TALK ABSTRACTS
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Organized alphabetically by presenter last name. Presenter last names are shown in bold.

USING ROBOTS TO CONDUCT BEHAVIORAL RESEARCH: A CASE STUDY OF SPECIES RECOGNITION IN PRAIRIE-CHICKENS
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Behavioral research is often conducted by observing natural behaviors in the field. However, numerous confounding factors may influence quality of the data obtained, such as the previous interactions between the research subjects or interruptions by non-focal individuals. To control some of these variables, ornithologists have used vocal playback and model presentation experiments with great success. Technological advances are giving behavioral researchers another tool: remotely-controlled robots. The benefits of remotely-controlled robots is that the model has the ability to respond to the focal bird and may elicit more realistic behaviors. I used robotic female Greater and Lesser Prairie-Chickens (Tympanuchus cupido and T. pallidicinctus, respectively) to study mate choice recognition in a hybrid zone. If male display behavior is costly, and males are able to correctly differentiate between conspecific and heterospecific females, then males should display more intensely to conspecific females. Robotic females of each species were presented to males using the same path, and stayed on each focal male’s territory for 5 min. The presentation of the robotic females was video-taped using a Sony HDR-CX160 video camera with 30x optical zoom. Proximity to the robot, time spent displaying and fighting, and intensity of display and aggression were recorded. Results suggest that males of both species display more intensely to female Greater Prairie-Chicken models than Lesser Prairie-Chicken models. This study demonstrates the value of robotic models in conducting behavioral research, but I will also outline the challenges to constructing and properly using robots.

DISSECTING THE GENETIC UNDERPINNINGS OF COCAINE AND METHAMPHETAMINE CONSUMPTION IN DROSOPHILA MELANOGASTER
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Abuse and addiction to psychostimulants like cocaine and methamphetamine present a worldwide health issue. The Drosophila melanogaster model system can be used to identify genetic and transcriptional networks that underlie variation in effects of drug exposure that can serve as a blueprint for subsequent studies on humans. Drosophila also exhibit many of the effects that are observed in humans when cocaine and methamphetamine are consumed. We have derived an outbred advanced intercross population (AIP) from 37 of the sequenced inbred wild-derived lines of the D. melanogaster Genetic Reference Panel (DGRP). The lines are maximally genetically divergent, have minimal residual heterozygosity, are not segregating for common inversions and are not infected with Wolbachia pipientis. We assessed voluntary consumption of 4% sucrose, 4% sucrose + 1.0 µg/µL methamphetamine and 4% sucrose + 1.0 µg/µL cocaine of two replicates of 1,500 flies for each sex and condition. We found significant phenotypic variation in the AIP, in both sexes, for consumption of both drugs; and distinct behavioral effects in some of the tested flies. We collected and froze pools of 150 randomly collected flies and the top 150 consumers for each replicate, sex and condition, and performed whole genome sequencing on each of these pools. We evaluated changes in allele frequencies genome-wide among high consumers and the control flies and identified hundreds of variants associated with drug consumption. These variants are in many novel candidate genes with human orthologues that we will use to further understand the genetic mechanisms underpinning increased drug consumption.
GONADAL HORMONES MODULATE MICROGLIAL CELL MORPHOLOGY IN MEDIAL PREFRONTAL CORTEX IN A SEX- AND STRESS- DEPENDENT MANNER

