggest that low self-esteem poses a risk factor for developing major depressive disorder (MDD) (Sowislo & Orth, 2013). Previously, we found that MDD patients differed from healthy volunteers on measures of self-worth that were based on two contrasting domains: external validation (e.g., approval from others) and internal contingency (e.g., God's love). In particular, MDD patients based their self-worth more on approval from others than did healthy volunteers, whereas the reverse was observed on self-worth contingent on God's love. In the present study, we examined resting state functional connectivity patterns in MDD patients and healthy volunteers, and explored regional brain networks associated with trait self-worth measures based on approval from others and God's love. Resting state fMRI scans were acquired from 19 female patients with current MDD (mean age ± SD: 28.94 ± 10.03; mean HAMD ± SD: 17.30 ± 3.15) and 19 age matched female healthy volunteers (mean age ± SD: 30.52 ± 11.2). Healthy volunteers had no previous history of any psychiatric illnesses and all participants were free of psychotropic medications at the time of study. Prior to scans, all participants completed the Contingencies of Self-Worth Scale which measures the extent to which various sources contribute to one's sense of self-worth. The nucleus accumbens (NAcc) was chosen as a seed of interest for the functional connectivity analysis, based on previous work showing its role in gains of self-reputation (Meshi et al., 2013). Our preliminary findings are as follows: (1) Within group seed-to voxel analysis revealed positive correlations between NAcc and fronto-parietal network in MDD patients, whereas healthy volunteers showed more widespread connectivity with the NAcc. (2) We found evidence to suggest that increased connectivity between left NAcc and anterior cingulate (ACC) (ρ= -0.67, p=0.002) as well as right NAcc and ACC (ρ= -0.53, p=0.02) correlated negatively with self-worth contingent on God's love in MDD patients. We found no such correlations in healthy volunteers, although a previous study found that structural white matter tracts between the NAcc and ACC correlated positively with trait self-esteem in healthy volunteers (Chavez & Heatherton, 2014). (3) Self-worth based on approval from others did not correlate significantly with resting state connectivity in either MDD patients or in healthy volunteers. The present findings suggest that in MDD, increased connectivity in fronto-striatal regions particularly between the NAcc and ACC, is associated with less reliance on God's love as a contingency of self-worth. Funding source: K01 MH085035 (DTH)

Keywords: Resting state fMRI, self worth, Major Depressive Disorder

B30 Role of periaqueductal gray in modulating emotion perception in humans

Keren Haroush[1,2], Akshay Sharma[1], Ziv Williams[1]; [1]Department of Neurosurgery, Harvard Medical School, Massachussets General Hospital, [2]HHMI Janelia Research Campus

The periaqueductal gray (PAG) are a collection of primitive brainstem nuclei that interconnect with higher cortical areas believed to be involved in emotion processing, but its precise role in humans is unknown. Using transient stimulation in a rare subset of human participants, we find that PAG activity significantly alters the perceived emotional state of another individual, and that this influence is both selective and robust to negative emotional valences across orthogonal emotional axes. Control trials probing the participants' perceived pain levels indicate that the participant comfort level did not change throughout the experiment. These findings suggest that the PAG plays a specific causal role in guiding and modulating emotion perception in humans, and point to a plausible target for treating selected neuro-psychiatric disorders.

Keywords: PAG; facial-expression; emotion perception; social judgement

B31 Creating the Hypersensitive Reward System: The Role of Age of Alcohol Initiation and First Social Alcohol Experiences

Claire Gorey[1], Colleen O'Leary[1], Marina Bornovalova[1], Geoffrey Potts[1]; [1]University of South Florida

Large-scale epidemiological studies consistently report that individuals with early alcohol initiation (EAI) are 4

times more likely to experience an alcohol use disorder in their lifetime (Gruber et al., 1996). This vulnerability is not alcohol-specific, as EAI use is robustly related to other substance use disorders as well as impulse control disorders (e.g., Ellickson, Tuker, & Klein, 2003; Elliott, Huizinga, & Menard, 1989; Hajcak, Moser, Holroyd, & Simons, 2006). Although the exact processes activated by EAI use remain undetermined, animal literature suggests that EAI may sensitize or "kindle" the reward system. That is, the impact of alcohol during a developmentally sensitive period of time has been shown to heighten reward anticipation (pleasure before the reward is delivered) and reward learning (ability to quickly pair a US with a CS) to alcohol and food in rats (e.g., Badanich, Maldonado-Devincci, & Kirstein, 2007; Maldonado-Devincci, Banadich, & Kirstein, 2010). Despite these findings, no research has examined the impact of EAI on reward anticipation and learning to alcohol and general reward in humans; additionally, no work has been conducted on the impact of EAI on reward consummation to alcohol and general reward. Furthermore, given that adolescents are particularly sensitive to the social context and to positive rewarding consequences, it would seem relevant to examine whether specific contextual factors of the first drinking experience (e.g., how many peers present) may lead to an even greater kindling effect. In the current study, we addressed these gaps using neural data to all three reward components using a sample of 120 college students. The participants were administered the Monetary Incentive Delay (MID) and the MID -Alcohol (MID-A) tasks. Before each task initiates, the subject must learn the US (neutral or alcohol cue) and CS pairing (money; neural and behavioral learning phase). After the pairings are learned, the subject is presented with the trained cue that signals a monetary amount (neural anticipation phase). Then, they are presented with a target square and told that the speed at which they press the "1" key will determine whether or not they win the monetary amount. After this, they are presented with feedback regarding whether they won or not (neural consummation phase). Electroencephalography was used to collect Event Related Potentials (ERPs) that index the three reward components: 1) reward anticipation (P300), 2) reward consummation (Late Positive Potential), and 3) reward learning (Feedback Related Negativity). Interestingly, contrary to previous animal literature, preliminary results suggested that EAI is associated with decreased reward anticipation and consummation to general and alcohol rewards. However, in line with our predictions, EAI was associated with heightened ability to pair money with alcohol cues; moreover, positive first social alcohol experiences was related to heightened general and alcohol reward anticipation. Our findings suggest that EAI may result in hyposensitivity to general or alcohol rewards. Furthermore, the role of positive first social alcohol experiences may have a greater impact on the reward system than previously believed. Results will be discussed in light of extant animal literature.

Keywords: EEG, alcohol, reward

B32 Neural mechanisms underlying social memory and social familiarity

Teruhiro Okuyama[1], Takashi Kitamura[1], Dheeraj Roy[1], Shigeyoshi Itohara[2], Susumu Tonegawa[1]; [1]Massachusetts Institute of Technology, [2]RIKEN

For social animals, it is crucial to remember and recognize different conspecific individuals (social memory), and exhibit appropriate social behaviors, such as preference behavior or avoidance behavior, to each individual. In humans, lesion of the hippocampus leads to multiple memory deficits including social memory, suggesting that the hippocampus, at least in part, stores memory information on the individual as well as other components of episodic memory such as spatial or temporal memory. However, in rodents, the literature has not reached a consensus regarding the role of the hippocampus in social memory formation. Some studies using lesion experiments or electrophysiological recording concluded that the hippocampus is dispensable for recognizing a familiar conspecific, whereas other studies suggested the contrary. Thus, the neural mechanism of how social memory is encoded still remains unclear. Since mice naturally tend to spend more time interacting with novel mice, rather than familiar mice (social discrimination behavior), we can quantify the degree of memory of individuals by calculating the total duration of time spent with novel versus familiar individuals. Using this behavioral assay, we found that optogenetic inhibition of a subpopulation in the hippocampus resulted in a deficit of social discrimination behavior. Our research gives us new insights and clues into the neural mechanisms underlying social memory and social familiarity.

Keywords: social memory, hippocampus, engram

B33 Coloring Outside the Lines: Exploring a Continuous Model of Sexual Orientation and Reward Responses to Sexual Images.

Colleen O'Leary[1], Elizabeth Kiebel[1], Ashley Acosta[1], Michelle Beach[1], Claire Gorey[1], Geoffrey Potts[1]; [1]University of South Florida

The ventral striatum (VS) plays a key role in the processing of sexual stimuli, with enhanced activity to sexually-laden images. Recent fMRI evidence has suggested that patterns of VS activation to sexual images varies across individuals' sexual orientation and gender. Specifically, the activity for lesbian women as well as for heterosexual and homosexual men showed categorical VS activity (i.e., heightened VS activity was

contingent on a specific type of nudity); whereas, the other sexual orientations showed a non-preferential response, with heightened VS activity exhibited across nudity types. Despite these findings, the literature has been limited because researchers have examined the relationship between VS activity and sexual preference using a categorical model of sexual orientation, instead of the more empirically supported and ecologically valid continuous model. Additionally, previous research using heterosexual, male subjects suggests that individual differences in homophobia can mediate the relationship between sexual orientation and reward consummation for pornographic images. However, no research has investigated whether this same relationship exists for women or men who are not heterosexual. This study seeks to address these limitations by investigating the difference in VS activity for individuals by gender and orientation to images with both same sex and opposite sex interactions, measuring sexual orientation using the Klein Sexual Orientation Grid (Galupo, 2014), and homophobia with the Modern Homophobia Scale (MHS; Raja & Stokes, 1998). Medial frontal negativity (MFN) is an ERP component that is elicited when an individual makes a value judgment. It appears when a stimulus is evaluated as appetitive or aversive, and peaks at about 250-450 milliseconds. MFN has been localized to the anterior cingulate cortex (ACC), which is a brain structure that is involved with emotional feedback. MFN amplitude is more negative when a stimulus produces an unexpected, negative outcome (Miltner, Braun, & Coles, 1997).The current study uses a reward expectation violation paradigm - delivering an unexpected outcome 20% of the time - and uses the MFN as an index of the perceived valence of the outcome. Subjects with a more negative MFN to opposite sex interactions value those photos less than photos with same-sex interactions - providing a measure of sexual interest in the photo. Preliminary results suggest that while homophobia mediates the relationship between sexual orientation and reward consummation for pornographic images by category for men and women higher in heterosexuality, this relationship dissipates as an individual's orientation approaches bisexuality and is non-existent in individuals firmly on the homosexual end of the spectrum. Additionally, this effect was much smaller for women reflecting the less categorical response to sexual images by heterosexual women.

