

POSTER PRESENTATION ABSTRACTS

Organized alphabetically by first author last name. Numbers indicate poster numbers.

1 AFD VILLI INTEGRITY IS NECESSARY FOR MAGNETIC ORIENTATION BY *C. ELEGANS*

Barickman L, Bracht B, Bainbridge C, and Vidal-Gadea A

School of Biological Sciences, Illinois State University

Previous research by our lab demonstrated that *C. elegans* uses the earth's magnetic field to engage in vertical soil migrations. Magnetosensation in *C. elegans* takes place through the AFD neurons, the first magnetosensory neurons described in any animal. How these cells integrate magnetic information about their environment is not known, nor are the proteins necessary and sufficient for magnetic field detection and orientation. Here we show that orientation to magnetic fields relies on the number and integrity of the sensory villi at the tip of the AFD neurons. Present work in our lab focuses on identifying the molecular transduction machinery responsible for this sensory modality in *C. elegans* and will potentially shed light on how magnetic transduction takes place in other taxa.

2 CIRCADIAN DISRUPTION, COGNITIVE FUNCTION AND NEUROTRANSMISSION IN A RODENT MODEL

Balachandran RC¹, Leventhal MB¹, Robertson AL¹, Beaudin S², Mahoney MM¹, and Eubig PA¹

¹*Department of Comparative Biosciences, College of Veterinary Medicine, University of Illinois at Urbana-Champaign;* ²*Microbiology and Environmental Toxicology, University of California Santa Cruz*

Endogenous circadian rhythms regulate physiological and behavioral functions and synchronize to various cues such as light. Desynchrony of circadian rhythms results in physiological disorders, including cognitive impairments in attention. Shift work is the most common cause of circadian disruption in the working population in the U.S. At the molecular level, cholinergic projections from the nucleus basalis magnocellularis (NBM) modulate circadian rhythmicity in the suprachiasmatic nucleus (the brain's master clock) and also project to the medial prefrontal cortex (mPFC), where they modulate dopamine release and performance on the 5-Choice Serial Reaction Time Task (5-CSRTT), a test of attention and impulsivity. We modeled circadian disruption in adult Long-Evans rats by testing them on the 5-CSRTT during the light-phase (day rats) or the dark-phase (night rats) of their circadian cycles. Importantly, night rats were exposed to light for 1 hour daily during transport and while in the testing room. Attention was not affected by phase of testing, but premature responding (impulsivity) differed between phases. Night rats remained nocturnal and were more impulsive than day rats, which entrained to the time of testing by becoming more diurnal. Yet, in the day rats, nocturnality (% activity in the dark) was negatively correlated with premature responding. Subsequently, we determined that choline acetyltransferase (ChAT) expression in cholinergic cell bodies in the NBM was increased in day rats. Expression of ChAT and tyrosine hydroxylase (TH) in the mPFC did not differ between groups, but, in day rats, mPFC TH expression was negatively correlated with nocturnality. Our results suggest that the 1-hour exposure to light experienced by night rats in the testing room was more detrimental to circadian rhythmicity than day testing, and that premature responding in our experiment may be mediated by dopaminergic signaling. Future studies will further explore these new hypotheses.

3 AFRICAN ELEPHANT CALVES EXHIBIT THE TYPICAL LATERAL SEQUENCE GAIT AND A WALKING TROT

Bates HR¹, and Dale RHI²

¹Department of Biological Sciences, Butler University; ²Department of Psychology, Butler University

Quadrupedal mammals typically use a lateral sequence walk (a Left Hind, Left Front, Right Hind, Right Front footfall sequence) when moving slowly and a trot (alternating between simultaneous Left Hind/Right Front footfalls and Right Hind/Left Front footfalls) when moving faster (Vogel, 2013). Most observers report that African elephants (*Loxodonta africana*) rely on only the lateral sequence walk - modified to "ambling" at higher speeds (Estes, 2012). However, in 1976 Hildebrand presented a limited amount of data, from a combination of Asian and African elephants of unknown ages, indicating that elephants do both walk and trot. In fact, at high speeds elephants move as if their front feet were walking but their hind feet were trotting (Ren & Hutchinson, 2008). Thus, the situation is confusing. On the other hand, it is common for juvenile and adult mammals of the same species to exhibit different gaits (Parker & Clarke, 1990) and there have been no systematic studies of elephant-calf locomotion. We studied two female elephant calves at the Indianapolis Zoo, collecting multiple digital video recordings of them moving freely in several yards (usually in the main exhibit). Consistent with Hildebrand's (1976) data, the calves exhibited both a walking trot and a lateral sequence walk. However, the walking trot tended to occur at low stride frequencies and when the duty factor (stance period as a proportion of stride period) was high. These data suggest that these calves used the walking trot at their slowest speeds. Elephant calves may use the walking trot at particularly slow speeds because of the superior stability that gait allows. A walking trot is the most dynamically stable gait for slowly moving vertebrates such as turtles (Renous, de Broin, Depecker, Davenport & Bels, 2008) and human infants (Patrick, Noah, & Yang, 2012).

4 RHESUS MONKEYS SELECTIVELY SHIFT ATTENTION WITHIN WORKING MEMORY TO PRIORITIZE RELEVANT INFORMATION

Brady RJ and Hampton RR

Department of Psychology, Emory University; Yerkes National Primate Research Center

Attentional mechanisms evolved to allow animals to focus limited processing capacity on information relevant to on-going behavior. In addition to focusing attention within the external environment, humans can shift attention within contents of working memory to prioritize relevant information. While evidence exists that monkeys exhibit some cognitive control over memory, little is known in nonhumans about how attention can be shifted between representations in working memory. Using a post-sample cueing paradigm, we tested the extent to which monkeys can control attention within working memory to prioritize relevant information. Monkeys saw an array of multiple images. Shortly after its disappearance, they were visually cued to a location that predicted which item would be tested in a subsequent recognition test. If monkeys use the cue to shift attention to the cued item within working memory, then they will show better memory for cued items compared to non-cued items. The results of two experiments indicate that monkeys prioritize the cued item with a memory load of two items, but not three. Our results suggest that monkeys selectively shift attention within working memory to prioritize relevant information. Future work will be aimed at understanding the degree of control monkeys have over attention within working memory.

5 EVIDENCE FOR THE SPLIT-ATTENTION HYPOTHESIS: MALE SAILFIN MOLLIES (*POECILIA LATIPINNA*) SPLIT ATTENTION BASED ON SOCIAL ENVIRONMENT

Burridge SB¹, Makowicz AM², and Schlupp I¹

¹Department of Biology, University of Oklahoma; ²Department of Biology, University of Konstanz

In complex social environments mating interactions rarely ever occur privately. Instead, interactions often occur within view of other individuals, known as an audience, which has been shown to influence the behavior of the focal individual. While much of the current literature focuses on how a rival audience influences the mate choice of a focal individual, little is known about how an audience of the opposite sex influences the total amount of time spent with a preferred mate. The split-attention hypothesis predicts that an individual will reduce the time spent with an accessible stimulus when an audience is present, splitting their attention between the two stimuli. Using a sexual-asexual mating complex (*Poecilia latipinna* and *P. formosa*), we tested this hypothesis. Specifically, we asked how male sailfin mollies (*P. latipinna*) split their attention when presented with an accessible stimulus female and a non-accessible audience female using both conspecific females and the male's sexual parasite, the gynogenetic Amazon molly (*P. formosa*). Male attention was observed in four different social conditions: 1) sailfin stimulus, sailfin audience; 2) sailfin stimulus, Amazon audience; 3) Amazon stimulus, sailfin audience; and 4) Amazon stimulus, Amazon audience. Attention was recorded as the amount of time the male spent interacting with either the stimulus or audience female. We found that when there is an Amazon audience, males tend to spend more time with the stimulus females regardless the species. In addition, males spent an equal amount of time between the females when the stimulus female was an Amazon molly and the audience female was a sailfin. Males also tend to spend a greater amount of time with the stimulus female when both the stimulus female and audience female were sailfin mollies. Our study is one of the first to provide direct evidence for the split-attention hypothesis by showing that a male's attention is allocated based upon the social environment in which he interacts.

6 INDIVIDUAL DIFFERENCES IN AGGRESSION ARE BETTER PREDICTED BY SEX THAN BY DIFFERENCES IN VISION

Caceres J, Suriyampola PS, Iruri-Tucker AA, Sykes DJ, and Martins EP

Department of Biology, Indiana University

Many animals become more aggressive when in crowded or stressful contexts, or when their sensory or motor abilities are impaired. Overt aggression may protect these animals by deterring potential attackers before they have a chance to act. Here, we ask whether individual or sex differences in aggression can be predicted by visual or motor abilities as measured in a behavioral task. In this study, we test to see if there is an association between aggression and visual response of male-female pairs of zebrafish (*Danio rerio*). We measured the aggressive behavior (chases) of each individual in the pair in two different test arenas, and then measured their response to a visual stimulus (moving vertical lines) in two different assays. We found low correlations between measures of aggression in two different arenas and moderate correlations between measures of visual response in two different assays, suggesting that the visual-motor response is less plastic than aggression. Moreover, we found only very weak evidence of a negative relationship between aggression and visual response: more aggressive zebrafish were only slightly less likely to respond to the visual stimulus than were less aggressive individuals. Sex was a better predictor of aggression, and females were consistently and significantly more aggressive than were males. However, we found no evidence of a sex difference in visual-motor behavior. Additional studies are needed to explore whether variation in body size can explain individual or sex differences in aggression or vision.

