

The 14th Annual Indiana University Animal Behavior Conference



April 23, 2007
IMU Frangipani Room



CISAB

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The 14th Annual Indiana University Animal Behavior Conference Schedule

SUNDAY, APRIL 22

4:00– 5:00pm Hang Posters (Frangipani Room / IMU)

MONDAY, APRIL 23

8:00 — 8:50 Hang Posters & load talks

8:30 — 8:50 Light breakfast

8:55 — 9:00 Welcome from CISAB director, Emilia Martins

9:00 — 10:15 Session I (Moderator: Idelle Cooper)

9:00 Joel W. Mcglothlin
Natural variation in a testosterone-mediated tradeoff between mating effort and parental effort.

9:15 Benjamin Miller
Spike synchrony in the striatum: Insight into up and down-state dynamics in normal physiology and disease.

9:30 Sayuri Kojima
Maternal induction of filial preferences begins in late infancy for norway rats (*Rattus norvegicus*)

9:45 Erin Keen-Rhinehart
Increased corticotropin releasing hormone in the central nucleus of the amygdala using lentiviral vectors mimics chronic stress treatment and inhibits reproduction in female rats.

10:00 Jennifer Miller
Vocal improvisation in brown-headed cowbirds (*Molothrus ater*) is sensitive to social ecology and social companions.

10:15 — 10:45 Poster Session and Morning Break

10:45 — 12:00 Session II (Moderator: Melissa Scotti)

- 10:45 Kathryn M. Lenz
Artificial rearing and tactile stimulation influence motoneuron morphology and copulatory reflex behavior in male rats.
- 11:00 Idelle A. Cooper
Ecological causation of sexual dimorphism in damselflies.
- 11:15 Dayna R. Loyd
Sex differences in morphine analgesia.
- 11:30 Skyler S. Place
Mate Copying in Humans.
- 11:45 Molly Puente
When should parasitoids respond to herbivore induced plant volatiles?

12:00 — 1:15 Lunch and Poster session

1:15 — 2:15 Session III (Moderator: Julienne Rutherford)

- 1:15 Thomas Hills
The role of animal foraging in the evolution of human cognition.
- 1:30 Grant T. Goodrich
The role of anecdotal evidence in 19th century studies of animal behavior.
- 1:45 Andrea G. Gillman
Circadian activity patterns in nicotine addiction under fixed and varying zeitgebers.
- 2:00 Nick K. Priest
Epistasis and mating-induced recombination: A genetic link between sex and sexiness.

2:15 — 2:45 Poster Session and Afternoon Break

2:45 — 3:45 **Session IV (Moderator: Sayuri Kojima)**

2:45 Julien Ayroles
Functional genomics of speciation in *Drosophila yakuba* and *Drosophila santomea*.

3:00 Aaron Wilber
Neonatal maternal separation alters adult eyeblink conditioning and glucocorticoid receptor expression in the interpositus nucleus of the cerebellum.

3:15 Aaron M. Jasnow
Using self-inactivating lentivirus vector for In vivo manipulation of gene expression.

3:30 Heather Rupp
Menstrual cycle and partner risk modulate patterns of neural activation in women in response to photos of male faces.

3:45 — 4:00 Awards Ceremony – Emilia Martins

4:00 — 5:00 Plenary Speaker (introduced by Laura Hurley)

**Michael J. Ryan, University of Texas at Austin
Brain, Behavior and Evolution in Sexual Communication in Tungara Frogs.**

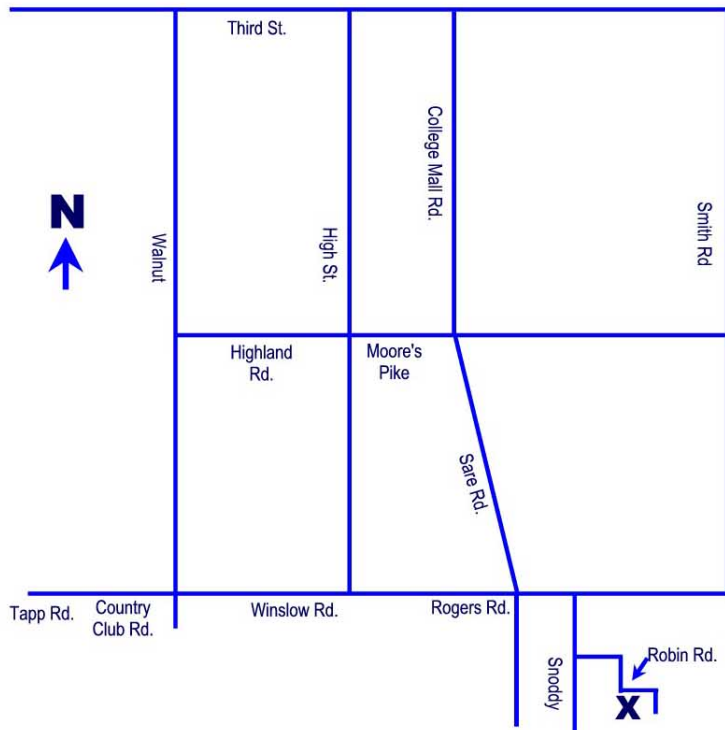
7:30 — 9:30 Evening Reception

**Laura Hurley & Troy Smith's home
3660 E. Robin Road (Please see a map in page 6)
IU-ers are asked to bring a dish to share**

MAP to Smith/Hurley house

Directions:

1. Take your favorite route south (unless you live even further south) to Tapp/Country Club/Winslow/Rogers.
2. Go east on Tapp/CountryClub/Winslow/Rogers (unless you're coming down Smith Rd., in which case, go west).
3. Turn south onto Snoddy Rd.
4. Turn left onto Robin Rd. (at the bottom of the hill).
5. Robin Rd. will turn to the right. Our driveway will be right in front of you (where Robin Rd. turns left again). Our house is white with red brick. The address is 3660. Phone 332-1691.



TALK PRESENTER AND ABSTRACTS (in order of presentation)

SESSION 1

1. Joel W. McGlothlin (jmcgloth@indiana.edu)

NATURAL VARIATION IN A TESTOSTERONE-MEDIATED TRADE-OFF BETWEEN MATING EFFORT AND PARENTAL EFFORT.

Joel W. McGlothlin*, Jodie M. Jawor*, †, and Ellen D. Ketterson*

*Department of Biology and Center for the Integrative Study of Animal Behavior, Indiana University

†Department of Biological Sciences, University of Southern Mississippi.