Keywords: sex differences; sexual orientation; ventral striatum; EEG; homophobia

B34 Smile though your heart is aching: Loneliness is associated with impaired spontaneous smile mimicry

Andrew Arnold[1], Piotr Winkielman[1]; [1]University of California, San Diego

As social beings, humans harbor an evolved capacity for loneliness. Loneliness—perceived social isolation—is associated with aberrant social processing as well as various forms of physiological dysregulation. More specifically, loneliness is believed to induce an implicit hypervigilance for social threats. An influential model for the maintenance of chronic loneliness posits that this attentional bias leads to dysfunctional social behavior, but empirical support for faulty interaction mechanisms is lacking. Mimicry, the process of "mirroring" the actions of another, is an important interaction mechanism that promotes social connection and facilitates empathy. Facial mimicry, in particular, involves mirroring the emotional expressions of another and can propagate emotional contagion. Therefore, the goal of the present study was to assess if loneliness is associated with aberrant facial mimicry patterns. We used facial electromyography (fEMG) to measure muscle activity of the zygomaticus major ("smiling muscle") and corrugator supercilii ("frowning muscle") while participants viewed videos and images. Spontaneous facial mimicry (SFM) was assessed when participants passively viewed video clips of actors expressing anger, fear, sadness, or joy. Evidence was found for SFM in greater zygomaticus activity joy, and greater corrugator activity to negative emotions. However, individuals reporting higher levels of loneliness lacked SFM for expressions of joy, with no difference in SFM to negative emotions. In other words, lonely people did not automatically mimic smiles. Loneliness did not affect deliberate mimicry to the same expressions, or spontaneous facial muscle reactions to positive, negative, or neutral IAPS images. However, social content did moderate zygomaticus activity to some positive images—suggesting that lonely individuals smile more to positive nonsocial images than their connected counterparts. Importantly, individual differences in depression and extraversion—constructs that are strongly correlated with loneliness—were not associated significant differences in smile mimicry. These results provide support for the dysfunctional social behavior node in the maintenance model for chronic loneliness. We argue that impaired automaticity of "smiling back" at another—a faulty interpersonal resonance response—represents a pervasive behavioral mechanism that likely contributes to negative social and emotional consequences of loneliness, and supports loneliness contagion. Smile mimicry may represent a fruitful new target for loneliness reduction interventions.

Keywords: loneliness, mimicry, facial electromyography, social behavior

B35 Spousal Touch during Sleep: Better Sleep Unless You're Anxiously Attached?

Shiza Shahid[1], Mary Burleson[1], Nicole Roberts[1]; [1]Arizona State University

Affiliative touch, such as physical affection between relationship partners, activates neural systems associated with reward, relaxation, and attachment. Co-sleeping is a common practice among romantic partners, and the social context of sleep is linked to well-being. The effect of touch during sleep, however, remains largely untested. As a first study, we asked 210 married couples how much they generally touched during sleep and how important it was for them to touch during sleep. We hypothesized that perceptions of more spousal touch during sleep, as well as greater importance placed on that touch, would be associated with better quality of sleep. Given the strong links between touch and attachment, and previous findings of poor sleep associated with attachment anxiety, we expected these effects to be greatest among spouses higher in attachment anxiety (who might benefit most from a sense of security arising from touch). We ran separate regression analyses for husbands and wives, controlling for affective symptoms of depression (which were significant predictors of poor sleep for both spouses). For both spouses, higher reports of amount and importance of touch during sleep predicted better quality of sleep. For wives, the predicted interaction was significant, but in the opposite direction: Reported amount and importance of spousal touch during sleep was positively related to sleep quality only among those with lower attachment anxiety, whereas it was unrelated among those with higher attachment anxiety. Higher attachment anxiety also was related to worse sleep among wives, but not husbands. We speculate that wives who are lowest in attachment anxiety may feel more comfortable when being touched by their partners. As a result, they may touch more often, place more importance on touch, and be more likely to experience rewards of touch such as better sleep quality. Our findings lend support to the idea that social touch can serve a regulatory function, even during sleep.

Keywords: spousal touch, attachment anxiety, sleep

B36 Framework Synthesis for Guiding Design of a Personal Record of Eudaimonic Flourishing and Enhanced Resilience (PREFER) for People with Complex Chronic Conditions

Peter Pennefather[1,3], Katie Seaborn[2,3], Deb Fels[2,3]; [1]Laboratitory for Collaborative Diagnostics, Leslie Dan Faculty of Pharmacy University of Toronto, [2]Dept of Mechanical & Industrial Engineering, University of Toronto, [3]Inclusive Media Design Center, Ted Rogers School of Information Technology Management, Ryerson University

By analogy with the concept of nourishment, the concept of flourishment is advanced as a health system output aimed at reducing episodic disabilities associated with a person's complex chronic conditions. We present a synthesis of conceptual frameworks that integrates insights from the fields of neuroscience, psychology, and Aristotelian philosophy concerning how flourishment can be monitored, anticipated, and designed for. We start with the concept of eudaimonic flourishing. Eudaimonia is an Aristotelian concept that refers to living a flourishing life through the pursuit of one's best self (i.e., one's deamon or true spirit). Recently, eudaimonic flourishing has been re-imagined as a discretely measurable psychological trait that correlates with measures of health such as psychological well-being and resilience. It also can be correlated with worldview warrant traits, including empowerment, agency, and engagement, and meaning-in-life traits, including coherence, purpose and, significance. Ways of measuring such psychological trait components can be derived from consideration of logical and philosophical principles of mental activity and recorded using validatable modes of assessment. Mental activity also is associated with measurable activity in large-scale brain networks that are correlated with observed integration of emotional, social, and cognitive phenomena. Within our framework synthesis, psychological traits are conceptually linked to measurable brain network activity, as well as to Aristolian concepts of mental activity that gave rise to the idea of Eudaimonia. Aristotle rationalized that different mental priorities can drive distinct types of conscious mental activities, each having two nodes of meaning: their essential nature and the impact of their performance. In our framework salience network activity related to condition symptoms and therapetic interventions is proposed to be preferentially linked to the experience of coherence and empowerment along the theoria-episteme (theorizing-science) axis; executive control is linked to the experience of agency and purpose along the praxis-phronesis (acting-judgment) axis; and the default network is linked to the experience of engagement and significance along the poeisis-techne (creating-proficiency) axis. It is proposed that organizing descriptive measures of these concepts as entries within a Personal Health Record (PHR) domain will improve patients' capacity to live a flourishful life through more effective participation in care plans for dealing with chronic disease afflictions. For that participation to be perceived as flourishing, it must be associated within personal appraisals, actions, and modifications to the care program that are interpreted by the patient as improving and promoting a flourishful life. Our framework synthesis outlines the possibility of using measures of psychological traits and of brain network activity to help the patient to represent a virtuous flourishment cycle within a PHR and associated with records of appraisals, actions, and modifications. We propose the concept of a Personal Record of Eudaimonic Flourishing and Enhanced Resilience (PREFER) domain within a patient-owned PHR with self-reported perceptions, tracked

results to structured questionnaires, and heuristic content analysis of care narratives, all contextualized through the framework synthesis.

Keywords: Eudainomia, well-being, brain-networks, psychological traits

B38 Early ablation of oxytocin-like peptides shapes adult zebrafish sociality

Ana Rita Nunes[1,2], Michael Gliksberg[3], Savani Anbalagan[3], Einav Wircer[3], Gil Levkowitz[3], Rui Filipe Oliveira[1,2,4]; [1]Integrative Behavioral Biology Lab, Instituto Gulbenkian de Ciência, Oeiras, Portugal, [2]Champalimaud Center for the Unknown, Lisboa, Portugal, [3]Weizmann Institute of Science, Rehovot, Israel, [4]ISPA- Instituto Universitário, Lisboa, Portugal

Oxytocin and vasopressin-like peptides (isotocin in fish, mesotocin in birds, reptiles and amphibian, and vasotocin) have been implicated in the regulation of social behavior across vertebrates [1]. Although vasopressin is more involved in aggression behavior while oxytocin-like peptides in pro-social behaviors, these neuropeptides and receptor subtypes are similar [2]. Using zebrafish as a model organism, we have been investigating the role of oxytocin-like peptides in the regulation of adult sociality. We have characterized how early relevant sociality, measured as a shoal preference, can be studied during zebrafish ontogeny. Our data shows that shoal preference emerges around the third week post-fertilization. In order to explore how oxytocin can modulate the acquirement of social paradigms underlying social cognition, we have been using a genetic approach to specifically perturb the oxitocinergic-like neuronal circuits in zebrafish and to study how loss of function of these neurons during embryonic development, or throughout the organism's lifetime, modifies zebrafish adult social behavior. Using an oxytocin neurons-specific transgenic system for conditional (i.e. temporal) and cell-specific ablation of oxytocin-like neurons, we demonstrated that early ablation, but not adult ablation, significantly alter shoal preference behavior in adulthood. Furthermore, early inhibition of oxytocin-like vesicular release also impairs adult sociality in zebrafish. In conclusion, our findings suggest that the oxytocin-like neuronal system is involved in a specific social behavior trait that becomes hardwire during early development. 1- Goodson JL, Thompson RR. Nonapeptide mechanisms of social cognition, behavior and species-specific social systems. Curr Opin Neurobiol, 20:784-94, 2010. 2-Chini B and Manning M. Agonist selectivity in the oxytocin/vasopressin receptor family: new insights and challenges. Biochem Soc Trans, 35:737-41, 2007.