7 BIRTH: AN OVERLOOKED EVENT IN THE DEVELOPMENT OF BRAIN AND BEHAVIOR?

Castillo-Ruiz A, Mosley M, and Forger NG

Neuroscience Institute, Georgia State University

Birth involves dramatic changes in a newborn's environment and the processes associated with birth trigger an 'adaptive stress' response which prepares key organs for the transition to postnatal life. However, little is known about how birth influences the brain and behavior. Cell death is an important feature of brain development as it shapes neural connections. In mice, there is increased cell death across many brain regions around the time of birth. Whether birth induces cell death, and whether mode of birth (Vaginal "V" vs Cesarean "C") influences cell death has not been addressed. We manipulated birth mode in timed-pregnant mice and collected the brains of offspring *in utero* at embryonic day (E)18.5 and E19 and *ex utero* at postnatal day (P)0 (3h after birth), P1, P3, and P23. We monitored the morphometric development (body weight and eye-opening) of these mice and assessed affective state by measuring ultrasonic vocalizations in an isolation test at P9. While birth mode did not affect gross development of newborn or juvenile mice, we observed increased body weight in C mice at weaning. We also found that birth mode may alter neurobehavioral development because C mice had softer calls than V mice in the isolation test. We also found that C born mice had higher cell death perinatally in stress related brain areas and hippocampal subregions. Together our results suggest that birth may be an important event for brain development and deviations from the natural mode of birth may interfere with brain and behavioral development.

8 CHRONIC STRESS DIFFERENTIALLY ALTERS MICROGLIA ACTIVATION IN THE ORBITOFRONTAL CORTEX OF MALE AND FEMALE RATS

Collins C¹, Bollinger JL^{1,2}, and Wellman CM^{1,2}

¹Department of Psychological and Brain Sciences and ²Center for the Integrative Study of Animal Behavior, Indiana University

The incidence of stress-linked psychological disorders such as depression and post traumatic stress disorder differs markedly between men and women. Stress has a profound impact on the structure and function of prefrontal cortex, a brain region that has been implicated in many stress-linked disorders. Previously, we found sex-related and stress-linked differences in microglia cell activation in the medial prefrontal cortex (mPFC) of rats: Unstressed females showed greater activation compared to males, and stress increased activation in males but decreased activation in females. Given that stress has opposite effects on the structure of neurons in medial prefrontal cortex versus orbitofrontal cortex, we examined the effect of stress on microglia activation in orbitofrontal cortex (OFC) of male and female rats. Males and females either were placed in plastic restrainer (3 h) for either 1 day (acute stress) or 10 days (chronic stress) or left unstressed. On the last day of restraint, rats were euthanized and their brains were processed for immunohistochemical visualization of microglia. To characterize activation state, microglia were classified as either ramified, primed, reactive, or amoeboid and counted stereologically. Unlike in mPFC, basal microglia activation in the OFC was similar in males and females. However, chronic stress suppressed microglia activation in males compared to unstressed controls, but slightly increased activation in females. Thus, chronically stress females had significantly increased microglia activation compared to chronically stressed males. Therefore, stress produced different effects on microglial activation in OFC versus mPFC. Given that microglia may play a role in regulating neuronal structure and function, the different patterns of stress-induced activation may contribute to different patterns of stress-induced dendritic remodeling in these two brain regions.

9 EMBRYONIC EXPOSURE TO BPA AND RESULTING EFFECTS ON LEARNING IN HATCHLING RED-EARED SLIDER TURTLES (*TRACHEMYS SCRIPTA*)

Dillard JE, Paitz RT, and Bowden RM

School of Biological Sciences, Illinois State University

Bisphenol-A (BPA) is an endocrine disrupting compound (EDC) introduced into the environment from production of various plastic products. Specifically, BPA is an estrogenic EDC and recent work in our laboratory has shown that BPA inhibits the metabolism of maternally derived estradiol *in ovo* in the red-eared slider turtle (*Trachemys scripta*). Exposure to BPA and other estrogenic EDCs during embryonic development has been implicated in deficits of learning and cognition later in life in other systems, but has not yet been investigated in reptiles. In the present study, we tested learning in 29 hatchling *T. scripta*, which were exposed to one of three treatments during embryonic development: BPA only, BPA and estradiol, or vehicle control. For BPA treatments, we used concentrations identical to those we discovered to inhibit estradiol metabolism in previous work, in order to better understand the implications later in life following this altered embryonic endocrine state. We video recorded hatchlings as they were presented with a simple two-choice arena similar to a T-maze. For all observational days, hatchling turtles were assessed over ten 30 minute trials. For the first 5 days of assessment (training period) both arms of the maze contained a shelter. For the remaining 9 days of assessment (learning period) one of the shelters was removed. Of the 29 animals tested, 8 met our *a-priori* criterion of 8/10 reward (shelter) choices for 2 consecutive days. We found no differences in learning between any of the treatments tested, but we did find that treated animals were significantly more likely to be biased in their training period. We are currently scoring trials for measures of general activity, to determine if there are other more subtle cognitive effects from embryonic exposure to BPA in *T. scripta*. This study demonstrates, for the first time, the capacity for hatchling *T. scripta* to learn a repeated behavior regardless of treatment.

10 NO DETECTABLE EFFECT OF DISTURBANCE ON FEATHER FAULT BARS IN CAPTIVE DARK-EYED JUNCOS (*JUNCO HYEMALIS*)

Gall BJ, Hanauer RE, and Ketterson ED

Department of Biology, Indiana University

As human intrusions into wildlife habitats increase around the world, it is important to understand how human disturbance affects animal physiology. We asked whether non-invasive measures such as fault bars in feathers can provide information about the effects of disturbance without inflicting additional stressors. Fault bars are visible bands in feathers indicating an interruption of feather growth. We tested whether the number of fault bars reflects the frequency of stressors experienced during feather growth. We exposed captive dark-eyed juncos (*Junco hyemalis*) to a frequent disturbance treatment during feather growth. Birds in the disturbance treatment experienced 30-minute disturbances (researcher chasing birds inside the cage or presence of a predator mount) four times per day for three weeks; control birds were disturbed only for standard animal care. To determine the effect on fault bar formation, six tail feathers (R2, R4, R6 on each side) of all of the birds were plucked ten days before the treatment began, inducing feather growth during the treatment. Newly-grown feathers were plucked after the treatment concluded, and fault bars were counted. We found no differences in fault bars between the control group and disturbance group. Repeated measures ANOVA found that feathers grown in captivity had significantly more fault bars than feathers grown in the wild. We conclude that the number or type of fault bars cannot be used to determine the frequency of disturbance experienced during the growth of feathers for captive juncos. Researchers should use caution in interpreting fault bars in the future.

11 NEUROGENOMIC RESPONSES TO SOCIAL CHALLENGES: AN EXPERIMENTAL TEST OF SOCIAL PRIMING IN MALE SONGBIRDS

George EM¹, Peterson MP², Buechlein A³, Tang H³, Rusch D³, Ketterson ED¹, and Rosvall KA¹

¹Department of Biology, Indiana University; ²Biology, Viterbo University; ³Center for Genomics and Bioinformatics, Indiana University

The challenge hypothesis predicts that testosterone (T) rises following a social challenge to bring about changes in behavior and physiology that prepare animals for continued social instability. Evidence has been accumulating, however, that males of many songbird species do not socially modulate T, raising key questions about the degree to which social priming can occur without systemic changes in T, and the nature of alternative physiological mechanisms. We hypothesized that changes in local hormone synthesis and sensitivity would prime individuals for continued social competition, at the expense of self-maintenance, even in the absence of a systemic rise in T. We staged social challenges in free-living male dark-eyed juncos (*Junco hyemalis*), a species of songbird that does not elevate T in response to simulated territorial intrusions under most circumstances. We used custom microarrays to assess transcriptional responses to social instability in seven distinct brain regions in males that were euthanized after an acute social challenge, after persistent social challenges, and unmanipulated controls. Acute and persistent challenges both led to significant changes in expression in hundreds of genes, with nearly all brain regions affected more so by persistent challenges than acute. Affected genes are known to be involved in immune response, cell death, energy metabolism, synaptic plasticity, and hormone signaling (e.g., Glutamate, GABA, and various catecholamines). These results show that social challenges can cause rapid and lasting changes in gene expression in the brain without a systemic change in the hormones that have long been hypothesized to coordinate adaptive responses to the social environment.