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Recent studies indicate a role for neuroimmune pathways and microglia in psychological health and disease. Microglia can regulate synaptic plasticity by releasing neuroactive factors and modulating neuronal architecture. We have shown that stress differentially affects microglial activation in males and females in a number of brain regions critical for emotion regulation and cognition, including medial prefrontal cortex (mPFC). Contrary to findings in male rats, chronic stress reduces microglial activation in mPFC in females. To investigate the potential, modulatory role of gonadal hormones in stress-induced microglial remodeling, male and female rats underwent sham surgeries (SHAM), gonadectomies (GDX), or GDX with hormone replacement (male: testosterone [T], female: estradiol [E]). After a recovery period, rats received daily restraint stress (3 h/day, 10 days) or were left unhandled except for weighing. Following the final day of restraint, brains were processed for visualization of microglia via Iba-1 immunohistochemistry. The total area of Iba-1-positive (Iba-1+) material was assessed in mPFC. Gonadectomy increased the total area of Iba-1+ material in males, whereas the total area of Iba-1+ material was similar across unstressed females regardless of hormonal manipulation. Congruent with previous findings, chronic stress had little effect on the total area of Iba-1+ material in mPFC in males. This was reduced in SHAM females, suggesting a reduction in microglial activation state. Chronic stress had no effect on microglial morphology in GDX females. However, the chronic stress-induced reduction in Iba-1+ material was restored in GDX+E animals. Thus, T regulates basal microglial state in mPFC in males, whereas E mediates the effects of chronic stress on microglial morphology in females. This suggests that gonadal hormones may contribute to the differential effects of stress on microglia in mPFC and, in turn, neural function and behavior in males versus females.

SEX DIFFERENCES IN OXYTOCIN MODULATION OF THE REWARDING PROPERTIES OF SOCIAL INTERACTIONS

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The rewarding and motivating properties of social interaction are a fundamental element in the expression of adaptive social behaviors and the development of social relationships. Furthermore, dysfunctions in social reward likely contribute to the etiology of many psychiatric disorders. However, 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 it seems likely that these sex differences may contribute to sex differences in the prevalence of psychiatric disorders. Additionally, recent studies have implicated the OT system in the regulation of social reward. Thus, we hypothesized that OT in the ventral tegmental area (VTA) has sex specific effects on social reward. Using the traditional Conditioned Place Preference (CPP) test and a novel Operant Social Preference (OSP) task, we investigated the role of OT receptors in the VTA on the rewarding and motivating properties of social interactions in male and female hamsters. Although both male and females showed a preference for same-sex social interactions, females showed a greater preference for social interactions in both the CPP and OSP behavioral assays compared to males. Males and females also displayed neuronal activation of OT neurons in the paraventricular nucleus and supraoptic nucleus following a social encounter. Furthermore, injections of OT receptor antagonist into the VTA decreased social reward in both males and females. However, treatment with oxytocin or an OTR agonist into the VTA decreased social reward in females, but increased social reward in males. In conclusion, social interactions were more rewarding in females compared to males, and although the oxytocin system in necessary for social reward in males and females, exogenous treatment of OT decreases social reward in females, but increases it in males. Thus, our data suggest the rewarding properties of social interactions may take the shape of a dose response curve, with females more sensitive to the rewarding properties of social interactions mediated by the oxytocin system.
THE EFFECT OF EXTINCTION ON THE DESTABILIZATION OF AN OVERTRAINED FEAR MEMORY

Reconsolidation is a process by which memories are destabilized, updated, and then restabilized. Strong memories are resistant to undergoing reconsolidation. In the present experiments, we addressed whether an overtrained fear memory could be made susceptible to reconsolidation by first extinguishing, and then, renewing the memory. Rats were trained with ten tone-footshock pairings, followed by eight days of tone extinction in the training context. The next day, rats were placed into a second context and memory for the tone was reactivated/renewed with a single tone presentation. Immediately following reactivation, rats received an injection of midazolam or vehicle. Midazolam has previously been shown to disrupt the reconsolidation of fear memories. Rats were then tested for freezing to the tone in a third context. Midazolam had no effect in rats that did not undergo tone extinction. This is consistent with previous findings suggesting that strong memories do not undergo reconsolidation upon retrieval. However, midazolam significantly attenuated freezing to the tone in extinguished rats. Thus, rats that received tone extinction underwent tone memory reconsolidation following its renewal. In a second experiment, we administered the reactivation session and midazolam injections prior to extinction. Midazolam had no effect and rats extinguished at a rate similar to controls. These data suggest that strong emotional memories may be capable of updating following weakening of memory expression through extinction. This could prove invaluable for therapeutic approaches that attempt to weaken the impact of debilitating memories.