Keywords: Social Behavior, Zebrafish, Oxytocin

B39 Oxytocin receptors modulate correlated Fos expression across forebrain nuclei during sociosexual interaction in male prairie voles

Zachary Johnson[1], Hasse Walum[1], Lanikea King[1], Mike Xiao[1], Paula Reifkohl[1], Fuad Haddad[1], Larry Young[1]; [1]Silvio O. Conte Center for Oxytocin and Social Cognition, Center for Translational Social Neuroscience, Department of Psychiatry and Behavioral Sciences, Yerkes National Primate Research Center, Emory University, Atlanta, GA 30329

Oxytocin receptors (OXTRs) modulate vertebrate social behavior and exhibit diverse patterns of central expression both within and across species. Neural network models hypothesize that social behavior is modulated in a fundamentally distributed and interregional manner across reciprocally interconnected limbic and mesolimbic reward nuclei; and further that diverse patterns of neuropeptide receptor (e.g. OXTR) expression across these networks allow for diverse and species-specific network functions during social contexts. Previous experiments have not tied these hypothesized functional principles with specific neuromodulatory systems. Here, we first establish that central OXTRs modulate pair bonding behavior in socially monogamous male prairie voles, reversing a narrative that has pervaded the literature for decades. Then, using Fos immunoreactivity as a proxy of neural activation, we apply pharmacological and genetic approaches to investigate how multiple parameters of OXTR organization and signaling are linked to distributed patterns of Fos expression across a neural network that modulates social olfactory learning in rodents. We show that central OXTR signaling during sociosexual interaction modulates global covariance in Fos expression across this network in male prairie voles ($p=0.008$). We then restrict our focus to the nucleus accumbens (NAcc), a region in which OXTR density and signaling are important for social learning and behavior in prairie voles and other rodents. We hypothesized that variation in OXTR signaling in the NAcc of prairie voles would result in variation in distributed patterns of Fos expression across the network. We demonstrated that site-specific blockade of OXTRs in the NAcc decreases coupling (i.e. correlated Fos expression) of the NAcc shell with other nuclei in the network ($p=0.02$) during sociosexual interaction in male prairie voles. Next, we used a naturally occurring genetic polymorphism in the prairie vole OXTR gene (Oxtr; NT213739) that strongly predicts individual variation in OXTR binding density in the NAcc and other regions, and showed that genotype at this locus is associated with differences in global covariance in Fos expression across the network during sociosexual interaction ($p=0.02$). Collectively, these data support previously hypothesized links between central neuropeptide systems and distributed network function during social contexts, and suggest

mechanisms by which OXTR signaling may modulate salience and reinforcing value of social stimuli during the formation of selective social attachments.

Keywords: immediate early gene, social decision making network, social behavior network, functional coupling

B40 Electrophysiological processing of angry faces and its relationship to social anxiety.

G. Park[1], R.S. Lewis[1], S.G. Goto[1]; [1]Pomona College

Being able to read faces is critical for deriving important information about identify, gender, age, thoughts and feelings. Therefore, understanding the neural mechanisms associated with reading faces provides insight into an important human social function. The N170 event-related potential (ERP) is the most heavily studied electrophysiological index of facial processing, and is usually the first ERP measure distinguishing the processing of faces and non-face objects. Less well understood is the electrophysiology of facial expression. We investigated the temporal and spatial dimensions of the processing of angry faces, and sought to examine if the neural activity to angry faces correlated with self-report measures of social anxiety. Participants were presented with randomized pictures of cars and faces and instructed to count the number of cars. Fifty car stimuli were selected from an online search whereas 50 angry faces and 50 neutral faces were selected from the NimStim Face Stimulus Set (Tottenham et al., 2009). The Social Anxiety Scale for Adolescence (SAS-A) (LaGreca, 1998) survey was also administered. The EEG was continuously recorded using and Electrical Geodesics Inc. 128-channel Hydrocel Geodesic Sensor Net. The net was connected to a DC-coupled high impedance (200 MΩ) Net Amps 300 amplifier. Analog voltages were amplified by a gain of 1,000 and a bandpass filter of .3-100 Hz was used during recording. Voltages were digitized with a 24-bit A/D converter at 250 Hz. The impedance for all of the electrodes were kept below 50 kΩ. Raw EEG data were filtered using a .1—30 Hz bandpass filter. EEGs were segmented beginning 100ms prior to the onset of the stimulus and ending 1000ms after its onset. Trials with artifacts were eliminated from further analysis. To date, we have currently analyzed eight of 25 participants. As expected, there was a larger negativity at the N170 in response to faces than to cars at the lateral posterior electrodes, which was larger on the right than the left. At electrode T6 there was a large effect of faces (d = 0.86) with the N170 to neutral faces (M = -10.0 μV, SD = 4.0 μV) being greater than to cars (M = -6.6 μV, SD = 5.2 μV). The largest difference between the angry and neutral faces was evident at centroposterior electrodes for the P2 ERP. At electrode P4 there was a large effect of facial expression (d = 0.96), with a greater P2 ERP in response to angry (M = 4.4 μV, SD = 2.5 μV) than to neutral (M = 2.3, SD = 2.4μV) faces. Moreover, the P2 amplitude of the angry face was highly correlated to the Fear of Negative Evaluation subscale of the SAS-A measure of social anxiety (r = 0.90, p = .04). However, the P2 to angry faces was not related to the generalized social distress subscale of the SAS-A (r = -0.02, NS). This suggests that greater allocation of attention, as indexed by the P2, was specifically associated with fear of negative social evaluation.

Keywords: N170, affect, face perception, ERP

B41 Brain networks supporting neuroticism, loneliness, and social networks in Traumatic Brain Injury

Janelle N Beadle[1], Arianna Rigon[2], Michelle Voss[2], Melissa Duff[2]; [1]University of Nebraska at Omaha, [2]University of Iowa

Introduction. Traumatic brain injury (TBI) can significantly impact cognition, emotion, and social behavior, as well as contribute to personality changes that may negatively affect social relationships. However, little is known about the impact of TBI on social network size and loneliness, and interactions with personality. Furthermore, by studying the brain networks supporting these processes, researchers can develop targeted interventions to improve social well-being in TBI. Thus, we investigated relationships between social network size, loneliness, and personality in TBI and examined brain networks supporting social relationships. Methods. Participants included 22 individuals with chronic moderate-severe TBI and 19 demographically-matched healthy comparison participants (HC). Participants completed self-report questionnaires measuring perceived loneliness (UCLA loneliness scale), neuroticism (NEO-FFI), and social network size (NSHAP). Additionally, participants underwent resting state functional magnetic resonance imaging (rs-fMRI) to obtain a measure of functional connectivity (rs-FC). Results. Individuals with TBI and HCs had comparable social network sizes ($p>.05$). Despite this fact, individuals with TBI had higher perceived loneliness ($p<.05$) and neuroticism ($p<.05$) than HCs. Within the TBI group, there was a strong, positive correlation between loneliness and neuroticism [$r(21)=.86$, $p<.001$], and significant, negative correlations between social network size and loneliness [$r(21)= -.53$, $p<.05$], and neuroticism [$r(21)= -.49$, $p<.05$]. A mediation analysis revealed that within the TBI group, loneliness had a significant indirect effect on social network size which was mediated by neuroticism [b=.-1.32, 95% BCa CI [-2.54, -.43]; large effect size, k2=.45]. To examine the relationship between neuroticism and brain connectivity in TBI, we conducted an exploratory whole-brain analysis selecting the amygdala as a seed region. Individuals with TBI who reported higher neuroticism had less functional connectivity between amygdala and precuneus than HC. Discussion. We found that despite

having similar numbers of friends to healthy adults, patients with TBI felt lonelier, and high neuroticism mediated this relationship. Furthermore, in TBI patients, brain networks related to neuroticism involved regions important for social relationships (amygdala) and self-regulation (precuneus) in healthy adults. Taken together, the present study provides evidence that in TBI the brain networks supporting neuroticism may be an important target for rehabilitation efforts aimed at improving social well-being.