12 SKIN LIPIDS OF STRIPED PLATEAU LIZARDS (*SCELOPORUS VIRGATUS*) MAY SIGNAL FEMALE RECEPTIVITY AND REPRODUCTIVE QUALITY ALONGSIDE VISUAL ORNAMENTS

Goldberg JK^{1,2}, Wallace AK¹, and Weiss SL¹

¹Biology Department, University of Puget Sound; ²Department of Biology, Indiana University

Lizards and snakes are especially attuned to olfactory cues and accordingly utilize pheromones during mating. Pheromones can serve a variety of functions including assisting in the location of viable mates and the assessment of mate quality and receptivity. In this study, we determined possible pheromonal functions of skin lipids in a species of lizard (*Sceloporus virgatus*) by comparing chemical profile of a female lizard's skin lipids to various indicators of phenotypic quality. Lipid profiles were determined by gas chromatography/mass spectrometry (GC/MS) of derivatized samples. Then principle component analysis combined with multivariate linear models allowed us to determine if the relative quantity of certain compounds predicted a female's phenotypic condition. We found that the relative amounts two fatty acids predict a female's clutch size, as does a visual signal. We also found that the amount of an unidentified sterol to be reduced in receptive females. These results indicate that certain skin lipid components may function as pheromones in this species, but future behavioral analyses are required to fully test this hypothesis.

13 THE ACTIVATION OF VASOACTIVE INTESTINAL POLYPEPTIDE BRAIN CELLS IN RESPONSE TO FIGHT OR FLIGHT

Gucwa A, Staehler N, Jan N, Alexander G, Goodson JL, and Kingsbury MA

Department of Biology, Indian University

In mammals and birds, vasoactive intestinal polypeptide (VIP) neurons, fibers and receptors are present in virtually every brain area that is important for social behavior. However, few studies have examined the social relevance of this peptide outside of its role as the main releasing factor for prolactin secretion from the pituitary. Here we examine which VIP cell groups in the brain are activated in asocial territorial finches in response to territorial interactions and a non-social stressor in order to identify brain VIP sites that modulate aggression and stress responses. Male violet-eared waxbills were assigned to one of four conditions: Control, Dominant, Subordinate or Defense. Dominant and Subordinate subjects were exposed to a resident-intruder paradigm and Defense subjects were pursued by a human hand. To examine VIP expression and induction of c-Fos immediate early gene expression in VIP cells, we processed brain tissue for combined VIP in situ hybridization and Fos immunocytochemistry. Relative to Controls, VIP-Fos colocalization was significantly increased in the anterior hypothalamus of Defense animals and in the ventromedial hypothalamus and ventral tegmental area of Defense and Subordinate animals. Interestingly,

multiple measures of aggressive behavior exhibited by Dominant animals correlated negatively with the number of VIP-Fos colabeled cells in these brain areas. Taken together, transcriptional (Fos) activity of VIP cells within these areas may reflect modulation of a stress response, particularly given significant neural activation of the paraventricular nucleus for animals exposed to Subordinate and Defense conditions.

14 USE OF A TEMPERATURE LOGGER TO MONITOR NEST ATTENDANCE IN HOUSE SPARROWS (*PASSER DOMESTICUS*)

Hamilton HP, Martin GR, and Fox RA

Biology, Transylvania University

House sparrows exhibit both personality (consistent between-individual differences in behavior) and plasticity (within-individual variations in behavior) in a number of aspects of parental care. Such differences likely have implications for fitness; however, measuring parental behavior during incubation and chick rearing is generally quite labor intensive, requiring either video monitoring followed by scoring of videos or direct observation of behavior. We tested whether temperature changes within the nest might be useful as a proxy for at least some aspects of parental behavior during both incubation and the nesting period in a population of free-living house sparrows nesting in nest boxes at the University of Kentucky's Maine Chance Farm. We monitored the behavior of several pairs by placing the sensor of a HOBO U23 Pro v2 temperature and relative humidity logger in a pair's nest, directly under either the eggs or the brood, for a one hour period, while simultaneously conducting direct observation of the behavior of both pair members. Our data suggest that temperature changes within the nest reflect patterns of nest attendance, and we suggest that temperature loggers may be useful for extended monitoring of some aspects of parental behavior. We also report on differences among pairs in nest attendance.

15 BODY SIZE AND MATE SELECTION: FEMALE EASTERN NEWTS (*NOTOPHTHALAMUS VIRIDESCENS*) DO NOT EXHIBIT PREFERENCE FOR SMALL MALES

Hart SL, Spicer MM, and Gall BG

Biology, Hanover College

Previous studies have found that during mate selection male newts exhibit a preference for larger females (increased fecundity) and females exhibit a preference for smaller males (less harassment). We conducted an investigation to re-evaluate whether female newts are selective about male body size during mating. During choice trials, we exposed a female newt to a large male (3.61- 4.11g) and a small male (2.44 - 3.17g) and recorded the amount of time the female spent in a preference zone adjacent to each of these males. There was no significant difference in the amount of time female newts spent near the large and small males. In addition, tail height and length were also not correlated with female preference. These data suggest that female eastern red-spotted newts may not utilize body size as an indicator of quality in their mate selection. Moreover, these data contradict a previous study based on a small sample size that suggested female newts select small males to reduce the intensity of harassment.

16 TRANSGENERATIONAL EFFECTS OF DI-(2-ETHYLHEXYL) PHTHALATE ON ANXIETY BEHAVIOR AND BRAIN GENE EXPRESSION IN MALE AND FEMALE MICE

Hatcher KM^{1,3}, Willing J^{2,3}, Chiang C¹, Rattan S¹, Juraska JM^{2,3}, Flaws JA¹, and Mahoney MM^{1,3}

¹*Department of Comparative Biosciences, University of Illinois;* ²*Department of Psychology, University of Illinois;* ³*Neuroscience Program, University of Illinois*

Phthalates, including di-(2-ethylhexyl) phthalate (DEHP), are plasticizers found in common materials, including personal care products, medical equipment, and food packaging. Phthalates bond non-covalently to plastics and are thus capable of leaching into food or other material, a characteristic that contributes to human exposure. Several phthalates, including DEHP, have been identified as chemicals capable of disrupting endocrine pathways in humans and animals. Evidence indicates that DEHP effects on reproduction are capable of spanning generations, however little is known about these transgenerational effects on behavior or brain gene expression in males or females. Here, pregnant CD-1 mice (F0 generation) were orally dosed daily with either corn oil (vehicle control) or varying concentrations of DEHP (20 or 200µg/kg/day; 500 or 750 mg/kg/day) from gestational day 10.5 until birth to produce the F1 generation. Female offspring from the F1 and F2 generations were bred with untreated males until the F3 generation was produced. F3 adult female and male mice were subjected to the elevated plus maze (EPM) around P60 to test for exploratory and anxiety behaviors. In our female cohort, DEHP exposure significantly increased time spent in open arms in EPM without increasing total arm entries compared to controls, indicating that increased open arm time was not due to an increase in overall activity. Currently, we are analyzing male EPM data and will compare to our female cohort to identify potential sex differences. Additionally, we are performing qPCR to measure changes in expression of selected genes in the hippocampus, amygdala, and bed nucleus of the stria terminalis (BNST), areas involved in anxiety brain circuitry.

17 THE EFFECT OF APOMORPHINE AND MPTP ON ADULT ZEBRAFISH

Helmke E, Douma MJ, Cruz YT, De Venecia AN, and Saszik S

Department of Psychology, Northeastern Illinois University

Dopamine is a neurotransmitter that plays an important role in regulating motor function and complex social behaviors. This research seeks to determine how behavior is controlled by dopamine using the Zebrafish (*Danio rerio*) model in an effort to better understand how manipulating cortical dopamine concentrations will affect behavior. Apomorphine (APO, dopamine agonist) and 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP, dopaminergic neurotoxin) were used to manipulate the dopaminergic system. We predict observable differences in behavior after the administration of both APO and MPTP. Adult zebrafish were randomly selected and assigned to 1 of 3 groups: [control, MPTP (150 μ M), and APO (150 μ M)], and dosed for two minutes. Groups of 3 fish were recorded in 300 mL of water in a novel tank. Distance (cm) and velocity (cm/sec) were calculated for each fish in order to assess motor behavior. In addition, nearest neighbor distance (NND) (cm) was calculated and used as a measure of social behavior. Preliminary results show that treatments with both MPTP and APO alter motor function and social behavior, as indicated by recorded differences in overall distance swam and average velocity between control and both MPTP and APO groups. These results suggest a modification in the dopaminergic system, however, additional testing is needed to better understand the observed changes. Based on our results, both APO and MPTP alter swim and social behavior. The present findings help to characterize the connection between complex biological mechanisms, in this case the dopaminergic system, and its regulation of complex behaviors. Further efforts are being taken to understand the effect that these manipulations have on social behaviors and interactions.