ISOLATION AND IDENTIFICATION OF A BEHAVIORALLY SIGNIFICANT COMPOUND IN SOCIAL ODORS OF TERRITORIAL ANIMALS

Social odors are complex, containing many types of compounds that individually or collectively convey important information about signalers to receivers. Chemical secretions from specialized scent glands on the inner thighs of Sceloporus lizards elicit territorial responses, but which compounds are important for this behavior has not been determined. We identified the volatile organic compounds present in Sceloporus secretions, then conducted a series of chemical playback experiments in the lab using a select few compounds of interest. Our aims were to determine whether (1) these compounds were behaviorally significant when presented alone or in combination, and (2) relative proportions would alter behavioral responses. We presented adult Sceloporus jarrovii (Yarrow’s spiny lizard) males with each chemical stimulus separately for 15 minutes, recording chemosensory responses. Lizards responded to femoral pore secretions (positive control) with the highest rates of chemosensory behavior, and to the fatty acid matrix (negative control) with the lowest rates. Interestingly, an aromatic pyrazine elicited nearly as much chemosensory behavior as the positive control. Lizards were less interested in an aromatic dipeptide, which elicited as much chemosensory behavior as the negative control. Together, the two aromatic compounds elicited an intermediate amount of chemosensory behavior. Our results emphasize that the level of response behavior elicited by a chemical stimulus may not increase with compound abundance, as illustrated by at least one pyrazine present in Sceloporus odors. We discuss the implications of our results for territorial and social behavior.
PLENARY LECTURE: EVOLUTION OF EMOTIONS AND EMPATHY IN THE PRIMATES
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Emotions suffuse much of the language employed by students of animal behavior -- from "social bonding" to "alarm calls" -- yet are often avoided as explicit topic in scientific discourse. Given the increasing interest of human psychology in the emotions, and the neuroscience on animal emotions such as fear and attachment, the taboo that has hampered animal research in this area is outdated. The main point is to separate emotions from feelings, which are the subjective experiences that accompany the emotions. Whereas science has no access to animal feelings, animal emotions are as observable and measurable as human emotions. They are mental and bodily states that potentiate behavior appropriate to mostly social situations. I will discuss early ideas about animal emotions and draw upon research on empathy and the perception of emotions in primates to make the point that the study of animal emotions is a necessary complement to the study of behavior. Emotions are best viewed as the organizers of adaptive responses to environmental stimuli.

THE EVOLUTION OF COLORFUL FEMALES; A MODEL FOR SOCIAL EVOLUTION
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The evolution of exaggerated coloration in male animals has long been an area of active research. It is now well understood that competition for reproductive opportunities (i.e. sexual selection) usually drives the evolution of bright colors in males. However, empirical studies now report numerous examples of exaggerated coloration in female animals. Furthermore, exaggerated female colors are often found in species where female fecundity is not limited by access to males and therefore females should be immune to sexual selection. Nonetheless, colorful females have evolved across taxa. These traits in females tend to share one important feature of the analogous traits in males: they are usually related to reproduction. However, they differ in several ways from the common patterns of exaggerated color in males. In particular, my research (both empirical and theoretical) suggests that females may not evolve bright colors to directly increase their fecundity, but rather to obtain socially mediated fitness benefits (e.g. protection from predation or paternal care). In this case, “social selection” may explain a large swath of poorly understood biodiversity (exaggerated female coloration). In turn, the study of exaggerated coloration in female animals represents a powerful model for understanding how variation in the social landscape shapes trait evolution more generally.