Males often face a trade-off between acquiring mates and caring for offspring. Hormone manipulation studies indicate that testosterone often mediates this trade-off, increasing mating effort at the expense of parental effort. Little is known, however, about individual covariation between testosterone and relevant behavior, which is necessary in order for selection to act. Using wild male dark-eyed juncos (*Junco hyemalis*), we measured individual variation in testosterone levels before and after standardized injections of gonadotropin-releasing hormone (GnRH). GnRH challenges have been shown to produce testosterone short-term increases that are repeatable, greater in males with more attractive ornaments, and similar to those produced naturally in response to social stimuli. We compared these testosterone measures to behavioral measures of mating and parental effort (aggressive response to a simulated territorial intrusion and nestling feeding, respectively). Males that showed higher absolute post-challenge testosterone levels displayed more territorial behavior, and males that produced larger GnRH-induced testosterone increases above initial levels displayed reduced parental behavior. Initial testosterone levels did not significantly predict either behavior. These relationships suggest that the capacity to generate short-term testosterone increases may underlie individual variation in the mating effort/parental effort trade-off.

2. Benjamin R. Miller (benmille@indiana.edu)

SPIKE SYNCHRONY IN THE STRIATUM: INSIGHT INTO UP AND DOWN-STATE DYNAMICS IN NORMAL PHYSIOLOGY AND DISEASE.

Benjamin R. Miller and George V. Rebec.

Program in Neuroscience and Department of Psychological and Brain Sciences, Indiana University.

The striatum is the central information processing hub in the basal ganglia, serving as the major input nucleus that temporally gates afferent sensorimotor, cognitive, and motivational information for the control of goal-directed behaviors and habits. Medium spiny neurons (MSNs), the primary output neurons of the striatum, oscillate (~1 Hz) between two preferred subthreshold states: a hyperpolarized down-state and a depolarized up-state. Spike output occurs only during the up-state, which is driven by the convergence of temporally coherent glutamatergic input from the cortex. Interestingly, task-related neural ensembles in the striatum are compartmentalized and membrane potential oscillations in MSNs from these populations are highly correlated. These findings, however, are based on data obtained from anesthetized animals; thus it is somewhat speculative whether coordinated periodicities in membrane potential oscillations exist during behavior.

We used chronically implanted micro-wire bundles to record from populations of striatal neurons in free-behaving mice. Cross-correlograms were constructed to assess the presence of pair-wise spike correlations (spike synchrony). Cross-correlation analyses revealed that ~30% of pair-wise striatal spikes fire synchronously at ± 200 ms delay. Since spikes only occur in the up-state, we suggest that subsets of MSNs in local populations synchronously alternate between up and down-states during behavior.

Huntington's disease (HD), a tri-nucleotide repeat disorder characterized by progressive loss of motor control and cognitive decline, impairs operation of the striatum in part by disrupting glutamatergic signaling in the corticostriatal pathway. Perturbations in corticostriatal glutamate signaling in HD likely

alter synchronous spiking in MSNs. Indeed, at the time of symptom onset, there is a marked reduction of pair-wise spike synchrony, where only ~5% of pair-wise spikes from MSNs fire synchronously in the R6/2 transgenic and 140 CAG knock-in murine models of HD compared to wild-type controls. Altered spike synchrony in the striatum may signify that convergent--presumably cortical--information is not properly processed.

Our data support the view that spike synchrony is crucial to normal striatal information processing during behavior and that dysfunction of spike periodicities is a key component of HD pathophysiology.

3. Sayuri Kojima (skojima@indiana.edu)

MATERNAL INDUCTION OF FILIAL PREFERENCES BEGINS IN LATE INFANCY
FOR NORWAY RATS (*RATTUS NORVEGICUS*).

S. Kojima and J. R. Alberts.

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

At birth, Sprague-Dawley rat pups huddle vigorously and non-selectively with animate and inanimate sources of heat, thus reducing heat loss and metabolic expenditures. By Postnatal Day (PD) 15, pups prefer to huddle with a conspecific rather than with a different rodent species or other sources of heat. Thus, during the first two postnatal weeks, huddling transforms from a response to heat (physiological huddling) into a manifestation of social affiliation (filial huddling). Previous studies demonstrated that pups can learn their filial huddling preference from contact with an olfactorily-tagged dam or thermotactile stimulus (i.e., a localized heat). Recently, there was a hypothesized "mammalian imprinting model" accounting for the formation of social attachments in infant rats that featured a sensitive period for early olfactory learning, ending by PD 10 (Moriceau & Sullivan, 2005).

The present study was designed to identify during the first 14 postnatal days a possible sensitive period in the establishment of odor-guided huddling preferences. Beginning on PD 1, 5, or 10, pups received daily 2-hr exposures for 5 days to a lactating foster dam anointed with a novel scent. Littermate control pups were similarly exposed to the odor but in the absence of a dam. On PD 15, when odor-guided huddling naturally begins, pups exposed to a maternally-paired odor on PDs 5-9 or PDs 10-14 displayed a reliable preference for the paired odor, but the youngest group did not. Additional analysis revealed a sex difference in which female pups more reliably acquired the olfactory huddling preference than did males. This was also seen in an additional cohort in which odor conditioning performed on PDs 10-14, but testing was conducted on PD 20, demonstrating retention of the acquired preference for 6 days at least. The present study did not reveal a circumscribed sensitive period for the acquisition of odor-guided huddling. Instead, it did identify a period after PD 10 sufficient for inducing odor preference in huddling, as contrasted to the hypothesized sensitive period for social attachments in rats.

4. Erin Keen-Rhinehart (ekeenrh@emory.edu)

INCREASED CORTICOTROPIN RELEASING HORMONE IN THE CENTRAL NUCLEUS OF THE AMYGDALA USING LENTIVIRAL VECTORS MIMICS CHRONIC STRESS TREATMENT AND INHIBITS REPRODUCTION IN FEMALE RATS.

E. Keen-Rhinehart, V. Michopoulos, L. Martin, D. Toufexis, K. Ressler, M. Wilson.

Center for Behavioral Neuroscience and Yerkes National Primate Research Center, Emory University.