18 LANDMARKS ALTER GROUP STRUCTURE OF ZEBRAFISH, *DANIO RERIO*

Howard EM, Suriyampola PS, Sykes DJ, and Martins EP

Department of Biology, Indiana University

Dominant or territorial animals often use a resource or landmark as the central focus of their behavior, defending the area immediately around that structure vigorously. Here we ask whether social groups also use physical structures to focus their behavior, or whether the presence of such structures leads the group to subdivide as dominance interactions become paramount. Specifically, we investigate the effects of landmarks on group formation and space utilization in zebrafish, *Danio rerio*. We formed 36 groups of six fish each and kept half of the groups for two months in aquaria with structural complexity, created using plastic aquarium plants and clay flower pots. The other half was kept in aquaria without physical structures for the same amount of time. We then tested each group in two treatments, with and without landmarks (four plastic plants) on consecutive days. We used automated software to track individual fish and to estimate space use. We found that zebrafish formed smaller groups around the plastic plants when they were available. The extent of space used by zebrafish was not significantly influenced by landmarks, however, they tended to use more space when they were present in a habitat with familiar structural complexity. Fish with recent experience in complex habitats used more space in the complex current context and fish with previous experience in empty habitats used more space in an empty current context. Although zebrafish have not been previously known to utilize landmarks in a manner that alters their group formation, this study identifies such physical structures could have an influence on their group dynamics. This information gives insight to understand how social groups may alter their behavior in response to habitat alterations and how this response will be shaped by their previous habitat experience.

19 THE MORE THE MERRIER: LARGER GROUPS ARE BETTER AT RESPONDING TO FLUCTUATING ENVIRONMENTS

Iruri-Tucker AA, Suriyampola PS, Enriques A, Blackwell G, Shelton DS, Caceres J, and Martins EP

Department of Biology, Indiana University

Many animals live in social groups to gain benefits associated with group living such as predator detection, enhanced foraging and better coordination. However, by being in a group, individuals can also easily get distracted by social interactions and may become more visible to predators. Thus, group size may have a profound impact on collective behavior of social animals. In this study, we investigate the effects of group size on responses to a basic physical stimulus - water flow. Zebrafish (*Danio rerio*) are an ideal system for this study because they are social fish and have evolved in habitats that undergo rapid fluctuations in water flow due to monsoon weather in their native India. We placed 35 groups of two and 35 groups of four zebrafish in a fluvial tank exposing them to a series of different flow rates, and scored the orientation of the fish to water flow (i.e, rheotaxis). Groups of four zebrafish exhibited stronger rheotaxis than did pairs. Larger groups were also more cohesive than were zebrafish pairs, potentially reducing energy expenditure while facilitating communication. These results may provide insights into understanding how social groups will respond to future climate-induced changes to hydrology.

20 VISUAL RESOLUTION OF TWO SPECIES OF *SCELOPORUS* LIZARDS THAT DIFFER IN VENTRAL COLORATION

Jarvis HV¹, Ossip-Klein AG¹, Ronald KL², Fernández-Juricic E², Hews DK³, and Martins EP¹

¹*Department of Biology, Indiana University;* ²*Biological Sciences, Purdue University;* ³*Department of Biology, Indiana State University*

For social communication, visual signals should evolve to match the visual abilities of the intended receivers. North America is host to a number of species of the lizard genus *Sceloporus* that each possess varying degrees of blue ventral coloration. Males of most species have paired blue belly patches that they use during aggressive male-male encounters and not while courting the plain-bellied females. Males of a handful of species have evolutionary lost the blue belly patches and in these species both sexes have plain bellies. Here we test for sex and species differences in visual resolution to determine a potential link between variation in signal properties and variation in visual resolution. We assessed the visual resolution of *S. virgatus* (both sexes have plain-bellies) and *S. undulatus* (males have blue patches) males and females that occupy overlapping regions in southern North America by counting and classifying the density and distribution of three classes of cone photoreceptors associated with chromatic vision. Areas of the retina that possess higher densities of photoreceptors typically have higher visual resolution. Results will compare and contrast the relative densities and distributions of cone photoreceptors around the fovea and periphery of the retina to determine potential sex and species differences in visual resolution.

21 HORMONE AND MELANOCYTE SIGNALING IN A SOCIAL FEATHER ORNAMENT

Kassab HD, Fitzpatrick KD, Bryant J, Abolins-Abols M, and Ketterson ED

Department of Biology, Indiana University

Bird feathers are one of the most striking examples of variation in nature. Some of the variation in feather ornaments has been shown to act as signals of the quality of an individual and enhance fitness by increasing the probability of attracting a mate. To understand why feathers are used as signals of quality, we must understand the factors that regulate their development. In some instances feather size and color are mediated by the steroid hormones testosterone and corticosterone, which can bind directly to feather follicles. We examined whether the color and development of a specific melanin-based feather ornament used in attracting mates and signaling status -the white outer tail feathers of Dark-eyed junco (*Junco hyemalis*)- is mediated by hormonal signaling. In particular, we investigated the abundance of androgen receptor (AR) and estrogen receptor (ER), and compared receptor abundance among males of varied ornament size and between different feathers from the same individual. Furthermore, we asked in hormone receptor expression in developing feathers was correlated with expression of key melanocyte signaling markers agouti signaling peptide (ASIP), melanocortin 1 receptor (MC1R), and tyrosinase (TYR). Preliminary results indicate that dark inner tail feathers have higher expression of AR than white outer feathers. However, outer ornamental feathers appear to have a negative relationship between AR expression and percent-dark area. We found no significant relationship between ER expression and feather color. We are currently investigating expression of ASIP, MC1R, and TYR.

22 LOSS OF FUNCTION IN THE NEMATODE *UBE3A* ORTHOLOG LEADS TO NEUROLOGICAL IMPAIRMENTS IN A *C. ELEGANS* MODEL OF ANGELMAN SYNDROME

Khalil M and Vidal-Gadea A

School of Biological Sciences, Illinois State University

Angelman syndrome (AS) is a neurodevelopmental disorder caused by mutations in the maternally inherited allele of the *Ube3a* gene. AS is characterized by cognitive and behavioral impairments. *Ube3* codes for an *E3 ubiquitin ligase* and this protein is primarily responsible for tagging proteins for degradation. Work on mice and *Drosophila* models afford some valuable insights but have generally struggled to recapitulate the severe cognitive and motor phenotypes observed in the disease. A genetic model capable of recreating the motor and cognitive characteristics seen in AS patients would accelerate progress in this field. We investigated the feasibility of the nematode *C. elegans* as a model system for AS and uncovered through a BLAST analysis that *herc-1* was the worm ortholog of the human *Ube3a* gene. We performed several behavioral tests on animals with loss of function (*lf*) mutations on *herc-1* and found that *herc-1(lf)* mutants display motor deficits. Similarly, these animals showed cognitive impairments in both associative learning and short-term habituation. Presently, we are interested in investigating the expression pattern of *herc-1*. Thus we conclude that *C. elegans* appears to be a viable system for the study of the molecular and neuronal basis of AS.

23 SEX AND BODY TEMPERATURE PREDICT SPATIAL POSITIONING OF INDIVIDUALS IN HUDDLE

Kim NS^{1,2}, Myers MA¹, Cahela JP³, Shelton DS^{1,2}, and Alberts JR¹

¹*Department of Psychological and Brain Sciences, Indiana University;* ²*Department of Biology, Indiana University;* ³ *Department of Psychology, University of Hawaii*

Infants of many mammalian species reside in huddles, where behavioral and social interactions are first established. We examined the movements of individual mouse pups within huddles of littermates, with special attention to whether they occupied central or peripheral position in the group. We used infrared thermography to examine simultaneously the body surface temperatures and spatial positions of individual mouse pups comprising mix-sexed groups. Pups were allowed to interact freely on a flat surface, thus providing relatively clear view of each individual. We found a trend for warmer pups to be more central in the huddle. We also noted female pups were more spatially central than males, probably due to the correlation of sex and body temperature. Our result shows that sex and body temperature can predict spatial position in the huddle. As a result of these differences, female and male pups may experience different spatial and social influences during early development.

24 THE NEUROBIOLOGY OF NOCICEPTION: ANALYZING DENDRITIC MORPHOLOGY OF TRANSGENIC *DROSOPHILA*

Fisher K, Jeffirs S, and Kumar E

Program in Neuroscience, Indiana University

The goal of our lab is to further understand nociceptive pathways using neurobiological techniques. By using the model *Drosophila melanogaster*, we are able to conduct research on a smaller scale with the hopes of applying the results on a more widespread basis. In this experiment, we analyzed and quantified GFP-expressed neurons of transgenic fruit flies to compare and contrast the dendritic morphology in order to ultimately determine whether or not the qualitative measurements had a significant impact on nociceptive sensitivity. The genes of interest were the G protein alpha o subunit and smoke alarm. After crossing GFP-encoded females with males that contained the Gao gene, the larvae were harvested. With a confocal laser-scanning microscope, we were able to take images of the larvae's neurons. From these images, we used NeuroLucida software to trace and analyze the structure of the dendrites. Our research supports the notion that hypersensitivity is linked to an increase in dendritic amount and length. The working hypothesis is that larvae that are hypersensitive to pain have a greater total dendritic length and a different morphological structure compared to traced control genotypes.