MOLECULAR MECHANISMS UNDERLYING OXYTOCIN RECEPTOR REGULATION IN THE PRAIRIE VOLE
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Several psychiatric disorders are characterized by social deficits, and genetic variation in the oxytocin receptor gene (Oxtr) has been found to associate strongly with social cognition and behavior in humans. The socially monogamous prairie vole provides a unique opportunity to explore how variation in Oxtr influences the brain and behavioral phenotypes. Among voles, there is substantial individual variation in Oxtr expression and receptor density across the brain, notably in the striatum. Previously our lab has shown that higher Oxtr expression in the striatum predicts increased alloparental behavior and resilience to early-life social isolation. Further, a tightly linked group of 14 single nucleotide polymorphisms (SNPs) across Oxtr predicts variation in receptor density in many areas of the brain, and most significantly in the nucleus accumbens (NAcc), a subregion of the striatum. We aligned sequences spanning these associated SNPs to transcription factor binding site data from brain tissue in mice. One SNP, NT213739, is located within a genomic region marked with histone modifications unique to enhancer activity, and with the CCCTC binding factor CTCF. We then assayed interactions between CTCF and Oxtr in prairie vole brain tissue using Chromatin Immunoprecipitation and quantitative Polymerase Chain Reaction (ChIP-qPCR). We confirm a significant > 4-fold enrichment for CTCF binding in vole striatum (n=6) at NT213739 but not at a distal linked SNP, which supports that NT213739 specifically may be implicated in CTCF activity and variation in expression. Future directions will be to analyze allelic affinity for CTCF at the NT213739 locus, and to generally define CTCF binding and histone modifications across the entire gene and in more brain regions. This research may provide future targets for pharmacological regulation of Oxtr, and generally deepen our molecular understanding the relationship between Oxtr and social cognition and behavior.
Lizards are known to be highly variable with respect to sensory cues used while foraging. Some species are active foragers that follow trails of olfactory cues, whereas other species are ambush foragers that focus on visual cues to locate prey. While the responses of lizards to olfactory cues of prey and non-prey items have been well characterized throughout the years, few studies have tried to hone in upon the specific compounds that elicit responses from predatory lizards. In the present study, we expose two species of predatory lizards - each representing different foraging strategies - to two different volatile chemical compounds associated with herbivorous insects in nature. We found that an ambush foraging species (Sceloporus virgatus) responded to trans-2-hexenal, a compound produced by plants to attract predators to the location of herbivorous arthropods; whereas we found that an actively foraging species (Aspidoscelis exsanguis) responded to hexanoic acid, a component of insect body odor. This suggests that foraging strategy and olfactory responses may be linked. Based upon these findings, we also hypothesized that our actively foraging species would respond to other components of arthropod body odor as well. To test this, we further exposed lizards to cuticular hydrocarbons (CHCs) isolated from various naturally occurring arthropods. We found that CHCs alone were sufficient to cause A. exsanguis to attack cotton swabs, suggesting that they are sufficient for prey recognition in our study species. Altogether, our results show that an active foraging lizard species is highly attuned to the body odor of prey, whereas an ambush foraging species responded to a plant-derived odor associated with the presence of herbivorous arthropods. Future comparative studies utilizing a larger sample of lizard species could disentangle the relationship between foraging behavior and olfactory perception.