Keywords: social cognition, Traumatic Brain Injury, neuroimaging, loneliness, social networks

B42 The role of oxytocin and anterior insula activity in social transmission of fear in mice

Elissar Andari[1,2], James P. Burkett[1], Rachel C. Pearcy[1], Kiyoshi Inoue[1], Brian G. Dias[2], Kerry J. Ressler[3], Larry J. Young[1,2]; [1]Silvio O. Conte Center for Oxytocin and Social Cognition, Center for Translational Social Neuroscience, [2]Department of Psychiatry and Behavioral Sciences, Emory University, Atlanta, GA, [3]Department of Psychiatry, Harvard Medical School, Boston, MA

Oxytocin plays a pivotal role in in empathy-like behaviors, including consoling behavior in prairie voles. Exogenous administration of oxytocin promotes social skills in humans who suffer from social deficits such as Autism Spectrum Disorders (ASD). Here, we first validated a paradigm of social transmission of fear in mice and showed that mice are also able to display prosocial responses in response to the distress of their cagemate. We examined the neural underpinnings of these prosocial responses using Fos immunohistochemistry. During the social fear learning paradigm, demonstrators were fear conditioned using tone-shock pairings alone during a 15min session. Control demonstrators were placed in a neutral chamber using tones without shocks for 15 min. Demonstrators and observers were male cagemate. One day later, observers and demonstrators were then exposed together to the conditioned stimulus 24 hours afterward. Partner-directed grooming toward the conditioned demonstrator that is displaying fear responses represents the dependent variable of prosocial responses. Observers were given a social memory test using the socially conditioned tone 24 hours after the paired exposure. Percentage of freezing in observers depicts social transmission of fear. A subset of observers were euthanized following paired exposure with conditioned or unconditioned demonstrators and tested for neural activation using Fos immunohistochemistry. Observers of fear conditioned partners displayed a significant increase of partner-directed grooming in response to the distress of the partner as compared to an unstressed control partner ($P < 0.05$). Observers also show a significant increase of freezing behavior in response to the socially conditioned stimuli in the subsequent fear memory test ($P < 0.05$). At the neural level, observers show a significant increase of Fos positive neurons in the anterior insula, selectively in response to the distress of the partner as compared to an unstressed partner ($P < 0.05$) following 15 min exposure to the demonstrator. Sub-regions of amygdala, the anterior cingulate cortex and posterior insula did not show a significant increase in response to the distress of the partner ($P > 0.05$). In addition, we compared the behavior and neural activity of oxytocin receptor knockout mice (Oxtr-/-), an animal model relevant to ASD, and wild type siblings (Oxtr+/+) in the paradigm above of social transmission of fear. Oxtr-/- observers showed reduced freezing to the socially conditioned stimulus relative to Oxtr+/+ ($P < 0.05$). Oxtr-/- did not show a non-social memory deficit following classical fear conditioning ($P > 0.05$), indicating no general deficit in fear learning. We also found significantly fewer Fos positive neurons in the anterior insula ($P < 0.05$, butnot the posterior insula ($P > 0.05$) in Oxtr-/- mice following exposure to stressed conspecifics, relative to Oxtr+/+. These findings suggest that Oxtr-/- mice have a selective deficit in socially transmitted fear memory. In addition, in congruence with human literature, the insula may be involved in emotional responses to others' pain in rodents and in a manner dependent on oxytocin receptors. Supported by NIH P50MH100023

Keywords: Oxytocin, Autism, Insula, social transmission of fear

B43 Whole genome sequencing reveals genetic variants underlying molecular differences in neuroreceptors among free-ranging rhesus macaques

Michael Montague[1], Noah Snyder-Mackler[2], Seth Madlon-Kay[1], Karli Watson[3], Lauren Brent[4], J.H. Skene[2], Julie Horvath[5], Michael Platt[1]; [1]University of Pennsylvania, [2]Duke University, [3]University of Colorado at Boulder, [4]University of Exeter, [5]North Carolina Museum of Natural Sciences

Evidence suggests that individual variation in social behavior arises from a combination of genetic predispositions and individual experience, yet the underlying biological mechanisms remain poorly understood. One of the hallmark features of autism spectrum disorders is dysfunction in social perception, attention, and interaction. Nonetheless, significant individual variation in these features frustrates diagnoses and challenges the development of effective treatments. Progress lags due to the lack of a suitable animal model, such as a non-human primate model, in which variation in both the underlying genetics and individual experiences generates heterogeneity in social behavior. To address this gap, we have sought to understand the genetic, developmental, and neurobiological contributions to social behavior in the

Cayo Santiago (Puerto Rico) population of rhesus macaques (Macaca mulatta), which represents a large, free-ranging study sample with a known pedigree and deep phenotype data. Such behavioral and cognitive data, when combined with a catalog of genetic variants, offers comparative insight into human behavioral and psychiatric phenotypes. We hypothesize that genetic variants underlying molecular differences in neuroreceptors are associated with distinct suites of behaviors in this socially complex species. In order to describe the genetic variation, we generated whole genome sequences for 217 individuals using 100bp Illumina paired-end libraries. The population was sequenced to a total genome coverage of 1240X (mean 5.7X per individual), and the reads were then aligned to the rhesus macaque reference genome. With over 99% of the reads mapped to the reference genome assembly, we implemented variant detection and identified over nineteen million single nucleotide variants in the population, including over 60,000 that were predicted to alter transcription factor binding sites, transcript splicing sites, or the translated protein sequences. Regarding the latter, amino acid changes were described in dopamine receptors, oxytocin and vasopressin receptors, serotonin transporters, and the opioid receptor, mu-1 (OPRM1). We assessed the functional impact of these amino acid changes using computational tools that predict the potential damage of missense genetic mutations, finding neutral, tolerated and deleterious impacts on the receptor and transporter proteins. With long-term implications for disease-related research and comparative population genomics, we posit that particular genetic variants within fundamental neurotransmitter pathways underlie social behavioral differences.

Keywords: non-human primates, population genomics, genetic variants

B44 Immediate Early Gene Activation in the Social Decision-Making Network is Associated with Dynamic Social Behavior in Social Hierarchies

James Curley[1], Won Lee[1], Cait Williamson[1], Inbal Klein[1], Hollie Dowd[2]; [1]Columbia University, [2]Barnard College

Dominance hierarchies are a common form of social organization in group-living social species. We show that male laboratory CD1 mice living in large semi-natural housing consistently form highly linear and stable dominance hierarchies in groups of up to 30 individuals. Within each hierarchy all animals have a unique social rank and individuals exhibit high directional consistency in their aggressive and subordinate behavior towards mice of relatively higher or lower social status. Here we demonstrate that sub-dominant mice attend to social context and exhibit social behavior that is appropriate to their current social environment. Firstly, using temporal cross-correlation analysis we demonstrate that mice inhibit their aggression towards lower ranked individuals specifically when the alpha male is active. Using immunohistochemistry, we demonstrate that the processing of odors related to familiar versus unfamiliar individuals of dominant and subordinate males is associated with specific patterns of activation within the brain social decision-making network. Secondly, sub-dominant mice are able to rapidly increase their social dominance behaviors towards animals of lower rank within minutes of the alpha male being removed from the hierarchy. We also show using immunohistochemistry that these dynamic changes in social behavior during this social ascent are associated with activation of immediately early genes in the social decision-making network. These findings provide a strong framework for delineating those brain regions responsible for regulating dynamic and flexible changes in complex social behaviors that occur within all group-living social species.

Keywords: Social Dominance

B45 How age differences and environmental manipulations effects cooperative decision making in the prisoner's dilemma game

Maliheh Taheri[1], Pia Rotshteina[2], Ulrik Beierholma[3]; [1]University of Birmingham, B15 2TT, Birmingham, United Kingdom, [2]University of Birmingham, B15 2TT, Birmingham, United Kingdom, [3]Durham University, DH1 3LE, Durham, United Kingdom

Are we getting wiser with age? And does that lead to more cooperation as we grow older? Whilst the concept of aging and wisdom is accepted commonly, as the life expectancy is increasing, aging and social decision making has also captured the attention of psychologists, economist and neuroscientist. Older people are seen as being better able to regulate their emotion, i.e. controlling for their anger, making more economically rational decisions and are better at conflict resolution. To study aging and cooperative decision making in a conflict situation, we recruited 48 elderly (age range) and 52 young (age range). Participants were randomly paired within an age group and played the Prisoner's Dilemma Game (PDG) multiple times with each other, or with a computer for a total of 96 games. Across blocks the games were played in three environmental contexts (negative randomly losing money, randomly winning money, baseline environment). Overall elderly were more cooperative than young. All participants cooperated more when they played against another human than when they played against a computer but the effect was larger for young people. Incurring random monetary losses (relative to wining or baseline blocks) encouraged all participants to cooperate more, but this effect was primarily observed when playing

against human and was stronger for the young participants. Our finding shows that overall the pattern of decision making was similar across young and elderly. Overall elderly were more cooperative and trusting, but at the same time less flexible in adapting their strategy to changing environments.

