S4SN 2018 Annual Meeting | Committees

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Journal Affiliation

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.
2018 Annual Meeting Program

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

www.s4sn.org
## Schedule Overview

### Friday, November 2, 2018

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<td>8:30 am – 7:00 pm</td>
<td>Exhibits Open, Sapphire Ballroom IJMN</td>
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<td>8:55 am – 9:00 am</td>
<td><strong>Welcome Remarks</strong> by President Rui Oliveira, Sapphire Ballroom IJMN</td>
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<td>9:00 am – 10:00 am</td>
<td>Keynote Address, <em>The Neurobiology of Social Bonding, Social Loss and Empathy: Implications for Autism</em>, Larry Young, Emory University, Sapphire Ballroom IJMN</td>
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<td>10:00 am – 10:20 am</td>
<td>Coffee Break</td>
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<td>10:20 am – 10:50 am</td>
<td><strong>Remembrance of John T. Cacioppo.</strong> Founder and First President of S4SN</td>
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<td>10:50 am – 11:50 am</td>
<td>Symposium 1: <strong>Neuronal substrates of interactive social behavior.</strong> Chairs, Raymundo Báez-Mendoza and Ziv M. Williams, Sapphire Ballroom IJMN</td>
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<td>10:50 am – 11:05 am</td>
<td>Talk 1: Representation of social information in the prefrontal cortex and its autism-associated disruption, Ofer Yizhar</td>
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<td>11:05 am – 11:20 am</td>
<td>Talk 2: Cortico-subcortical networks underlying social reward valuation, Masaki Isoda</td>
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<td>Talk 4: Single neuron basis of social reciprocity in the anterior cingulate cortex, Raymundo Báez-Mendoza</td>
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<td>2:00 pm – 2:30 pm</td>
<td>Emerging Topics I: <strong>A systems approach to understanding empathy.</strong> Chairs, John P. Christianson and Hee-Sup Shin (5 min each with an all-panel Q&amp;A at the end for all the speakers), Sapphire Ballroom IJMN</td>
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<tr>
<td>2:00 pm – 2:05 pm</td>
<td>Talk 1: Social Affect and the Insular Cortex, John P. Christianson</td>
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<td>2:05 pm – 2:10 pm</td>
<td>Talk 2: Genetic and circuit analysis of empathic fear in the mouse, Hee-Sup Shin</td>
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<td>Talk 3: Neural mechanisms of empathically motivated altruism, Oriel Feldman Hall</td>
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<td>Symposium 2: <strong>Neural response to socio-emotional vocal information produced by important others: influence of social learning and developmental change.</strong> Chair, Michele Morningstar, Sapphire Ballroom IJMN</td>
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<td>Talk 1: Insights from songbirds into neural circuits underlying positive affective communication, Lauren Riters</td>
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<td>2:45 pm – 3:00 pm</td>
<td>Talk 2: Neural mechanisms supporting natural social interactions in marmosets, Cory Miller</td>
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<td>3:00 pm – 3:15 pm</td>
<td>Talk 3: Imaging the development of neural responses to voice and environmental sounds of typically developing infants and infants at risk with fMRI and fNIRs, Anna Blasi</td>
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<td>3:15 pm – 3:30 pm</td>
<td>Talk 4: Development of vocal emotional processing in adolescence and its disruption in temporal lobe epilepsy, Michele Morningstar</td>
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<td>3:50 pm – 4:50 pm</td>
<td>Symposium 3: <strong>The neurophysiology of social and affective touch.</strong> Chair, Katalin Gothard</td>
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<td>3:50 pm – 4:05 pm</td>
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<td>4:05 pm – 4:20 pm</td>
<td>Talk 2: Cellular correlates of social and emotional touch in primates, Katalin Gothard</td>
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<td>4:20 pm – 4:35 pm</td>
<td>Talk 3: Neural correlates of social and emotional touch in humans, India Morrison</td>
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<td>Talk 4: Touch perception altered by chronic pain and opioid blockade, Catherine Bushnell</td>
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<td>4:50 pm – 5:20 pm</td>
<td>Emerging Topics II: <strong>Navigating social relationships using hippocampal networks.</strong> Chair, Daniela Schiller, Sapphire Ballroom IJMN</td>
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<td>Talk 3: Navigating social relationships in healthy and psychiatric populations, Daniela Schiller</td>
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<td>Animal Method: Nonhuman social neuroscience at a crossroads, Eliza Bliss-Moreau</td>
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<td>5:45 pm – 6:00 pm</td>
<td>Human Method: Prosocial apathy: Neural mechanisms for exerting effort to benefit others, Matthew Apps</td>
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Keynote

Larry Young
Silvio O. Conte Center for Oxytocin and Social Cognition, Department of Psychiatry and Behavioral Sciences, Yerkes National Primate Research Center, Emory University, Atlanta GA

Taylor and Francis Social Neuroscience Keynote Address
Friday, November 2, 2018, 9:00 - 10:00 am, Sapphire Ballroom IJMN

The Neurobiology of Social Bonding, Social Loss and Empathy: Implications for Autism

The monogamous prairie vole provides an opportunity to examine the neural and genetic mechanisms underlying complex social decisions, including social bonding and empathy-related behaviors. Oxytocin receptor (OXTR) signaling in the nucleus accumbens (NAcc) and prefrontal cortex (PFC) is critical for mating-induced pair bond formation between mates. Diversity in expression patterns within the brain contribute to diversity in social behaviors across and within species. In prairie voles, oxytocin links the neural encoding of the social signature of the partner with the rewarding aspects of mating through interactions with dopamine and by coordinating communication across a neural network linking social information with reward. Using in vivo electrophysiology and optogenetics, we have found that PFC modulation of NAcc activity facilitates pair bonding. Genetic polymorphisms robustly predict natural variation in OXTR expression in the NAcc, which predict pair bonding behavior and resilience to neonatal social neglect. We have also explored the capacity of prairie vole to display empathy-like behavior, specifically consoling. Prairie voles increase their partner-directed grooming toward mates that have experienced an unobserved stressor. This consoling response is abolished blocking OXTR antagonist into the anterior cingulate cortex, a region involved in human empathy. Finally, loss of a bonded partner results in the development of depressive-like “grieving” behavior. Infusion of oxytocin into the NAcc prevents social loss-induced depression. Clinical studies suggest that the role of oxytocin in regulating social cognition is conserved from rodent to man. Thus pharmacological manipulation of the oxytocin system may represent a means of improving social function in psychiatric disorders such as autism.
The neurophysiology of social and affective touch: implications for social dysfunction

Raymundo Báez, University of Oxford, UK

For decades it has been debated what contribution - if any - the medial prefrontal cortex (mPFC) makes to social cognition and behaviour. However it is sometimes overlooked that within the mPFC there are multiple sub-regions, each with distinct cytoarchitecture and structural and functional connectivity, that are indicative of distinct functional properties. Neuroeconomic research examining how we ascribe value and make decisions in order to maximise our own rewards has highlighted that different regions of the mPFC make distinct contributions to processing the subjective value of our own and other’s actions. Here, I use tasks which manipulate the subjective value of a behaviour, who that valuation pertains to, and for whom that value matters (self or other) to dissect out the contribution of different regions of the mPFC to social cognition. We show that within the mPFC several sub-regions contribute to social cognition, but in different frames of

TALK 1: REPRESENTATION OF SOCIAL INFORMATION IN THE PREFRONTAL CORTEX AND ITS AUTISM-ASSOCIATED DISRUPTION

Ofer Yizhar, Weizmann Institute of Science, Israel

The prefrontal cortex (PFC) plays an important role in regulating adaptive responses to social stimuli in all mammals. Prefrontal impairment is associated with various forms of psychiatric disorders and is associated with cognitive and behavioral dysfunction in autism spectrum disorder. However, little is known of how the prefrontal cortex encodes social information, and how such social representations may be altered in disorders involving social dysfunction remains largely unexplored. We established a novel apparatus that allows electrophysiological recording of the activity of neurons in the medial PFC (mPFC) of freely behaving mice presented with precisely timed social and non-social olfactory cues. Both single-unit and population activity patterns in the mPFC differed considerably for social and non-social stimuli and showed prominent experience-dependent refinement. In mice lacking the autism-associated gene CNTNAP2, both the categorization of social information and its between-day dynamics were impaired. The degree to which social representations were disrupted correlated strongly with elevated noise in baseline neural activity. Our findings reveal the dynamics of social representations in prefrontal circuits and their autism-associated social dysfunction.

TALK 2: CORTICO-SUBCORTICAL NETWORKS UNDERLYING SOCIAL REWARD VALUATION

Masaki Isoda, National Institute for Physiological Sciences, Japan

Human behaviors are influenced by not only one’s own rewards, but also rewards for others. It is not known which brain regions or networks of regions monitor rewards for others and how others’ reward information affects one’s own reward valuation system. To address this issue, we developed a novel Pavlovian conditioning procedure for a pair of monkeys facing each other. Behaviorally, the subjective value of upcoming self-rewards, albeit constant in amount and probability, decreased as the probability of partner’s rewards increased. We found that neurons in the medial prefrontal cortex (MPFC) selectively monitored self-reward and partner’s-reward information, whereas dopaminergic neurons in the midbrain integrated this information into a subjective value. Furthermore, simultaneous recordings of neural activity in the two brain regions revealed that the neural information flow predominantly directed from the MPFC to the dopaminergic midbrain nuclei. These findings suggest a dedicated circuit within cortico-subcortical networks for subjective reward valuation in social contexts.

TALK 3: DISTINCT SOCIAL ‘FRAMES OF REFERENCE’ FOR VALUATION ACROSS THE HUMAN MEDIAL PREFRONTAL CORTEX

Matthew Apps, University of Oxford, UK

For decades it has been debated what contribution - if any - the medial prefrontal cortex (mPFC) makes to social cognition and behaviour. However it is sometimes overlooked that within the mPFC there are multiple sub-regions, each with distinct cytoarchitecture and structural and functional connectivity, that are indicative of distinct functional properties. Neuroeconomic research examining how we ascribe value and make decisions in order to maximise our own rewards has highlighted that different regions of the mPFC make distinct contributions to processing the subjective value of our own and other’s actions. Here, I use tasks which manipulate the subjective value of a behaviour, who that valuation pertains to, and for whom that value matters (self or other) to dissect out the contribution of different regions of the mPFC to social cognition. We show that within the mPFC several sub-regions contribute to social cognition, but in different frames of

Symposium Session 1

NEURONAL SUBSTRATES OF INTERACTIVE SOCIAL BEHAVIOR

Friday, November 2, 10:50 - 11:50 am, Sapphire Ballroom IJMN

Chair: Raymundo Báez-Mendoza and Ziv M. Williams

 Speakers: Ofer Yizhar, Masaki Isoda, Matthew Apps and Raymundo Báez-Mendoza

1 Neuronal substrates of interactive social behavior

We established a novel apparatus that allows electrophysiological recording of the activity of neurons in the medial PFC (mPFC) selectively monitored self-rewards. In mice lacking the autism-associated gene CNTNAP2, both the categorization of social information and its between-day dynamics were impaired. The degree to which social representations were disrupted correlated strongly with elevated noise in baseline neural activity. Our findings reveal the dynamics of social representations in prefrontal circuits and their autism-associated social dysfunction.

2 Neural response to socio-emotional vocal information produced by important others: influence of social learning and developmental change

Behaviorally, the subjective value of upcoming self-rewards, albeit constant in amount and probability, decreased as the probability of partner’s rewards increased. We found that neurons in the medial prefrontal cortex (MPFC) selectively monitored self-reward and partner’s-reward information, whereas dopaminergic neurons in the midbrain integrated this information into a subjective value. Furthermore, simultaneous recordings of neural activity in the two brain regions revealed that the neural information flow predominantly directed from the MPFC to the dopaminergic midbrain nuclei. These findings suggest a dedicated circuit within cortico-subcortical networks for subjective reward valuation in social contexts.

3 The neurophysiology of social and affective touch

The prefrontal cortex (PFC) plays an important role in regulating adaptive responses to social stimuli in all mammals. Prefrontal impairment is associated with various forms of psychiatric disorders and is associated with cognitive and behavioral dysfunction in autism spectrum disorder. However, little is known of how the prefrontal cortex encodes social information, and how such social representations may be altered in disorders involving social dysfunction remains largely unexplored. We established a novel apparatus that allows electrophysiological recording of the activity of neurons in the medial PFC (mPFC) of freely behaving mice presented with precisely timed social and non-social olfactory cues. Both single-unit and population activity patterns in the mPFC differed considerably for social and non-social stimuli and showed prominent experience-dependent refinement. In mice lacking the autism-associated gene CNTNAP2, both the categorization of social information and its between-day dynamics were impaired. The degree to which social representations were disrupted correlated strongly with elevated noise in baseline neural activity. Our findings reveal the dynamics of social representations in prefrontal circuits and their autism-associated social dysfunction.
reference. Areas 8 and 9 in the dmPFC process information about the value of acts regardless of whether they are valued based on self or social information. However, portions of the anterior cingulate gyrus process information about the value of others’ behaviors and not one’s own, and areas 11 and 32 in VMPFC process information about self and other value but in an opposing manner. These results show that none of these mPFC regions is absent of social valuation based information, but different sub-regions process self relative to other distinctly across the medial wall, potentially explaining the ongoing debate about how social the mPFC is. We show that within the mPFC several sub-regions contribute to social cognition, but in different frames of reference. Areas 8 and 9 in the dmPFC process information about the value of acts regardless of whether they are valued based on self or social information. However, portions of the anterior cingulate gyrus process information about the value of others’ behaviors and not one’s own, and areas 11 and 32 in VMPFC process information about self and other value but in an opposing manner. These results show that none of these mPFC regions is absent of social valuation based information, but different sub-regions process self relative to other distinctly across the medial wall, potentially explaining the ongoing debate about how social the mPFC is.

Symposium Session 2

NEURAL RESPONSE TO SOCIO-EMOTIONAL VOCAL INFORMATION PRODUCED BY IMPORTANT OTHERS: INFLUENCE OF SOCIAL LEARNING AND DEVELOPMENTAL CHANGE

Friday, November 2, 2:30 – 3:30 pm, Sapphire Ballroom IJMN
Chair: Michele Morningstar
Speakers: Lauren Ritters, Cory Miller, Anna Blasi and Michele Morningstar

TALK 1: INSIGHTS FROM SONGBIRDS INTO NEURAL CIRCUITS UNDERLYING POSITIVE AFFECTIVE COMMUNICATION

Lauren Ritters, University of Wisconsin-Madison, USA
Similar to emotional prosody observed in human speech, songbirds modify structural features of song to convey information to others about motivational and affective state, and these vocal adjustments can strongly influence the motivational state of others. Studies in male European starlings, Sturnus vulgaris, demonstrate a critical role for mu opioid receptors (MORs) in the medial preoptic area (mPOA) in adjusting vocal structure to match affective state within distinct social contexts. In many songbirds, long highly structurally stereotyped male songs reflect a state of sexual motivation. In contrast, more structurally variable songs reflect a state of non-sexual, social motivation observed in starlings in large affiliative flocks. The non-stereotyped structure of these affiliative songs is not attractive to females and is non-threatening to other males, thus promoting social tolerance. Our research indicates that MOR stimulation in the mPOA facilitates affiliative, variable vocal production, but inhibits the production of stereotyped song observed in a sexual context. Furthermore, MOR activation in mPOA appears to underlie an intrinsic reward state associated with the production of affiliative song. In addition to modifying vocal production, studies on female responses to male starling song also implicate MOR activity in the mPOA in the affective state induced by hearing song. Based on these studies, we propose that the mPOA is part of a core, conserved neural circuit (mPOAventral tegmental areaventral pallidum-motor regions) in which opioids act to integrate affective state and vocal-motor output to context-appropriately adjust 1) vocal structure (i.e., prosody) and 2) receiver responses to distinct vocal signals.

TALK 2: NEURAL MECHANISMS SUPPORTING NATURAL SOCIAL INTERACTIONS IN MARMOSETS

Cory Miller, University of California, USA

Neural mechanisms supporting natural social interactions in marmosets
Marmoset monkeys are a highly gregarious, voluble species of nonhuman primates that is emerging as a powerful model of the primate social brain. The species, for example, engages in natural, reciprocal conversations with each other that share many of the behavioral characteristics of the analogous communication behavior in humans. Here I will present evidence from single-neuron recordings that support this natural and social vocal interaction. Specifically, we data suggest that the response properties of single PFC neurons
to vocalization stimuli recorded in more traditional, head-restrained contexts may have little predictive value for the determining the same neuron’s role during these natural vocal interactions. Furthermore, evidence indicates that a distinct suite of neural mechanisms may support social interactions in this structure that can only be explicating when individuals are engaged in the distinct challenges of primate sociality.

TALK 3: IMAGING THE DEVELOPMENT OF NEURAL RESPONSES TO VOICE AND ENVIRONMENTAL SOUNDS OF TYPICALLY DEVELOPING INFANTS AND INFANTS AT RISK WITH fMRI AND INIRS
Anna Blasi, Birkbeck, University of London; University College London, UK

Human voices play a prominent role in human communication, and areas of the adult brain show specialization for processing human voices and their emotional content [Belin et al 2000]. In several studies, we have collected fMRI and INIRS data from infants as young as three months while they listened to auditory stimuli including human vocal and environmental sounds, and we have demonstrated the existence of specialized voice processing regions in the brain from very early infancy [Blasi et and Mercure 2011, Lloyd-Fox et al 2012]. Further, we have used these neuroimaging techniques to find early makers of atypical development before the onset atypical behaviours associated with neurodevelopmental disorders such as Autism Spectrum Disorder (ASD). We have studied infants with older siblings diagnosed with ASD and we have followed them until diagnostic age (at three years). Our results show differences in voice processing in the high- compared to the low-risk group [Blasi et al 2015] and the existence of an association between the response to voice sounds and later ASD diagnosis [Lloyd-Fox et al 2017]. We are currently focusing on the context of global health, and the potential effects of risk factors such as socio-economic and environmental challenges [Lloyd-Fox et al 2017].