The endogenous circadian system synchronizes physiology and behavior with the environment. This system is regulated by exogenous and endogenous factors, such as light and hormones, respectively. Exposure to other environmental factors, including dim light at night and phthalates, modifies brain physiology and hormone synthesis. Phthalates, including di-(2-ethylhexyl) phthalate (DEHP), are ubiquitous endocrine disrupting plasticizers capable of modulating behavior. However, the effects of dim light at night (dLAN) and phthalate exposure on circadian behavior have remained largely unexplored. Here, we used a “two-hit” model to test the hypothesis that dLAN and DEHP disrupt locomotor and feeding behaviors. Adult CD-1 male and female intact mice were individually housed with running wheels. Mice (8/sex/group) were treated for 30 days with one of the following conditions: 12h:12h light:dark (Control), 12h:12h light:dLAN with 5 lux light during the dark phase (dLAN), 12h:12h light:dark with 50µg/kg/day DEHP (DEHP), or 12h:12h light:dLAN with 5 lux light during the dark phase and 50µg/kg/day DEHP (dLAN-DEHP). Animals dosed with DEHP were orally dosed by gently pipetting DEHP into the cheek. The dose of DEHP was selected as it is within the range of human exposure and has been shown to modify other behaviors in mice. Daily wheel running was used for locomotor behavior analysis. For feeding behavior, light phase and dark phase food consumption was measured every 12 hours. Preliminary data indicate that treatment increases body weight in males, but not females. Interestingly, total food intake is modified in males and females, as well as nocturnal vs. diurnal food consumption. Furthermore, preliminary data indicate there is an increase in activity and modification of the ratio of diurnal:nocturnal activity, in both males and females of multiple treatment groups. Together, these data will provide some of the first evidence how dLAN and DEHP impact circadian output.
PRAIRIE VOLES DELIVERED VIA CESAREAN SECTION FAIL TO FORM PAIR-BONDS AS ADULTS
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There is ample evidence that social behavior is shaped by experiences in early life, particularly stressful experiences. Birth is an especially stressful event, however, the birth experience varies considerably as a function of birth mode. Infants delivered via cesarean section, which now makes up nearly one third of all births in the U.S., have lower levels of several hormones classically associated with the stress response: oxytocin, vasopressin and cortisol. These same hormones are important regulators of social behavior within the brain. We therefore sought to investigate the impact of birth mode on later-life social behavior using the monogamous prairie vole as a model. Prairie voles delivered via cesarean section exhibited behavioral differences throughout development, with changes in the initiation of independent thermoregulation at birth, indices of arousal, and adult social behavior. Specifically, cesarean delivery produced an increase in sensitivity to cold challenge in female offspring, hypoactivity in males, and a failure to form pair bonds when either sex was tested as adults. The changes in thermoregulation and arousal parallel those observed in human infants delivered via cesarean, indicating this may be a useful model to discover new domains of behavior sensitive to birth mode.

MALE COURTSHIP PREFERENCE IS POTENTIALLY ADAPTIVE IN SEASONALLY SYMPATRIC POPULATION DIVERGENCE
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Animal migration can lead to a special case of temporal divergence, seasonal sympathy, in which closely related migrant and resident animal populations co-occur in sympathy during part of the year, but are otherwise allopatric. Because migrants delay reproduction because of the energetic demands of migration, residents would be expected to favor potential mates with similar reproductive timing. We studied dark-eyed juncos (Junco hyemalis), a songbird that exhibits seasonal sympathy. We conducted simulated courtship interactions in which we presented free-living resident males with either a caged migrant or resident female and quantified courtship behavior early in the breeding season of the resident population prior to the departure of the migrants. We found that resident males exhibited a preference for resident females: they sang more short-range song and exhibited more visual displays associated with courtship toward resident females. We conclude that males distinguish between migrant and resident females when risk of interacting with non-reproductive females is high, and thus that male mate choice in seasonal sympathy may be adaptive and act to reinforce divergence between populations with different migratory strategies.
TIME OF FEEDING DETERMINES THE OFFSPRING QUANTITY-QUALITY TRADE-OFF IN ZEBRA FINCHES
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Reproduction is an energy-intensive process, especially for the female. The ability to align physiological rhythms related to reproduction with the day length and nutrient availability confers a species improved reproductive fitness and selection. Studies have shown that temporal restriction of food can synchronize circadian clocks both in brain and peripheral tissues. Also, the effect of caloric restriction or diet supplementation on reproductive fecundity has been demonstrated in birds. However, it is still less understood whether and how feeding times would affect the reproduction and the offspring health. We took the advantage of ability of breeding potential of zebra finches (Taeniopyga guttata) in captivity, and asked the question as to whether food availability restricted for a few hours in morning or evening will impact reproduction in adult birds. Breeding pairs of zebra finch were housed under 12 h photoperiod (12 h light: 12 h darkness). While the experimental birds were given food for 4 hours in morning or evening, the controls were fed ad libitum. The experiment ran for over a year, and various aspects of annual reproductive fitness, fecundity and offspring quality were analyzed. The time of food availability significantly affected the reproductive performance and offspring ‘quality’ in the opportunistic breeder, zebra finches. Whereas an only evening diet significantly delayed the onset of breeding and compromised annual reproductive success rate, the only morning diet compromised severely the offspring activity and body size. Thus, differences in the reproductive performance and offspring ‘quality’ may be the result of a ‘trade-off’ between the ‘quality’ and ‘quantity’ of offspring produced under imposed food availability conditions in zebra finches. Perhaps, the asynchrony between the central clock and peripheral metabolic clock induced by aberrant food availability times has long lasting effects on reproduction in birds.