Keywords: Cooperation; Decision Making; Aging; Experimental economics;Behavioural economics;Prisoner's Dilemma Game; Psychology and Economics

B46 Altruistic behavior in Colombian youth related to history of vulnerability and sex differences: electro-physiological and endocrine correlates

Juan Carlos Caicedo-Mera[1], Jorge Martínez-Cotrina[2], Mauricio Aponte-Canencio[3]; [1]Universidad Externado de Colombia. Grupo de Salud, Conocimiento Médico y Sociedad, [2]Universidad Externado de Colombia. Grupo de Salud, Conocimiento Médico y Sociedad, [3]Universidad Externado de Colombia. Grupo de Salud, Conocimiento Médico y Sociedad

INTRODUCTION: In human beings, experiences of stress and adversity early in life could affect cognitive and emotional processes in late stages of life, an association which is partially mediated by alterations in stress response physiological mechanisms. However, few studies have explored whether these changes could have effects in pro-social behaviors such as altruism and cooperation, in which case they go beyond the level of individual consequences and could affect the forms of relation and organization of the human groups. OBJECTIVE: To explore possible associations between antecedents of individual and familiar vulnerability with altruistic behavior, also analyzing its physiological correlates related to hypothalamus-pituitary-adrenal axis response and sympathetic autonomic activation. METHODS: The study was carried out with 32 youth university students (16 males and 16 females) who completed a short version of instrument named Exploratory Multi-factorial Questionnaire of Aggression and Cooperation (CEMCA), a battery of psychological test developed by the authors, which in this case was used to evaluate the antecedents of individual and familiar vulnerability, social cognition and pro-social behaviors. In order to evaluate altruism, the Opportunities Dictator Game (JDO) which is an adapted version of classic dictator game was performed. It consist on give to each subject a set of game tokens to participate in the raffle for a tempting prize and ask if he want to donate to other unknown person some of his game tokens to also give chance to win the prize. Physiological variables were salivary cortisol levels pre-game and post-game, galvanic skin resistance and heart rate. RESULTS: Significant association between familiar vulnerability and declining altruistic trend in JDO was found. There was also a sexual dimorphism expression which consisted on an increase of altruistic behavior in women, associated to a falling pattern in salivary cortisol levels and an increase of heart rate and galvanic skin resistance. CONCLUSIONS: Taken together, results suggest that a history of vulnerability and adversity conditions, as well as the sex, could significantly modulate the altruistic trend in this population. People who donate more presented a decrease in salivary cortisol and an increase in sympathetic-adrenergic response, which could be interpreted as a correlate of a socio-cognitive conflict associated to the making decision task, that favored an active coping strategy represented in accepting the suggestion to donate. On the other hand, such a physiological pattern could also be associated to experiencing positive valence emotions related to altruistic behavior.

Keywords: altruism, pro-social behaviors, sympathetic-adrenergic response, salivary cortisol, sexual dimophism

B47 Metaphor in Politics: Bringing affect to the decision space?

Vesna Gamez-Djokic[1], Elisabeth Wehling[2], Lisa Aziz-Zadeh[1]; [1]University of Southern California, [2]University of California, Berkeley

Moral evaluations often construe (im)morality in terms of (im)purity/disgust (e.g., "A rotten thing to do."). However, it is unclear what specific advantage there might be to using moral disgust metaphors when compared to literal counterparts (e.g., "A bad/immoral thing to do"). According to Conceptual Metaphor Theory, the concept of immorality is intimately tied with our understanding of impurity (hence physical disgust) as co-occurrences of these two concepts during development establish cross-domain mappings. One prediction is that comprehending moral disgust metaphors should automatically recruit emotion-related processes relevant to physical disgust experience and this may have consequences for moral decision-making in the brain. In the current study we investigated how the processing of familiar disgust metaphors that express moral political attitudes could distinctly modulate both more automatic emotion-related brain areas also relevant to physical disgust processing (i.e., areas of gustatory cortex) and brain areas implicated in more deliberate, top-down processes in decision-making (i.e., ventral medial prefrontal cortex (VMPFC) and dorsolateral prefrontal cortex (DLPFC)) when compared to literal paraphrases. Conservative and liberal participants read each statement presented during a reading-period followed by a response-period during which they indicated their degree of agreement with the statement. Our results indicated that moral disgust metaphors (both during reading and response periods)

recruited emotion-related brain regions relevant to physical disgust processing when compared to their literal counterparts (matched for arousal and valence), but in a context-dependent fashion. Activity within emotion-related brain regions implicated in disgust processing significantly covaried with political orientation during the reading period for moral disgust metaphor when compared to literal counterparts with increased activity for those scoring high on political conservatism. Emotion-related brain regions relevant to disgust processing were also found during the response part of the task across all participants. Critically, literal moral reading and judgment showed increased activity in regions in the VMPFC and DLPFC when compared to moral disgust metaphors, providing additional evidence of a differential impact of moral disgust metaphors on moral processing in the brain. Taken together these findings suggest that moral disgust metaphors engage more automatic emotional processes relevant to physical disgust processing to a greater extent than their literal counterparts, which instead engage brain areas associated with more top-down processes in moral decision-making.

Keywords: Metaphor, Morality, Insula, VMPFC, Conservatives, Liberals

B48 Neural mechanisms of communication via facial expression

Stephen Shepherd[1], Winrich Freiwald[1]; [1]Rockefeller University

Human communication abilities are unique, but build upon a common foundation we share with our primate kin. Primates live in complex social groups with which they must coordinate their behavior, exchanging signals comprising postures, movements, and vocalizations. Scientists have made progress in understanding how facial signals are decoded in primate brains, but know almost nothing about how these signals are produced. We recorded brain activity in monkeys seeing and responding to communicative signals in an MRI scanner. Stimuli were made from video recordings of six monkeys producing a variety of facial expressions. Stimulus videos were simultaneously recorded from multiple angles; a half-silvered mirror was used when recording direct gaze to facilitate naturalistic eye contact. Two 10-second clips were gathered from each monkey, synchronously from three viewpoints. Phase scrambled versions of each video were used as low-level visual controls, and were generated by randomly rotating each Fourier component a consistent amount across each frame. To reduce habituation, we limited exposure to each video. Long (14 second) gaps were placed between videos. Within each run, only one video per subject was shown. Within each session, each video (i.e. subject, event, perspective and scramble) was shown exactly once. Monkeys produced an affiliative gesture, called a 'lipsmack', in response to brief video of subject-directed monkey expressions. Facial movements were recorded by MR-safe video camera and later analyzed both digitally and by manually scoring behavior while blind to stimulus condition. IRON-fMRI imaging was used to track changes in cerebral blood volume associated with neural activity. By comparing both perceived and produced facial behavior to these simultaneously-recorded brain images, we identified key regions involved in processing social interactions and translating perceived signals into appropriate expressive responses. We find that perception of social stimuli activated the extended face patch system, and that production of the macaque 'lipsmack' signal correlated with activation of facial motor regions. Finally, we examine functional correlations between perceptual and motor face patches to determine candidate pathways by which these socially-driven facial expression may arise.

Keywords: orofacial movement; facial expression; comparative neuroscience; communication; fMRI; functional connectivity

B49 Toward molecular mechanisms underlying genotype-dependent diversity in striatal oxytocin receptor expression in the prairie vole.

Byron Gardner[1,2,3], Hasse Walum[1,2,3], Larry Young[1,2,3]; [1]Silvio O. Conte Center for Oxytocin and Social Cognition, [2]Yerkes National Primate Research Center, [3]Emory University

Several psychiatric disorders are characterized by deficits in the social domain, and variation in the oxytocin receptor gene (Oxtr) may contribute to diversity in social cognition and behavior. Studies in animal models have demonstrated that the oxytocin system modulates essential social behaviors including parental nurturing, individual discrimination, empathy related behaviors, and social bonding. The monogamous prairie vole model specifically provides a unique opportunity to explore how variation in Oxtr influences brain and behavioral phenotypes. Among prairie voles, there is extraordinary individual variation in Oxtr expression and receptor density in the striatum that predicts diversity in alloparental behavior and resilience to early-life social isolation. A set of 14 link SNPs in the prairie vole Oxtr predicts >80% of the variation in Oxtr density in the striatum, but not in other brain areas. By aligning the set of SNPs to the whole brain mouse dta provided by the Encyclopedia of DNA Elements (ENCODE), only one SNP, NT213739, was identified to lie in a region marked with features of transcriptional regulation, including the CCCTC binding factor (CTCF). Here, we assessed interactions of CTCF with Oxtr in prairie vole striatum and cortex using Chromatin Immunoprecipitation and quantitative Polymerase

Chain Reaction (ChIP-qPCR) by targeting NT213739 and distal SNP that did not align with markers of transcriptional regulation in the mouse ENCODE alignment. We confirm a significant > 4-fold enrichment for CTCF binding in vole striatum and cortex (n=6) at NT213739 but not in the distal linked SNP, consistent with the possibility that NT213739 directly influences striatal expression. Future directions will be to map CTCF binding and methyltransferase enhancer markers across the entire Oxtr in several brain regions in voles using ChIP-seq, and to quantitatively assess allele specific interactions across the SNPs, to further refine hypotheses regarding the mechanisms linking genotype to phenotype. This will provide a better understanding of how genetic variation in the Oxtr gene may influence variation in social behavior as well as psychopathology.