TALK 4: DEVELOPMENT OF VOCAL EMOTIONAL PROCESSING IN ADOLESCENCE AND ITS DISRUPTION IN TEMPORAL LOBE EPILEPSY
Michele Morningstar, The Research Institute at Nationwide Children’s Hospital; Ohio State University, USA

Humans’ tone of voice during speech contains unique information about their affective state. The ability to produce vocal cues to communicate one’s own emotional state, as well as the capacity to interpret such information in others, begins to develop early in infancy but follows a protracted developmental trajectory that extends into late adolescence. Using a multimodal approach which integrates task-based functional magnetic resonance imaging, functional connectivity, and diffuser tensor imaging, we investigated the neural mechanisms supporting the maturation of vocal emotion recognition in adolescence. We found that typically-developing teenagers’ growing capacity to recognize vocal emotional prosody was associated with age-related increases in activation in the middle and inferior frontal gyrus, and greater structural and functional connectivity between middle frontal regions and the right temporal-parietal junction. Further, we compared these developmental influences on neural function in typically-developing youth and adolescents with temporal lobe epilepsy, a neurological disorder known to be associated with deficits in the recognition of socio-emotional cues. Compared to healthy youth, epilepsy patients showed delayed growth in their vocal recognition skills and differential neural response to emotional prosody, particularly in the anterior cingulate and caudate. Teenagers with epilepsy also failed to show the expected age-related increases in activation in the frontal regions noted to be relevant for emotion recognition in healthy youth. Our results suggest that atypical development of regions involved in linguistic and emotional processing may be implicated in the disruption of emotion recognition capacities.

Symposium Session 3
THE NEUROPHYSIOLOGY OF SOCIAL AND AFFECTIVE TOUCH
Friday, November 2, 3:50– 4:50 pm, Sapphire Ballroom IJMN
Chair: Katalin Gothard
Speakers: Alexander Chesler, Katalina Gothard, India Morrison and Catherine Bushnell

TALK 1: CONSERVED TOUCH MECHANISMS IN MICE AND HUMANS
Alexander Chesler, NIH/National Center for Complementary and Integrative Health (NCCIH), USA

The senses of touch, hearing and proprioception rely on the ability to detect and transduce mechanical force. We identified and characterized individuals with major deficits in touch and proprioception caused by compound heterozygous mutations in a gene called PIEZO2. Quantitative sensory evaluation of these subjects relative to healthy volunteers revealed a highly specific role of PIEZO2 in mechanosensation and the importance of this molecule in all aspects of daily life. Analyses of mouse models of this genetic condition fully recapitulated the phenotypes found in patients. Together, these results provide insight into the conserved mechanisms that underlie the sensation of touch in mice and humans.

TALK 2: CELLULAR CORRELATES OF SOCIAL AND EMOTIONAL TOUCH IN PRIMATES
Katalin Gothard, University of Arizona, USA

Touch is our first social-emotional language – the language that allows us to receive and understand affective signals and helps lay the foundation for future social bonds. Despite the widely recognized importance of touch for brain development and for affective and social communication throughout life, remarkably little is known about its cellular neural substrate. We have recently reported that the primate amygdala contains neurons that respond to touch. The presence of these neurons in the amygdala suggests that the amygdala may play a role in the emotional evaluation of touch stimuli. Moreover, it is possible, that in monkeys, the amygdala plays a role in processing the social dimension of touch, especially in the context of social grooming. To test these hypotheses, we are recording neurons from the amygdala but also from earlier stages of tactile processing (i.e., somatosensory cortex) while monkeys receive non-social (air flow) and social (grooming) tactile stimuli. Different individual delivered the grooming stimuli. In this talk, I will describe the difference in neural
responses in the amygdala elicited by social and non-social touch and by different social partners. While still preliminary, these data suggest important and distinctive role of the amygdala in processing tactile stimuli with affective significance. Understanding the cellular machinery of affective touch in the primate brain is expected to provide important insights into why touch processing is so profoundly altered in functional pain syndromes, autism, and numerous other mental disorders.

TALK 3: NEURAL CORRELATES OF SOCIAL AND EMOTIONAL TOUCH IN HUMANS
India Morrison, Lindköping University, Sweden
A hug from a friend, a caress from a lover, the secure embrace of a parent: social touch is central to our emotional lives as humans, bolstering attachment and fostering feelings of closeness and emotional connection. The category of social and emotional (or "affective") touch is anatomically and functionally dissociable from discriminative touch, yet is likely to enlist multiple neural systems at multiple, interacting levels. This talk will outline the relevant component systems and processes comprising our current understanding of human affective touch neuroanatomy. Central processing of affective touch may be underpinned in part by specialized peripheral neural mechanisms, chief among these a unique subtype of tactile-sensitive C afferent nerves known as CT afferents. Within cortical networks, the insula, orbitofrontal cortex, and regions of superior temporal cortex have been consistently implicated in affective touch. These networks are likely modulated by critical subcortical hubs, as well as by hormonal factors, allowing integration of peripheral tactile signals and mediating higher-level transformations of tactile information into emotionally meaningful representations. Together, these processes provide a channel for affiliative social interactions and interpersonal connection through touch.

TALK 4: TOUCH PERCEPTION ALTERED BY CHRONIC PAIN AND OPIOID BLOCKADE
Catherine Bushnell, NIH/National Center for Complementary and Integrative Health (NCCIH), USA
Gentle touch is an important component of social behavior, and within the appropriate social context is perceived as pleasant. There is evidence from non-human primate studies that the rewarding value of touch involves endogenous opioid release. We examined the possible involvement of opioids in pleasant gentle touch in healthy human subjects by administering naloxone, a µ-opioid receptor antagonist, and observing changes in the perceived pleasantness and intensity of stroking the hand. We also examined patients with fibromyalgia, a chronic pain condition shown to include reduced opioid receptor availability. Before naloxone administration, healthy subjects rated slow brushing of the skin as more pleasant and less intense than fast brushing, but chronic pain patients did not make these distinctions. Further, healthy subjects, but not pain patients, rated touch as more pleasant after opioid blockade. In contrast, pain patients rated touch as less intense after opioid blockade. These findings suggest a role for endogenous opioids in touch processing, and provide further evidence for altered opioid functioning in chronic pain patients.
Emerging Topics

Emerging Topics I
A SYSTEMS APPROACH TO UNDERSTANDING EMPATHY
Friday, November 2, 2:00 – 2:30 pm, Sapphire Ballroom IJMN
Chairs: John P. Christianson and Hee-Sup Shin
Speakers: John P. Christianson, Hee-Sup Shin, Oriel Feldman Hall and Carolyn Parkinson

TALK 1: SOCIAL AFFECT AND THE INSULAR CORTEX
John P. Christianson, Boston College, USA
Social animals must detect, evaluate and respond to the emotional signals of other individuals in their group. Expressions of emotion are nuanced and come in a variety of modalities including facial expressions, vocalizations, odors and movements. To correctly respond to these cues, an individual must assemble the sensory information into a coherent representation of the other, match it to the interaction setting and then initiate behavioral responses. Features of the stranger clearly inform how to respond to the emotional cues and this is critical to empathic helping behaviors, cooperation, intimacy and other social phenomena. We discovered that rats behave somewhat like humans do when they encounter strangers in distress and their behavior requires oxytocin in the insular cortex. This talk will summarize ongoing work to delineate the neural tracts by which social affective information reaches insular cortex and the insular projections to the social decision making network that are needed to orchestrate prosocial behaviors.

TALK 2: GENETIC AND CIRCUIT ANALYSIS OF EMPATHIC FEAR IN THE MOUSE
Hee-Sup Shin, Institute for Basic Science, Korea
Empathy is an important capacity that involves recognition and understanding of other's mental states. Deficits in empathy manifest in a variety of mental disorders such as autism, schizophrenia, alexithymia, and psychopathy. Functional imaging studies in humans have shown that multiple brain regions, including anterior cingulate, amygdala, midline thalamus, and insula, appear to be involved in pain-related empathy in humans. We have previously reported that the observational fear learning (OFL) in the mouse show many aspects similar to those of empathy fear in humans. This finding has prompted us to study neurobiological mechanisms underlying empathy fear utilizing diverse tools available in mouse experiments. We have tried to find genes involved in control of empathy fear in the mouse, through both forward and reverse genetics approaches. Results identified several mutations with impaired OFL, and others with enhanced OFL. Neurobiological analyses utilizing these gene mutations have revealed the neural circuits underlying the expression of observational fear response in the mouse. The activity of Neurexin-3, in particular, appears to regulate the expression of observation fear bi-directionally: suppresses observational fear when its activity is increased whereas enhances, when decreased. This regulation is dependent on the inhibitory transmission controlled by Neurexin-3 in the somatostatin positive inhibitory neurons at the anterior cingulate cortex. Studies in the mouse may lead to understanding the neurobiological mechanism underlying human empathy.

TALK 3: NEURAL MECHANISMS OF EMOTIONALLY MOTIVATED ALTRUISM
Oriel Feldman Hall, Brown University, USA
Why do we self-sacrifice to help others in distress? Here we explore the relationship between costly altruism and empathy, finding that an individual's trait empathy motivates acts of helping others who are in pain. This relationship is supported by activity in the ventral tegmental area, caudate and subgenual anterior cingulate, key regions for promoting reward and social attachment. The findings are twofold. First, an individual's trait empathy is a stable predictor of costly altruism, suggesting that a specific affective phenotype underlies the motivation to engage in prosocial action. Second, a reward network appears to regulate empathically biased goal-directed behavior—even when actions are at a cost to the self.

TALK 4: SOCIAL RELATIONSHIP KNOWLEDGE SHAPES PROSOCIALITY
Carolyn Parkinson, University of California, Los Angeles, USA
Little is known about how knowledge of ties between others impacts prosocial behavior, despite mounting evidence that such knowledge is spontaneously retrieved by the human brain when encountering others and shapes social thought and behavior. We tested if beliefs about shared social connections cause people to behave altruistically towards strangers. Additionally, we investigated if any such effects stem from participants valuing the welfare of people to whom they are indirectly exceptionally highly or from concerns regarding reputation management. Participants completed a task where they could earn rewards for three targets: a friend, a stranger who was ostensibly
a friend of one of their friends, and a stranger with whom they shared no mutual friends. This procedure was conducted both in contexts where participants’ actions would ostensibly be made public and kept anonymous. Participants behaved more prosocially towards strangers to whom they believed they were connected by a mutual friend than strangers who were allegedly farther from them in their social network, regardless of whether or not their behavior would remain anonymous. These results demonstrate that beliefs about relationships between third parties shape prosocial behavior, and suggest that distance from oneself in social ties shapes the value placed on others’ welfare.

**Emerging Topics II**

**NAVIGATING SOCIAL RELATIONSHIPS USING HIPPOCAMPAL NETWORKS**

Friday, November 2, 4:50 – 5:20 pm, Sapphire Ballroom IJMN

Chair: Daniela Schiller

Speakers: Nachum Ulanovsky, Christian Doeller and Daniela Schiller

**TALK 1 SOCIAL PLACE-CELLS IN THE BAT HIPPOCAMPUS**

Nachum Ulanovsky, Weizmann Institute, Israel

Social animals need to know the spatial position of conspecifics, for purposes of social interactions and group navigation. However, it is unknown how the position of others is represented in the brain. Here, we addressed this question by studying Egyptian fruit bats (Rousettus aegyptiacus) – highly social mammals that excel in observational-learning and in navigation. We designed a spatial observational-learning task where animals were trained in pairs: In each trial, one bat (‘observer’) had to observe and remember the flight-trajectory of the other bat (‘demonstrator’). After a short delay, the observer had to imitate the demonstrator’s flight to receive a reward – which required the observer to pay close attention to the demonstrator’s position. We recorded hippocampal dorsal-CA1 neurons from the observer bat using a miniaturized wireless electrophysiology system that allowed recording of individual neurons in freely flying bats. A neuronal subpopulation represented the position of the other bat, in allocentric coordinates. About half of these “social place-cells” represented also the observer’s own position—that is, were place cells. The representation of the demonstrator bat did not reflect self-movement or trajectory planning by the observer. Some neurons represented also the position of inanimate moving objects; however, their representation differed from the representation of the demonstrator bat. This suggests a role for hippocampal CA1 neurons in social-spatial cognition.

**TALK 2: DOMAIN GENERAL NAVIGATIONAL COMPUTATIONS IN HIPPOCAMPAL NETWORKS**

Christian Doeller, Norwegian University of Science and Technology & Max Planck Institute for Human Cognitive and Brain Sciences

The hippocampal formation has traditionally been suggested to underlie both wayfinding and memory formation. Here, we discuss the idea that neural coding mechanisms identified in spatial navigation research generalize across information domains to support a wide spectrum of cognitive functions. More specifically, the mapping of variable dimensions of cognitive spaces at different resolutions and hierarchical levels enables the rapid reorganization of codes across behavioral contexts. Furthermore, simulations and read-out of trajectories through cognitive spaces might facilitate flexible decision making. In sum, spatial processing principles of the hippocampal-entorhinal system may provide a geometric code for high-level cognition.

**TALK 3: NAVIGATING SOCIAL RELATIONSHIPS IN HEALTHY AND PSYCHIATRIC POPULATIONS**

Daniela Schiller, Mt. Sinai School of Medicine, USA

How do we place ourselves within a social structure? Social encounters provide opportunities to become intimate or estranged from others and to gain or lose power over them. The locations of others on the axes of power and intimacy can serve as reference points for our own position in the social space. The goal of our research is to uncover the neural encoding of these social coordinates. This talk will describe recent experiments tracking the online neural encoding of the perceived locations of others relative to us through dynamic interactions with multiple peers. Theories in social psychology and experimental evidence across species identify two main factors that define social relationships: power and affiliation. Social theories suggest that the interaction between power and affiliation, rather than each factor separately, is the major determinant of social perception. If such interactions are implemented directly in specific brain circuits, then their neural activity should co-vary with both power and affiliation, placing others in a two-dimensional social space at varying distance from us. To examine these predictions, participants were lead characters in a novel role-playing game in which they were to find a new home and a job through interactions with virtual characters. The outcome of each social interaction was taken to reflect changes in either the power or affiliation between the participant and the character, depicted as a trajectory resulting in an individual “map” of each character’s “movement” through each participant’s unique social space. To calculate a geometric proxy of social relationships over time, we determine the characters’ location in the participants’ social space during each interaction. We then calculate social coordinates by drawing a vector between the theoretical point of view and the character’s position. We found that the characters’ social coordinates (the vector’s angle) predicted hippocampal activity. Moreover, participants who reported better social skills showed stronger covariance between hippocampal activity and “movement” through “social space.” These results predict that an impaired geometric representation of social space in the hippocampus may relate to social dysfunction across psychiatric populations. The talk will present preliminary findings from studies testing this prediction in psychiatric patients presenting with a broad dimensional range of psychopathology. Altogether, the results suggest that the hippocampus is crucial for social cognition, and imply that beyond framing physical locations, the hippocampus computes amore general, inclusive, abstract, and multidimensional cognitive map consistent with its role in episodic memory.
Early Career Award Talks

Congratulations to the 2018 Early Career Award Winners

Eliza Bliss-Moreau, University of California, Davis
Matthew Apps, University of Oxford

The Early Career Award special lectures take place on Friday, November 2, 2018, 5:30 – 6:00 pm, in Sapphire Ballroom LJM of the Hilton San Diego Bayfront Hotel.

The Society for Social Neuroscience has established this award to recognize Early Career Contributions to Social Neuroscience.

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 2018 Annual Meeting.

Nonhuman social neuroscience at a crossroads
Friday, November 2, 2018, 5:30 – 8:45 pm, Sapphire Ballroom LJM

Eliza Bliss-Moreau
University of California, Davis

Drawing on experience and data from her career thus far, Bliss-Moreau will discuss some of the major challenges facing social neuroscience conducted with nonhuman animals and how we treat those challenges as opportunities to unearth neural mechanisms of the social brain. She will emphasize opportunities to make nonhuman animal social neuroscience more translatable to humans, as well as highlight places were such work can contribute uniquely to the conversation about what it is to be social.

Prosocial apathy: Neural mechanisms for exerting effort to benefit others
Friday, November 2, 2018, 5:45 – 6:00 pm, Sapphire Ballroom LJM

Matthew Apps¹,²
¹ BBSRC Fellow & University Research Lecturer
Department of Experimental Psychology & Welcome Centre for Integrative Neuroimaging,
² Senior Associate Research Fellow
Christ Church College, University of Oxford.

Prosocial acts — those that are costly to ourselves but benefit others — are a central component of human coexistence. The influence of financial and moral costs on prosocial behaviours are relatively well understood, yet everyday prosocial acts do not typically come at such costs. Instead, they require the motivation to exert effort. Whilst research has identified regions of the frontal cortex that play an important role in motivating and ascribing value to efforts that benefit oneself, little is known about the behavioural and neural mechanisms underlying how people choose to exert effort into prosocial acts.