IMMEDIATE BENEFITS OF SOCIAL PLAY BEHAVIOR
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Social play behavior provides positive behavioral outcomes and is critical to the normal development of juveniles; however, it is also associated with serious and immediate costs, which strongly suggest that play must be adaptive. A promising theory for the adaptive function of play is the “socialization hypothesis,” which suggests that play provides some immediate social benefits, including stronger social bonds, reduced aggression, and reduced stress. We tested these three components of the socialization hypothesis in wild spotted hyenas (Crocuta crocuta). Developing spotted hyena cubs are an ideal model organism in which to test this hypothesis because they spend most of their first year of life at a communal den, where they engage in play, aggression, and other social interactions. In this study, we used behavioral observations coupled with endocrine data obtained using a novel sampling technique to assess the effects of play on both social relationships and juvenile physiology. We first examined whether play predicted different types of social behavior between cubs. We also used repeated endocrine sampling to test for causal effects of play on concentrations of circulating stress hormones. In this way, we assessed the potential immediate benefits of social play behavior.
Serotonin signaling differentially affects morph-specific aggressiveness among two divergent populations of the horn polyphenic beetle, *Onthophagus taurus*

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Sexual selection has led to the evolution of diverse reproductive behaviors that are often well integrated with complex, exaggerated, and equally diverse morphological traits. In many cases, the development of these traits is highly condition-dependent, requiring plastic mechanisms that flexibly adjust behavior to appropriately match morphology. In the horn polyphenic beetle, *Onthophagus taurus*, larval nutrition cues the development of males into either small-bodied hornless or large-bodied horned morphs, each expressing discrete alternative reproductive tactics used to gain access to females. Interestingly, two recently established exotic populations of *O. taurus* have rapidly diverged in several sexually selected traits, including life history traits and horn investment. However, the molecular mechanisms that integrate behavior and morphology across morphs and shape their divergence among populations remain unclear. In this study, we focus on serotonin as one candidate mechanism because i) it has been well established as a regulator of insect aggression, and ii) recent transcriptomic data from *O. taurus* demonstrate differential expression of serotonin biosynthetic genes across morphs and populations. Specifically, we take a pharmacological approach to increase serotonin production of adult male *O. taurus* and ask how this manipulation affects both non-aggressive (approaches, interactions, and retreats) and aggressive (fights and head-butts) behavior. Our findings show that increasing serotonin decreases the frequency and duration of non-aggressive behaviors, while increasing the frequency, intensity, and duration of aggressive behaviors, but does so differentially across morphs and populations. Therefore, serotonin signaling may play a critical and highly context-dependent role in the evolution of morph-specific reproductive behavior and its evolution across populations.