Keywords: Prairie Vole, Genetics, Oxytocin Receptor Gene, Oxtr, Psychiatric Disorders

B50 Loneliness Predicts Preferences for the Maintenance of Larger Interpersonal Distances from Intimate Others

Elliot Layden[1,2], Stephanie Cacioppo[2,3], John Cacioppo[1,2]; [1]The University of Chicago, [2]Center for Cognitive and Social Neuroscience, [3]The University of Chicago Pritzker School of Medicine

Perceived social isolation, or loneliness as this aversive state is more commonly known, leads to depression, poor physical health, and an increased risk of mortality. Despite the stigma commonly associated with loneliness, Cacioppo and colleagues have postulated that loneliness may also confer adaptive advantages for social animals. In particular, lonely individuals tend to exhibit a hypervigilance for social threats, a pre-attentive adjustment which may have helped to protect lonely ancestral humans from threatening or hostile others. Similarly, personal space, or interpersonal distance (ID), is thought to confer protection by enforcing a safe interaction space around an individual. Although the protective functions of ID are well known, no research to our knowledge has investigated the extent to which lonely individuals prefer increased ID, particularly for intimate (most proximal) ID, as would be predicted given their hypervigilance for social threats. Here, we report two survey-based studies to test this hypothesis. In Study 1, we collected data from 175 online US participants, including measures of loneliness, objective social isolation, depressive symptomatology, anxiety, and preferred ID within three distinct social dimensions (intimate, relational, & collective). Implementing step-wise model selection, we found that social dimension, loneliness, and gender significantly predicted ordinal ratings of ID preference (proportional odds mixed model, with subject treated as a random factor, $\chi2$ (8) = 440.6, $p < .001$; McFadden R^2 = .35). Loneliness within the intimate dimension significantly predicted preferences for larger ID ($\beta = .94$, $\chi2$ (1) = 4.3, $p = .038$, OR = 2.56, 95% CI [1.05, 6.21]), whereas the effect of loneliness within the relational and collective dimensions were non-significant. In Study 2, we confirmed this model in a larger sample of 405 participants recruited via MTurk, again finding a significant effect of loneliness within the intimate dimension ($\beta = .69$, $\chi2$ (1) = 13.56, $p < .001$, OR = 2.0, 95% CI [1.38, 2.89]), but non-significant effects for loneliness within other social dimensions. Study 2 extended Study 1 by introducing a set of putative mediator variables, including social closeness, preference for social closeness, self-other overlap, frequency of contact, and preference for contact. After step-wise selection, closeness significantly predicted reduced ID as a nominal effect ($\chi2$ (3) = 40.09, $p < .001$), partially mediating the effect of loneliness (Sobel Test: $z = 5.32$, $p < .001$). Self-other overlap ($\chi2$ (1) = 5.42, $p = .02$) and preference for contact ($\chi2$ (1) = 4.90, $p = .03$) also predicted reduced ID as ordinal effects. These results confirm the main hypothesis, that loneliness would predict preferences for larger ID for intimate space. The paradigm we have developed can be easily adapted for neuroimaging studies to investigate the neural correlates of the expansion of ID in lonely, in contrast to non-lonely, individuals.

Keywords: Perceived Social Isolation, Loneliness, Interpersonal Distance, Personal Space,

B51 Self-regulatory depletion increases liking but attenuates social processing in the dorsomedial prefrontal cortex for extraverts

Andrea Courtney[1], Todd Heatherton[1], William Kelley[1]; [1]Dartmouth College

Previous research has demonstrated that self-regulatory depletion increases reward signals (Wagner et al., 2013) and approach motivation (Schmeichel et al., 2010). The present studies examined whether this heightened reward response and approach motivation extends to the social domain – but there is reason to believe that social reward does not enhance across the board. Rather, social reward sensitization might vary with subject-level factors related to approach motivation, namely extraversion. Extraverts are more sensitive to social information (Fishman et al., 2011) and might show exacerbated sensitivity to social reward following depletion. In the present studies, we measured behavioral (Study 1) and brain (Study 2) responses to faces after depletion, considering the influence of 1) target valence – a potential indicator of social accessibility, and 2) perceivers' extraversion (BFAS, DeYoung et al., 2007) – a trait measure of one's propensity for social interaction, which might be exacerbated by depletion. In Study 1, thirty-eight

participants underwent a self-regulatory depletion or control manipulation after which they rated the likeability of happy and neutral faces. Results revealed an interaction between depletion condition and facial expression on likeability ratings; happy faces were rated higher when participants were depleted whereas neutral faces were rated lower. Moreover, this effect was further moderated by extraversion; extraverts rated happy faces more positively following depletion. The results suggest that depletion increases social reward, but mainly for extraverts. In Study 2, thirty-four participants again underwent a self-regulatory depletion or control manipulation after which they viewed happy and neutral faces during an event-related fMRI scan. We interrogated a region of the dorsomedial prefrontal cortex (DMPFC) – which is involved in social processing (e.g., Powers, Chavez, & Heatherton, 2016) – for activation while participants viewed the emotional faces. DMPFC activation did not differ by condition (depletion vs. control) or by emotional expression (happy vs. neutral). However, extraversion and depletion condition interacted to predict DMPFC activation – trait extraversion predicted increased DMPFC activity for the control group, but decreased DMPFC for the depletion group. The results suggest that extraversion drives increased social processing in the DMPFC in response to emotional faces – but this relationship might be attenuated under depletion. Trait-level factors (like extraversion) may chronically motivate social processing and evaluation, but this relationship may be temporarily enhanced or attenuated by state-related motivational changes in the individual (e.g., under self-regulatory depletion).

Keywords: extraversion, self-regulation, depletion, face processing, DMPFC

B52 Perception of Emotional Faces at the Periphery: Do Outer Faces Impact Crowd Perception?

Sara Driskell[1], Aina Puce[1]; [1]Indiana University

Emotion recognition in crowds is important when we consider how often we encounter and interact with crowds of people. Despite its importance, very few studies have investigated this issue. In a behavioral study (N=24; 11 women; Mage = 23.75, SDage = 3.86), we investigated how emotional faces (happy, angry, and neutral) in different positions (centrally or peripherally located) in our visual field are perceived and understood. In the study, we used faces from the Chicago Face Database (Ma, Correll, & Wittenbrink, 2015). Participants focused on a central fixation cross while single faces were presented centrally (i.e., within 3 degrees from the fixation cross) or peripherally (i.e., between 3 and 13 degrees from the fixation cross). Participants then pressed one of three response buttons to indicate which emotion was seen. Reaction time and accuracy data were analyzed using 2-way ANOVAs to examine the effects of emotional expression (happy, angry, and neutral) and stimulus location (central and peripheral). Overall, we found that people were faster, $F(1,138) = 14.42$, $p < .001$, $\eta p2 = .01$, and more accurate, $F(1,138) = 30.58$, $p < .001$, $\eta p2 = .18$, for centrally-presented emotions (Maccuracy = .76, Mreaction time = 381.20 milliseconds) than peripherally-presented emotions. However, peripherally-presented emotions also had performance measures that were well above chance (Maccuracy = .61, Mreaction time = 433.47 milliseconds). Happy faces (M = 347.62 milliseconds) were identified faster than both neutral and angry faces (Ms = 402.35 and 464.75 milliseconds, respectively) in both locations, $F(2,138) = 19.56$, $p < .001$, $\eta p2 = .22$. In addition, people were more accurate at identifying happy and neutral faces (Ms = .76 and .79, respectively) compared to angry faces (M = .50), $F(2,138) = 47.93$, $p < .001$, $\eta p2 = .41$. Our data indicate that even faces in the periphery of crowds can contribute to our perception of the crowd's collective emotion. This work contributes to our foundational understanding of crowd perception and gives us clear next steps in continuing to study crowds and their collective emotions.

Keywords: Visual perception, emotion, crowds

B53 Social and Non-social Play Behaviors in Infant Rhesus Macaques following Multiple Sevoflurane Anesthetic Exposures

Kelsey L. Hurt[1], Jessica Raper[2], Mark G. Baxter[3], Maria C. Alvarado[2]; [1]Oglethorpe University, [2]Yerkes National Primate Research Center, Emory University, [3]Icahn School of Medicine at Mount Sinai

Animal studies have demonstrated that early exposure to general anesthesia leads to widespread damage in the developing brain, specifically in the hippocampus and amygdala, areas important for cognition and social behavior. In addition, evidence suggests that single short exposures to general anesthesia are safe in children, but there is an increased risk with each additional anesthesia exposure experienced before the age of four. To date, animal and human studies have primarily focused on learning and memory outcomes with few investigating socioemotional changes such as anxiety, internalizing behaviors, and attention deficit hyperactivity disorder. Further, no studies have examined the potential that early life exposure to anesthesia may have an effect on social play behavior. We have previously found that three exposures to sevoflurane general anesthesia affected socioemotional development in infant rhesus macaques at 6 months of age (Raper et al., 2015) and cognitive performance in the first year of life (Alvarado et al., 2015). By contrast, this same treatment did not impact the mother-infant bond, assessed during the first month

of life. The present study examined whether these same monkeys showed normal or altered social development as measured by social and non-social play behavior between 3 and 5 months of life. Monkeys were born over two years: Cohort 1 included six females and four males. Cohort 2 included four females and six males. Infant monkeys in the anesthesia group (Sevo) were exposed to 4-hours of sevoflurane three times during the first six weeks of life. The control group (Control) was not exposed to anesthesia; rather, they experienced three brief maternal separations at corresponding ages. Infant monkeys and their mothers were returned to their social group the following day after either procedure. Individual subjects were videotaped in their natal groups for 30 min twice weekly over the first year of life. Social play behaviors were assessed from 3 to 5 months of age using a detailed ethogram, and coded using Observer XT 10 (Noldus) software by two experimenters, who were blinded to the treatment conditions. The ethogram consisted of two levels of non-social play behaviors [quiet (subject playing alone and/or manipulating objects) vs. solitary (subjects playing vigorously alone i.e. swinging, jumping, or climbing)] and three levels of social play behaviors [brief (low intensity play while embracing only each others' upper bodies) vs. rough (subjects embracing each others' entire body and high intensity play i.e. wrestling or tumbling) vs. chase (subjects chasing each other)]. Preliminary analyses focused on overall group and sex comparisons within Cohort 1. Univariate analyses revealed a species typical sex difference, such that females in Cohort 1 spent more time in brief and solitary play than males in Cohort 1; however, at present there is no indication that early exposure to general anesthesia impacted social behavior at these young ages. Coding for Cohort 2 is ongoing and the full dataset will be presented.