Using computational modeling of a novel effort-based decision-making task we are able to probe people’s willingness to choose to exert effort - and the subsequent force exerted into actions - to benefit oneself or another person. I will show that people are prosocially apathetic. People are less willing to choose to initiate highly effortful acts that benefit others. Moreover, even when choosing to initiate effortful prosocial acts, people are superficial and exert less force into the actions that benefit others compared to those that benefit themselves. Using fMRI I will then demonstrate that partially distinct regions of the frontal cortex are engaged in motivating and ascribing value to prosocial and self-oriented effortful acts. Thus, although people sometimes ‘help out’, they typically do so only if it requires little effort and such behavior may be driven by a distinct circuit in the brain.
Maternal care is profoundly important for mammalian survival, and maternal behaviors can also be expressed by non-biological parents after experience with infants. One critical molecular signal for maternal behavior is oxytocin, released by hypothalamic paraventricular nucleus (PVN) and enabling plasticity within maternal auditory cortex for recognizing infant cues. To determine how these changes occur during natural experience, we continuously monitored home cage behavior of female virgin mice co-housed for days with an experienced mother and litter, synchronized with in vivo recordings from virgin PVN/oxytocin neurons. Mothers engaged virgins in maternal care, by ensuring that virgins were in the nest and self-generating episodes of isolated pup retrievals. These behaviors activated virgin PVN and gated behaviorally-relevant plasticity to improve behavior and cortical responses to pup distress calls. Thus maternal behavior can be learned by social transmission, and our results describe a mechanism for adapting the newly-maternal brain to infant needs via endogenous oxytocin.

**Keyword:** maternal behavior, pup retrieval, oxytocin

### Poster Schedule

Poster sessions are scheduled for Friday in Sapphire Ballroom IJMN of the Hilton San Diego Bayfront Hotel in San Diego, CA. All attendees must present their S4SN 2018 name badge to enter the Sapphire Ballroom IJMN. 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 listed below in the “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 up after the “Take-down Complete” will be removed and discarded.

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* Please note that only scheduled registered poster presenters may enter the exhibit hall during the half hour set-up time. **Note:** Please remove your poster promptly at take down complete time, so that the next presenter may set up their poster.

### Posters Session A

**Friday, November 2, 2018, 1:00 pm – 2:00 pm, Sapphire Ballroom IJMN**

**A1** Individual differences in social play behaviour in rats: How do they affect adult social behaviour and reward sensitivity?

_E.J.M. Achterberg, H.M.B. Lesscher, L.J.M.J. Vanderschre, Utrecht University_

Social play behaviour is a characteristic form of social behaviour displayed by the young of many mammalian species, including rats and humans. Being a rewarding activity, the performance of social play depends on its pleasurable and motivational properties. Importantly, social play behaviour is modulated through neural systems that also mediate the rewarding and motivational effects of other rewards such as food, sex and substances of abuse. Social play behaviour is thought to have an important role in socio-emotional and cognitive development. This is supported by experiments in which rats were deprived of social play, by housing them in isolation during the period in which this behaviour is most abundant (postnatal day 21 to 42). This play deprivation makes rats unable to respond appropriately to social and cognitive challenges in adulthood. Next to that, play-deprivation leads to enhanced sensitivity for cocaine self-administration, amphetamine and alcohol place preference and alcohol consumption in adulthood. Since play-deprivation profoundly affects brain and behaviour, individual differences in playfulness may have long-term implications as well. To investigate this, we characterized young rats on the expression of social play behaviour and subsequently tested them on their motivation to play, adult social behaviour, impulsivity and operant responding for sucrose and alcohol. In addition, expression of relevant genes was assessed in brain regions involved in social play, reward processes and executive functioning. Preliminary data indicate that individual differences in social play expression predict the motivation for social play as well as reward sensitivity and gene expression.

**Keyword:** Social play behavior, motivation, impulsivity, gene expression

**A2** Social transmission of maternal behavior by oxytocin


Imitation plays an important role in the development of social skills and of social attachment, in human and non-human primates (Field, 1997; Ferrari et al., 2009; Paukner et al., 2009). Imitation is also a significant tool in the art of actors, where it is used as an exercise to decrease stage fright and to ease emotional communication. Based on these, we hypothesized that imitative interactions could be used as a form of behavioral therapy for decreasing stress levels and for increasing closeness. To test this possibility, we developed a stereotyped imitative interaction between a subject and an experienced, trained actor. Variations of this behavior include positive or negative feedback given by the actor. To date, we tested 78 healthy young adult subjects, and found that all variants of imitative interaction decrease self-reported stress levels and increase well-being. The strongest effect was observed following the interaction with positive feedback (VAS stress before: 28.1±4.3, VAS stress after: 20.4±3.6), which also strongly increased scores on a test of subjective perception of closeness to the interacting partner (IOS before: 3.6±0.2, IOS after: 4.9±0.2). In agreement with this, salivary cortisol levels decreased, and salivary oxytocin
levels increased after the imitative interaction. To understand the neural substrates for these behavioral and endocrine changes, we record EEG activity before, during, and after the imitative interaction. In intracranial recordings, we find that following imitation, the image of the interaction partner evokes stronger event-related potentials in the insula, parietal and premotor cortex. In future work, we will determine if this neuronal plasticity correlates with or might cause the behavioral and hormonal responses we detect following imitating interactions. We will also investigate if these interactions would be effective in PTSD, autism, ADD and elderly populations.

Keyword: social imitation, oxytocin, intracranial EEG recordings

A4 The Rapid Effects of Hippocampally-synthesized Estrogens on Recognition and Spatial Learning in Ovariectomized Mice

Elena Choleris, T. Martin, L. King, M. Klemens, R. Rose, University of Guelph

Estrogens are known to play a role in modulating cognition. Specifically, estrogen has been found to facilitate recognition and spatial learning. The female hippocampus is known to synthesize its own estrogens, and to be highly sensitive to estrogenic action (Frick et al., 2015). Local hippocampal administration of 17-β estradiol was found to facilitate recognition and spatial learning (Phan et al., 2015), whereas a significant decrease in estrogens impaired long-term recognition memory (Tuscher et al., 2016). However, whether locally synthesized, physiological estrogens are also involved in the initial processes of learning of spatial and recognition tasks is unknown. Here, 2-3-month-old CD1 mice were ovariectomized, hippocampally cannulated and infused with the estrogenic synthesizing enzyme inhibitor, letrozole (at one of 3 doses: 0.01, 0.05 or 0.1μg/µL), or vehicle (2% dimethyl-sulfoxide) 15 minutes before a social, object or spatial recognition task. These tasks included 4-minute learning periods where two identical stimuli were repeatedly introduced, followed by a 4-minute test period where a novel stimulus was either replaced one of the repeated stimuli or moved to a novel location. We hypothesized that hippocampally-synthesized estrogens are involved in the initial learning of spatial and recognition memories. It was predicted that letrozole at all doses would impair recognition and spatial learning. In partial support of the predictions, groups treated with 0.01 or 0.05μg/µL of letrozole did not show social or object recognition, whereas groups treated with 0.1μg/µL were not impaired in either. In direct contrast, spatial recognition was unimpaired at the 0.01 and 0.05μg/µL doses, but impaired at 0.1μg/µL. These results contribute a greater understanding of the function of hippocampally-synthesized estrogens within the context of learning and memory. Keyword: Aromatase, letrozole, estrogen, learning, memory.

A5 Determining which estrogen receptor rapidly interacts with oxytocin to mediate social recognition

Pietro Paletta, A. Collins, E. Choleris, University of Guelph

Estrogens are gonadal hormones that have a variety of functions throughout the body, including affecting cognitive abilities like learning and memory. One of these cognitive functions is social recognition (SR), the ability to distinguish between conspecifs. Previous studies have shown that knocking out the estrogen receptors impairs SR, while the administration of 17β-estradiol (E2) or estrogen receptor agonists were able to rapidly facilitate SR. Oxytocin is also necessary for SR, in the medial amygdala as shown by gene knockout and receptor antagonist studies. These studies, as well as the high expression of estrogen receptors in the paraventricular nucleus (PVN) of the hypothalamus where oxytocin is produced, led to the idea that estrogens and oxytocin may interact to rapidly mediate SR. We tested this by first infusing E2 into the PVN and using a rapid SR paradigm found that E2 was able to facilitate SR within 40 minutes of administration. We then tested whether this effect occurs through an interaction with oxytocin by administering a subeffective dose of an oxytocin receptor antagonist into the medial amygdala while also administering E2 into the PVN. We found that the oxytocin receptor antagonist blocked the facilitative effect of E2 on SR. These results show support for the idea that the rapid effects of estrogens and oxytocin do interact to facilitate SR. However, it is not currently known which estrogen receptor is mediating this interaction with oxytocin. Both estrogen receptor beta (ERβ) and the G-protein coupled estrogen receptor (GPER) are highly expressed in the PVN and either one or both receptors could be involved. This is being tested by administering either the ERβ agonist DP1 or the GPER agonist G1 into the PVN to determine if they can facilitate SR. This is the first demonstration of the estrogen-oxytocin interplay in regions of the social brain in the mediation of SR. Funded by NSERC.

Keyword: Estrogens, Oxytocin, Social Recognition

A6 Prenatal testosterone affects social and anxiety-like behaviours in a sexually dimorphic and hormone-dependent manner

Emily R. Martin, C.S. Wasson, C. Howes, A.J. Giuga, M. Castro, H. Wilson, N.J. MacLusky, E. Choleris, University of Guelph, Guelph, ON

Gonadal hormones, such as testosterone (T), organize sexually dimorphic brain regions during development and consequently sex differences in behaviour later in life. Heightened prenatal T has been associated with Autism Spectrum Disorder, which is partially characterized by deficits in social interaction and communication. We assessed the effects of elevated prenatal T on social learning (SL), social recognition (SR), sociability, and anxiety-like behaviour, in mice. Pregnant CD1 female mice were treated with 10μg of T propionate or sesame oil vehicle control on gestational days 12, 14 and 16. Experimental litters were assessed in the above listed behavioural tests during adolescence (age 35-42 days). Mice then underwent sham surgery, gonadectomy (GDX), or GDX with silastic capsules, [T for males and estradiol (E) for females] and were re-tested for the same behaviours in adulthood (age 68-76 days). Prenatal T increased anxiety-like behaviour in adult male mice, but females were resilient to the effects of this treatment. Prenatal T enhanced SR in both males and females during adolescence. In adulthood, prenatal impaired SR in gonad intact and GDX males and this was reversed by T replacement. In females, GDX impaired T but replacement did not reverse this effect. For SL, castration improved learning in male controls but blocked SL in adult mice treated prenatally with T, an impairment that was not reversed by T replacement. Conversely, in ovariectomized mice, SL was impaired following prenatal T treatment, but recovered after E replacement. These results are reminiscent of the effects of prenatal stress and suggest that prenatal T exposure may alter the development of normal social and anxiety-like behaviours, resulting in long-term effects that modify responses to gonadal hormone exposure in adulthood. The molecular mechanisms through which prenatal T acts remain to be elucidated, but may involve pathways similar to those activated by prenatal stress.

Keyword: testosterone, development, gonadal hormones, behaviour, sex differences

A7 Effects of dorsal hippocampal inhibition of actin polymerization or protein synthesis on rapid estrogen-facilitated social recognition in female mice

Paul Sheppard, H. Asling, S. Armstrong, V. Elad, A. Walczyk-Mooradally, J. Lalonde, E. Choleris, University of Guelph

Estrogens can rapidly facilitate social recognition (SR) – the ability of an animal to recognize another. In ovariectomized (OVX) female mice, SR was facilitated within 40min of systemic (Phan et al., 2012) or dorsal hippocampal (dh; Phan et al., 2015) administration of 17beta-estradiol (E2). Within the same timeframe, E2 increases dendritic spine density in CA1 dh neurons (Phan et al., 2012; 2015). Mechanisms underlying these effects remain unclear. Estradiol rapidly stimulates changes in actin cytoskeletal dynamics through rapid enhancement of actin polymerization (Briz & Baudry, 2014), increases dendritic spine scaffolding
protein PSD-95 expression in an Akt pathway-dependent manner in cultured NG108-15 neurons without a concurrent increase in PSD-95 mRNA (Akama & McEwen, 2003), and increases translation of dendrite-localized mRNA in an ERK-dependent manner in primary cultured hippocampal neurons (Sarkar et al., 2010). Although we previously found dH activation of both the ERK and Akt pathways is necessary for the rapid facilitation of SR by E2 in OVX female mice (Sheppard et al., 2016; 2017), the role of protein synthesis or actin polymerization has not yet been examined. We first determined the highest doses of either actin polymerization inhibitor latrunculin A or protein synthesis inhibitor anisomycin that do not block SR when infused into the dH of OVX female mice 15min prior to testing. We then determined whether these treatments could prevent the enhancing effects of E2 in a task where control mice do not typically perform SR. The paradigms are completed within 40min of E2 administration, enabling investigation of rapid effects of estrogens. Both actin polymerization and protein synthesis were found to be necessary for E2 to rapidly facilitate SR. Brains were collected and either stained with Golgi-Cox solution to evaluate dendritic spine density and length in the dorsal CA1 or were used to determine the effects of treatment on Arc protein expression.

Keyword: estradiol, Arc, actin polymerization, protein synthesis, translation, dendritic spines

A8 The interplay between gonadal sex hormones and dorsal hippocampus D2-type dopamine receptors in the mediation of social learning in mice

Noah Bass, J. Anthonypillai, R. Matta, E. Choleras, University of Guelph

Social learning, learning following social interaction or observation, allows a conspecific to avoid or mitigate the consequences of individual trial and error learning (Galef, 1998). Social learning may be investigated using a social transmission of food preference (STFP) paradigm, where a preference for a novel flavored food is transferred from a demonstrator (DEM) to an observer (OBS) animal during social interaction. Previous research shows that the dopamine (DA) system is directly involved in STFP (Choleris et al., 2011) and that there is a sex difference in the role of D2-type DA receptors (Matta et al., 2017). Dorsal hippocampus (HPC) infusions of D2-type DA receptor antagonist raclopride blocked social learning only in female mice (Matta et al., 2017). Furthermore, estrogen treatment enhanced the STFP (Ervin et al., 2015) and regulates the DA system, and androgen treatment increased HPC DA release (Tucci et al., 2008). These findings suggest an interplay between HPC D2-type DA receptors and male and female sex hormones in the mediation of social learning in mice. In this study, male and female, gonadectomised or gonadally intact, experimentally naïve CD 1 mice (2-3 months old), are undergoing a STFP paradigm following dorsal HPC infusions (0.5 μL per hemisphere) of a D2-type DA receptor antagonist, raclopride (18 μg/L, 20 μg/L) or physiological saline solution. Researchers are blind to the drug and dose. First, a DEM consumes 1 of 2 novel flavored food diets for 1-hour while an OBS receives dorsal HPC infusions of raclopride or saline. Following a 10-minute delay, a 30-minute social interaction between the DEM and OBS occurs. Finally, an 8-hour OBS choice test where the OBS is free to consume the 2 novel flavored food diets measures food intakes at 1, 2, 4, 6, and 8 hours. It is predicted that raclopride will block social learning in only castrated males, ovariectomized females, and gonadally intact females.

Keyword: Social learning, dopamine, D2-type dopamine receptors, dorsal hippocampus, raclopride, CD1 mice, sex difference.

A9 Socially learned food preferences are associated with sex-specific changes in dorsal hippocampal dopamine release in mice

Richard Matta, M. J. Russell, C. L. Limebeer, L. A. Parker, E. Choleras, Department of Psychology and Neuroscience Program, University of Guelph

One form of social learning, often studied in the lab, is the social transmission of food preferences (STFP). Our previous work using systemic treatments of dopamine (DA) receptor antagonists has shown an involvement of DA D1-type receptors in social learning (but not food intake), and DA D2-type receptors in food intake (but not social learning) in the STFP in female mice (Choleris et al., 2011). We are now examining the potential brain region(s) underlying these effects. Dopaminergic projections ascend from the ventral tegmental area (VTA) to many limbic brain structures, including the hippocampus, which has been established as necessary for the initial encoding/acquisition of the STFP in rodents. Our previous work using DA receptor antagonists infused directly into the dorsal hippocampus has shown that female mice rely on both DA D1- and D2-type receptors, while male mice only rely on DA D1-type receptors (Matta et al., 2016, 2017). In this study we examined whether social learning in the STFP was associated with changes in dorsal hippocampal DA release in male and female mice. This study involved the use of in vivo microdialysis sampling, and high-performance liquid chromatography detection of dopamine. Direct comparisons between males versus females showed that hippocampal DA release during the NON-DEM diet odor (novel food), NON-DEM social (no social learning), and STFP was greater for males than females. Comparisons directly to baseline samples further showed that male hippocampal DA release increased during the NON-DEM diet odor, NON-DEM social, STFP exposure, and choice test. On the other hand, female hippocampal DA release decreased during the NON-DEM diet odor, NON-DEM social, and STFP exposure. Together, the current and our previous findings suggest sex-specific mechanisms in dorsal hippocampal DA mediation of social learning. Supported by NSERC.