A CENTRAL PATTERN GENERATOR DRIVEN NEUROMECHANICAL MODEL OF FORWARD LOCOMOTION IN *C. ELEGANS*
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*C. elegans* locomotes in an undulatory fashion, generating thrust by propagating dorsoventral bends along its body. Three hypotheses have been postulated: (a) Stretch-receptor feedback driven mechanism for generating and propagating waves; (b) A central pattern generator (CPG) in the head and stretch-receptor feedback for propagating the wave down the body; and (c) A chain of multiple network CPGs along the body. Existing neuromechanical models of forward locomotion in the worm have demonstrated the feasibility of (a) and (b), in this work we build a model to test the third hypothesis. Previously, we showed that, given the neuroanatomy of the ventral nerve cord (VNC) and the available neurophysiology of *C. elegans* neurons, network CPGs are feasible. In the current study, we integrate multiple interconnected VNC neural units along the length of the worm’s body, innervating a model of the musculature, which in turn affects a 2D model of the biomechanics of the body and of the forces in the environment. We use an evolutionary algorithm to fit the unknown physiological parameters of neurons, synapses, and neuromuscular junctions so as to match the mean velocity observed in worms moving on agar, successfully. The evolved solutions demonstrate that the VNC can drive forward locomotion on agar in the absence of stretch-receptor feedback. Each successful evolutionary search produced a distinct set of parameter values, leading to an ensemble of model solutions that are consistent with the known biological constraints. We analyze the properties of the entire ensemble and identify different possible classes of solutions.
EARLY BIPARENTAL CARE IMPACTS EPIGENETIC REGULATION OF THE OXYTOCIN RECEPTOR GENE IN A SOCIALLY
MONOGAMOUS RODENT
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Early experiences impact displays of many social behaviors associated with variation in oxytocin receptor density, especially in the nucleus accumbens. Mechanisms regulating effects of these experiences are not fully understood. Here we studied the socially monogamous prairie vole (Microtus ochrogaster), examining the hypothesis that early parental care impacts epigenetic regulation of the oxytocin receptor gene (Oxtr). Two models that affect oxytocin-regulated species-typical social behaviors were used: one where parental care differed spontaneously, and a second where parental care differed after families received early handling, or not. Four CpG sites in the Oxtr promoter were studied; these are conserved from the human OXTR and are associated with several mental health conditions. Methylation levels did not differ between prenatal offspring and offspring receiving high amounts of early care. Offspring receiving decreased parental care had increased Oxtr DNA methylation in both the nucleus accumbens and whole blood at the four conserved CpG sites. Methylation levels were strongly correlated between central and peripheral tissues. Methylation was also negatively correlated with gene expression and receptor protein levels. Results suggest parental care regulates Oxtr epigenetic markers and these markers are functionally significant. Peripheral measures are also likely good indicators of central Oxtr regulation. These data are the first to show functionally significant changes in epigenetic regulation of Oxtr in the prairie vole that are sensitive to early life experience. These findings further implicate changes in the oxytocin receptor as a mechanism through which early experiences may drive lasting changes in behavior.

WHO’S THE BOSS: SOCIAL DYNAMICS ASSOCIATED WITH LEADERSHIP IN ENDANGERED TOQUE MACAQUES
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In many permanent, multigenerational social groups, certain individuals may have disproportionate influence on group activities and collective decisions. Ties among group members lead to complex and varying patterns of social interactions. We tested whether individuals that have more numerous and stronger relationships with others in the group also have greater influence on group decisions. Specifically, we used Social Network Analysis to explore how social interactions are associated with initiation of group movements and the number of followers in Toque macaques, Macaca sinica. Scan sampling was used to collect behavioral data from a free ranging group of macaques (n= 42) from June–August 2014 in the Mihintale Sanctuary, Sri Lanka. We used USINET 6.528, SPSS 23.0, and SOCPROG 2.5 to perform statistical analyses. The total number of attempts to initiate movement was correlated with the mean number of followers. There was no significant difference in initiation attempts by adult males versus adult females, but the mean number of followers was significantly higher for males than for females. Initiation attempts were significantly associated with both aggression and affiliative behaviors, as well as with dominance scores. However, the mean number of followers was not associated with any of these three traits. Thus, having more interactions is correlated with initiating group movement, but not necessarily with success in influencing movement.
The bidirectional links between hormones and behavior have been a rich area of research for decades, perhaps especially so for the vertebrate sex steroid testosterone (T). Nearly 30 years ago, theory on the evolution of T levels was advanced by the “challenge hypothesis” (Wingfield et al. 1990, American Naturalist), which presented a framework for understanding male patterns of T secretion within and among species. By and large, interspecific, seasonal, and social variation in T levels in males appears to be shaped by the competing demands of parental care vs. male-male aggression. Female competition and aggression are also widespread; however, it is unclear whether and how the challenge hypothesis applies to females. Here, I will present data from my lab, which seeks to identify mechanisms of female aggression and how they evolve. We study the tree swallow (Tachycineta bicolor), a cavity-nesting bird for which social challenges from prospecting rivals pose a very real threat to territorial females. Our results demonstrate that female aggression is adaptive and mediated by T. However, seasonal changes in aggression do not mirror changes in T in circulation, suggesting that additional mechanisms must exist to allow for marked aggression in the face of low T. Our data reveal how seasonal changes in ovarian gene regulation may influence sex steroid production, including high levels of androgen synthesis during the time when females are establishing territories. We also show how seasonal variation in tissue level processing of T (i.e. local steroidogenesis and receptor expression) may support aggression in the absence of elevated T in circulation. Ongoing work investigates the degree to which these seasonal changes in hormones, genes, and behavior also respond to direct social challenges, with the ultimate goal of developing a framework for understanding mechanisms of social competition in females and how they are shaped by natural selection.