Keywords: Anesthesia, Social Behavior, Macaque, Development

B54 Reversal of the durable consequences of adolescent social isolation

Elizabeth Hinton[1,2], Amanda Allen[1,2], Shannon Gourley[1,2]; [1]Yerkes National Primate Research Center, [2]Emory University

Adolescent-onset depression is associated with high rates of depression recurrence later in life, is frequently precipitated by social adversity, and is more prevalent in women. Therefore, identifying both the durable consequences of early-life social adversity in female populations and corrective interventions is of great importance. Here, female C57BL/6 mice were isolated or group-housed from postnatal days (P) 31-60. At P60, all mice were "re-socialized," with each cage containing 3-4 previously-isolated mice (n=6-8/pen). Expression levels of 2',3'-Cyclic-nucleotide 3'-phosphodiesterase (CNPase) were assessed throughout the prefrontal cortex (PFC), amygdala, and hippocampus. Circulating corticosterone (CORT) levels were analyzed via ELISA. Decision-making strategies were classified using response-outcome contingency degradation. Anhedonic-like behavior was assessed via the sucrose consumption test. Dendritic spines on deep-layer PFC neurons of thy1-YFP-expressing mice were imaged using confocal microscopy. Finally, CaMKIIa-controlled Gi-coupled Designer Receptors Exclusively Activated by Designer Drugs (DREADDs) were expressed bilaterally in the ventromedial PFC (vmPFC), and activated by their ligand Clozapine-N-oxide via i.p. injection. We found that isolation during adolescence induced hypocortisolemia. Despite social re-integration and normalization of CORT, a history of social isolation also reduced CNPase expression, increased vmPFC spine densities, impaired goal-directed decision-making, and induced anhedonic-like behavior. Reversal of these behavioral outcomes via DREADD-mediated vmPFC inhibition provides a novel G protein-coupled receptor-based approach for mitigating neuropsychiatric outcomes related to social adversity in adolescence.

Keywords: prefrontal cortex, depression, decision making

B55 Understanding Neural Mechanisms underlying Irritability: Discrepancies between Parent and Child Reports

Roaa Jambi[2], Kevin Pelphrey[1,2], Denis Sukhodolsky[1]; [1]Yale Child Study Center, Yale University, [2]Autism and Neurodevelopmental Disorders Institute, The George Washington University

In the context of a large-scale NIMH-supported RDoC clinical trial of Cognitive Behavioral Therapy for disabling levels of irritability in adolescents who have been referred for care because for aggressive behavior, we are examining the extent to which parents and children provide similar or different reports of irritability and affective reactivity. In a sample of greater than 75 participants with functional neuroimaging data as a primary outcome measure, we will test the similarity/different in parent versus child irritability ratings. Data analysis has just commenced. We are identifying 3 groups: High Parent/Low Child, Low Parent/High Child and High Parent/High Child and comparing these groups on the ratings of key psychopathology variables: ADHD, depression and anxiety. We are also examining the effects of age and gender on self-report discrepancies. We are predicting that girls and children with higher level of anxiety will have higher ratings of self-reported irritability. Finally, we are evaluating the effect of callous-unemotional traits on irritability.

Keywords: Psychopathology

B56 Adolescents' Empathic Reactions to Others' Triumph Over Adversity are Positively Related to Connectivity at Rest between the Default Mode Network and the Anterior Insula

Rebecca Gotlieb[1,2], Xiao-Fei Yang[1,2], Shawn Rhoads[3], Rodrigo Riveros Miranda[1,3], Mary Helen Immordino-Yang[1,2,3,4] , [1] Brain and Creativity Institute, University of Southern California, [2] Rossier School of Education, University of Southern California, [3] Center for Mind and Brain, University of California at Davis, [4]Department of Psychology, University of Southern California, [5]Neuroscience Graduate Program, University of Southern California

Empathizing with others requires imagining their cognitive and affective states. The default mode network (DMN) is associated with internal imaginative processes and activates during empathic social emotions. The anterior insula is involved in the experience of social emotions, but is not part of the DMN. Here we examined associations between 53 adolescents' (*M*=15.9) spontaneously described empathic reactions to stories of others' adversities and triumphs during an open-ended private interview, and DMN connectivity during a subsequent 7-minute resting state scan. Responses were coded for evidence that the participant was imagining being in the protagonist's situation or simulating the protagonist's affect or cognition. The DMN was identified at the group-level using Independent Component Analysis and back-reconstructed for each participant. Individuals' network maps were entered into a group level whole brain regression analysis with empathy score as a regressor. Results were examined within the whole brain. Adolescents' tendencies to experience greater empathy for triumph over adversity predicted greater connectivity between the DMN and the right anterior insula at rest (p=0.0001 [correcting for multiple comparisons], cluster size 333 voxels). This suggests that more empathic adolescents may have a general neural readiness for empathic engagement that is observable in the absence of social stimuli. That the DMN and anterior insula are more closely coupled in more empathic adolescents suggests the possibility that educators may be able to support their students developing empathy, a skill critical to academic and personal success, by providing structured opportunities to connect internal reflections with emotional feelings.

Keywords: Functional Connectivity, Default Mode Network, Empathy, Insula.

B57 Effortful resonance: Effects of cognitive load on motor resonance and automatic imitation

Jennifer Gutsell[1], Victoria Drumm[1]; [1]Brandeis University

When one person watches another person moving, the observer's own sensorimotor system becomes activated. This so-called motor resonance facilitates an embodied, intuitive understanding of the action being observed. On the flip side, motor resonance can also interfere with one's own actions by causing motor interference potentially leading to uncoordinated joint action. Hence, at times, 'switching off' motor resonance might be beneficial for social coordination. While motor resonance does not seem to require conscious intent to generate, it is as of yet unknown to what extent it truly proceeds effortlessly, or whether it requires cognitive resources to initiate. To investigate these questions, we imposed cognitive load in the form of the n-back task onto a socially guided motor task, wherein participants were required to align their actions with those of an observed individual. Electroencephalography (EEG) was used to measure suppression of oscillatory activity in the mu frequency band over sensorimotor areas as an index of motor cortex activity, while also controlling mu-suppression resulting from actual movement required to perform the motor task. We found that the addition of cognitive load yielded diminished motor resonance, but only when participants were required to perform actions complementary, as opposed to imitative to those being observed. These results provide preliminary support for the hypothesis that the production of motor resonance requires cognitive effort, but also raise further questions, regarding what circumstances this effect might be constrained.

Keywords: motor resonance, automatic imitation

B58 Rats hunt stag:Integration of social and economic information drives cooperation in a collective decision making task.

Renne Scott[1], Eric Dewitt[1], Alexandra Madeiros[1], Gonzalo Polavieja[1], Marta Moita[1]; [1]Champalimaud Neuroscience Programme

Collective, economic decision-making requires the integration of predictions based on the outcomes of prior interactions alongside predictions generated from ongoing social information. Many collective decisions are made as individuals interact with each other, however how direct social information affects economic decisions remains largely overlooked. Hence we developed a social dilemma task, traditionally focused on how experienced outcomes affect choices, but allow each rat player access to proximate social information. To explore how pairs of rats integrate these forms of information we developed a double T-maze assay for testing 2x2 social dilemma games and established a social choice task that corresponds to a high risk Stag Hunt (SH) game, where each animal can

see the other. In the SH game there are two Nash Equilbira: mutual cooperation, yielding the highest reward at the greatest risk (reward depends on reciprocation by the other) and mutual defection, which provides a constant (independent of the other) intermediate reward. Next we examined the behaviour of rat dyads, where each rat has the option to choose first and defect or risk cooperating, or choose second and coordinate or anti-coordinate. Rats displayed a robust ability to coordinate from the first session (70%) and gradually increased the levels of mutual cooperation (50% by session 6, chance levels corresponds to 25%) significantly surpassing mutual defection. Once stable cooperation was established across all dyads we removed all social information which resulted in the majority of pairs reverting to mutual defection, Furthermore, by manipulating the payoff matrix we found that reward history alone, when rewards are independent of the other behaviors, does not lead to robust mutual cooperation. Our results show that rats learn to cooperate in a coordination high risk game, for which they use both economic and social information. We believe this study paves the way for mechanistic underpinnings of collective decisions between interacting rodents.

Keywords: Cooperation. Social Dilemma. Neuro-Economics, Stag Hunt, Reinforcement learning, social information.

B59 Social modulation of defense behaviors in Drosophila melanogaster

Clara Howcroft Ferreira[1], Ricardo Zacarias[1], Marta Moita[1]; [1]Champalimaud Center for the Unknow

Fruit flies respond to threats with defense behavioral responses. When presented with a looming stimulus, a threatening expanding shadow, individual flies typically jump or show in flight escape maneuvers. Recently, our group and others have found that flies exposed to repeated inescapable looming stimuli also run or freeze. Since in rodents freezing is modulated by the social environment, which can either dampen (social 'buffering') or enhance freezing behavior, we decided to study the responses of groups of flies to recurring unavoidable looming stimuli. For this purpose we analyzed the behavior of groups of female and male flies. We compared individuals to groups of 2, 3, 4, and 5 animals. In line with recent reports of social regulation of defense behaviors, we show that flies in groups display substantially less defense responses, both in terms of freezing and running. We aim to further characterize defense behaviors in groups of fruit flies, and to study the underlying mechanisms at the molecular and circuit level.