Keyword: social learning, dopamine, hippocampus

A10 Muscarinic acetylcholine receptors play a role in social learning in female mice

Kelsy Ervin, S. Howard, P. Sankar, E. Choleras, University of Guelph

Social learning is a unique form of cognition in which an animal acquires information from a conspecific, rather than individually through trial and error. Social learning is common and important in many animals but we know little about the underlying neurobiological mechanisms. Social learning can be studied using the social transmission of food preferences (STFP), in which an observer prefers a food it smelled on the breath of a conspecific demonstrator over other novel food choices. From studies using general muscarinic acetylcholine receptor (mAChR) antagonist scopolamine, we know that mAChRs are involved in acquisition of a socially learned food preference (Boix-Trelis et al,2007,Neurobiol Learn Mem,87:659; Carballo-Márquez et al,2009,Neurobiol Learn Mem,19:299; Carballo-Márquez et al,2009,Neurobiol Learn Mem,91:98). However, we still do not know which specific mAChR subtypes drive these effects on social learning. The M1 and M2 subtypes are involved in other types of learning and thus could also play a role in the STFP (Van Der Zee and Luiten,1999,Prog Neurobiol,58:409). Our aim was to determine whether M1 or M2 blockade with dicyclomine or AFDX-116, respectively, would disrupt social learning in the STFP. Female CD1 observer mice were treated IP with dicyclomine (1, 4, 8, 16, or 32mg/kg) or AFDX-116 (1, 3, 6, or 12mg/kg) 30min prior to a social interaction with a demonstrator. Observers were then individually housed and tested for food preference 48h later. Social learning was blocked by 32mg/kg dicyclomine, suggesting that M1 mAChRs may play a role in social learning. Since the effect occurred only at the highest dose, there may have been a loss of selectivity and other subtypes may be involved. Results of the STFP with the M2 antagonist AFDX-116 will further elucidate the respective roles of the M1 and M2 receptors. Our findings help to clarify how the cholinergic system mediates social learning, an important yet understudied form of learning in humans and animals.

Keyword: feeding, memory, food preference, associative learning
A11 Sex differences in social reward regulation in juvenile rats: Focus on glutamate signaling in the lateral septum

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Social play is a highly rewarding behavior, essential for the development of social skills, and is impaired in children diagnosed with autism, a disorder with a strong sex bias in prevalence. We recently showed that the arginine vasopressin (AVP) system in the lateral septum (LS) regulates social play behavior in opposite directions in male and female juvenile rats. We further showed that glutamate (glu) is involved in the sex-specific regulation of social play by the LS-AVP system. Intriguingly, males show higher LS-glu release than females at baseline and during social play while pharmacological blockade of the AVP V1a receptor (V1aR) in the LS eliminates this sex difference by increasing LS-glu release in females only. Here, we aimed to determine the origin of the sex difference in glu release as well as potential sex differences in the cell types that express the V1aR in the LS. Retrosgrade tract tracing (using cholera toxin subunit B, CtB) combined with c-Fos (cell activation marker) and vglu2 (marker for glu neurons) was used to investigate potential sex differences in social play-induced activation of glu projections to the LS. We found that females have more glu projections from hypothalamic subregions to the LS and a higher percentage of c-Fos-positive glu projections from specific prefrontal cortex subregions to the LS compared to males. CtB-positive neurons were also found in the ventral hippocampus and peri-aqueductal gray and we are currently examining whether these neurons are potential sources of sex-specific glu release in the LS. Finally, we will also determine if there is a sex difference in the expression of V1aR by astrocytes and by neurons. This research will help elucidate the neural mechanisms mediating the sex-specific regulation of social play, which is an important step towards better understanding the neural basis of sex-biased social disorders such as autism.

Keyword: Social motivation, sex differences, juvenile, glutamate, lateral septum

A12 Activation of the ventral tegmental area supports the expression of social play behavior in juvenile rats

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Using juvenile male and female rats, we investigated the recruitment of the ventral tegmental area (VTA) following social play exposure (Experiment 1), and how temporary inactivation of the VTA affected the expression of social play (Experiment 2). In Experiment 1, 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). Fos and tyrosine hydroxylase (TH) immunohistochemistry was used to determine activation of the VTA and its dopaminergic neurons in response to social play. Subjects in the play condition had greater Fos induction in the rostral and mid VTA than subjects in the no play condition; there was no effect of play exposure on Fos induction in the caudal VTA. Likewise, subjects in the play condition had greater Fos induction within TH-positive VTA neurons than subjects in the no play condition, although the occurrence of double-labeled neurons was very low. In Experiment 2, subjects received, in counterbalanced order, bilateral infusions (0.3 μL/side) of vehicle (aCSF) or the GABA-A receptor agonist muscimol (10 ng/side) into the VTA 20 min prior to exposure to the 10 min social play test (as described for the “Play” condition above). Temporary inactivation of the VTA with muscimol selectively decreased the expression of social play behavior while leaving social investigation intact. Together, these data suggest that activation of the VTA supports the expression of social play behavior in juvenile male and female rats. To better understand the role of the VTA and its dopaminergic neurons in the regulation of social play, we will measure dopamine release in the VTA during the expression of social play behavior using in vivo microdialysis.

Keyword: reward, motivation, juveniles, ventral tegmental area, Fos, social play

A13 Delineating the hippocampal circuitry underlying pair bonding in prairie voles

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Pair bonds are long-lasting social attachments that form between mating partners. While pair bonding is common among humans, the majority of mammals, including laboratory rats and mice, do not exhibit this trait. Instead, socially monogamous prairie voles, which form life-long pair bonds, provide an excellent model for studying attachment in adults. To date, the study of pair bonding in prairie voles has focused on neuroendocrine systems, including oxytocin, vasopressin, dopamine and endogenous opiates, while the specific neural circuits that modulate attachment remain largely unexplored. The ventral hippocampus has been implicated in regulation of emotions and social memory across a variety of rodent species. Thus, we asked whether the ventral hippocampus is required for a selective partner preference, a behavioral indicator of pair bonding. We used ibotenic acid to bilaterally lesion the ventral CA1 region in female prairie voles. After two weeks of recovery, estrogen-primed females were paired and mated with a male. Twenty-four hours later, we performed a partner preference test, which revealed that lesion animals failed to form a preference, while sham animals exhibited a strong preference for their mate. Our ongoing work is examining the specific role of different hippocampal projections in different phases of pair bonding. This research will provide a novel dissection of the role of hippocampal systems in pair bonding behavior, potentially providing valuable insights into how disruption of these circuits contributes to social deficits.

Keyword: prairie voles, hippocampus, pair bonds

A14 Oxytocin regulation of social buffering and social contagion of fear in zebrafish

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Social animals can use social information provided by the behaviour of conspecifics for adaptive decision making (e.g. predator detection). However, the mechanisms involved in the processing of social information remain poorly understood. Moreover, although the neuropeptide oxytocin has been implicated in the regulation of social behaviour, its exact role in the modulation of social information processing, is also poorly understood. Here, we used the response to alarm substance (AS) and the sight of alarmed conspecifics to study social transmission of information in adult zebrafish. We found that zebrafish exhibit less fear response when exposed to AS in the presence of conspecifics (i.e. social buffering). Furthermore, we found that zebrafish responds to fear response by freezing when conspecifics are exposed to AS (i.e. social contagion of fear). Using zebrafish with constitutive deletion in the oxytocin receptor gene (OXTR-/-), we tested the involvement of oxytocin in social information use. We show that OXTR-/- zebrafish have an impairment of both social buffering and social contagion of fear. Overall, our results provide evidence for the use of social information use in threat perception in zebrafish, and suggest an involvement of oxytocin in social information use.

Keyword: oxytocin, zebrafish, fear

A15 Moral Injury and Posttraumatic Stress Disorder Are Dissociated by Resting-State Spontaneous Brain Activity


Background: Moral injury refers to guilt- and shame-based disturbances often experienced by combat veterans after contradicting deeply held moral and ethical
beliefs and expectations. Moral injury is tightly associated with but conceptually different from the post-traumatic stress disorder (PTSD), which is related with threat and fear. Moral injury events can be explained by two factors: perceived transgression and perceived betrayals. Unfortunately, little is known about the neural underpinnings of moral injury, the neural differences between moral injury and PTSD, and the different neural correlates between the two factors of moral injury.

Methods: Multiple regression model was employed to investigate the relationship between scores of Moral Injury Events Scale (MIES)/Clinician Administered PTSD Scale and the amplitude of low frequency fluctuation (ALFF) in 26 participants (2 females; 28–55 years old) based on their resting-state functional magnetic resonance images. Results: Larger ALFF in the left angular gyrus, is associated with higher scores of perceived transgressions and lower scores of perceived betrayals, but has no relationship with PTSD symptoms.

Conclusion: Our findings provided the first evidence that moral injury and PTSD are different in neural correlates. The results also suggest that left angular gyrus, which area is important in social cognition and morality, plays different roles in transgression and betrayals in moral injury. The findings increase our knowledge of PTSD and moral injury, and may contribute to developing new diagnoses and interventions to moral injury.

Keyword: Moral Injury; PTSD; resting-state fMRI; Angular Gyrus; ALFF

A16 Neuropeptidergic regulation of sociality and physiology in juvenile marmoset monkeys

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Developing and maintaining high-quality social relationships is fundamental to both physiological and psychological well being across the lifespan. The neuropeptides oxytocin (OT) and vasopressin (AVP) have critical and pervasive roles in reproduction and physiology, and have attracted enormous interest as neuromodulators of social and cognitive functioning. While it is clear that these two hormones have important roles in the initiation of social interactions in adulthood, less attention has been given to whether OT and AVP regulate sociality during early development. Thus, the goal of these studies was to determine the extent that OT and AVP modulate social preferences, affiliative affiliation, and physiological and behavioral responses to stress in prepubertal marmoset monkeys across multiple developmental time-points. The expression of familial affiliation, including the initiation of social approach \([F(2,12)=13.0, p=.001]\) and total time spent in social proximity \([F(2,12)=4.78, p=.03]\), decreased as prepubertal marmoset progressed to independence. Neuropeptide treatment also interacted with age to modulate the initiation of social approach behavior \([F(4,24)=2.5, p=.07]\); ten-month old marmosets that received AVP experienced the largest decline in social approach behavior. We also show that AVP enhances stress recovery, but not stress reactivity, following social isolation in juvenile marmosets \([F(6,60)=2.14, p=.06]\). These findings indicate that neuropeptides differentially modulate affiliation and the physiological stress response in juvenile marmoset monkeys. Ultimately, these results inform the design and application of selective therapeutic treatments for neuropsychiatric disorders that include maladaptive social functioning by promoting affiliative behavior in juvenile marmoset monkeys.

Keyword: Oxytocin, Vasopressin, Social, Behavior, Primate

A17 Oxytocin and social attraction in marmosets

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Social attraction and affiliation between individuals facilitates relationship formation and may preserve long-term bonding between partners. Oxytocin (OT) is a neuromodulator that regulates the formation and maintenance of social relationships, and acts in part by promoting affiliative behavior towards partners. Previous studies have shown that marmosets treated with OT are more socially attractive to their untreated partners, and receive higher rates of affiliative behavior. In this study, we examined the role of OT in promoting social attraction toward opposite-sex strangers in pair-living marmosets. We tested whether OT-treated marmosets received affiliation from untreated, opposite-sex strangers, and we also tested whether OT-treated marmosets initiated affiliative behavior toward opposite-sex strangers. OT treatment did not impact affiliative behavior received from partners, but did influence initiated behavior. Male marmosets treated with OT exhibited higher rates of genital investigation of non-partner female marmosets, and displayed higher average penile erection durations. Both male and female marmosets that received OT decreased the number of times they gazed at opposite-sex non-partners, but there was no change in overall duration of gazes. Male marmosets displayed higher rates of open mouth displays and gazed at, approached, and reached toward stimulus females more often than females directed these behavior patterns toward males. However, female marmosets exhibited a higher total duration of gaze than males. These results suggest that while OT may not impact the social attractiveness of a potential partner, OT does impact social attraction in male marmosets through increased sexual interest and responsiveness.

Keyword: Oxytocin, marmoset, social attraction, affiliation

A18 Does acetaminophen affect the sensitivity of neurons in macaque anterior cingulate cortex to the valence of outcomes in a social decision-making task?

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Human imaging studies have implicated both dorsal anterior cingulate cortex (dACC) and anterior insula, areas associated with the affective component of pain and discomfort (Rainville et al., 1997), in empathy (Singer et al., 2004). Oral acetaminophen (active ingredient in tylelenol/paracetamol) reduces BOLD activity in ACC and eases self-reported pain induced by social rejection (DeWall et al., 2016) and also diminishes empathy for others in distress (Mischkowski et al., 2016). These observations suggest acetaminophen, and possibly other painkillers, may interfere with normal processing of negative outcomes for both self and others. One potential cellular substrate for these effects are recently reported neurons in anterior cingulate cortex that have been shown to be sensitive to others’ reward (Chang et al., 2013). It remains unknown whether these neurons also process negatively valenced information for other and whether the activity of these neurons is sensitive to acetaminophen. To answer these questions, we recorded the activity of neurons in ACC gyrus (ACCg) in rhesus monkeys choosing between two differently colored targets associated with varying magnitudes of fluid. On each trial, the fluid on offer was cued to be pleasant (fruit juice) or unpleasant (diluted quinine) for either self or a recipient monkey (sitting across the room and facing the actor monkey). Monkeys rapidly learnt the valence, magnitude and recipient associated cues and showed overall preference for good tasting fluid for both self and other. Neurons in ACCg were also sensitive to outcome valence and recipient. Next, we studied decisions and activity of ACCg neurons following oral acetaminophen. Behaviorally, monkeys showed reduced sensitivity to negative outcomes for both self and the other. Preliminary results also suggest that acetaminophen diminishes the sensitivity of ACCg neurons to positive and negative outcomes for both self and the other.

Keyword: tylenol, paracetamol, macaque, ACC, social, decision-making

A19 Non-social observational learning in macaque monkeys: first evidence of observational learning in a “ghost display” condition.

Lorenzo Ferrucci, S. Nougaret, V. Fascianeli, A. Genovese, Sapienza University of Rome

We trained three rhesus macaques in an object-in-scene task to evaluate the learning of a stimulus-reward association under three experimental paradigms: individual learning, observational social learning with a human model and...
observed non-social learning with a computer. These paradigms allowed us to compare these learning processes, and to assess whether macaques monkeys can learn from a “non-social” agent. The task consisted in the presentation of a block of five successive different scenes. Each scene was unique and composed by different geometrical figures and colors, and two different objects. Monkeys had to choose one of the two objects to receive reward. Only one object was rewarded, while the other was unrewarded. At the end of the first block, the second block started, with the same five scenes presented in the same order, until the sixth block. In the individual learning, monkeys performed all the six blocks alone. In social and non-social learning conditions, the first block was performed respectively by a human agent or automatically by the computer, while the monkeys were required to perform the remaining five. We found that one-trial learning occurred in all tasks versions with the monkey’s performance in the second block always significantly above chance. Furthermore, we observed that while monkeys learned more from their own correct choices, conversely they learned more from the observation of other’s mistakes, regardless of which actor was performing the action in the first run, the human or the computer. These results suggest that rhesus macaques can learn by observation in absence of a real physical agent, and that observing mistakes is more informative in observational learning than in individual learning. Proving the monkey’s ability to learn in the non-social condition creates a window of opportunity to better understand the role of the social agent in observational learning and the neurophysiological substrates underlying these processes.

Keyword: monkeys, observational learning, social

A20 Causal manipulations of live social gaze by microstimulating the primate prefrontal cortex

Siqi Fan, O. Dal Monte, N.A. Fagan, C.C.J. Chu, S.W.C. Chang, Yale University

A typical gaze interaction among two or more individuals is made up of a series of contingent behaviors that unfold over time. Correlative evidence from electrophysiological recording studies in non-human primates, as well as neuroimaging studies in humans, have shown that several regions in the prefrontal cortex, the superior temporal sulcus, as well as the basolateral amygdala (BLA) are implicated in social gaze processing. Our recent data support that different prefrontal areas as well as BLA encode various aspects of social gaze, and that prefrontal areas and BLA are synchronized during specific social gaze events (see Dal Monte et al., 2018 S4SN abstract). However, the causal contributions of these brain regions in social gaze remain unknown. Here, we tested whether and how causally manipulating specific populations of neurons affects social gaze by using a live gaze interaction paradigm, in which we can study spontaneously occurring gaze patterns. We investigated this question in three prefrontal regions—dorsomedial prefrontal cortex (dmPFC), anterior cingulate cortex (ACCg), orbitofrontal cortex (OFC)—as well as BLA. We applied closed-loop microstimulations that are contingent upon specific social gaze events. Specifically, we triggered the onset of microstimulations by three distinct types of social gaze events—1) looking at the partner’s face, 2) looking at the partner’s eyes, and 3) mutual eye contact. We also explored the microstimulation parameter space to characterize a set of parameters that can effectively and reliably modulate social gaze behaviors. Depending on the stimulated brain region and the type of gaze events triggering the microstimulation, we observed distinctive changes in social gaze behaviors. Our findings inform some of the causal workings underlying dynamic and contingent social gaze in the primate brain.