Chronic stress is linked to numerous health problems including infertility, obesity, depression and anxiety. Currently there is a gap in information regarding how chronic stress contributes to these problems. It is well established that the stress neuropeptide, corticotropin releasing hormone (CRH), is increased in the limbic system during chronic stress, and that the central nucleus of the amygdala (CeA) in the limbic system is a critical nucleus in the chronic stress response network. However, a causal link between increased CRH in the CeA and reproductive dysfunction has not yet been established. These studies use a lentiviral vector to increase CRH expression site specifically in the CeA to mimic the neurobiological changes that occur during chronic stress to examine its effects on neuroendocrinology and behavior. In this model, increased CRH in the CeA causes both similar behavioral changes as other chronic stress models such as reduced active coping in the forced swim test and enhanced startle as well as similar physiological changes as other chronic stress models such as chronically elevated serum corticosterone and abdominal obesity. These data support the notion that increased CRH in the CeA using lentiviral vectors is a valid model of chronic stress in female rats. In addition, increased CRH in the CeA causes abnormal estrous cyclicity and inhibition of reproductive behavior, supporting the idea that increased CRH from the CeA contributes to reproductive dysfunction caused by chronic stress. These data delineate a potential new model of chronic stress and implicate increased CRH in the CeA as a causative factor in chronic stress-induced reproductive dysfunction.

5. Jennifer L. Miller (jlm19@indiana.edu)

VOCAL IMPROVISATION IN BROWN-HEADED COWBIRDS (MOLOTHRUS ATER) IS SENSITIVE TO SOCIAL ECOLOGY AND SOCIAL COMPANIONS.

Jennifer L. Miller.

Department of Psychological and Brain Sciences, Indiana University.

Previous work has found that male cowbirds (*Molothrus ater*) housed with adult females, who do not sing, improvised on songs they were tutored with as opposed to tutored males, housed with nonconspecifics, who did not improvise. The present work extends this finding to examine the role of adult vs. juvenile female social behavior to stimulate improvisation in males. In this study, I housed juvenile males with adult or juvenile females in large flocks as opposed to pairs or triads in sound attenuating chamber. Over the course of a year, I recorded their song and social behavior. I found in early fall that juvenile males housed with adult females improvised more than males housed with juvenile females. During late fall, the males were switched across female age class conditions. The males switched to the adult female condition increased the number of improvised elements in their vocal repertoires. Analysis of the sequences of female-male social contact reveals juvenile females, but not adult females, interacted indiscriminately with the males. Virtually all male improvisation appears to originate with contact with adult females. These patterns of male-female interactivity were associated with different song ontogenies and reproductive success.

SESSION 2

6. Kathryn M. Lenz (kmlenz@indiana.edu)

ARTIFICIAL REARING AND TACTILE STIMULATION INFLUENCE MOTONEURON MORPHOLOGY AND COPULATORY REFLEX BEHAVIOR IN MALE RATS.

Kathryn M. Lenz.

Department of Psychological and Brain Sciences and Program in Neuroscience, Indiana University.

Early social contact between mother and offspring influences offspring neural and behavioral development. For example, neonatal maternal care in rats influences the development of adult male copulatory behavior, and also shapes the underlying development of the spinal nucleus of the bulbocavernosus (SNB), a sexually dimorphic motoneuron population which in males innervates muscles at the base of the penis to control copulatory penile reflexes. Specifically, experimentally reducing maternal licking behavior during the neonatal period produces a 50% regional decrease in adult dendritic length in the SNB of offspring. In this experiment, we focused on a possible mechanism through which early maternal care influences the development of the SNB. Reducing maternal licking behavior causes decreases in perineal tactile stimulation of the offspring, which likely alters the pattern of afferent activity that SNB motoneurons receive and potentially produces differential dendritic development. Using an artificial rearing paradigm, we isolated the tactile stimulation component of maternal licking behavior by varying the amount of maternal licking-like stimulation pups receive during the neonatal period, and subsequently assessed penile reflex behavior and SNB motoneuron morphology in adulthood. Artificially reared animals that received reduced licking-like stimulation showed both deficits in adult penile reflex behavior and decreased SNB dendritic length in adulthood. These results suggest that the tactile stimulation component of maternal licking influences the development of the SNB and resultant sex behavior.

7. Idelle A. Cooper (idcooper@indiana.edu)

ECOLOGICAL CAUSATION OF SEXUAL DIMORPHISM IN DAMSELFLIES.

Idelle A. Cooper.

Department of Biology, Indiana University.

The cause of phenotypic differences between sexes has long attracted the attention of biologists. While sexual dimorphism is almost exclusively attributed to sexual selection, the role of natural selection remains poorly understood. My research indicates that natural selection plays a major role in the evolution of female and male color types in the Hawaiian damselfly, *Megalagrion calliphya*. Although most species in this genus exhibit sexual dimorphism in color (red males and green females) this species contains a female-limited dimorphism in which the male color is expressed by some females. Such female-limited dimorphisms are common in odonates, but the adaptive significance remains unknown. Previous studies examined whether male mimicry allows females to avoid costly sexual interactions but found no evidence for sexual selection. Here, I examine the ecological distribution and selection pressures on the two morphs to understand the role of natural selection in determining this trait. The male-colored females increase in frequency from 0% to 97% over an elevational increase of 1400 meters. Along that gradient, maximum temperature and solar radiation also increase. Additionally, a field transplant experiment to test the effect of solar radiation on female body temperature suggests that male coloration in females is adaptive for thermal balance in the exposed habitat found at high elevations. This research is novel in suggesting that intersexual mimicry could arise as a consequence of natural selection rather than sexual selection.

8. Dayna R. Loyd (biodrl@langate.gsu.edu)

SEX DIFFERENCES IN MORPHINE ANALGESIA.

Dayna R. Loyd and Anne Z. Murphy.

Center for Behavioral Neuroscience, Department of Biology, Georgia State University.

Chronic pain is an important issue to healthcare providers, legislators, and the tax-paying population. While the opioid-based narcotic morphine is the most prevalent treatment for chronic pain in clinical settings, it is becoming increasingly clear that morphine produces a significantly greater degree of analgesia in males compared to females. In a rat model of persistent pain, the effective dose of morphine for males is 4-5 mg/kg, while the comparable dose for female rats is 9-10 mg/kg. The midbrain periaqueductal gray (PAG) and its descending projections to the rostral ventromedial medulla (RVM) is one of the primary anatomical substrates underlying opioid analgesia. Using a systems level approach, we have recently shown that the PAG-RVM pathway is sexually dimorphic both in its anatomical organization and in its activation during persistent pain. Interestingly, while female rats have a greater number of PAG neurons that project to the RVM, inflammatory pain activates these cells to a greater degree in males. Additionally, systemic morphine inhibits the pain-induced activation of PAG neurons to a greater degree in males. These sex differences in neuronal activity during pain and morphine analgesia are prominent in the ventrolateral PAG, a region containing a large population of mu opioid receptor-containing neurons. Using immunocytochemistry, we have recently shown that females have significantly lower levels of mu opioid receptors in this region, however it is not known whether sex differences in mu opioid receptor expression contribute to our observed sex differences in morphine analgesia. To test the role of ventrolateral PAG mu opioid receptors in systemic morphine analgesia, the cytotoxin saporin conjugated to the mu opioid receptor agonist dermorphin was injected into the ventrolateral PAG to site-specifically lesion mu opioid receptor-containing neurons. Twenty-eight days later, the right hindpaw was injected with an inflammatory agent to induce persistent pain and twenty-four hours later morphine was administered systemically. Our data demonstrate that lesions of PAG mu opioid receptor-containing neurons significantly attenuate morphine analgesia in both male and female rats as compared to controls. These results indicate that the PAG is a primary locus for systemic morphine analgesia and implicates a novel target for sex-specific treatment of persistent pain.