25 HABITAT SELECTION AND THE EFFECT OF CONSPECIFIC PRESENCE IN FORAGE FISH

Levell ST¹ and Greene CM²

¹*Department of Biological Science, Florida State University;* ²*Fisheries Ecology, Northwest Fisheries Science Center*

Over the last 40 years, Puget Sound's pelagic waters have witnessed a dramatic shift in the abundance of different species of forage fish: in particular, declines in Pacific herring and concomitant increases in Pacific sandlance, shiner perch, and threespine stickleback. These shifts are directly related to changes in human population density. Possible mechanisms for these shifts include changes in abundance of prey taxa, and changes in intertidal and subtidal habitats including hardened shorelines and submerged aquatic vegetation. We asked whether these two mechanisms could account for differences in abundance patterns, stable isotopes, and morphometrics using several analyses of a Sound-wide survey incorporating shoreline land use in the sampling design. We explored habitat preferences (including socially facilitated habitat preferences) by introducing fish in an inter- and intraspecific manner into tanks set up with different habitat types. Behavior trials and observations were used to gauge their response to different social settings. In addressing habitat preferences and linking the experimental results to field observations in Puget Sound, we discuss our results in the context of observed changes in forage fish communities.

26 THE SOCIAL DEVELOPMENT OF AN *EX SITU* ELEPHANT CALF MIRRORS THAT OF AN *IN SITU* CALF

Machado JM, Haddon AJ, and Dale RHI

Department of Psychology, Butler University

Female African elephants (*Loxodonta africana*) within their home range live in family groups typically consisting of 9-11 closely related individuals - although the size of groups ranges from 2-24. The eldest cow, referred to as the matriarch, is most often the mother or grandmother of all other group members (Douglas-Hamilton 1992). Mother-calf relationships can last more than 50 years and tend to be intense. Sub-adult females as old as 9 can spend more than half their time within 5 meters of their mother (Perry 1953). Other females within the group often help with the rearing of calves that aren't theirs and are referred to as "allomothers" (Spinage 1994). When the calf is young, the mother is responsible for maintaining contact with it. However as the calf develops the burden of maintaining close contact will shift over to the calf itself (Perry 1953). We studied the social development of a young elephant calf with her elder sister, mother and an unrelated female in their large, natural exhibit at the Indianapolis Zoo. Using digital video recordings of the elephants moving freely within their exhibit, we measured the calf's proximity to conspecifics and which individuals were responsible for maintaining close contact. We found that, as it aged, the calf spent relatively less time with its mother and the matriarch and more time alone. The proportion of time the calf spent with her elder sister did not change. The calf took primary responsibility for maintaining proximity with her mother and the matriarch throughout the study. On the other hand, the elder sister took relatively more responsibility for maintaining contact with the calf as the calf aged. Calves *in situ* show similar patterns of social development. Our results suggest that the social habitat in this zoo evokes natural behavior in this calf.

27 BEHAVIORAL AND ELECTROPHYSIOLOGICAL CHANGES IN THE Q175 MOUSE MODEL OF HUNTINGTON'S DISEASE FOLLOWING ADMINISTRATION OF AAV9-GLT1

McCormick BM, Bunner KD, Rangel-Barajas CR, Barton SJ, and Rebec GV

Program in Neuroscience, Indiana University

Huntington's disease (HD) is an autosomal dominant neurodegenerative disorder characterized by a deficit in cognitive, psychiatric, and motor control. Knowledge of the sole cause of HD, a CAG expansion on exon 1 chromosome 4, has led to numerous animal models. Previous work by our lab has shown electrophysiological and behavioral changes in the Q175 mouse model, which parallels changes seen in other HD mouse models. Our results showed a significant decrease in quality of nest built and percentage of Nestlet used in both HET and HOM compared to WT controls. Q175 mice also show a significant decrease in activity level in number of line crossings compared to WT controls along with changes in spontaneous behaviors (i.e. grooming, quiet rest, and rearing). Changes in neuronal firing, noted by an increase in firing in HET mice compared to WT controls along with decreased communication denoted by significant decrease in burst firing patterns showed disruption of neuronal communication in the Q175 mouse model of HD. These changes are consistent across HD models and begin prior to HD symptom onset. Alleviation of these symptoms and neurological changes, which are a persistent phenomenon of the disorder, would improve quality of life in HD patients. Glutamate uptake is either down regulated or dysfunctional in murine models of HD as well as in HD patients, and is correlated with lowered levels of glutamate transporter 1 (GLT1). Intravascular (i.v.) injections of GLT1 attached to adeno-associated virus serotype 9 (AAV9) would allow upregulation of the GLT1 protein on astrocytes throughout the brain. Our results showed post-viral administration improved deficits in nest building behavior to that of WT controls. Furthermore, administration of AAV9-GLT1 returned normalized neural processing in HET striatum to that of WT controls. Thus, even at this relatively early stage of data analysis, we are able to show that treatment with AAV9-GLT1 markedly improves deficits in both behavior and neuronal communication.

28 BEHAVIORAL EFFECTS OF PRENATAL OXYTOCIN MANIPULATION IN MICE

Miller TV¹, Tamborski S², and Caldwell HK^{1,2}

¹School of Biomedical Sciences, Kent State University; ²Department of Biological Sciences, Kent State University

Male oxytocin knockout (Oxt^{-/-}) mice have increased inter-male aggression when born to Oxt^{-/-} dams, but not when born to heterozygous (Oxt^{+/-}) dams. Moreover, oxytocin receptor knockout (Oxtr^{-/-}) mice also have increased inter-male aggression, whereas mice with a conditional oxytocin receptor knockout (Oxtr^{FB/FB}), in which the gene is not excised until approximately three weeks postnatal, show normal levels of inter-male aggression. These observations have led us to hypothesize that oxytocin during fetal development acts to organize the neural circuitry that underlies aggressive behavior. Based on previous work in which we mapped the developing oxytocin system, we hypothesize that blocking oxytocin's ability to bind to the oxytocin receptor at embryonic day (ED) 14 and/or 16 will result in increases in inter-male aggression in adulthood. To test this hypothesis, we injected an oxytocin receptor antagonist (OTA) into the lateral ventricles of fetal C57/BL6 mice at ED14 and ED16; after birth, and upon reaching adulthood, these mice underwent three resident-intruder tests 1 day apart to test for aggressive behavior. Our preliminary results suggest that treatment with an OTA can affect adult aggressive behavior.

29 BODY TEMPERATURES AND SOCIAL CENTRALITY IN MOUSE PUPS

Myers MA¹, Kim NS¹, Cahela JP³, Shelton DS^{1,2}, and Alberts JR¹

¹*Department of Psychological and Brain Sciences and* ²*Department of Biology, Indiana University;*
³*Department of Psychology, University of Hawaii*

Altricial rodents' glabrous skin, lack of subcutaneous fat, and high surface area to volume ratio render them renowned for rapid heat loss. To combat cool challenges, young mice vigorously clump together or huddle. Here, we examine whether individual body surface temperatures are associated with the number of littermates each pup contacts. We also examined these contact patterns in relation to sex and body weight. We used video recordings and infrared thermography to examine the contacts and body surface temperatures of individual mouse pups in a group. Pups were allowed to ambulate freely on a flat, circular surface, which allowed them to view their surroundings unobstructed. Warmer pups had more contacts. Pups with warmer body surface (interscapular) temperatures were in contact with more littermates. We also found that females were warmer than male littermates and, similarly, tended to have more contacts. Furthermore, pups that weighed more were warmer, but did not have more contacts than lighter pups. These results suggest that body surface temperature is a strong predictor of social contacts with other littermates, and sex is associated with pup-pup interactions.

30 SEASONAL VARIATION IN THE PRODUCTION OF BEHAVIORAL TYPES IN *TRACHEMYS SCRIPTA*

Nichols H, Wilson Carter A, and Bowden R

Illinois State University

Correlated, repeated patterns of behavior are called behavioral types and can affect the fitness of an individual. The behavioral type that is most advantageous for an individual may differ across changing environments, such as with season. Maternal effects may be a source of phenotypic variation that facilitates a match between predictable changing environments and offspring behavioral type. Recognizing these patterns is the first step to gaining an understanding of the underlying mechanisms and their ecological implications. In this study we sought to understand if the production of proactive-reactive behavioral types differs across the nesting season in turtle hatchlings (*Trachemys scripta*). We measured righting response, an indicator of behavioral type, of juvenile turtles emerging from early and late season clutches. We found a significant effect of season, with early season hatchlings being more proactive than late season turtles, which were more reactive. The seasonal variation in righting time combined with significant clutch effects suggests a maternal influence on this behavior. We also examined whether seasonal variation in maternally derived estrogens, which are known to influence other aspects of phenotype, was correlated with seasonal righting patterns. We dosed early season eggs to resemble the estrogen levels in late season eggs with a cocktail of 20 ng estradiol + 77.5 ng estrone sulfate/5 μ l 70% ethanol, or with a sham control, and assayed righting responses of hatchlings. There was no effect of the estrogen dose on hatchling righting. We demonstrate that the production of behavioral types systematically varies across the nesting season; however, future research is needed to identify the ecological contexts favoring each behavioral type and the underlying mechanisms.