Keyword: Live Social Gaze, Microstimulation, Non-human Primates, Prefrontal Cortex, Basolateral Amygdala

A21 Neural coding of live social gaze interactions

Olga Dal Monte, S. Fan, N. A. Fagan, C. C. J. Chu, S.W. C. Chang, Yale University

Gaze interaction, particularly eye contact, is central to social behavior. Single-neuron recording and neuroimaging studies have indicated that several prefrontal regions and the basolateral amygdala (BLA) are implicated in the processing of social gaze. However, the precise mechanisms underlying how prefrontal and amygdala neurons encode social gaze events remain elusive. To address this gap, we investigated neuronal correlates of social gaze using a live gaze interaction paradigm, in which we can study spontaneously occurring gaze interactions between pairs of rhesus macaques. We recorded single-neuron and local field potential activity from three prefrontal structures—the anterior cingulate gyrus (ACCg), the orbitofrontal cortex (OFC), and the dorsomedial prefrontal cortex (dmPFC)—and BLA, in order to investigate the contribution of each brain region, as well as the coordination between each of the prefrontal regions and the BLA, in guiding social gaze. We aligned the neuronal data to two types of spontaneous social gaze events—1) looking at the partner’s eyes, and 2) mutual gaze to the eyes by both monkeys (mutual eye contact). The proportion of significantly modulated cells that differentiated looking at the eyes from looking at the other parts of the face changed around the time of the gaze event. Similarly, the proportion of a sub-group of these cells that significantly differentiated mutual eye contact from non-mutually looking at the eyes also changed around the time of the gaze event. Furthermore, upon mutual eye contact, compared to non-mutually looking at the eyes, we found changes in the coherence both in the gamma band and in the low frequency ranges (0-15 Hz). Our findings suggest that various social gaze events are computed across multiple brain regions and their synchrony patterns reflect particular social gaze functions.

Keyword: Amygdala-prefrontal, synchronization, eye gaze, social interaction

A22 Tensor component analysis of spiking activity related to social gaze dynamics in the prefrontal cortex and the amygdala

Cheng C.J. Chu, O. Dal Monte, S. Fan, N.A. Fagan, S.W.C. Chang, Yale University

Human and non-human primates gain critical information about their conspecifics using gaze. However, little is known about how social gaze is computed in the brain. Toward answering this question, we recorded single-neuron and local field potential activity from four different brain regions during spontaneously occurring social gaze interactions: dorsomedial prefrontal cortex (dmPFC), anterior cingulate cortex gyrus (ACCg), orbitofrontal cortex (OFC), and basolateral amygdala (BLA). We examined how these regions encode social gaze variables by focusing on spiking activity related to looking at the eyes of the partner monkey. Based on the single neurons recorded, we found that each region exhibited heterogeneous temporal dynamics relative to the time of looking at the eyes of the conspecific partner (see Dal Monte et al., 2018 S4SN abstract). To better characterize population spiking dynamics, we applied the tensor component analysis (TCA) - a dimension reduction method based on canonical polyadic decomposition, which unfolds neural responses to neuron, time, and trial dimensions (Williams, AH et al., 2017). Whereas TCA indicated that dmPFC modulates its firing rates in a manner that is time-locked to when monkeys looked at the partner's eyes, BLA exhibits both excitatory and suppressive rate modulation patterns mostly after the onset of this social gaze event. Furthermore, TCA revealed that OFC modulates firing rates on a longer time scale around the same social gaze event. Notably, ACCg exhibits oscillations and rate modulations after looking at the partner's eyes. These TCA results mirrored the neural features observed using Principal Component Analysis (PCA) of the same data. Overall, TCA and PCA analyses suggest that amongst the four brain regions we sampled, each exhibits different time-locked modulations of neural features (rate and oscillation) during social gaze. Overall, TCA provides a useful tool to characterize complex neuronal dynamics.

Keyword: Prefrontal cortex, Amygdala, Social gaze, Dimension reduction
A23  Representation of subjective value for self and other in the dorsal anterior cingulate cortex is consistent across tasks and predicts social attitudes

Matthew Piva, K. Velnoskey, R. Jia, A. Nair, I. Levy, S.W.C. Chang, Yale University

While making decisions on behalf of others is ubiquitous in daily life, few studies have addressed the neural computations underlying this phenomenon. We investigated the neural correlates of value-based decision-making for both self and other in two independent behavioral tasks using fMRI. Behavioral paradigms included intertemporal choice (n = 20) and risk (n = 21) paradigms. Behavioral modeling indicated that participants distinguished between themselves and others with dissimilar preferences. We then calculated the difference in subjective value between options, defined as relative subjective value. Dorsal anterior cingulate cortex (dACC) activity negatively correlated with relative subjective value, while ventromedial prefrontal cortex (vmPFC) activity positively correlated with relative subjective value (P < 0.05, corrected). Both effects were consistent in self and other trials and in both behavioral tasks. Multivoxel pattern analysis indicated that the dACC, but not the vmPFC, decoded high versus low relative subjective value consistently across self and other and in both tasks (P < 0.01, permutation). The code for relative subjective value in the dACC was generalizable across self and other, as classifiers trained on data from self trials were able to categorize value in other trials and vice versa (P < 0.01, permutation). Notably, this neural code in the dACC was even generalizable across tasks, as classifiers trained on data taken from the dACC during intertemporal choice were able to predict value in trials from the risk paradigm (P < 0.01, permutation). Finally, classification accuracy in other relative to self trials correlated with self-reported social attitudes (P = 0.03, Spearman). Together, these results indicate the importance of subjective value-related signals in the human dACC, arising during decision-making across different perspectives and contexts.

Keyword: neuroeconomics, social decision-making, subjective value, intertemporal choice, risk, dACC, vmPFC, fMRI

A24  Associative learning of self and other ownership

Patricia Lockwood, Marco Wittmann, Matthew Apps, Miriam Klein-Flugge, Molly Crockett, Glyn Humphreys, Matthew Rushworth, University of Oxford, University of Yale

Sense of ownership is a ubiquitous and fundamental aspect of human cognition. Here we used model-based functional magnetic resonance imaging and a novel minimal ownership paradigm to probe the behavioural and neural mechanisms underpinning ownership acquisition for ourselves, friends and strangers. We find a self-ownership bias at multiple levels of behaviour from initial preferences to reaction times and computational learning rates. Several areas within medial prefrontal cortex tracked ownership associative strength between objects and agents. Ventromedial prefrontal cortex and anterior cingulate (ACC) sulcus responded more to self vs. stranger associations but despite a pervasive neural bias to track self-ownership, no brain area tracked self-ownership exclusively. However, ACC gyrus specifically coded ownership prediction errors for strangers and ownership associative strength for friends and strangers but not for self. Core neural mechanisms for associative learning are biased to learn in reference to self but also engaged when learning in reference to others. In contrast, ACC gyrus exhibits specialization for learning about others. These findings could have important implications for understanding the neural basis of learning and decision-making as well as disorders of ownership and social cognition.

Keyword: self, other, fmri, ownership, prediction error, medial prefrontal cortex

A25  Physiological synchrony in conversation in real and hypothetical dyads

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During social interaction, many behaviors tend to synchronize including total speaking time, accents, postures, and emotions (Cappella & Panalp, 1981; Chartrand & Bargh, 1999; Gies, Coupland, & Coupland, 1991). Moreover, neural measures like brain activity will synchronize between communication partners (Stephens, Silbert, & Hasson, 2010), and autonomic nervous system measures like skin conductance response (SCR) have been shown be similar in dyadic social interaction (Marci et al., 2007). Synchrony of these behaviors can signal active interest, mutual understanding, and enhance social affiliation (Cacioppo et al., 2014; Cappella & Panalp, 1981; Garrod & Pickering, 2009). However, synchrony of physiological responses has not been well studied outside of intensely emotional situations like therapy sessions (Marci et al., 2007) or between married couples discussing personal marital issues (Levenson & Rues, 1997). The purpose of this study is to analyze physiological synchrony of SCR between dyads (college friends) having emotional (Experiment 1, n=35 dyads) or personal (Experiment 2, n=44 dyads) conversations. It is predicted that there will be significantly more physiological synchrony between the two participants who actually conversed (real dyads) compared to the data from two random participants who did not converse (hypothetical dyads) and that this difference will be greatest when the conversations involve emotional or personal topics relative to neutral/impersonal topics. For both experiments, there was a significant main effect of dyad type (real vs. hypothetical) but no main effect of conversation type (personal vs. impersonal or emotional vs. neutral) or interaction between the two. These results suggest that real conversations do elicit physiological synchrony of autonomic nervous system activity at levels greater than chance, but that this synchrony is not dependent on the emotional content of the conversation.

Keyword: social interaction, synchrony, physiology, interpersonal coordination

A26  Standardised gestures can be used for interpersonal touch communication

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Interpersonal touch is an important form of social interaction that allows us to communicate a variety of emotional cues. We developed a set of standardised touch gestures that could be performed by an experimenter and interpreted by naive participants. Across touchers, we hypothesised that people intuitively choose gestures with common physical features, according to what is being communicated. In a behavioural experiment, we compared performance on a touch communication task for standardised touch gestures (N = 16) against intuitive touch gestures, as performed by emotionally close pairs (N = 21). The results indicated the standardised touch gestures were correctly interpreted at a significantly higher rate (63%) than the intuitive touch gestures (54%) (p = 2.63e-10, 95% CI of the difference = 6.5%, 12.4%). Of the six individual cues, the standardised touch gestures were significantly better decoded in three cases (calming, happiness, love), not significantly different for two cases (attention, sadness), and significantly worse for one case (gratitude). Furthermore, to better understand attributes of hand-to-forearm contact that underlie these gestures, we developed a method for the quantitative tracking of gesture movements, so as to capture the position and velocity of the hand, contact area and pressure. Using hand-to-forearm tracking, a second set of experiments characterised these gestures based on their likely degree of engagement with three somatosensory neural pathways, specifically the CT-afferent system (processing slow touch), the A-beta system (processing fast, high acuity touch) and the muscle system (processing deep or strong touch). All together, the results provide strong evidence that touch gestures used in communication have common features that can be universally recognised. Keyword: affective touch communication emotion
For over half a century, research on emotional information perception and the neural processes underlying human cognition and behavior has primarily focused on visual perception. However, more recently, increasing research on auditory emotional information processing has helped contribute valuable new insights into understanding the role emotion plays in successfully negotiating the world. We investigated the interactions between auditory emotion perception and other factors including physical condition, personality traits, political beliefs, relationships, bilingualism, and birth order. First, we developed MAARI, the Multidimensional Auditory Affect Ratings Inventory (Society for Neuroscience 2013), a set of 650 non-verbal emotive vocalizations, standardized for length, amplitude and onset amplitude. Then 822 participants (F=609, M=213) performed 1072 ratings of MAARI vocalizations on three of the following five dimensions: valence, arousal, dominance, authenticity and personal impact. Participants then took a battery of psychological tests (including PANAS-X, Basic Emotional Empathy Scale, Big 5 Personality traits, political beliefs, birth order, and the ratings the individuals assigned to the MAARI emotive vocalizations. These interactions indicate auditory emotion perception can both influence and be influenced by non-emotive factors, both internal (intrinsic and learned) and external (contextual) to the individuals who heard and rated MAARI non-verbal emotional vocalizations.

Keyword: emotion, audition, vocalizations

For some people (vicarious pain responders), seeing others in pain is experienced as pain felt on their own body and this has been linked to empathy. Since empathy is not a unitary construct, the aim of this study was to establish which empathic traits are more pronounced in vicarious pain responders. The Vicarious Pain Questionnaire (VPQ), was used to divide participants into three groups: 1) non-responders (people who report no pain when seeing someone else experiencing physical pain), 2) sensory-localised responders (report sensory qualities and a localised feeling of pain) and 3) affective-general responders (report a generalised and emotional feeling of pain). Participants completed a series of questionnaires investigating emotional empathy, cognitive empathic traits such as perspective taking and social skills, prosocial behaviour, and a self-other association task. Vicarious pain responders showed significantly greater emotional reactivity (Emotional Reactivity subscale of the Empathy Quotient) and contagion (Emotional Contagion Questionnaire). No differences were recorded in personal distress. There were also no significant differences in prosocial behaviours (Helping Attitudes Scale), individualistic-collectivistic attitudes (The Individualism–Collectivism Interpersonal Assessment Inventory) and a self-other association task. These results indicate that vicarious pain responses are mainly linked to heightened affective empathy (i.e. emotional reactivity and contagion) and suggest that affective and cognitive components of empathy can be dissociable. They and are discussed considering neuro-cognitive models of empathy and self-other distinctions.

Keyword: Vicarious Pain Responses; Empathy; Self-Other Distinctions

Infants rely on the mother to provide them with the sensory stimulation needed for normal brain development. Maltreatment by the mother initiates a pathway to pathology, much of which remains dormant until later life. However, immediate effects can be detected in the maltreated infant by using the Strange Situation Test (SST), which progressively stresses the child to uncover atypical responses to the caregiver. Here we adapted this test for use in rat pups to aid in identifying pups’ atypical neurobehavioral features within a maltreatment-associated dyad. Using the Scarcity-Adversity Model of maltreatment induced by low bedding (SAM-LB) for nest building from postnatal days (PN)8-12, we observed features of disordered attachment in the SST. Recording of cortical oscillations using local field potentials (LFP) showed that the mother had reduced ability to modulate the infant’s rhythmic brain activity during SST, compared to pups with no maltreatment experience. Next, we considered the progression of pups’ atypical behavior and cortical oscillations by recording LFP in both pup and mother during brief periods of SAM (between PN10-17). Neocortical telemetry LFP electrodes were implanted in PN10 pups and mothers and LFP was recorded during 1 hr periods of SAM or typical rearing in the same animal. With progressing SAM, the dynamic range of LFP induced by mother-pup interactions decreased, with both pup and mother showing impaired LFP responses to specific interactions, such as nursing and grooming. These results suggest that when a mother is stressed, she has impaired ability to modulate both her own and pups’ neural function.

Keyword: oscillations, trauma, attachment, development

Paternal care is important for healthy offspring development. However, the neuroendocrine regulation of paternal care remains poorly understood. There is a well-established role for the hormone prolactin (PRL) in mediating maternal behavior through its actions on central PRL receptors (PRLR). Male mice have a similar central PRLR distribution as females, however, it is unknown whether PRL actions in the brain are critical for paternal behavior expression. In sharp contrast to virgin female mice, virgin male mice are infantilic towards pups, but approximately 2 weeks after mating, infantilical behavior is suppressed and the emergence of paternal care coincides with the birth of pups. To begin testing whether PRL is involved in the mating-induced transition to paternal care we performed two experiments to identify specific groups of PRL-responsive neurons that are activated after mating and during pup care. The first experiment collected brains from males that either mated with a receptive female or control untreated males. The second experiment used males who mated and sired pups before being separated from the litter on postpartum day 3. The following day males were either exposed to pups or no pups (control) and brains were collected. Brains were processed for c-fos using immunohistochemistry in our novel PRLR-Cre-tomato mouse line, in which PRLR-responsive neurons express a fluorescent tag (td-tomato). We predict that mated males will show more c-fos overlap with PRL-responsive cells than non-mated males in the bed nucleus of the stria terminals and medial amygdala, which are active after mating and express PRLRs. We expect that fathers with pups will show increased c-fos activation in PRLR neurons in the medial preoptic area, a critical area for both maternal and paternal care. This work will inform future experiments which causally test for a role of neural PRL signaling in paternal care and whether paternal care is regulated similarly to maternal care.
Why are some people more likely to hold extreme views and to regard violence as appropriate to effect political change? A social neuroscience perspective has the potential to reveal the mechanisms underpinning extremism, political polarization, and support for political violence (Decety & Workman, 2018). In line with this perspective, the present study sought to characterize the dispositional and psychological factors and neural computations associated with polarized views and support for violence. Participants (n=45) completed questionnaires measuring beliefs about politics, violence and moral convictions, personality dispositions, and demographics prior to undergoing fMRI scanning. During scanning, they rated the appropriateness of violent acts carried out by protagonists as depicted in photographs. The purported motivations for the violence were either congruent or incongruent with participants’ political views. Support for political violence was predicted by intrinsic religiosity (β=0.44, p=0.000003) and victim sensitivity (β=0.034, p=0.0009), but not by political polarization (difference between agreement with liberal and conservative issues; p>0.05). Congruent relative to incongruent violence was associated with increased activity in the dorsolateral prefrontal cortex, orbitofrontal cortex (OFC), insula, and temporoparietal junction. Activation correlated positively with support for political violence in regions including OFC, with victim sensitivity in insula, and with intrinsic religiosity in parietal cortex. Sensitivity to feeling victimized by injustices and degree of personal religious commitment, but not political polarization, predicted support for political violence. Congruent political violence engaged a spatially-distributed network of brain areas implicated in political attitudes and social cognition. Correlations with activations implicated regions consistent with previous fMRI research on justified violence, justice sensitivity, and religiosity.

Decoding neural computations of fairness in three-party distributions

Keith Yoder, J. Decety, University of Chicago

Humans are motivated by both self-interest and concern for others, and neuroeconomic studies have begun to untangle whether fairness-related processing is altered when making decisions for oneself or on behalf of another. The current study used multi-voxel pattern analysis to decode fairness for the self and others from patterns of fMRI data. Participants played the role of responder in a Three-Party Ultimate Game, where $12 was divided among three individuals in a 2 (Fair/Unfair) x 2 (Self/Other) design. Three 3mm-radius searchlights were applied to find regions for which a classifier could reliably distinguish between either the four distributions, SelfFair and SelfUnfair, or OtherFair and OtherUnfair. Good four-way classification was found only in visual regions, and no searchlights showed above chance classification for OtherFairness. However, SelfFairness was accurately decoded throughout much of visual cortex, and additionally in core nodes of cognitive control and salience networks (e.g., dorsolateral prefrontal cortex and anterior insula). These findings suggest that fairness-related population coding in these networks is more reliable when the target of unfairness is oneself, rather than another individual, and that self-interest and concern for others may rely on largely distinct neural computations.

Deficit of oxytocin receptor increased repetitive behaviors and reduced preferences for social novelty in male prairie voles.