9. Skyler S. Place (ssplace@indiana.edu)

MATE COPYING IN HUMANS.

Skyler S. Place and Peter M. Todd.

Department of Psychological and Brain Sciences and Cognitive Science Program, Indiana University.

Animals take many shortcuts in gathering information they need to behave adaptively in their environments. One such informational shortcut is seen in the phenomenon of mate copying, where a female will obtain useful information by watching the mating interactions between other members of her species. If an interaction is successful, her preference for mating with the male involved will increase. While this behavior is well documented in fish and bird species, little research has investigated whether humans use a similar adaptive information-gathering mechanism during mate search. We will present early findings from a study of human mate copying, using speed-dating as an empirical mating interaction that is observed by college-age participants.

10. Molly Puente (mepuente@ncsu.edu)

WHEN SHOULD PARASITOIDS RESPOND TO HERBIVORE INDUCED PLANT VOLATILES?

Molly Puente.

Department of Entomology, North Carolina State University.

In laboratory experiments, wasps that parasitize caterpillars are attracted to volatile chemicals produced by plants in response to the caterpillar feeding. Although some researchers have concluded that breeding crop plants to increase volatile production will increase parasitization, this may be misleading because the laboratory tests miss the spatial and temporal dynamics that occur at the population level. Delays in plant chemical production, parasitized hosts that continue to injure plants, and the density of hosts in the field might all impact how useful plant cues are to the parasitoids. I created a stochastic, spatially-explicit simulation model to examine these potentially confounding variables. By following individual plants and caterpillars through a typical season length, I can identify when wasps benefit from following herbivore induced plant signals.

SESSION 3

11. Thomas Hills (thills@indiana.edu)

THE ROLE OF ANIMAL FORAGING IN THE EVOLUTION OF HUMAN COGNITION.

Thomas Hills.

Department of Psychological and Brain Sciences, Indiana University.

Recent evidence from a number of fields supports the evolution of human goal-directed cognition out of components initially used to control foraging behavior. I will present this evidence by describing the evolution of neural architectures designed to modulate between local and global foraging behavior (i.e., area-restricted search). These components involve the modulation of glutamatergic synapses via the action of dopamine, and lead to more or less spatial perseveration as dopamine levels respectively rise and fall. These mechanisms are extant in all major clades of eumetazoans (e.g., insects, mollusks, and vertebrates), but show a distinct proliferation in interneurons with the rise of the mammalian cortex. This property is most evident in the striatum and prefrontal cortex, which are known to control human attention, eye-movements, and goal-directed behaviors. The properties of this control are clearly related both in behavior and molecular machinery to that of animal foraging and this is further evidenced by the relationship between behavioral extremes and their related underlying etiologies in human goal-directed pathologies such as Attention-deficit/hyperactivity disorder, obsessive-compulsive disorder, and stereotypies in autism.

12. Grant T. Goodrich (gtgoodri@indiana.edu)

THE ROLE OF ANECDOTAL EVIDENCE IN 19TH CENTURY STUDIES OF ANIMAL BEHAVIOR

Grant T. Goodrich.

Department of History and Philosophy in Science, Indiana University

Recently, researchers debating the use of anecdotal evidence and anthropomorphism have referred to similar debates that occurred in the 19th century. Clive Wynne (2007) and Mark Blumberg (2007) argue that the researchers who employed such methods in the 19th century were mistaken and that current researchers who use anecdotes and anthropomorphize are similarly mistaken. Both researchers focus on George Romanes' anecdotes and his justification for using them. In this paper I present Romanes' reasons for using anecdotal evidence and the role that such evidence would play in producing experiments in the late 19th century. I hope to show that in many instances anecdotal evidence was advantageous to the progression of science and that the historical debates can inform current debates surrounding the use of anecdotes and anthropomorphism in comparative psychology and ethology.

13. Andrea G. Gillman (aggillma@indiana.edu)

CIRCADIAN ACTIVITY PATTERNS IN NICOTINE ADDICTION UNDER FIXED AND VARYING ZEITGEBERS.

Andrea G. Gillman and William D. Timberlake.

Department of Psychological and Brain Sciences, Indiana University.

Administration of addictive drugs, such as nicotine, on both 24 hour (circadian) and 31 hour (infradian) schedules has been shown to entrain circadian activity patterns that persist for at least 2 days when the drug is withheld. Most of the studies that have investigated this phenomenon have done so under constant lighting conditions and rate-limited feeding to negate the influences of the food- and light-entrainable circadian oscillators. This study compared wheel running, drinking, and feeding behaviors in female Sprague-Dawley rats under both rate-limited and ad libitum food schedules (Experiment 1), and under both constant and varying light schedules (Experiment 2). In all rats, activity became entrained to the nicotine administration time, and both pre-injection (anticipatory) and post-injection (elicited) activity patterns were observed for feeding, drinking, and wheel running. These activity patterns entrained to new administration times when the nicotine injections were moved to different times of the day. When injections were withheld on test days, nicotine-entrained activity persisted around the nicotine injection time for 2 to 4 days. No significant differences in activity levels were found between the two food availability schedules in Experiment 1. For the differing light schedules in Experiment 2, no significant differences were found for pre-injection activity. Post-injection activity persisted for a longer period of time under the fixed light schedule than under the varying light schedule. These results show that endogenous circadian activity patterns will entrain to nicotine administration times under both normal and novel zeitgeber conditions. These results also provide further evidence that the pre-injection and post-injection activity rhythms are controlled by separate oscillators.

14. Nick K. Priest (nkpriest@indiana.edu)

EPISTASIS AND MATING-INDUCED RECOMBINATION: A GENETIC LINK BETWEEN SEX AND SEXINESS.

Nick K. Priest and Michael J. Wade.
Department of Biology, Indiana University.