31 MULTIVARIATE SEXUAL SELECTION ON MALE TEGMINA IN WILD POPULATIONS OF SAGEBRUSH CRICKETS, *CYPHODERRIS STREPITANS* (ORTHOPTERA: HAGLIDAE)

Ower GD¹, McGrath CM¹, Halpin R², Hunt J³, and Sakaluk SK¹

¹*School of Biological Sciences, Illinois State University;* ²*Division of Mathematical and Natural Sciences, Arizona State University;* ³*School of Biosciences, University of Exeter in Cornwall*

Male sagebrush crickets attract females with song produced through stridulation of their tegmina. Unlike true crickets (Gryllidae) which sing with a right-over-left tegminal orientation and katydids (Tettigoniidae) which sing with a left-over-right orientation, sagebrush cricket individuals sing with a preferred handedness and few individuals are capable of singing ambidextrously. Geometric morphometric techniques were used to measure sexual selection on the shape, size and symmetry of both top and bottom tegmina. Sexual selection was more intense on the bottom tegmen, conceivably because it interacts more freely with the subtegminal airspace which may play a role in song amplification. The anterior edge of the bottom tegmen, which likely acts as a baffle against noise cancellation, was found to be under selection for enlargement. Despite the strong stabilizing selection found previously on the dominant frequency of the song of sagebrush crickets, significant stabilizing selection was not found on the resonator that regulates dominant frequency according to the clockwork cricket model. However, the shape principal components showed little variation in the landmark placement around the resonator, and this reduction in variance suggests that strong stabilizing selection has occurred in the past.

32 SEX-DEPENDENT STRESS EFFECTS ON MICROGLIAL CELL MORPHOLOGY IN BASOLATERAL AMYGDALA

Patel R¹, Bollinger JL^{1,2,3}, and Wellman CL^{1,2,3}

¹*Program in Neuroscience,* ²*Department of Psychological and Brain Sciences,* and ³*Center for the Integrative Study of Animal Behavior, Indiana University*

Males and females differ in susceptibility to various stress-linked psychological disorders, including depression and PTSD. Stress can precede and exacerbate these disorders, and can disrupt brain and behavior in a sex-specific manner. For instance, both acute and chronic restraint stress reduce microglial activation in medial prefrontal cortex in female rats, but induce microglial activation in males. Microglia are the immune cells of the brain. Activated microglia can modulate neurotransmission, synaptic plasticity, and behavior. Previous reports indicate basal sex differences in microglial activation state in other stress-susceptible brain regions, including the amygdala. This would suggest potential sex differences in stress effects on microglia in basolateral amygdala (BLA). Therefore, we analyzed microglial morphology in basolateral amygdala in male and female rats following acute or chronic restraint stress. Animals were subjected to either 1 day (3 hr, acute) or 10 days (3 hr/day, chronic) of restraint stress, or were left unstressed. Brains were removed on the final day of stress, sectioned, and microglia were immunohistochemically visualized. Microglia were classified into four activation states based on their morphology (ramified, primed, reactive, or amoeboid), and counted using unbiased stereological technique. The total density of microglia in BLA did not differ between males and females, nor did stress affect total microglial density. Acute stress reduced the proportion of primed to ramified microglia in both males and females, whereas chronic stress reduced the proportion of primed to ramified microglia in males only. This finding may represent a mechanism driving sex differences in BLA structure and function.

33 C. ELEGANS SUPPRESSOR MUTANT RESCUES MUSCULAR DEGENERATION IN NEMATODE MODEL OF DUCHENNE MUSCULAR DYSTROPHY

Rodriguez A, Barickman L, Goel S, Schuler A, DeVries P, Cisneros M, Alvarado G, Anastitia A, Barsanti B, DePerez J, Dickens S, Esfahanian M, Jarris B, Larson B, Mathis C, Mecidor R, Mills S, Oates B, Pascalis T, Quintana E, Telander T, Young J, and Vidal-Gadea AG

School of Biological Sciences, Illinois State University

Duchenne muscular dystrophy (DMD) is a degenerative disease afflicting up to one in 3,500 males. It results from a mutation in the gene encoding the dystrophin protein which is responsible for anchoring the contractile machinery of muscles to cell membranes. Lack of functional dystrophin results in progressive muscle cell damage and eventually leads to death. To date, there is no cure for DMD. The nematode *C. elegans* is a useful model system because it is easy to culture and study in the lab while at the same time sharing nearly two thirds of its genes with humans. We previously showed that worms lacking functional copies of the dystrophin gene (*dys-1*) parallel many of the motor and muscular deficiencies observed in DMD patients. We conducted the first suppressor screen on DMD animals and isolated several mutants where the damages associated with DMD were spared (suppressed). Students in the Vidal-Gadea lab and in Biotech I used a combination of approaches including behavioral analysis, immunohistochemistry, confocal microscopy, RNA interference, and CRISPR/Cas9 to study how DMD worms become dystrophic and how suppressor mutants avoid this fate. *C. elegans* is in a unique position to facilitate the study of neurogenetic diseases allowing its use in laboratory as well as classroom settings to make meaningful contributions to the study of disease.

34 ARE NEOPHOBIA AND HABITUATION RELATED TO NESTING HABITAT IN HOUSE SPARROWS (*PASSER DOMESTICUS*)?

Rowe RD, Saldaña CA, and Fox RA

Biology Program, Transylvania University

House sparrows live in close association with human settlements, and will readily breed in nestboxes across a range of habitats ranging from high-disturbance locations such as livestock barns or urban neighborhoods to lower-disturbance locations such as isolated bluebird boxes in agricultural fields. Birds in high-disturbance areas are more likely than birds in low-disturbance areas to be exposed to a wide variety of harmless, unpredictable anthropogenic stimuli (e.g., vehicle traffic, human presence, trash such as food wrappers, etc.). Thus, it may be beneficial to such birds to be less neophobic and to habituate more quickly to previously-unfamiliar objects. However, in low-disturbance habitats, low neophobia and fast habituation may be costly rather than beneficial, at least partly as a result of predation pressure. We tested the hypothesis that neophobia and habituation covary with nesting habitat in a population of house sparrows at Maine Chance Farm at the University of Kentucky. An initially-novel object (a laminated paper square printed with a colored pattern) was presented in 3-4 separate 1 hour sessions over an 8 day period to pairs of house sparrows that were actively feeding nestlings. The pair's behavior was monitored with video recordings taken before and during presentation of the object. For each pair member, we measured latency to begin feeding nestlings, time spent on the nest, and time between feeding visits during baseline and object trials. We describe differences in neophobia and habituation to the object between birds nesting in high-disturbance and low-disturbance habitats.

35 THE SOCIAL DEVELOPMENT OF AN *EX SITU* AFRICAN ELEPHANT CALF RESEMBLES THAT OF *IN SITU* CALVES

Ruppert SJ, Knepper BA, and Dale RHI

Department of Psychology, Butler University

Female African elephants (*Loxodonta africana*) within their home range live in family groups typically consisting of 9-11 closely related individuals - although the size of a group can range from 2-24. The eldest cow, referred to as the matriarch, is most often the mother or grandmother of all other group members (Douglas-Hamilton 1992). An African elephant calf under one year of age usually spends over 90% of its time near its mother (Moss, Croze & Lee 2011). Other young females within the group, referred to as allomothers or "aunties", often help with the rearing of a calf (Spinage 1994). We studied the social development of a young elephant calf with her mother, the dominant elephant ("matriarch") and an unrelated female in their large, natural exhibit at the Indianapolis Zoo. Using digital video recordings of the elephants moving freely within their exhibit, we measured the calf's proximity to conspecifics and which individuals were responsible for maintaining close contact (which elephant in each dyad approached and left the other one most often). We found that the calf spent most of her time with her mother, about a third of her time alone, and relatively little time with either the "matriarch" or the third adult. The calf took primary responsibility for maintaining proximity with all three adults. Calves *in situ* show similar patterns of social development, although spending relatively more time with their mothers (Moss, Croze & Lee, 2011). Our results suggest that the social habitat in this zoo evokes natural behavior in this calf - and, perhaps, even accelerates its social development.

36 CORRELATES OF MELANINIZATION IN MULTIPLE HIGH AND LOW-ELEVATION POPULATIONS OF THE LIZARD, *SCELOPORUS OCCIDENTALIS*: AGGRESSION, TESTOSTERONE, AND STRESS REACTIVITY

Seddon RJ and Hews DK

Department of Biology, Indiana State University

We study pleiotropic effects of mechanisms underlying pigment production. Melanin, and molecules regulating melanin, can directly and indirectly affect other traits such as aggression and stress physiology. Our earlier study revealed population differences in breeding-season male *Sceloporus occidentalis* from two elevations. Here we examine four additional populations (two high, two low). As expected, the two new higher-elevation populations were significantly darker than the lower-elevation populations. Principle-components analysis on behavioral responses to staged territorial intrusions revealed that males in the two darker (higher-elevation) populations were more aggressive than males in the two lighter populations, as we found in our earlier two-population comparison. Analyzing baseline plasma testosterone (TESTO) we found no differences associated with elevation and no differences among these four populations. Analyses of plasma corticosterone (CORT) revealed no difference in stress reactivity (CORT after 30-min of captivity) between high and low elevation populations. Hence these high- and low-elevation differences in aggression, the lack of an association of behavior with TESTO, and the lack of population differences in stress-reactivity appear to be robust results. Assays of plasma α -MSH are underway to determine if population differences in the melanization or aggression are associated with differences in plasma levels of this peptide.