Kengo Horie, K.Inoue, S. Suzuki, S. Adachi, S. Yada, T. Hirayama, S. Hidema, L. J. Young, K. Nishimori, Tohoku University, Emory University

The prairie vole (Microtus ochrogaster) is a socially monogamous rodent species, which forms enduring pair bonding between mates. Prairie voles take care of their pups bi-parentally and attack unfamiliar conspecifics selectively. These social behaviors are completely different from mice and rats commonly used as animal models in the social neuroscience field, thus prairie voles are regarded as the model of social affiliation and attachment. In prairie voles, oxytocin (Oxt) and oxytocin receptor (Oxtr) have been shown as one of the key regulators of these social behaviors. Although many reports indicated relationships between the functions of Oxt/Oxtr and the social behaviors in prairie voles by using pharmacological methods, there are no reports using genetically engineered prairie voles to uncover molecular mechanisms of their social behaviors. To further elucidate the neural mechanisms of social behaviors in prairie voles, genetically modified prairie voles will be the most powerful tools. In this study, we report that we successfully generated Oxtr knockout (KO) prairie voles by CRISPR/Cas. Additionally, we demonstrated that male Oxtr KO prairie voles showed increased repetitive behaviors in the marble burying test, and they also showed reduced preferences for social novelty, but not sociability, in the three chamber test. These behavioral phenotypes are regarded as the autism-like behaviors. In conclusion, Oxtr KO prairie voles will be the new animal models for studying autism spectrum disorders and reveal the detailed functions of Oxtr in social behaviors of prairie voles.

Posters Session B

Friday, November 2, 2018, 6:00 pm – 7:00 pm, Sapphire Ballroom IJMN

Effects of Qualia on the Event-related Potentials of Close Others

Amanda Tardif, A. Chau-Morris, M. Lecousy, M. Sparks, J.B. Debrullle, McGill University, Douglas Mental Health University Institute

While engaging in social interactions, we assume that others are experiencing the same qualia (e.g., the “redness” of red, timbres of different sounds, etc.) as us. Although it is suggested that qualia, the building blocks of consciousness, emerge from patterns of activity of neural networks, the assumed specificity of these patterns appears problematic as different networks seem able to produce similar qualia across individuals. However, for individuals to communicate effectively about the environment, they must be similar. So, there is reason to search for an explanation for this similarity other than networks’ similarity. Here we tested whether one person’s brain could be sensitive to others’ qualia by examining whether their late posterior negativity (LPP), an ERP component associated with conscious processing, could depend on the stimulus presented to a close other. We thus recorded ERPs from pairs of partners as they separately but simultaneously viewed visual stimuli. To prevent any classical communication, participants were tested in adjacent rooms separated by a curtain-covered window. Unbeknownst to the partners, half of the images were identical, half were not. Nevertheless, as predicted, LPP amplitudes varied across these two conditions. This supports the hypothesis that an individual’s stimulus processing can impact another’s brain activity, which provides a potential basis for qualia similarity across individuals.

Deficit of oxytocin receptor increased repetitive behaviors and reduced preferences for social novelty in male prairie voles.
It is widely accepted that holistic processing is critical for early face recognition, but recent work has suggested a larger role for feature-based processing. Indeed, there is some indication that as familiarity increases, recognition becomes less dependent on holistic processing and more dependent on facial features. Regardless of the nature of the mechanism, the earliest step in familiar face recognition is the matching of a perceptual representation of the familiar face to a stored representation of that same face; a process thought to be indexed by the N250 event-related potential (ERP). In the current face priming ERP studies, we investigated whether this perceptual representation can be effectively activated by faces that are manipulated to emphasize feature-based processing and to disrupt holistic processing. To emphasize feature-based processing of primes, we utilized isolated face parts in the first experiment and face inversion in the second experiment. In the first experiment, we observed the well-documented N250 modulation when a familiar whole face prime was followed by a face of the same identity. Critically, we also observed this effect for familiar isolated eye primes (though not for mouth primes) when followed by a whole face of the same identity. In the second experiment, prime images were familiar faces presented in either an upright or inverted orientation. Face inversion is known to disrupt holistic processing. However, the inverted face primes were no less effective than the upright face primes in modulating the N250. Together, the results of these studies indicate that activation of the earliest face identity recognition processes is not dependent on holistic processing of a typically configured face (though this does not preclude a role of holistic processing in natural viewing). Rather, feature-based processing can effectively activate the perceptual memory of a familiar face.

Keyword: N250, face, holistic

### B3 Social risk and routine in context: Relating network structure to principles of brain organization in spider monkeys (Ateles fusciceps rufiventris)

Emily Boeving, E. Nelson, Florida International University

Hemispheric specialization is thought to be reflected by side biases in certain behaviors. The prevailing pattern of lateralization in vertebrates suggests social behavior is delineated to the right hemisphere, yet research across species has failed to test the cerebral lateralization hypothesis across different social interaction types, particularly in socially complex species. To address this issue, we previously captured 186 hours from 15 socially housed Colombian spider monkeys (Ateles fusciceps rufiventris) across three social interaction types: embrace, face-embrace, and grooming. We described a right hemispheric pattern of laterality potentially driven by qualitative differences in social risk during embracing, and absence of laterality during grooming, potentially owing to the routine state of the behavior. To explore if social network structure diverges similarly to patterns of laterality, we leveraged social network analysis to identify structural differences between embrace, face-embrace, and grooming. Results indicate a significant structural difference between the three networks (F = 6.31, df = 2, p = 0.004). Post-hoc comparisons indicate no significant difference between embrace and grooming (t = 1.51, df = 30, p = 0.14), while differences between face-embrace and embrace (t = 3.38, df = 19.64, p = 0.003) and face-embrace and grooming (t=3.56, df = 30, p=0.001) were both significant. These findings suggest that face-embrace is the riskiest social interaction, and that level of risk alters network structure. We discuss these results in light of the spectrum of social risk and routine involved in these behaviors, and how these elements may drive differences in hemispheric specialization.

Keyword: non-human primates, social interactions, social network analysis, hemispheric specialization, spider monkeys

### B4 Heart rate changes in response to people living or dying show evidence of cognitive biases

Jo Cutler, J. J. Miles-Wilson, D. Campbell-Meiklejohn, The University of Sussex

Emotional responses and prosocial acts are often different toward single victims than to mass suffering. Behavioural experiments show that identity factors such as nationality can change our social responses. One theory for the neuroscience of numerical biases is that our physiology has not evolved to scale reactions from individuals to thousands, and thus the influence of arousal-dependent cognition is progressively non-linear for large numbers. If such a theory is plausible, biases in valuing lives of others will be reflected in physiology. We tested how the human heart reacts to learning people in different locations and numbers survived an ordeal or died. 189 UK residents (138 female, 50 male, 1 other; 122 UK nationality, 65 non-UK, 2 nondisclosed) read 120 real news stories in which varying numbers of people were at risk of dying (60 in the UK, 60 abroad). The presentation stated nationality and number at risk, followed by anticipation and the outcome revealing whether the people lived or died. Heart rate data were collected with a pulse oximeter. We calculated the change in heart rate (ΔHR) as the difference in beats per minute between the beat before the trial and the second beat after the outcome. Mixed models showed that overall ΔHR did not depend on story location or participant nationality. However, the effect of the number of people on ΔHR did depend on location and outcome. The effect of people dying was quadratic in the UK, t(180)= -2.4, p= .016 and linear abroad, t= 2.4, p=.016, while live outcomes were unresponsive to the number of people (3-way interaction t=-2.8, p=.005). Individual differences in these patterns show associations with personality traits. Participants numbed (reduced ΔHR) to abroad deaths over the experiment, but not the UK deaths. Biases in how we value the lives of others can be detected in ΔHR within seconds of learning their fate, supporting the idea that factors affecting the valuation of others are reflected in physiology.

Keyword: Prosocial, physiology, cognitive biases

### B5 Insular cortex projections to the nucleus accumbens core modulate social affective behaviors

Morgan Rogers-Carter, A. Djerdlaj, K.B. Gribbons, J.P. Christianson, Boston College

Social animals detect the affect of others to organize appropriate social behaviors. Age-specific responses to social affect are evident when an adult male rat is presented with a pair of unfamiliar male conspecifics, one of which is stressed via 2 footshocks and the other naive to treatment. Test rats prefer to interact with a stressed juvenile (PN30) conspecific, but will avoid a stressed adult (PN50) conspecific. This pattern depends upon the insular cortex (IC) which is anatomically connected to the nucleus accumbens core (NAc). Prior network analysis of fos immunoreactivity indicated greater involvement for the NAc during social interactions with stressed juvenile conspecifics. Here, bilateral pharmacological inhibition of the NAc (tetradotoxin 1μM; 0.5μl/side) abolished the preference for stressed juvenile conspecifics, but not naive adults. To explore if NAc projecting IC neurons contribute to social exploration we chemogenetically activated IC terminals in the NAc. After intranigral injection of AAV5-hSyn-hM3Dq-mCherry, bilateral microinjection of clozapine-N-oxide (1μM; 0.5μl/side) to the NAc increased social exploration with juvenile, but not adult conspecifics. Ongoing analysis using functional retrograde tracing and chemogenetic inhibition will establish the necessity of this pathway to social approach. The current findings suggest that behavioral responses to stressed juveniles involve the NAc and activation of NAc-projecting IC neurons is sufficient to elicit prosocial behaviors.

Keyword: Insular Cortex, Nucleus Accumbens, Social Affect
**B6 Early life sleep disruption increases cortical parvalbumin and impairs social and behavioral development in prairie voles**

Carolyn E. Jones, Ryan A. Opel, Davelle L. Cocking, Alex Q. Chau, Jazmine Quintana, Elizabeth A.D. Hammock, Miranda M. Lim, Oregon Health & Science University, Portland VA Healthcare System, Florida State University

Across species, juveniles sleep more compared to adults, with disproportionately more time spent in REM sleep stages in the young. One function of REM sleep may be to facilitate the timing of GABAergic parvalbumin interneuron expression in the developing brain, a function critically important for tuning of excitation and inhibition. Here, we show that one week of REM sleep deprivation during a sensitive postnatal window of development increases parvalbumin-immunoreactivity in the cortex of prairie voles (Microtus ochrogaster), a highly social rodent species that forms lifelong pair bonds with other individuals. Prairie voles subjected to this protocol of early life sleep disruption failed to form pair bonds, showed locomotor hyperactivity, and showed more neophobia when presented with novel objects, compared to control subjects. There was a strong effect of sex on both parvalbumin-immunoreactivity and behavior testing, with impairments predominating in male animals. Taken together, these results may be reminiscent of the pathology and phenotype seen in autism spectrum disorder, a developmental disorder characterized by disrupted sleep, altered cortical parvalbumin, and social impairment. We propose that sleep in early life plays a crucial role in the tuning of inhibitory neural circuits and the subsequent development of species-typical social behavior, and that sleep itself may play a causal role in the pathogenesis of neurodevelopmental disorders.

**Keyword:** sleep, development, pair bond, autism

**B7 Hyperconnectivity of Social Brain Networks during Action Perception in Autism**

Victoria Seghatol-Eslami, C. J. Ammons, R. K. Kana, University of Alabama at Birmingham

Neuroimaging studies have revealed altered functional connectivity within brain networks (i.e., face processing, metalizing, mirror neuron) in autism spectrum disorders (ASD) as a possible neural marker of social impairments (Kana and Just, 2011; Libero et al., 2014). The goal of this fMRI study is to examine connectivity of these three networks in ASD. Twenty-one ASD and 20 typically developing (TD) adults matched on age, gender, and IQ took part in an action-intention task of inferring the mental states of other agents, with each condition paired with the rest of the brain during the task. Task masks were correlated using Neurosynth to measure connectivity across groups using CONNv18. Seed-to-voxel analysis showed altered connectivity in ASD. During the intention condition, ASD had greater connectivity of the right fusiform gyrus with the left thalamus ([t(39)=3.31], the right temporoparietal junction with the left central opercular cortex ([t(39)=3.31], the left premotor cortex with the right middle frontal gyrus ([t(39)=3.31], and the right premotor cortex with the left inferior lateral occipital cortex ([t(39)=3.31]. All results were FDR corrected p<.05. Hyperconnectivity of large-scale cortical and subcortical networks may suggest increased attention to many different components of the social scenes in autism, which in turn might lead to increased effort and greater coordination of multiple neural resources for interpreting social events successfully.

**Keyword:** autism, fMRI, functional connectivity, theory of mind

**B8 The neural basis of emotional empathy: Intense emotion increases neural synchronisation between individuals.**

Matthew Hudson, K. Seppälä, L. Sun, V. Putkinen, E. Glerean, T. Karjalainen, J. Hirvonen, L. Nummenmaa, University of Turku, Finland

Empathy for the emotional states of other people is crucial for social interactions, and forms the foundation upon which human socilality is built. A deficit in emotional empathy has a profound impact on mental health and well-being. It is therefore important that we have a mutual understanding of others emotional state. This research sought to establish the neural basis by which we share emotional experiences with other people. Participants watched a horror movie to elicit extreme fear whilst neural activity was measured by functional magnetic resonance imaging. A separate sample watched the movie and continuously rated how scared they were, which provided a behavioural measure of fear by which to model the BOLD activity. A GLM stick function analysis revealed that during moments of intense fear, neural activity is higher in areas typically implicated in the experience of fear (e.g. amygdala, insula cortex, cingulate cortices, thalamus).

Neural synchronisation was analysed using inter-subject correlation (ISC), whereby a subject-by-subject correlation matrix is conducted on the BOLD signal for each voxel to provide a sample-wide measure of variability in neural activity. ISC was conducted for each time point with a sliding window of 10 samples to provide a dynamic measure of neural synchronisation during the movie, which was correlated with the feelings of fear. This revealed that, as fear increased, so too did neural synchronisation in brain regions involved in the experience of fear. Therefore, brain regions involved in the experience of fear not only exhibit heightened activity during moments of intense emotion, the neural activity becomes synchronised between individuals. Heightened emotion engenders an attunement of neural activity between individuals, which contributes to the understanding of each other’s emotional state, and ultimately the establishment of a shared emotional experience that enables the social functions and benefits of emotional empathy.

**Keyword:** fMRI, empathy, emotion, inter-subject correlation, fear

**B9 Patterns of emotional reactivity and associative learning across valence in humans**

Sarah R. Moore, Rebecca Todd, Adam Anderson, Richard Depue, University of British Columbia

Emotional learning is commonly studied in humans and animal models using associative conditioning procedures, in which the conditioned stimulus (CS) gains emotional value over repeated trials of pairings with a rewarding or aversive unconditioned stimulus (UCS). In previous research, individual variation in the emotional experience of the UCS is either neglected or the UCS is calibrated to individual thresholds. However, there is evidence for substantial individual variation in responsiveness to rewarding and aversive environmental stimuli, as well as propensities for emotional learning. Here, to better understand how responsiveness to rewards and threats corresponds to patterns of emotional learning, we performed a series of tasks on a large sample (N = 506) of young adults. Specifically, participants were first characterized in terms of momentary response thresholds to a monetary reward and an uncertain, aversive noise. Second, participants underwent associative conditioning procedures in which each UCS was paired on a 50% reinforcement schedule with a neutral face (CS). Overall, momentary response thresholds to rewarding and aversive UCSs predicted degree of conditioning to neutral contexts paired with these respective cues. Applying K-means clustering, more nuanced patterns of emotional behavior were identified, including groups of participants that were 1) highly emotionally reactive and high in emotional learning regardless of valence, 2) low in emotional reactivity and highly resistant to conditioning regardless of valence, and 3) only responsive to either aversive or rewarding stimulation. Relationships between these groupings and personality measures, and broader implications are discussed.
Target Engagement for Intranasal Oxytocin on brain function in Autism Spectrum Disorder

Elissar ANDARI, Gopinath Kaundinya, Gabriella Caceres, Joseph F. Cubells, Larry J. Young, Emory University

Autism Spectrum Disorder (ASD) is a heterogeneous set of neurobiological conditions characterized, in part, by significant difficulties in social interaction and nonverbal communication, along with restricted repetitive patterns of interests. Acute administration of intranasal oxytocin (IN-OXT) produces positive effects on social behavior and brain function in these individuals. The key question now is how to translate these promising findings into therapeutic avenues and long-term effects. Here, we administered several doses of IN-OXT (8IU, 24IU, 48IU, 0IU) to 32 patients with ASD (adults men, 18-45 years old, IQ>70) and examined its effects on brain functional connectivity during resting state (rsFC), in a within-subject, double-blind, placebo-randomized study. In order to show target engagement for IN-OXT, there should be a difference in rsFC between the different doses and in a consistent manner. Our hypothesis is that IN-OXT will increase rsFC between key socio-emotional networks in a dose-dependent way. By using independent component analysis, which is a data-driven approach that aims to decompose a whole-brain BOLD signal into a number of spatial maps and their associated time-course, we first performed a group ICA looking into all the networks that are above the noise and then performed FC analysis between these networks by taking into account the type of treatment (dose of IN-OXT). We show a linear dose-dependent effect of IN-OXT on increasing FC between emotional empathy and theory of mind networks in ASD. Our results have the potential to provide evidence for a targeted action of oxytocin in the brain and may pave the way for uncovering optimized oxytocin-based chronic interventions in individuals with social deficits.