In the absence of sperm limitation, the mechanisms driving the evolution of female mating frequency are not clear. Though it is widely presumed that females acquire “good genes” benefits for their offspring by mating with multiple males, in many species the costs outweigh the theoretical genetic benefits of multiple mating. Here we show that additional bouts of mating stimulate the rate of recombination between chromosomes within female fruit flies. Though increased recombination rate can provide genetic benefits for offspring, the benefits are likely to depend on genetic architecture. To better understand the role of mating-induced recombination in the evolution of sex and sexual behavior we have constructed a model which addresses how genes that alter recombination rate evolve under different genetic architectures and mating frequencies. Here we describe the model and outline how we will use the model to test the hypothesis that mating frequency evolves as a cue to increase crossover frequency when it is advantageous, but limit cross-over frequency when it is disadvantageous.

SESSION 4

15. Julien F. Ayroles (jfayrole@ncsu.edu)

FUNCTIONAL GENOMICS OF SPECIATION IN *DROSOPHILA YAKUBA* AND *DROSOPHILA SANTOMEA*.

Julien F. Ayroles, Mary A. Carbone, C. D. Jones, J. A. Coyne, T. F. C. Mackay.
North Carolina State University.

Several recent studies have focused on expression variation between closely related species, emphasizing the importance of expression variation in studying speciation. We present a gene expression analysis of two *Drosophila* sister species, *D. yakuba* and *D. santomea*, which diverged ~ 400,000 years ago, and their F1 hybrids. In interspecific crosses, F1 male hybrids are sterile but female hybrids are fertile. Our goals are to assess the difference between these species at the level of transcriptional regulation, and the extent to which dysregulation of gene expression may explain the observed hybrid breakdown. We hybridized genomic DNA from each species onto Affymetrix microarrays to uncover genomic regions with enriched variation between species and identified genomic regions ("speciation islands") that overlapped with previous regions identified via QTL analysis. The different candidate genes and regions uncovered by this screen indicate that the speciation of *D. santomea* and *D. yakuba* has a complex genetic architecture, involving many loci, with a large proportion of loci showing patterns consistent with overdominance in the F1. We find variation in the expression of a key pigmentation regulator, along with other metabolic and behavioral genes which may play an important role in the divergence of these two species. This approach, in which whole genome transcriptional profiling is paired with QTL analysis, offers a reliable, unbiased way to identify candidate genes involved in the speciation of *D. santomea* and *D. yakuba*.

16. Aaron Wilber (awilber@indiana.edu)

NEONATAL MATERNAL SEPARATION ALTERS ADULT EYEBLINK CONDITIONING AND
GLUCOCORTICOID RECEPTOR EXPRESSION IN THE INTERPOSITUS NUCLEUS OF
THE CEREBELLUM.

A. A. Wilber¹, C. J. Southwood¹, G. Sokoloff¹, J. E. Steinmetz² and C. L. Wellman¹

¹ Department of Psychological and Brain Sciences and Program in Neuroscience, Indiana University.

² Departments of Psychology and Molecular Bioscience, University of Kansas.

Neonatal maternal separation alters learning and memory. Glucocorticoids also modulate adult learning and memory, and neonatal maternal separation alters forebrain glucocorticoid receptor (GR) concentrations. We used eyeblink classical conditioning to assess the effect of neonatal maternal separation on associative learning. We assessed delay eyeblink conditioning, GR expression, and total neuron number in the interpositus nucleus, a critical site of plasticity in eyeblink conditioning, in adult rats that had undergone either standard animal facilities rearing, handling for 15 min, or maternal separation for either 15 min or 60 min per day on postnatal days 2 to 14. At two to three months of age, delay eyeblink classical conditioning was assessed. Brains were processed for GR immunohistochemistry and GR expression in the interpositus nucleus was assessed using a computer-based densitometry system. Neuron counts and nuclear volumes were obtained from an alternate series of thionin-stained sections. Maternal separation significantly impaired eyeblink conditioning in male but not female rats. Handling and maternal separation did not significantly affect interpositus neuron number and volume. However, prolonged maternal separation significantly increased GR expression in the posterior interpositus in males, and increases were correlated with eyeblink conditioning. In female rats, maternal separation and handling did not significantly alter interpositus neuron number, volume, or GR protein expression, and GR expression did not correlate with eyeblink conditioning. Thus, neonatal maternal separation produces adult deficits in eyeblink conditioning and alterations in GR expression in its neural substrate in a sex-dependent manner.

17. Aaron M. Jasnow (ajasnow@emory.edu)

USING SELF-INACTIVATING LENTIVIRUS VECTOR FOR IN VIVO MANIPULATION
OF GENE EXPRESSION.

Aaron M. Jasnow, Donald G. Rainnie and Kerry Ressler.

Emory University, Department of Psychiatry, Yerkes National Primate Research Center,
Center for Behavioral Neuroscience.

Retroviral vectors are attractive tools for in vivo manipulation of gene expression. First, they stably integrate into the chromosomes of their target cells which allows for long term expression. They do not transfer viral genes, avoiding cell death. Third, they have relatively large cloning capability, accepting approximately 8kb inserts. In addition, lentivirus vectors based on HIV-1 have the advantage of being capable of transducing nondividing cells in vitro and in vivo making them ideal for use in the CNS. Our lab has been using lentivirus-based vectors to examine the mechanisms underlying fear learning in rats and mice. We are now developing and using cell-type promoter specific lentiviruses to obtain region, temporal and cell specific manipulations of gene expression for use in electrophysiological and behavioral experiments. A final major advantage of lentivirus vectors is that they can be used to alter gene expression in a variety of species, allowing for comparative studies of the influence of specific genes on behavior.

18. Heather Rupp (hrupp@indiana.edu)

MENSTRUAL CYCLE AND PARTNER RISK MODULATE PATTERNS OF NEURAL ACTIVATION IN WOMEN IN RESPONSE TO PHOTOS OF MALE FACES.

Rupp, H.A., James, T.W., Ketterson, E.D., Sengelaub, D.R., Janssen, E., and Heiman, J.R.
The Kinsey Institute and Department of Biology, Indiana University.