37 THE EFFECTS OF DEVELOPMENTAL HYPOTHYROIDISM ON SHORT-TERM OBJECT RECOGNITION MEMORY

Sieg ML¹, Townes CA¹, Balachandran RC¹, Gilbert ME², and Eubig PA¹

¹*Department of Comparative Biosciences, College of Veterinary Medicine, University of Illinois at Urbana-Champaign;* ²*U.S. Environmental Protection Agency, National Health and Environmental Effects Laboratory, Toxicity Assessment Division*

Maternal hypothyroidism can be damaging to the developing offspring's nervous system because of the importance of thyroid hormone in neurodevelopment. Prior studies in rodents indicate that subtle maternal hypothyroidism affects hippocampal development causing changes in electrophysiology, gene expression, and deficits in hippocampal-mediated behavior that persist into adulthood. The present study examines the effects of subtle maternal hypothyroidism on the offspring's short-term object recognition memory, which is dependent on the perirhinal cortex. Dams were exposed to propylthiouracil (PTU) via drinking water from gestational day 6 through postnatal day (PND) 14. Offspring were cross-fostered at PND 2, resulting in 4 exposure groups: control (CON-CON), prenatally-exposed (PTU-CON), postnatally-exposed (CON-PTU), and both prenatally- and postnatally-exposed (PTU-PTU). All exposure groups were tested using a novel object recognition (NOR) paradigm at approximately PND 250. During NOR testing, rats were placed in a chamber with 2 identical objects for 3 minutes. They were then returned to their home cage for 1 hour before being placed back in the testing chamber with 1 original object and 1 new object for 3 minutes. Typically, rats spend more time examining the new object rather than the old one. Initial analysis revealed that rats spent significantly more time exploring either object during the first minute of the task, so we focused on evaluating the percent time spent exploring the novel object during the first minute. We found that PTU-CON males spent significantly less time exploring the novel object than control males, while the PTU-CON females explored the novel object as much as the control females. This suggests that prenatal hypothyroidism impacted novel object recognition memory only in male rats, but that compensation may have occurred when prenatal PTU exposure was followed by postnatal exposure.

38 SOCIAL HOUSING INFLUENCES SEROTONERGIC FLUCTUATIONS IN MALE MICE DURING RESIDENT-INTRUDER ENCOUNTERS

Sloss BG, Keesom SM, and Hurley LM

Department of Biology, Indiana University

Appropriate behavior during a social encounter requires that an animal attend to social signals, such as vocalizations, and past social experience plays an important role in shaping sensory responses to social signals. Mechanisms that mediate the influences of social experience on sensory processing for three reasons: 1) the serotonergic system itself is sensitive to social experience; 2) socially triggered serotonergic fluctuations reflect behavioral differences among social encounters; and 3) serotonin alters evoked responses of auditory neurons to natural vocalizations. The aim of this study was to test the effect of social housing on the socially induced serotonergic response in the auditory midbrain. Carbon fiber voltammetry was used to measure serotonergic activity in resident male mice (*Mus musculus*) during 30-min encounters with an intruder. Prior to these experiments, mice were either group-housed or individually housed from 3 weeks to 7 weeks of age. Social and non-social behaviors performed during the male-male social encounters were measured and compared with serotonin. Both group-housed and individually housed males experienced a similar degree of serotonergic elevation in response to an intruder male. However, social housing altered the timing of this elevation, with group-housed males demonstrating elevated serotonin 12 minutes before individually housed males. Social housing also altered the relationship between the serotonergic response and the subject mouse's weight (a possible indicator of social dominance): serotonin was positively related to the subject mouse's weight for group-housed males, but not for individually housed males. Preliminary data suggest that serotonin-behavior relationships are also affected by social housing; group-housed males exhibited a positive relationship between serotonin and social investigation, whereas individually housed males did not exhibit such a relationship. Taken together, these findings suggest that social experience obtained via group housing alters the ability of the serotonergic system to convey information about immediate social context in an auditory region.

39 RATS REMEMBER ITEM IN CONTEXT USING EPISODIC MEMORY

Panoz-Brown DE, Sluka CM, Brotheridge S, Corbin H, Dalecki S, Gentry M, Wu JE, and Crystal JD

Indiana University

Episodic memory in humans has been characterized as the vivid replay of unique and specific events in sequential order. However, the age (and hence the relative familiarity) of specific memories varies. Therefore, in nonhuman subjects it is important to rule out familiarity based explanations for putative episodic memories. Here we asked if rats remember the occurrence of multiple unique events and the contexts in which these events occurred (i.e., item in context memory). We used a well-established olfactory memory task in which novel (but not old) odors were rewarded. Our data suggest that rats remember the context in which odors were presented. When the identity of items in context was put in conflict with familiarity cues, rats relied on item in context memory rather than familiarity to complete the task. We conclude that rats remember multiple unique events and the contexts in which these events occurred using episodic memory, ruling out conflicting theories based on familiarity.

40 FEMALE MATE PREFERENCE IN EASTERN NEWTS (*NOTOPHTHALMUS VIRIDESCENS*) IN RELATION TO THE NUMBER AND BRIGHTNESS OF RED SPOTS ON MALES

Spicer MM, Hart SL, and Gall BG

Biology, Hanover College

Eastern red-spotted newts (*Notophthalmus viridescens*) exhibit tremendous variation in the number and brightness of red spots on the dorsum, which could be used by females for mate selection decisions. We conducted an experiment to determine whether females use these characteristics in their mate selection decisions by simultaneously exposing a female to a male with a high number of spots (≥ 20) and a male with a low number of spots (≤ 10). We then recorded the amount of time the female spent in a preference zone adjacent to each of the males. We also scored the relative brightness of each male and evaluated whether females used this metric in their selection. Female newts did not show a significant preference for either low spotted or high spotted males, spending roughly equal amounts of time in both preference zones. Females did spend more time on the side of the chamber with duller-spotted males; however this was also not significant. These results suggest that female eastern red-spotted newts do not use the frequency of spots or the brightness of those spots in their mate selection decisions.

41 EFFECTS OF A BROAD-SPECTRUM ANTIBIOTIC ON THE SIBERIAN HAMSTER (*PHODOPUS SUNGORUS*) GUT MICROBIOME

St. John EA, Sylvia KE, Jewell CP, and Demas GE

Indiana University

The gut microbiome is a diverse, host unique, and symbiotic bacterial environment, however, antibiotic treatment can adversely affect the bacterial population. Although therapeutically beneficial, antibiotics can change the structure, function, and evolution of host microbial communities in the gut, affecting nutrient availability and predisposing infection in the gut by non-communal species. Previous studies have shown the effects of antibiotics on the host's gut microbiome in many model species, yet in non-model species, such as the Siberian hamster, the role of the microbiome and the effects of antibiotics have yet to be fully explored. In order to study the various effects of antibiotics on the microbiome and ultimately the consequences it has on behavior in our species, we first had to determine if and how antibiotic treatment affects the gut microbiome of both male and female Siberian hamsters. In order to assess this question, male and female hamsters were either administered sterilized water or a broad-spectrum antibiotic (0.3 μ l of enrofloxacin (Baytril) 10% oral solution per gram of body mass) via sterile pipette orally once daily for seven days. Body mass was monitored, and fecal samples were taken throughout the seven days before treatment (D1-7), the seven days during treatment (D8-14), and the seven days following the treatment period (D15-21). Microbiome analysis was completed to determine the effects of this broad-spectrum antibiotic on the gut microbiome. At the end of the experiment, all animals were euthanized and organs were harvested and weighed. To determine the bacteria makeup of the gut microbiome, DNA was extracted and purified from the fecal material, and the V4 region of the 16S rRNA gene was amplified using the Illumina MiSeq platform to identify the bacteria present in each sample. Antibiotic treatment altered the makeup of microbial communities, and by the end of the recovery period (D21), the host gut microbiome was able to return close to baseline levels. There were no significant differences in body mass, and no differences in liver or spleen mass. The results of this work help us to advance our understanding of the gut microbiome's function in host communities, and they will allow us to further investigate the role that the microbiome plays in the gut-brain axis in non-model species.

42 DOES THE PRESENCE AND NATURE OF A CONSPECIFIC AFFECT THE BEHAVIORAL AND NEUROHORMONAL RESPONSE TO ACUTE STRESS IN MALE PRAIRIE VOLES?