Keywords: social, defense behaviors, Drosophila melanogaster

B60 Internet Gaming Disorder: Avatars in the Brain

Sasha Sioni[1], Mary Burleson[1], Debra Bekerian[2]; [1]Arizona State University – West, [2]Alliant University – Fresno, CA

The prevalence of internet gaming addiction has steadily increased as online games geared towards promoting social relationships become more readily available. Research has shown that excessive Internet use, combined with the basic psychological need to feel closely connected to others, can lead to the development of a behavioral addiction such as Internet gaming disorder. Moreover, recent neuroimaging research has demonstrated that the intensity of avatar involvement resembles the level of intimacy experienced with a close friend or partner. Clinical as well as evidence demonstrates that Internet addicts experience a number of psychological, biological, and socially-related symptoms and consequences; these include symptoms that are strongly associated with substance-related addictions. The current study explored the relationships between Internet gaming disorder (IGD), social phobia, and self-identification with a gaming avatar. Participants (N = 488) were recruited anonymously from online-gaming-based internet forums and completed a survey composed of four questionnaires and assessments. Data collected supported the proposed hypotheses. First, individuals who met the DSM-5 diagnostic criteria for IGD strongly identified with their avatar; findings supported the concept that players develop social and emotional relationships with their avatar, which may also increase the occurrence of a behavioral addiction. Results additionally showed a significant association between IGD and social phobia. That is, socially phobic individuals were found to engage in online gaming as a means of avoiding anxiety-provoking social situations. Furthermore, the findings of the current study suggested socially phobic players preferred non-physical (e.g. virtual) forms of social interaction. The connections between individual self-worth and the accomplishments of the avatar can, therefore, lead players to engage in excessive or problematic online gaming usage, such as those in IGD. Finally, this study provided preliminary support for the use of player-avatar identification as a construct for assessing IGD. Future research could explore how various aspects of self-identity relate to one's avatar, as well as the degree to which self-confidence or self-worth may be tied to virtual accomplishments and IGD diagnosis.

Keywords: Internet Gaming Disorder, Behavioral Addiction, Identity, Video Games, Avatar Identification

B61 Separating the agony from ecstasy: prosocial effects and neurotoxicity of R(-)-3,4-methylenedioxymethamphetamine in mice

Daniel Curry[1], Matthew Young[1], Karly Hampshire[1], Andrew Tran[1], Leonard Howell[1,2]; [1]Yerkes National Primate Research Center, Emory University, [2]Emory University School of Medicine

(+/–)-3,4-methylenedioxymethamphetamine ((+/–)MDMA) is an amphetamine derivative that became popular as a recreational drug (ecstasy) and therapeutic tool during the 1970's and early 1980's. Escalating use led to its prohibition but scientific interest in the drug has persisted due to its unique prosocial effects. Under clinical observation, volunteers report that (+/–)MDMA increases feelings of closeness towards others, empathy, and gregariousness. In addition to these acute effects, there is evidence of enduring therapeutic effects such as improved interpersonal functioning and significant symptom reduction in PTSD patients. An ongoing clinical trial is now investigating its potential as a treatment for autism. However, serious limitations remain to wider clinical use of (+/–)MDMA, including its abuse liability and suspected neurotoxicity. There is thus significant impetus to isolate the prosocial mechanisms of (+/–)MDMA from the neurotoxic and abuse related effects. We investigated the hypothesis that the left handed enantiomer of (+/–)MDMA, (–)MDMA, may retain the prosocial effects of racemic MDMA but lack neurotoxicity. We found that both (+/–)MDMA (7.8 mg/kg) and (–)MDMA (17 mg/kg) significantly increased murine social interaction, but only (+/–)MDMA produced stimulant-like side effects. Furthermore, unlike racemic MDMA, (–)MDMA did not induce hyperthermia or neuronal markers of toxicity such as reactive gliosis or decreased brain monoamine content. These results indicate that the prosocial effects of (+/–)MDMA are separable from the neurotoxic and locomotor stimulant effects. Further evaluation of (–)MDMA is needed in other species, but these results suggest that it may be a more viable therapeutic than racemic MDMA.

Keywords: pharmacology, MDMA

B62 Brain Networks Related to Loneliness in Adolescents

Abi M. Heller[1], David E. Warren[2], Tony W. Wilson[2], Vince D. Calhoun[3], Julia M. Stephen[3], Yu-Ping Wang[4], Janelle N. Beadle[1]; [1]University of Nebraska at Omaha, [2]University of Nebraska Medical Center, [3]University of New Mexico-Mind Research Network, [4]Tulane University

Higher levels of perceived loneliness are associated with poorer health, diseases, and a greater risk of mortality. Studies of loneliness suggest that it is heritable, and that some individuals are more prone to experiencing loneliness than others due to negative perceptions about their social behavior. Previous neuroimaging studies in adolescents have demonstrated that brain regions involved in emotion processing and regulation, such as the anterior cingulate cortex (ACC), medial prefrontal cortex, and amygdala, are associated with social exclusion and social network size. However, the brain networks underlying loneliness in adolescents are unknown. We used resting state functional connectivity (rs-FC) to investigate brain networks related to loneliness in adolescents. We hypothesized that greater loneliness would be associated with reduced functional connectivity between brain regions supporting emotion regulation, specifically connectivity between the medial prefrontal cortex and the amygdala. This study is part of the Developmental Chronnecto-Genomics project (Dev-CoG), which is an ongoing NSF-funded study that aims to map the developmental trajectory of cognition, social behavior, and the structure and function of the brain in 230 adolescents aged 9-15 years-old. The current project focuses on a subset of this data (N=42) investigating brain networks in adolescents associated with loneliness, as measured by a self-report questionnaire from the NIH Toolbox (Emotion Battery). In addition, measures assessing perceived rejection and friendship were included to investigate associations with loneliness. Participants underwent resting state functional magnetic resonance imaging to obtain a measure of functional connectivity (rs-FC). Resting-state data were collected using two identical multiband sequences (one eyes-open, one eyes-closed): voxel size, 3.3×3.3×3.0mm; TR, 460 msec.; TE, 29 msec.; duration, 306 sec. (i.e., 650 measurements). A whole-brain analysis was conducted with the amygdala as the seed region. We found that loneliness was positively correlated with perceived rejection ($r=.57$, $p<.01$) and negatively correlated with friendship ($r=-.59$, $p<.01$). Furthermore, we found that rs-FC between the amygdala, medial prefrontal cortex, and precuneus regions was significantly modulated by loneliness scores ($p<.05$). Previous research has demonstrated an important role for the medial prefrontal cortex in regulating emotional experience through its connection with the amygdala. Furthermore, the precuneus has been associated with self-reflection and social exclusion. Taken together, this suggests that loneliness in adolescents may be associated with differences in the underlying brain networks supporting emotion regulation and self-reflection. The identification of networks associated with loneliness in adolescents could be used to develop interventions aimed at treating loneliness early on to reduce the impact on future health consequences.

Keywords: adolescents, loneliness, brain networks, functional connectivity, amygdala

B63 What do monkeys know about others' preferences?

M. Sharika[1], Michael Platt[1]; [1]Perelman School of Medicine, University of Pennsylvania, PA, USA.

Previous studies on prosociality in rhesus macaques have shown that monkeys often choose to make positive decisions for a conspecific at no additional cost to self (Chang et al., 2011, Ballesta et al., 2015). However, how monkeys learn whether a particular outcome is preferable to others or not is not well understood. We examined this by making monkeys perform a 'willingness to pay' task in which they choose between different target options associated with varying magnitudes of positive or negative reward to self vs. other. We tested whether monkeys were able to make appropriate choices by observing the responses of their conspecifics during the task and if the sensitivity and specificity of choices differed when they were made for self vs. other. Our preliminary results suggest that this paradigm can be suitably used to explore the neural mechanisms of perspective-taking in monkeys.

Keywords: Empathy, Theory of mind, Social learning

B64 It Matters to Husbands: Spousal Touch Avoidance Moderates the Effects of Touch on RSA Responses to Laboratory Stress

Jessie Duncan[1], David K. Parkhurst[1], Nicole A. Roberts[1], Mary H. Burleson[1]; [1]Arizona State University

Previous studies have linked the avoidance of social touch with unfavorable psychosocial outcomes, including neuroticism, marital dissatisfaction, poor interpersonal skills, and even poor problem-solving. In the present study, we investigated whether avoidance of spousal touch predicted respiratory sinus arrhythmia (RSA) – an indicator of parasympathetic influences on the heart that has been linked to regulatory capacity and effort – during spousal interactions in the laboratory. Two hundred and fourteen married couples completed a measure of spousal touch avoidance, then subsequently attended a laboratory session in which they were randomly assigned to either touch (touch while sitting, then hug), talk (have an emotionally positive conversation, but not touch), both (touch while talking, then hug), or neither (sit quietly without touching). Next, spouses separately performed stress tasks that included giving a speech and doing mental arithmetic. For husbands, regression analysis predicting change in RSA from baseline to immediately following the touch/talk manipulation revealed a significant interaction between spousal touch avoidance and touch condition: Among husbands who reported stronger avoidance of spousal touch, those in touch conditions had significantly greater increases in RSA than those in no-touch conditions. Regression analysis predicting change from immediately after the touch/talk manipulation to immediately following the stress tasks also revealed a significant interaction between touch avoidance and touch condition for husbands: Among husbands with stronger avoidance of spousal touch, those in touch conditions had significantly smaller increases in RSA than those in no-touch conditions. Spousal touch avoidance was not related to wives' RSA. Phasic increases in RSA have been associated with regulatory effort, and stress-related phasic decreases are linked with efficient stress responding. These findings/patterns suggest that, even for those who might prefer to avoid it, spousal touch may play a unique role in contributing to physiological flexibility or regulatory capacity.

Keywords: Social Factors

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