In many species, mate choice is believed to involve a complex process that balances the potential reward of a high quality, sought after mate against the risks of low paternal care or sexually transmitted infection and disease. Because factors predicting quality may coincide with less desirable characteristics in humans as in other species, women may also balance potentially conflicting priorities when choosing a mate. Women's mate preferences have been found to vary over the menstrual cycle in ways that may relate to this hypothesized conflict in reproductive priorities. The mechanism by which hormones modulate females' fluctuating preferences for male traits is unknown. Because neuroimaging studies have shown that women process monetary risk and reward as a function of stage of the menstrual cycle, we considered whether hormones might act centrally in the brain to similarly mediate the assessment of the risk and reward in relation to men as potential mates. We tested the hypothesis that women's neural activation would differ across the menstrual cycle and be related to facial and behavioral characteristics of the men presented. Participants were six heterosexual women aged 23-28 who were not using hormonal contraceptives or in committed relationships. Women were scanned during both their follicular (days 10-12) and luteal (days 19-23) phases. Using pictures of male faces, women evaluated men as potential sexual partners while a 3T Siemens fMRI scanner measured brain activity. In an event-related design, women were presented with 280 photos of male faces and houses. The face stimuli varied with masculinity and risk. Faces were masculinized using morphing software (Psychomorph, Rowland & Perrett). Risk was based on information provided about the men's number of previous sexual partners and typical use of condoms. When shown a face, the women were asked to respond to the question, "how likely would you be to have sex with the man presented?" Results demonstrated effects of menstrual cycle phase, masculinity, and risk on neural activation. During the follicular phase, women exhibited more neural activation in areas related to reward and risk taking, namely the orbitofrontal cortex and anterior cingulate. Women in their follicular phase did not differ in their response to masculinized versus feminized male faces. During the luteal phase, women exhibited more overall activation with faces in occipital-temporal areas, and also more activation at this time when viewing low risk men in areas related to arousal, including the thalamus. Activation in the superior temporal sulcus was greater with masculinized compared to feminized faces, but this effect was driven largely by women in their luteal phase. These findings suggest that women's response to men as potential sexual partners varies depending on phase of the menstrual cycle and characteristics of the possible partner's face. This study is consistent with previous work demonstrating fluctuations in the relative activation of neural risk and reward systems across the menstrual cycle. The cyclic differences in central processing of male faces reported here may help to explain previously reported cyclic fluctuations in sexual behavior and partner preferences in women.

PLENARY SPEAKER

BRAIN, BEHAVIOR AND EVOLUTION IN SEXUAL COMMUNICATION IN TUNGARA FROGS.

Michael J. Ryan.

University of Texas at Austin.

Sexual communication systems function in mate recognition and thus can have critical importance in processes of species recognition and sexual selection. The evolution of these systems are also influenced by past historical effects, and our work suggests that recognition processes have a strong phylogenetic 'footprint'. The preferences that are so important in mate recognition arise from interactions of stimulus variation and sensory, neural and cognitive mechanisms. Thus we have attempted to understand how these factors influence both behavior and evolution.

POSTER PRESENTER AND ABSTRACTS
(in alphabetical order of presenter's name)

1. Jennifer Akst (jakst@indiana.edu)

**WHO CLAIMS THE CLAMS: KLEPTOPARASITISM BY ADULT AND YOUNG HERRING GULLS
(*LARSUS AGENTATUS*).**

Jennifer Akst* and Dan Cristof†

*Department of Biology, Indiana University

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Kleptoparasitism is the act of stealing food already procured by other individuals, as opposed to hunting for oneself. Populations of birds dropping hard prey items, such as clams, from great heights to break them open are systems where we would expect this behavior to evolve because the extremely long handling time gives ample opportunity for kleptoparasites to detect potential targets. Juvenile herring gulls, *Larus argentatus*, at a mudflat in Virginia attempted kleptoparasitism more often than adults, given their relative rates of feeding activity. I also discovered that juveniles were less efficient than adults at probing for and finding suitable clams in the mudflat. If the costs of stealing from another bird are less than the costs of searching for a new clam, kleptoparasite behavior should be selected for. If the adult birds have a very low cost of searching, as the result of experience, then individuals should shift from scrounging to producing as they age.

After comparing kleptoparasitism and foraging efficiency by age, I found that young gulls were less efficient at searching and attempted to steal more often. I hypothesized that the inability to find food led young birds to shift to stealing more often than adults. To test this hypothesis, I experimentally eliminated the searching part of the feeding process, by provisioning clams that required no searching. This effectively removed that cost of the feeding process, equalizing the foraging efficiency of juveniles and adults. As predicted, this led to a decrease in kleptoparasitism attempts by juveniles, closer to the observed rates of adult kleptoparasitism.

2. Jeff D. Alstott (jalstott@indiana.edu)

Ecological Factors Alter Security Seeking in *Rattus Norvegicus*

Jeff D. Alstott.

Indiana University Purdue University Indianapolis.

Since the 1930s, researchers have framed rat locomotion in a lit open field in terms of fear and anxiety. Modern studies have continued this interpretation, describing open field behavior in terms of "security optimization". Since rats are a prey animal, such hypotheses certainly seem ecologically appropriate, and empirical research supports them. However, the structure of rat movement in an open field cannot be predicted solely by fear reduction or "security optimization." This experiment analyzed how rats' security seeking behavior can be modified by both the sex of the animal and lighting conditions, as well as the rats' familiarity with environment and vibrissae-stimulating edges. "Security seeking", in this case, was measured primarily by how much of their time rats spent in the areas of the environment that gave the most cover.

3. Jonathan Awtell (jwatwell@indiana.edu)

EVOLUTIONARY RESPONSES OF ASSOCIATED HORMONAL, BEHAVIORAL, AND PLUMAGE TRAITS FOLLOWING COLONIZATION OF A NOVEL, URBAN ENVIRONMENT.

Jonathan Awtell

Department of Biology, Indiana University.

Organisms are not random assemblages of traits, and selection is expected to favor divergent combinations of traits in different environments. Selection should also favor underlying physiological (endocrine) mechanisms that efficiently coordinate patterns of trait expression. When environments change, such mechanisms, depending on their nature, may or may not constrain patterns of adaptation. For example, the sex steroid testosterone is known to mediate key life-history trade-offs and have pleiotropic effects on physiological, behavioral, and morphological traits. The actions of testosterone are relatively conserved across vertebrates, and patterns of testosterone secretion may respond plastically or genetically to novel selection pressures. Thus, established hormone-phenotype relationships may constrain potential patterns of adaptive divergence for associated traits in a novel environment (evolutionary conservation hypothesis). Alternatively, the linkage between testosterone and target traits may be evolutionarily labile, in which case associated traits may evolve independently of hormone levels (evolutionary potential hypothesis). Our ongoing studies will assess the degree to which testosterone expression and associated social behavior and plumage traits have responded independently or in concert following recent colonization of a mild, coastal, urban environment by an ancestrally montane songbird, the dark-eyed junco. Our initial results highlight divergence in trait means and patterns of covariation in the new urban population.

4. Anuradha Bhat (anubhat@indiana.edu)

VARIATIONS IN BEHAVIORAL TRAITS AMONG NATURAL POPULATIONS IN ZEBRAFISH (*DANIO RERIO*).

Anuradha Bhat.