Staebler N, Alexander G, Perkeybile AM, Kenkel WM, Carter CS, and Kingsbury MA

Department of Biology, Indiana University

Social contact has been shown in female prairie voles (*Microtus ochrogaster*) to diminish the stress response following an acute stressor, as evidenced by a decrease in blood levels of corticosterone and anxiety-related behaviors when compared to subjects recovering in isolation (Smith and Wang, 2014). This social buffering effect appears to be mediated by oxytocin release in the paraventricular nucleus of the hypothalamus. While the phenomenon of social buffering has been examined in females using pair-bonded partners following an acute stressor, it is unknown if such effects are also present in males. Furthermore, it is unknown if non pair-bonded conspecifics provide similar social buffering effects as pair-bonded partners. We hypothesize that males will exhibit similar social buffering effects as females, and that the nature of the social contact, i.e. with a partner or a sibling, will affect neurohormonal and behavioral measures of stress recovery. In this study, male prairie voles were subjected to a one-hour immobilization stressor and recovered for one hour in one of three conditions: in isolation, with a cage-mate sibling, or with a pair-bonded partner. Anxiety and stress-coping behaviors were observed and quantified for both test subjects and cage-mates or partners for the first hour following the stressor. Subjects were sacrificed one hour after the stressor and a blood sample and brain tissue were taken. Blood samples were assayed for corticosterone levels as well as circulating vasoactive intestinal polypeptide (VIP) and oxytocin (OT), two neuropeptides that are involved in regulating social behaviors and response to stressors (Carter et al. 2008; Kingsbury et al. 2014; Goodson et al. 2015). Brain tissue will be analyzed for VIP and OT expression and activity, as measured by Fos expression.

43 EFFECTS OF PREWEANLING STRESS ON DENDRITIC SPINE DENSITY IN BASOLATERAL AMYGDALA

Swanson KM¹, Skipper RA¹, Quinn JJ², Herbst MR², and Wellman CL¹

¹*Department of Psychological and Brain Sciences and Center for the Integrative Study of Animal Behavior, Indiana University;* ²*Department of Psychology, Miami University*

Stress has been implicated in many psychological disorders, such as depression, generalized anxiety disorder, phobias, and post-traumatic stress disorder (PTSD; 1). Importantly, these disorders are more prevalent in females than males, and typically emerge early in life (2). However, it is unknown how exactly early stress leads to these disorders, or how stress could impact males and females differently. Interestingly, stress during adulthood has significant morphological effects in various regions of the brain that are involved in emotional processing, including the amygdala and pre-frontal cortex (3). Dendritic spines are protrusions from dendrites that represent synaptic connections with other neurons and are especially plastic in a developing brain (4). Spines undergo morphological changes as they mature and are classified accordingly, progressing from stubby to thin to mushroom to branched spine types. Previous studies have shown that stress affects both spine density and the prevalence of different spine types (5). These changes lead to different synaptic connectivity. In this study, male and female rats were separated into stressed and unstressed groups. The stressed group underwent a single series of foot shocks during the preweanling period (on post-natal day 17). Spines in the basolateral amygdala were counted and classified as either thin, stubby, mushroom, or branched. Preliminary results suggest that, even without stress, spine density differs between males and females. Due to hormonal differences in stress responding (6), there may also be differential effects of stress. Results from this study will better characterize the effects of stress during juvenility, a critical time period that has not been thoroughly studied. Further stress research has largely focused on male rats. It is crucial to examine females as well, especially given the varying prevalence of stress-related disorders between sexes. Better understanding the effects of early life stress and sex differences in these outcomes will therefore shed light on two important but understudied areas.

44 THE ROLE OF ACID-SENSING ION CHANNELS (ASICS) IN OLFACTORY BEHAVIOR

Vann KT and Xiong Z

Neuroscience Institute, Morehouse School of Medicine

Acid-sensing ion channels (ASICs) are cation channels activated by protons. Activation of ASIC1a, a primary functional ASIC subunit in CNS, has been shown to play an important role in synaptic plasticity, learning and memory. ASIC1a subunits are enriched and characterized in the olfactory bulb. However, the potential involvement of ASICs in olfactory behavior remains unknown. We hypothesize that ASICs play a role in normal olfactory function. The role of ASICs in olfactory behavior was assessed in ASIC1a KO mice through buried food test, olfactory habituation/dishabituation test and computer-assisted olfactory testing. In addition, nasal irrigation of zinc gluconate, an agent known to cause anosmia, was applied to examine its effect on olfactory behavior. Data was analyzed using ANOVA and Student's t-test. In buried food test, ASIC1a KO mice took significantly longer time to uncover the food (55.108 sec) versus WT mice (32.837 sec). In olfactory habituation/dishabituation test, WT mice had significantly shorter sniffing times with orange extract ($p \leq 0.002$) and acetic acid ($p \leq 0.013$) compared to ASIC1a KO mice. As expected, the mean latency of zinc gluconate-treated mice was significantly longer than sham mice after 1 hr treatment ($P < 0.01$). In preliminary odor sensitivity and perception data, impairments in odor threshold were apparent in ASIC1a KO mice. These findings suggest that ASIC1a is essential for normal olfactory behavior/function.

45 THE EFFECT OF SOCIAL EXPERIENCE ON SEROTONERGIC FIBER DENSITY IN THE AUDITORY MIDBRAIN

Wise BM¹, Keesom SM¹, Sandlain R², and Hurley LM¹

¹Indiana University; ²Illinois Institute of Technology

Animal communication involves both a "sender," which emits a signal, and a "receiver," which processes the signal. Signal processing can be shaped by past social experience. In the auditory midbrain, serotonin is a potential mechanism for linking social experience with auditory processing for three reasons: 1) the serotonergic system is sensitive to social experience in other brain regions; 2) changes in serotonin concentration reflect contextual features of social encounters; and 3) serotonin influences single auditory neurons' response to sounds, such as conspecific vocalizations. Laboratory mice (*Mus musculus*) provide an excellent model for investigating this potential mechanism, because mice are being increasingly studied as a model of auditory communication and demonstrate sensitivity to social experience. In this study, we investigated how social experience affects serotonergic fiber density in the inferior colliculus (IC), an auditory midbrain region that demonstrates selectivity for species-specific vocalizations. From weaning (3 weeks) until 7 weeks of age, male CBA/J mice were housed either individually or in groups of 3 non-sibling mice. After the social treatment, coronal sections of brain tissue were processed via immunohistochemistry with fluorescence to label the serotonin transporter (SERT) as a marker for serotonergic fibers. Those coronal sections were imaged under a fluorescent microscope, and ImageJ and Matlab were used to conduct line intensity scan analysis to estimate serotonergic fiber density in the inferior colliculus. Preliminary results suggest that there is dense coverage of the IC by serotonergic fibers in males from both housing treatments. While individually housed mice had qualitatively lower coverage of the IC than socially housed mice, this difference was not statistically significant. While these preliminary results suggest that social experience does not affect serotonergic fiber density in the IC, this does not rule out influences of social experience on other aspects of serotonergic signaling in the auditory midbrain, including socially induced serotonin release and profiles of serotonin receptors.

46 CREATING A CULTURAL BRIDGE IN AN URBAN POVERTY ZONE TO INCREASE CANINE AND HUMAN WELFARE

Wisok A

Bergin University of Canine Sciences

A former manufacturing powerhouse, Detroit has experienced a 50-year slide into urban poverty. United Way reports 67% of Detroit families are near or under the poverty line. Remaining residents face many challenges and their pets understandably take second place after more imminent home and family needs. Dogs are commonly used as security animals and live outdoors and are often permanently tethered. These animals are not socialized, lack veterinary care, and can be potentially dangerous disease vectors. Accessing this difficult-to-reach population has been the goal of many outreach programs that have met with limited success. Michigan Humane Society cruelty investigation reports 90% of calls result in education. Residents do not possess computers or dedicated internet access. I have developed and will describe a method to reach and effect change in this population. In a pilot study this approach has found to be useful, necessary, and sufficient to change human and animal behavior. This method is easily expanded into other geographic areas of need.

47 MATERNAL BEHAVIOR IN VIRGIN FOREBRAIN OXYTOCIN RECEPTOR KNOCKOUT MICE

Witchey SK¹ and Caldwell HK^{1,2}

¹*Department of Biological Sciences and* ²*School of Biomedical Sciences, Kent State University*

In female rodents, the oxytocin (Oxt) system is not only important to birth and milk ejection but also plays a role in the initiation of maternal behavior. Previous work from our lab has shown that Oxt receptor knockout (Oxtr^{-/-}) mice and forebrain Oxt receptor knockout (OxtrFB/FB) mice are more likely to abandon their pups than wildtype (+/+) females; though, females that do initiate maternal behavior do not differ from +/+ controls. To determine aversion is restricted to the postpartum period, we examined maternal sensitization in virgin OxtrFB/FB and Oxtr +/+ females following repeated exposure to foster pups. On the last day of testing we collected brains to process for immediate early gene activation (c-Fos immunocytochemistry). We hypothesized that there would be genotypic differences in the onset of maternal behaviors, with OxtrFB/FB mice having a delay in their onset. We also hypothesized that there would be genotypic differences in c-Fos immunoreactivity in brain areas known to be important for maternal care, such as the paraventricular nucleus, the supraoptic nucleus, the medial preoptic area, the bed nucleus of the stria terminalis, and the lateral septum. Specifically, we predicted that OxtrFB/FB mice would show reduced c-Fos activation in some of these brain areas. While there were no significant differences in any maternal behaviors scored (i.e. nest building, licking pups, etc.) across any days, there were significance genotypic differences in the latency to retrieve the first pup on day one (p=.006) and all pups retrieved on day one (p=.012). We also found a difference in c-Fos activation, with OxtrFB/FB mice having decreased c-Fos immunoreactivity in the dorsal region of the lateral septum compared to +/+ controls.