Keyword: Targeted action, autism, oxytocin, resting state functional connectivity, Empathy

Neuronal substrates of group competitive foraging in male mice

Songjun William Li, L. Johnson, Z. Williams, Massachusetts General Hospital, Boston University School of Medicine, Harvard Medical School

Competitive foraging among conspecifics is an especially significant form of social interaction due to its importance in determining survival and reproductive outcomes. However, despite the importance of interactive social behavior and its dysfunction, its neuronal underpinnings are poorly understood. In this study, we developed a novel behavioral assay to observe the influences of social dominance hierarchies on the competitive foraging behavior, which offers a versatile method to ordinally quantify competitive success among larger groups of animals. We also recorded single-unit neuronal activity within the dorsal medial prefrontal cortex (dmPFC) in male wild-type mice while they performed the task. Consistent with prior studies that characterized the tendency of dominant animals to tend to monopolize food more effectively than submissive counterparts, our behavioral data revealed that greater social dominance directly correlated with greater competitive success. Thus, these results demonstrated a relationship between dominance and competitive success that extends across a social group of familiar mice in a higher-order group setting. Neuronally, we found a subset of neurons in the dmPFC that selectively encoded the animals’ hierarchical rank, the order in which they accessed the reward zone, and the reward amount. It is notable that individual dmPFC neurons differed in activity based on the subject’s relative rank regardless of others’ identity, while other neurons responded selectively to competitive success only before the recorded animal entered the reward zone - suggesting that dmPFC neurons may predict competitive outcomes based on information about competitors. This research provides insight into the social and neurobiological mechanics of dominance, competition, and success, allowing us to better understand group competitive behavior.

Keyword: Competitive foraging, mice, electrophysiology, dmPFC, group behaviors

Developmental exposure to pyrethroid pesticide causes an autism-related phenotype and dopamine system alterations in mice

James Burkett, R. Cliburn, C. Hoffman, R. Dhamiansi, E. Winokur, S. Gourley, G. Miller, Emory University

Pyrethroids are a class of pesticide whose use has broadly expanded in recent years, as it is considered the “safe” alternative to harmful organophosphates and organochlorides. Recent epidemiological studies, however, have suggested that residential exposure to pyrethroid pesticides during pregnancy increases the risk of Autism Spectrum Disorders (ASD) in the unborn child. Our lab’s previous work has shown that developmental exposure to the pyrethroid deltamethrin, in doses considered safe by the EPA, causes an ADHD-related phenotype and disruptions in the dopamine system in mice. In this study, we exposed female mice to a low dose of deltamethrin (3 mg/kg PO Q3D) during pre-conception, pregnancy and weaning. We tested the offspring on a broad behavioral battery representing all three diagnostic domains of ASD, as well as related symptoms and comorbid disorders. Consistent with our prior publications, we found evidence of hyperactivity and repetitive behaviors. In addition, we found decreased ultrasonic vocalizations, increased rigidity, and learning deficits. No deficits in social behavioral were found. We also found increased striatal dopamine, increased dopamine transporter, and other dopamine-related disruptions. Additional studies are urgently needed to determine whether exposure to this common class of pesticides contributes to ASD diagnosis in humans.

Keyword: Autism, pesticides, dopamine

Learning about other persons’ personality traits combines reinforcement learning with representations of trait distributions and similarities

Christoph Korn, Gabriela Rosenblau, Jan Glaescher, University Medical Center Hamburg-Eppendorf

In many social interactions, humans learn continuously about each other’s personality traits (e.g., how polite is another person?). But formal models that capture such complex social learning processes are lacking. Here, we surmise that humans may use specific types of reinforcement learning that incorporate knowledge about the distributions of different traits (e.g., most people are moderately polite) and the similarities between them (e.g., polite persons tend to be helpful). In two behavioral studies, participants (n=36; n=41) were asked to consecutively predict how four other persons had previously rated themselves on sets of 60 trait words. After each prediction, participants received veridical feedback. Distributions and similarities of all traits were derived from self-ratings of independent samples (total n=835). Additionally, we aimed at providing converging evidence that neural signals represent the similarities between different traits by applying representational similarity analyses on a published fMRI study, in which participants (n=27) were asked to rate themselves on 80 traits words. Bayesian model comparison shows that the winning behavioral models combine reinforcement learning with reliance on trait distributions and similarities. Crucially, the winning models generalize across traits according to their similarities. That is, when receiving information about a given trait the estimates of all other traits are updated according to how similar these are to the trait at hand. Representational similarity analyses of fMRI data in a non-learning task showed that trait similarities were reflected within the medial prefrontal cortex, a region classically associated with thinking about one’s own and other persons’ traits. Overall, our results indicate that variants of reinforcement learning algorithms which incorporate the distributions and similarities of personality traits
describe crucial aspects of the dynamics at play when persons interact each other.

Keyword: reinforcement learning, personality traits, representational similarity analyses

**B14 Ventral hippocampal inputs to the mPFC regulate social memory**

Mary Phillips, Lucas Pozzo-Miller, University of Alabama at Birmingham

Here we use Mecp2 knockout (KO) mice as a model of the autism-associated disorder Rett syndrome to define the behavioral consequences of altered ventral hippocampal (vHIP) to medial prefrontal cortex (mPFC) projections. We first identified an increased influence of vHIP afferents on mPFC network activity in Mecp2 KO mice when compared to wildtype (WT) littersmates, as determined by larger voltage sensitive dye (VSD) signals evoked by stimulation of vHIP fibers in mPFC slices. To identify active neurons during specific behavioral tasks, we performed retrobead tracing to label pyramidal neurons in the vHIP that project to the mPFC, followed by c-Fos immunohistochemistry. This approach revealed that mPFC-projecting vHIP neurons are selectively activated in WT and Mecp2 KO mice during social tasks, compared to non-social tasks and to other vHIP projection neurons. Using unbiased machine-learning classifiers to score behaviors in freely moving mice, we identified social memory deficits in Mecp2 KO mice. To test if stronger vHIP inputs to the mPFC are causal to social memory deficits in Mecp2 KO mice, we altered the activity of mPFC-projecting vHIP neurons by intersectional chemogenetics. Increasing the activity of mPFC-projecting vHIP neurons between P34-P45 with an excitatory DREADD impaired social memory in WT mice. In addition, this manipulation resulted in larger vHIP-evoked VSD signals in mPFC slices, resembling those in Mecp2 KO mice. On the other hand, reducing the activity of mPFC-projecting vHIP with an inhibitory DREADD was sufficient to restore social memory in Mecp2 KO mice, while reducing vHIP-evoked VSD signals in mPFC slices, resembling responses in WT mice. Further analyses revealed that the amplitude of vHIP fiber-evoked VSD signals in mPFC slices of inhibitory DREADD-expressing Mecp2 KO mice correlate with their performance in social memory tasks. These data demonstrate that the vHIP-mPFC projection is necessary for social memory.

Keyword: Social Memory, Rett Syndrome, ventral hippocampus, medial prefrontal cortex

**B15 Children’s tendencies to sustain cooperation during social and non-social exchange rely on distinct cognitive mechanisms**

Gabriela Rosenblau, C. Korn, N. Shah, K. Pelphrey, George Washington University, University Medical Center Hamburg-Eppendorf

Reinforcement learning (RL) offers a robust framework for learning in social and non-social settings and has been successfully extended to describe neurodevelopment in learning. RL models may reveal children’s unique tendencies to learn in social contexts. Using a developmentally appropriate version of the trust game, we test whether RL models vs. simpler non-learning strategies differentiate between children’s tendency to sustain cooperation in repeated interactions with a peer vs. non-social computer partner and whether this differentiation is represented in underlying neural networks. Children (n=25; age=12; SD=2.6) were matched with a peer, whom they did not know before the visit. They were told that they would sometimes play with their human partner and sometimes with a computer algorithm. In fact, they only played with their human partner once. Children did not know how many trials each game contained. Investors shared more in the social compared to the non-social conditions and they shared similar amounts when playing with the real human vs. when thinking they played with the human, but in fact played with an adaptive computer algorithm. Children were also more forgiving, re-initiating cooperation more often, after the trustee defected in the social conditions compared to the computer conditions. Bayesian model comparison shows that the decision to trust and sustain cooperation in the social and non-social conditions (in conditions that only differ in the information given to the child) relies on different strategies. While an RL model outperformed fixed strategies in the non-social condition, a simpler tit-for-tat strategy described behavior of children more accurately than RL in the social condition. Our results indicate that a computational modeling approach can detect selective social strategies for establishing trust and cooperation between children in multi-round economic games. In a next step, we will test the neural implementation of these strategies.

Keyword: social interaction, adolescence, computational modeling, reinforcement learning

**B16 Serotonergic innervation is decreased in the basolateral amygdala in Williams syndrome**

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Williams syndrome (WS) is a disorder characterized by a hyper-affiliative social drive and atypical social cognition. Previous neuroimaging studies have demonstrated both structural and functional irregularities of the WS amygdala. A recent postmortem study found a significant increase in the number of neurons in the lateral nucleus in WS. The lateral nucleus is the primary site of cortical input in the amygdala, and as the largest nucleus of the basolateral amygdaloid complex, is a critical component of sociocognitive neural circuitry. The serotonergic system is a key regulator of socio-emotional behavior, and the amygdala is heavily innervated by serotonergic axons. A qualitative study noted a general increase of serotonergic axon density in the postmortem brains of autistic individuals compared to neurotypical (NT) brains, but no study has yet quantitatively examined serotonergic axon density in the human amygdala. Utilizing immunohistochemical staining techniques and unbiased stereological methods, we quantified serotonergic axon density in the basolateral nuclear and central nucleus of the human amygdala in postmortem WS and NT brains. We found that serotonergic axon density was lower in WS compared to NT, with axon density in the basolateral nuclei demonstrating greater differences between the two groups than axon density in the central nucleus. These findings demonstrate that serotonergic innervation of the amygdala is disrupted in WS, with greatest deficits occurring in the basolateral nuclei. Given the critical roles of the basolateral nuclei in social brain circuitry and the serotonergic system in the regulation of social behavior, these findings may contribute to the hypersocial phenotype that characterizes WS.

Keyword: Williams syndrome, autism, amygdala, serotonin

**B17 Dopamine receptor coactivation enhances oxytocin potency and efficacy at marmoset and human oxytocin receptors**

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Oxytocin (OT) and dopamine (DA) are characterized by many physiological functions including their co-dependent roles in modulating social functioning. Both have received considerable attention as targets for therapies in social deficits because 1) exogenous OT and DA treatments influence social outcomes, 2) OT neurons innervate DA neurons, and OT/DA receptors co-localize and form physiologically relevant dimers in the reward system, and 3) structural variation in the coding sequence of the OT ligand (e.g., Pro8-OT) in primates is associated with species differences in social/parental behavior. We tested the hypothesis that co-administration of DA agonists and OT (Leu8-OT and Pro8-OT) in cells co-expressing marmoset OT (mOTR) or human OT receptors (hOTR) with DA-2 receptors (D2R) would produce enhanced in vitro pharmacological properties (e.g., Ca2+ signaling) compared to cells expressing OTR alone. The co-
administration of a D2R agonist, quinpirol, and Pro8-OT resulted in a significant increase in potency and efficacy at mOTR co-expressed with D2R compared to OTR alone, and less so at hOTR when co-administered with Leu8-OT. Moreover, co-administration with DA produced significant increases in both Leu8-OT and Pro8-OT efficacy at mOTR and hOTR co-expressed with D2R, but this only resulted in modest changes in potency. Overall, Pro8-OT potency at mOTR and Leu8-OT efficacy at hOTR show the greatest changes in signaling with the presence and activation of D2R. These DA dependent changes in OTR signaling suggest that targeting potential OT/D2 heterodimerization may lead to novel mechanisms and promising therapeutics for treating social deficits related to OT and DA receptor signaling.

Keyword: Oxytocin, Dopamine, Neuropharmacology, Marmoset

B18  Face-selective voxels in the macaque frontal lobe are activated more by illusory faces than non-face objects.

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Rhesus monkeys share our experience of face pareidolia, the perception of illusory faces in everyday objects. This finding indicates that face detection is driven by a rudimentary structural code that is common among real and illusory faces and diverted from the realistic visual characteristics of conspecifics (e.g. the typical color associated with faces). The study’s aim was to determine whether the face-selective areas of the monkey brain are responsible for distinguishing illusory faces from non-face objects. We used functional magnetic resonance imaging to capture the whole-brain response to illusory faces and non-face counterparts in awake macaques. We scanned four male rhesus macaques (Macaca mulatta) in a 4.7T Bruker scanner following an injection of monocrystalline iron oxide. The monkeys were trained to sit in an MR-compatible chair during scan sessions while fixating on a fixation spot (0.7-dva). During the experiment, monkeys viewed images of illusory faces and non-face objects presented in an on-off block design. For each subject, a face-selective mask was created using data from an independent localizer. For analysis, the mask included all voxels that were activated significantly more by monkey and human faces than by scrambled faces, objects, and scenes (individual voxel threshold, p = 0.001; cluster threshold = 1, 15 voxels). Using this mask as a region of interest, on average, 76% of the face-selective voxels were activated more by the presentation of illusory faces than by non-face objects. The face-selective voxels with the strongest response to pareidolia were in the frontal lobe, specifically the prefrontal orbital and prefrontal lateral face patches which are thought to be responsible for retrieving and responding to socially relevant information in faces, such as expression. These results indicate that the specialized and spontaneous response macaques have towards illusory faces during free viewing is supported by activity in the frontal lobe.

Keyword: Illusory faces, facial processing, fMRI, face patches

B19  Oxytocin dependent reopening of a social reward learning critical period with (+/-)-3,4-methylenedioxyamphetamine (MDMA)

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The concept of a ‘critical period’ originated from pioneering descriptions of filial imprinting behaviors in geese and ocular dominance plasticity in cats. Since these early observations, mechanistic characterization of critical periods has revealed an important role for exuberant brain plasticity during early development, as well as constraints imposed on these mechanisms as the brain matures. In disease states, closure of critical periods limits the ability of the brain to adapt even when optimal conditions are restored. Thus, identification of manipulations that reopen critical periods have been an obvious priority for translational neuroscience. To date, these advances have primarily come from studies focused on sensory critical periods, while mechanisms underlying the establishment and reopening of social critical periods remain largely unknown. Here we provide evidence that developmental regulation of oxytocin (OT) mediated synaptic plasticity (long-term depression, LTD) in the Nucleus Accumbens (NAc) establishes a novel critical period for social reward learning. Furthermore we show that a single dose of (+/-)-3,4-Methylenedioxyamphetamine (MDMA) reopens the social reward learning critical period and leads to a metaplastic upregulation of OT-LTD. MDMA-induced reopenning of the social reward learning critical period requires activation of OT receptors, and is recapitulated by OT terminal stimulation in the NAC. These findings have significant implications for understanding the pathogenesis of neurodevelopmental diseases characterized by social impairments, as well as disorders that respond to social influence or are the result of social injury.

Keyword: Oxytocin, MDMA, Critical Period, Social Reward Learning, Nucleus Accumbens, Synaptic Plasticity

B20  Searching for neural substrate underlying rule-observance behavior of competing mice in social conflict

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Violating social rules might bring immediate individualistic profit, whereas orderly resolution by consent rules requires patience, but enhances long-term mutual benefit. However, the neural circuits mediating these socio-economical strategies are remained unclear. Here, we developed modified two-armed maze that uses wireless electrical brain stimulation as reward. First, the mice were individually operant-trained to initiate and then receive the reward at the signaled arm. Then, two mice were coupled and had to cooperate to initiate reward but then to compete over reward allocation. Mice develop and observe a rule of reward zone allocation that increases the total amount of reward and reward equity between the pair. Now we are investigating on the role of medial prefrontal cortex (mPFC) in reward zone allocation by using chemogenetic DREADD system and in vivo unit recordings. These results will provide a framework for understanding the circuit basis of interactive social behavior.

Keyword: social conflict ; problem solving

B21  Sex differences in social reward and sex-specific effects of oxytocin on social reward and social motivation in Syrian hamsters

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The rewarding properties of social interaction are a fundamental element in the expression of adaptive social behaviors and the development of social relationships, while dysfunctions in social reward likely contribute to the etiology of many psychiatric disorders. Because social behavior evolved in response to different selective pressures in males and females, the neurobiological mechanisms mediating social reward are likely sex-dependent, and which may contribute to sex differences in the prevalence of psychiatric disorders. Using the traditional Conditioned Place Preference (CPP) test and a recently validated Operant Social Preference (OSP) test, we report that females displayed about a 4-fold greater preference for social interactions compared to males. We have previously shown that activation of oxytocin receptors (OTR) in the ventral tegmental area (VTA) is essential for social reward in male Syrian hamsters. However, because the mesolimbic dopamine system and the oxytocin (OT) system are sexually differentiated, we hypothesized that OT in the VTA has sex specific effects. Inhibition of OTR in the VTA during social interaction conditioning decreased social reward in both males and females. However, exogenous stimulation of OTRs or treatment of OT into the VTA had sex-specific effects on social reward. For females, injections of OT or an OTR agonist decreased social reward, but for males, OT or an OTR agonist increased social reward. In conclusion, females found same-sex social interactions more rewarding than
males, and although the OT system is necessary for social reward in both males and females, exogenous stimulation of the OT system can increase social reward in males, but decreases social reward in females. Thus, similar to sex differences in drug reward, females may be more sensitive to social reward; there may be an inverted-U shaped dose response curve for social reward value with females shifted more to the left compared to males.

Keyword: Dopamine, Mesolimbic Dopamine System, Drug Reward, Operant Conditioning, Nucleus Accumbens


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Introduction: Evidence for interventions involving combined mental and physical training is showing promise for reducing psychosocial stress in clinical and nonclinical populations. The purpose of this pilot was to examine a high-dosage combination intervention involving mindfulness meditation and aerobic exercise training and its theoretical mechanisms to guide future fully-powered research.