Department of Biology, Indiana University.

Zebrafish are small cyprinids (~ 30mm. standard length) and are native to South East Asia. Natural populations are reported to occur in India, Bangladesh and parts of Thailand. While these fish are a popular model system for various fields of genetics, biochemistry and neurobiology, surprisingly little is known about their behavior in the wild. Fish samples and data on natural habitat and water parameters have been recently collected from localities in West Bengal (India). Laboratory experiments on selected behavioral traits (such as latency to feed after stress, number of bites) were performed on 4 populations collected from the wild and 2 laboratory strains. These tests show clear differences across strains. Preliminary hormonal (cortisol) assays also indicate differences across strains. Results of these analyses hint at geographical distances and habitat variations across populations as being important factors in determining these differences in behavioral traits.

5. Cameron J. Buckner (cbuckner@indiana.edu)

THE ROLE OF RATIONALITY IN PSYCHOLOGICAL EXPLANATIONS OF ANIMAL BEHAVIOR.

Cameron J. Buckner.

Department of Philosophy, Indiana University.

Reason-based explanations of (non-human) animal behavior have been thought genuinely explanatory because they show how behavior “makes sense” given a creature’s representational and motivational states. Even if one regards reason-based explanation of non-human animal behavior as hopelessly anthropomorphic, theromorphism—the attempt to explain and predict an animal’s behavior by “seeing the world through their eyes”—has been thought useful in constructing systemic decompositions of animal behavioral repertoires. Both methods make use of internal, inferential, “rationalizing” connections—whether posited or simulated—in order to predict and explain.

The attribution of such connections must be underwritten by models of animal inference and rationality; but such models raise concerns of legitimacy which, if the recent interest in the topic is any indication (e.g. the 2006 volume *Rational Animals* and a recent issue of the journal *Animal Cognition* dedicated to these issues), are not easily laid to rest. First, the models must provide an effective and efficient framework in which to map behavioral patterns onto neural mechanisms. To accomplish this task, the models should help us gain traction against neural holism identifying the subsets of a creature’s representational and motivational states were “contentfully relevant” to the action performed. Secondly, the models should answer to realist constraints: they should not perform their explanatory functions by positing inferential abilities—such as those based in language or requiring daemonic optimizing calculations—which the creature could not plausibly be expected to possess. Thirdly, they should answer to internalist constraints—they should explain how a behavior makes sense given what the animal believes and desires. Finally, the models should answer to the pragmatic demands of science—they should be precise, falsifiable, and useful in devising an array of interesting experiments on a number of species.

Three models of animal rationality (and their corresponding models of inference) are considered as candidate solutions: procedural (classical) rationality, ecological rationality, and “heuristic rationality” (a mid-way position of the author’s design). All models are found to have strengths and weaknesses, and a question is posed to the researcher: what notion of rationality is most useful to your research?

6. Joanna J. Campodonico (jcampodo@indiana.edu)

DIFFERENTIAL EFFECTS OF ARACHIDONIC ACID ON MEDIAL VERSUS LATERAL
TYPE B PHOTORECEPTORS IN HERMISSENDA.

J. J. Campodonico, T. Walker, and J. Farley.

Department of Psychological and Brain Sciences and Program in Neuroscience, Indiana University.

Previous research has demonstrated that conditioned inhibitory learning (explicitly-unpaired presentations of light and rotation) produces reduced steady-state light responses (SSGPs) and light-evoked spike frequencies (Britton & Farley, 1999, *J. Neuroscience*) in Hermissenda Type B photoreceptors due to increases in voltage- and calcium dependent K⁺ currents (Smith & Farley, 2003, *Soc. Neurosci. Abstrs.*, 29:719.1). Arachidonic acid (AA) has also been previously shown to reduce light-evoked spike frequencies and increase K⁺ currents in B cells, thus mimicking the effects of inhibitory learning (J. Farley, K. Smith, B. Smith, 2003, *Soc. Neurosci. Abstrs.*, 29:719.2). While examining AA signaling in these photoreceptors, we found a difference in the response to AA between medial and lateral Type B photoreceptors. After adding AA, medial Type B photoreceptors decrease spike frequency 15.7% +/- 8.2% (n=11) while lateral Type B photoreceptors increase spike frequency 7.4% +/- 1.8% (n=4). To determine if this difference in response to AA is an intrinsic difference between type B photoreceptors or arises from interaction between the photoreceptors, we performed two experiments. Because acetylcholine is the neurotransmitter released by Hermissenda photoreceptors and the Hermissenda photoreceptors are known to inhibit each other, blocking acetylcholine receptors prevents interaction between the photoreceptors. In the first experiment, we bathed the Hermissenda nervous system in curare and atropine to block both ionotropic and metabotropic acetylcholine receptors. Unlike AA alone, which increased lateral photoreceptor spike frequency 7.4%, the

combination of curare, atropine, and AA reduced spike frequency 53% (n=1). As a result, this experiment suggests that AA decreases spike frequency in both medial and lateral type B photoreceptors. Therefore, the difference in response to AA between medial and lateral photoreceptors appears to be due to interactions between photoreceptors. In previous research, we found that bacalein, an inhibitor of the 12-lipoxygenase enzyme which converts AA into another active signaling molecule, blocked the AA induced spike frequency reduction in medial Type B photoreceptors (T. Walker, J. Campodonico, M. Teague, K. Ratliff, & J. Farley, 2006, Soc. Neurosci. Abstrs, 813.17). In fact, bacalein and AA lead to a modest increase in spike frequency: 4% +/- 3.9% (n=7). If the difference in response between lateral and medial type B photoreceptors is due to interactions between photoreceptors, we expected bacalein and AA to slightly reduce spike frequency in lateral type B photoreceptors. Unlike AA alone, which increased medial photoreceptor spike frequency 7.4%, the combination of bacalein and AA reduced lateral spike frequency 40.5% (n=1). Together, these experiments suggest that the spike frequency of lateral type B photoreceptors is modulated by AA and synaptic interaction.

7. Joel S. Cavallo (jcavallo@indiana.edu)

QUANTITATIVE MEASUREMENT OF BASAL AND LIGHT-STIMULATED INTRACELLULAR CALCIUM CONCENTRATIONS IN HERMISSENDA TYPE B PHOTORECEPTORS WITH FURA-2.

Nancy Metcalf, Emily Jordan, Joel Cavallo, and Joseph Farley.

Program in Neural Science, Indiana University.