Parasitic Exposure and Infection Induces Behavioral Alterations in a Freshwater Snail from New Zealand

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Some parasites with complex life cycles have evolved the ability to manipulate host behavior to increase the chances of infection of secondary intermediate and definitive hosts. Parasitic manipulation of behavior post-infection has been well-documented, but evidence of host behavioral alterations due to parasitic exposure alone is lacking. The freshwater snail species, Potamopyrgus antipodarum, is most commonly infected by Microphallus, a sterilizing trematode worm with a two-host life cycle, in which the snail is the intermediate host and ducks are the definitive host. During foraging, ducks will inadvertently consume infected snails giving the parasite the ability to develop into mature, reproductive adults. A previous study found that upon exposure to parasites snails increase the number of mating events and the number of mating partners. Potamopyrgus antipodarum females have the ability to either reject or accept mating attempts and thus can exert choice in mating partners. In the present study, female mate choice was examined from field-caught snails from two populations. Females from these two populations were presented with males collected from sympatric and allopatric populations. Individual female mating behavior was analyzed prior to and during parasite exposure. Snails were then dissected to determine infection status. Female mate choice was found to be dependent upon both exposure to and infection from parasites for only one of the two populations tested. However, females from both populations that were infected and exposed to parasites mated significantly less than uninfected, exposed females. These results suggest that parasitic exposure and infection may alter female mate choice differently between populations and that infection leads to a reduction in mating events.
FECAL ESTRADIOL AND PROGESTERONE ANALYSIS FOR DETERMINING REPRODUCTIVE STATE OF FEMALE RED COLOBUS MONKEYS (PROCOLOBUS RUFOMITRATUS)

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Conservation strategies benefit from species-specific knowledge of reproduction gained through observation and hormone monitoring; however, basic reproductive information for many endangered species, such as the Ugandan red colobus monkey (Procolobus rufomitratus) is lacking. We used behavioral observations and fecal hormone analyses to delineate red colobus estrous cycles using fecal estradiol and progesterone data gathered in Kibale National Park, Uganda. We created hormone profiles for 14 females undergoing estrous cycling, pregnancy, and lactation as determined from scan samples and ad libitum observations of mating behavior. Differences in average fecal estradiol levels for cycling (102.3 ± 108.6 ng/g), lactating (96.4 ± 217.5 ng/g) and pregnant females (561.9 ± 555.8 ng/g) were detectable (F2, 138 = 32.5, P < 0.0001); however, on an individual level fecal estradiol data yielded mixed results. Regularly cycling females did not follow an expected estrous pattern as spacing between peaks from baseline were often irregular, but females that became pregnant and then lactated tended to follow an expected estradiol profile. Differences in average fecal progesterone levels were not detectable among reproductive states. One possibility for discrepancies between fecal hormone levels and observed reproductive state is the consumption of phytosteroids, as extracts of some red colobus plant foods are estrogenic and others bind to progesterone antibodies. Future research will examine effects of phytosteroids on female red colobus fecal hormone profiles and reproductive state.