We focus on changes in use of emotion regulation strategies, improvements in cardiorespiratory fitness, and functional and structural adaptations of the brain.

Methods: 17 healthy participants (males = 8; age: M = 22.88 years) were subjected to 16 weeks of combination training. The aerobic component comprised half-marathon training conducted three days/week, while the mindfulness component comprised daily formal meditation and weekly group psychoeducation. Self-report indices were assessed through questionnaires. Cardiorespiratory fitness was assessed through incremental exercise testing. Functional plasticity of focused-attention meditation was assessed through fMRI in a blocked design. Structural plasticity was assessed using VBM analysis.

Results: The intervention yielded significant reductions in psychosocial stress, repetitive negative thinking, and improvements in use of cognitive reappraisal. There was no change in VO2max, but significant improvements in submaximal aerobic capacity. During focused-attention meditation, there were significant BOLD changes in regions implicated in social and affective functions. This included inhibitory control and selective attention (dorsal anterior cingulate) and introspective awareness (bilateral insula). There was a trend-level increase in hippocampal grey matter volume. Conclusion: These results provide preliminary support for high-dosage combination training for reducing psychosocial stress and identify potential mechanisms.

Keyword: psychosocial stress, mindfulness, aerobic exercise, fMRI, VBM, emotion regulation, cardiorespiratory aerobic fitness

B23  Yorodent: Measuring Social Behavior of Multiple Rodents Using Convolutional Neural Networks

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Although rodent social behaviors are far more rudimentary when compared to those of humans, they nevertheless are controlled by neural mechanisms that are similar to those in the human brain. Thus rodents have been widely used to study aspects of human social behaviors, such as social play, social defeat, social isolation, as well as diseases with social deficits, such as social memory loss, social anxiety, and autism. Social behaviors in these studies most commonly are quantified manually, which is both time-consuming and error-prone. Here, we present a deep learning-based method that automatically detects social behaviors among multiple rats in video (1080p, 30fps) data. Aided by 3D printed colored ear tags, we can track four rats from each video. A convolutional neural network (YOLO v3) was trained using over 8,000 manually labeled images to identify the nose, head, body, anogenital area, and tail from each rat. Our evaluation using over 8,000 images not used for training showed recall of 99.4–100%, 99.1–99.9%, 98.6–99.9%, 98.0–99.9% for these body parts from images with one to four rats, respectively. Precision ranged from 96.8–100%. Each rat is then digitally reconstructed in each video frame to allow the measurement of social events, including nose-nose, nose-body, nose-anogenital, body-body, as well as follow, grouping, and huddle. We tested our method on a set of videos of 2 – 4 rats. We found the quantitative measures obtained from these videos to be highly consistent across group sizes, with groups of 2 rats tend to have larger variations than groups of more rats. Because its high accuracy and consistency, this approach allows a rat of interest to be tested within the same test session with one familiar and one unfamiliar conspecific, thus improves experimental efficiency. We anticipate this method to have a wide range of applications in social neuroscience, including the study of social consequences of drug addiction.

Keyword: social behavior, deep learning, convolutional neuronal networks

B24  Oxytocin and Vasopressin Effects on Mentalizing

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In the past decade, research on oxytocin has sky rocketed. Oxytocin has been shown to have wide-ranging effects from increasing pair bonding to increasing trust to increasing fear of strangers. We examined whether oxytocin and vasopressin would also increase Theory of Mind performance on a mentalizing task. We recruited 186 undergraduate students in a double blind fMRI study to respond to the Why-How task (i.e. answering the ‘why’ or ‘how’ of a person’s action) after an intranasal administration of oxytocin, vasopressin, or a placebo. We found no improvement on accuracy or reaction time on the Why-How task for either oxytocin or vasopressin including when we controlled for sex. Even though we found very robust typical activation patterns for why vs. how, we did not find oxytocin or vasopressin moderation effects on these activations. We also did not find task based differences in functional connectivity within and between the default mode network (‘why’ network) and mirror neuron network (‘how’ network). With more explorative analysis, we did not find consistent results of multiple individual differences (e.g. Autism-Spectrum Quotient, Empathy Quotient, perspective taking, etc.) moderating connectivity depending on oxytocin or vasopressin. Given the large sample size of our study, it is reasonable to infer we could not find evidence of either oxytocin or vasopressin altering mentalizing ability and brain activation in the areas required for these tasks.

Keyword: Oxytocin, Vasopressin, Mentalizing, fMRI

B25  Action Observation Network Activity Modulated by Social Content of Action Stimulus

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Understanding others’ actions is crucial to social cognition. The Action Observation Network (AON) is a brain network that is activated both when performing and observing an action. Through connectivity with other brain regions, the AON has been implicated in social processing. Whether the AON preferentially responds to facial expression rather than hand actions is an open question. We hypothesized that the inferior frontal gyrus (IFG) of the AON would preferentially respond to observation of social effectors (i.e., emotional faces) over purportedly less social effectors (i.e., hands). A third category, non-emotional faces, was hypothesized to elicit intermediate activation between hand and emotional facial actions. Twenty typically developing children (11.2 ± 1.3 years) completed a functional neuroimaging experiment in which they observed and produced blocks of hand and face actions from these three stimuli categories in two separate runs. Action videos were observed; pictures cued action production. An ROI analysis was conducted in which each subject’s percent signal change during the observation task to each of the three stimuli categories over baseline rest was found in 8mm spheres drawn around points of bilateral peak group
activation in the IFG across all stimulus conditions during the action production task. Consistent with our hypotheses, responses to face and hand stimuli differed significantly, in both the right and left IFG ROIs, with responses to non-emotional faces trending to elicit an intermediate response between emotional faces and hands. While there was a graded response along the socialness of stimuli in the IFG, it was opposite to the direction expected, with hands eliciting the greatest response. In addition to being more novel, these hand stimuli may be more "social" than originally conceived, potentially invoking more action-understanding or implicit mentalizing-type processing than the more typical emotional face stimuli used.

Keyword: Action Observation Network, mirror neurons, hands, faces

B26 Empathic Accuracy and Empathy: Are People Motivated By Group Membership?

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The current study was designed to assess participants motivation to empathize with ingroup and outgroup members. An fMRI-based empathic accuracy paradigm was used (Zaki et al., 2013), where 40 individuals were shown autobiographical videos of orator’s discussing positive and negative events. Individuals were told to continually rate how good or bad the orator felt while they were describing the events. Empathic accuracy was measured by the correlation between participant’s ratings, and the orator’s own ratings of their emotional state. Behavioural results indicate that empathic accuracy scores did not differ among groups, and empathic concern scores were positively, albeit non-significantly, related to empathic accuracy scores. fMRI results suggest that for ingroup members, there was a negative association between activation in neural regions underlying empathy and perspective taking with participants’ empathic concern scores. While empathic concern scores do not appear to influence neural activity for outgroup members, for outgroup > ingroup members, there is a positive association between activity in left anterior insula (AI), middle prefrontal cortex and temporal cortices, for those higher in empathic concern. Parametric modulations between accuracy and neural activity were correlated with empathic concern to determine neural/accuracy synchrony. Results suggest a negative correlation for ingroup members, where there was lower neural/accuracy symmetry for those higher in empathic concern in regions such as the AI, medial prefrontal cortex and anterior cingulate cortex (ACC). There was a positive correlation for outgroup > ingroup members, where there was higher neural/accuracy symmetry for those higher in empathic concern in bilateral AI, mPFC and ACC for their outgroup members. While the behavioural and neural data are not inherently consistent, the results indicate that there are empathy-related differences towards those with varying perceived closeness.

Keyword: Empathy, Perspective-Taking, Empathic Accuracy

B27 Brain Dynamics of Female Hypoactive Sexual Desire Disorder (HSDD)

Wasuwat Siewsrichol, E. Kaske, S. Cacioppo, The University of Chicago

Hypoactive sexual desire disorder (HSDD) is one of the most prevalent female sexual health problems. The top-down neurofunctional self-attention-model (SAM) of desire suggests that HSDD is partly modulated by a specific cognitive interference that inhibits sexual desire and arousal. Recent neuroimaging research reinforced SAM in patients with HSDD by demonstrating not only lower brain activity in brain network of sexual desire, but also higher brain activation in the self-referential brain network. Because of the temporal limitation of functional magnetic resonance imaging (fMRI), the spatiotemporal dynamics of the HSDD brain network remains unresolved. Here, we investigated the spatiotemporal dynamics by combining a behavioral desire decision task with high-performance electrical neuroimaging. Procedure: A total of 22 female patients who met the DSM-V criteria for HSDD (Mean age=36.5 years, SD=10.5 years) were presented with a series of stimuli in our standard behavioral task i.e., the Desire Intention Task (DIT) while their brain activity was recorded with 128AgCl carbon-fiber coated electrodes. Results. HSDD patients showed low levels of sexual desire as gauged with the standard sexual desire index (M = 22.6, SD = 10.5) and a high percentage of “No” responses (M=78%) during the DIT. Electrophysiological neuroimaging results extended these behavioral data. Group-averaged evoked brain microstate analyses revealed four stable states: 1) between 70 and 86 with a Global Field Power (GFP) peak at 79ms; 2) between 105 and 144 ms with a GFP peak at 138ms; 3) between 160 and 256 ms with a GFP peak at 241ms; and 4) from 288 to 1000 with a GFP peak at 796ms. Results implicated the neural circuits reminiscent of early self-referential processing and spectatating temporally positioned to exert top-down influences on visual processing and decision making. Conclusions: These results are in accord with the self-attention model of desire.

Keyword: Social neuroscience, Neuroimaging, HSDD, Women’s Health

B28 Eye Dynamics of Desire

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Purpose: Reading other people’s eyes is a valuable skill during interpersonal interaction. Recent empirical evidence suggests that where someone looks can be indicative of their interests, goals, as well as emotional state. In our previous studies, we identified different visual patterns for love (towards the face and eyes) and for sexual desire (towards the torso) in healthy subjects. Little is known, however, whether these visual patterns differ in patients with hypoactive sexual desire disorder (HSDD). Based on the top-down neurofunctional self-attention-model of desire, which suggests that inspecting, monitoring, and evaluating oneself before or during sexual activities interferes with sexual desire, we hypothesized that patients with HSDD will look longer at the face than the torso of potentially desirable stimuli. Procedure: A total of 25 women with HSDD (Mean age: 31.40 years, SD: 8.47) and 18 women with no HSDD (NHSDD) (Mean age: 25.95 years, SD: 4.81) were presented with a series of stimuli in our standard behavioral task i.e., the Desire Intention Task (DIT). Participants then completed a series of questionnaires (e.g., demographics, level of sexual desire, anxiety and depression). Eye movements were recorded during DIT. Three main dependent measures were used: (1) time to first fixation (2) duration of first fixation, and (3) average duration of all fixations during stimulus presentation. As in our previous work, these measures were calculated for two visual regions of interest, face and torso. Results: Results showed that HSDD time to first fixation was significantly longer to the face (M=280.33ms, SD=53.16) compared to NHSDD (M=241.28 ms, SD=45.84) participants, t(38)= 2.475, p <.05. No significant differences were found for other dependent variables. Average duration of all fixations did not significantly differ between groups. Conclusions: These results are consistent with the top-down neurofunctional self-attention model of desire.

Keyword: social neuroscience, sexual desire, HSDD, eye tracking

B29 Stealing a win: social influences on risk taking correlate with theft.

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We sought to develop a real-time interactive version of the balloon analogue risk task (BART) in which social modulation of risk preferences and their neural correlates could be measured and related to real-world risk taking. Human participants were recruited in groups of 4-10 (1 of whom underwent fMRI) to play competitive version of the BART task, providing large behavioral samples (n=156) and fMRI data. In this competitive game, participants played a random opponent whose identity was hidden, allowing them to only utilize information from the immediate interaction. Post-experiment, standard economic measures of risk and ambiguity preferences, and surveys of real-world risk taking behaviors were
administered. Participants’ behavior on individual trials were coupled to the behavior of their opponent. Compared to playing alone, players would cash in after more pumps if their opponent pumped to a high level and after fewer pumps when their opponent’s balloon popped early. We determined the slope of this effect for each participant and used it as a measure of their susceptibility to social influence during risk taking. While behavior while playing alone correlates with drug use, this social-risk susceptibility measure correlates with the likelihood that a participant has stolen something in the last year (p<0.01). A finding that survives Bonferroni correction and replicates in a second, independent sample. FMRI activation specifically to risk taking in the competitive task correlates with activity in the temporal-parietal junction (TPJ) but not other areas of the brain associated with risk. We found that susceptibility to direct social influence on risk preferences correlated with stealing and was related to activation in the TPJ but not in areas of the brain previously associated with risky decisions. This is consistent with the domain specific view of risk, in which social risk is represented in areas of the brain related to social processing.

Keyword: Risk, TPJ, fMRI

B30 Neural substrates of hypersociality in Williams syndrome: correlating variation in genetics, structural anatomy, and postmortem histology


Williams syndrome (WS) is a rare neurodevelopmental disorder caused by the hemideletion of 25-28 genes at 7q11.23. Its unusual sociocognitive phenotype is notably characterized by the disinhibition of social behavior, with a relative sparing of language ability. Increased social approach behavior in WS may represent increased incentive saliency of social stimuli, likely implicating abnormalities of inhibitory circuitry within the prefrontal cortex, amygdala, and striatum. Our previous research found a major increase in oligodendrocyte density in the medial caudate nucleus, which receives cortical afferents from orbitofrontal and ventromedial prefrontal areas involved in reward processing. Given the important role of oligodendrocytes in myelination, we additionally utilized multimodal imaging techniques to examine white matter differences in living subjects with WS and neurotypical individuals. We found evidence for increased fractional anisotropy (FA) in caudate tracts which, along with other measures, may support evidence for disrupted myelination. These differences were not observed in individuals with WS who have smaller deletions of the WS region. Importantly, animal models of the deletion of GTF2I at the periphery of the WS deletion have demonstrated abnormalities of cerebral angiogenesis and dysfunction of endothelial cells, which guide the migration of oligodendrocytes along vasculature in the developing brain. Hyperabundance of oligodendrocytes in gray matter in the caudate may therefore relate to dysfunctional migration of oligodendrocytes into white matter, suggesting deficits in myelination that may underlie reduced frontostrital activation and behavioral response inhibition observed in the disorder. Taken together, differences in the brains of individuals with WS at both the macro- and microstructural level further indicate a role for frontostrital dysfunction in the disorder’s distinctive behavioral phenotype.

Keyword: Williams syndrome, autism, glia, myelination, oligodendrocytes, multimodal imaging

B31 The Social Origins of Rational and Logical Cognition of Intelligence

Suketu Patel, S. Patel, Independent Researcher

My argument purports that for rational behavior to transpire there must be restrictions on behavioral possibilities. These restrictions are moral and social rules that are both innate and learned. They lay the groundwork for cooperative behavior and create the internal dilemma that culminates to a rational decision. This paper puts forth a phylogenetic and ontogenetic rooted theory for how sociality provides the neural basis for our ability to logically reason and in-turn build complex tools. By using qualia and valence theory I illuminate the relationship to empathy, social rules, and altruism. My examination shows how hominin sociality provided the fundamental skills for intentional agents to behave rationally. The rudiments of mathematical cognition begin with the ability to subitize quantities and transgresses into the ability enumerate them. With increased proficiency, subitizing and enumerating allow for our incredible tool building aptitude as well as directly contribute to our rational decision making. A massive step in our evolution is when anatomically modern humans became behaviorally modern. We see this through archeological artifacts, artwork, and tools such as Lebomba and Ishango bones that are etched with enumeration marks. These tools and subsequent human artifacts provide evidence that sociality was a pre-requisite for behavioral modernity, enumeration, and is the foundation of our pioneering intelligence.

Keyword: Rationality, Valence, Mathematical Cognition, Morality, Intentionality, Agency, Theory of Mind, Qualia

B32 The Role of Parental Touch in the Development of Early Social Motivation in Individuals with Autism Spectrum Disorder

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Background and scope: Our ability to process and differentiate between affective and non-affective touch is thought to have potent evolutionary implications with the presence of specific affective-touch sensitive sensory receptors, C-tactile (CT) afferents, found in areas of the skin where hair is present. In neurotypical populations, parental touch has been shown to have positive effects on early social, emotional, motor, physiological, and autonomic development. The social motivation theory, as a developmental model of autism spectrum disorder (ASD), proposes that neurological dysfunction leads to diminished social motivation which drives deficits in social responsiveness and initiation reducing opportunities for social interaction and learning. The following research review summarizes the literature on the impact of early affective touch on social motivation in children with ASD and discusses the potential role of affective touch in intervention. Methods: Systematic searches were conducted using the PsycINFO and Google Scholar databases with search terms ‘touch’ and ‘autism’; ‘tactile’ and ‘autism’; and ‘social’, ‘touch’, and ‘parent’ for the period of 1995 to May, 2018. Findings: Both behavioral and neuro-biological research support altered reactivitiy to tactile stimuli in individuals with ASD. Conclusions: Research suggests that tactile avoidance in early childhood predicts later social deficits and may be an early indicator of ASD. Atypical tactile sensitivity, in particular, may limit infants’ opportunities for social engagement leading to detrimental effects on long-term development. Lack of social motivation leading to an avoidance of socially relevant tactile stimuli may diminish the reward associated with touch, perpetuating social withdrawal, and atypical social development in children with ASD.

Keyword: autism, affective touch, parent interactions, social motivation
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