Previous research suggests that induction and maintenance of long-term changes in excitability and somatic K⁺ currents of Hermissenda (H.c.) Type B photoreceptors with different associative learning paradigms are calcium-dependent phenomena. The conditioning-produced differences in B cell photoresponses that result from either paired, or explicitly-unpaired (EU), presentations of light and rotation (i.e., Pavlovian excitatory or inhibitory conditioning, respectively), are prevented if B cells are first injected with the calcium-chelator EGTA. Additional evidence suggests that the type of plasticity induced by paired- vs. EU- conditioning may depend upon the levels of [Ca²⁺]_i achieved during the different stimulation paradigms: i.e., amplitude modulation within the calcium-signaling pathway. During EU conditioning, rotation is presented many min (4-8) following light-offset. Thus, the synaptic effects of rotation impinge on B cells at a time when the [Ca²⁺]_i level would be expected to have declined from that achieved during, and just following, the end of light. To assess this possibility, we have directly measured Type B cell somatic [Ca²⁺]_i levels throughout multiple (5) consecutive 30 sec light steps, delivered at an inter-stimulus-interval (4 min.) identical to that used in EU conditioning. Fura-2 calcium fluorescence imaging and photometry were carried out on an InCyt I/P-2, Dual-Wavelength Imaging and Microphotometry system microscope. Following iontophoresis of fura-2 into the B soma of a B cell from an untrained specimen and 15-20 min of dark-adaptation, the dye was stimulated using 50 msec. exposure times with 340 nm and 380 nm stimulus pairs from the Xenon arc illuminator. Baseline calcium concentrations during the final 30 sec of the dark-adaptation period were stable and averaged 133 +/- 19 nM (n= 10). On average, presentation of the initial light step resulted in large increases in [Ca²⁺]_i that remained elevated for ~ 3.0 min. following offset of the first light. Peak [Ca²⁺]_i levels declined during subsequent light steps, and the return to baseline occurred more rapidly. Interestingly, after two light steps, [Ca²⁺]_i levels dipped below the original baseline level during the 2-3 min period beginning 4.0 min post-light before recovering to baseline. This time frame (4-7 min post illumination), when [Ca²⁺]_i levels are lower than baseline, coincides with the time frame when delivery of rotational/vestibular stimulation during EU-training results in decreases in B cell excitability. The data are consistent with a model for "non-coincidence" detection in which different [Ca²⁺]_i levels lead to differential modulation of Type B cell excitability by the synaptic effects of vestibular/hair cell stimulation. Additional research has explored the relative contributions of Ca²⁺-release from intracellular stores vs. Ca²⁺-influx through voltage-gated calcium channels to the light-induced increases in [Ca²⁺]_i.

8. Joel S. Cavallo (jcavallo@indiana.edu)

THE EFFECTS OF PROTEIN PHOSPHATASE 1 ON THE EXCITABILITY OF TYPE B
PHOTORECEPTORS IN HERMISSENDA.

J. Cavallo, H. Huang, and J. Farley.
Program in Neural Science, Indiana University.

Previous research indicates that protein kinase C (PKC) activation is critical in the induction and maintenance of memory-related excitability increases of Hermisenda Type B photoreceptors produced by light and rotation pairings. In contrast, Protein Phosphatase 1 (PP1) activity appears to antagonize many of these changes and decreases excitability (Huang and Farley, 2001, J. Neurophysiology). In conditioned inhibitory learning, exposing animals to explicitly unpaired (EU) presentations of light and rotation (4 min. ISI; non-coincidence training) produces marked decreases in excitability: hyperpolarized resting potentials, smaller light responses, less spiking, and increased somatic K⁺ currents (Britton and Farley, 1999, J. Neuroscience). The present study asked if PP1 might participate in EU-learning, by comparing the effects of PP1-injections on B cells from untrained vs. EU-trained animals. We found that while EU-training and PP1 injections both resulted in a trend of B cells with more negative resting membrane potentials (~ 4 mV), significantly fewer light-elicited spikes in partially light-adapted cells (decreases of ~17% for PP1 and 24% for EU-training, relative to the 1st light step), and larger K⁺ currents, the combination of EU training and PP1 produced no further decreases in excitability. Thus, prior EU training occluded acute PP1 effects on resting membrane potential and spike frequency for partially light-adapted cells. In contrast to EU-training, PP1 produced a marked increase (~30%) in the steady-state generator potential of B cells from untrained animals as well as in EU animals (~16%). This suggests the possibility that PP1 might facilitate the light response through mechanisms (i.e. enhanced phototransduction) that are partially independent of those that underlie EU-training. We speculate that whereas EU-training activates PP1 activity associated with somatic K⁺ channel complexes, injections of PP1 also affect photo-transduction related processes within the separate rhabdomeric compartment.

9. Emily M. Chester (emcheste@indiana.edu)

EFFECTS OF SOCIAL DEFEAT ON IMMUNE RESPONSES IN MALE SIBERIAN HAMSTERS
(*PHODOPUS SUNGORUS*)

Emily M. Chester and Gregory E. Demas.
Center for the Integrative Study of Animal Behavior, Department of Biology, Indiana University

Prolonged exposure to physical stressors causes decreased immune function as a result the activation of the hypothalamo-pituitary-adrenal (HPA) axis and the subsequent release of glucocorticoids. Likewise, social interactions can affect both the endocrine and immune systems. Recent studies suggest that social stressors, such as a defeat by a conspecific, impair specific immune responses. Here we tested the effects of social defeat on immune response of Siberian hamsters (*Phodopus sungorus*). Experimental animals were either subjected to a daily, 10-min social defeat for five consecutive days, or placed in one of three control groups: 1) exposure to a clean cage 2) exposure to a cage with soiled bedding or 3) exposure to a same-sex conspecific separated by a partition. All animals had baseline blood samples taken and subsequently were injected with the antigen keyhole limpet hemocyanin (KLH). Blood was collected on days 5 and 10 post-immunization. A secondary injection of KLH was given three weeks after the first injection. Blood was collected on days 7 and 10 post-secondary injection. Serum was analyzed for cortisol and immunological measures, including antibodies and bacterial killing ability. Initial results suggest that antibody production was suppressed by social defeat. Social defeat appeared to affect bacterial killing as well. Serum cortisol, however, was not significantly elevated in defeated animals immediately after defeat. Together, these results suggest that social defeat affects immunity, possibly independent of HPA activation. This study contributes to the understanding of the effects of complex social behavior on physiological functions in mammals.

10. Jenelle Dorner (jdorner@indiana.edu)

17 β -ESTRADIOL PREVENTS ASCORBATE RELEASE DYSFUNCTION IN STRIATUM IN A KNOCK-IN MOUSE MODEL OF HUNTINGTON'S DISEASE.

Jenelle Dorner.

Program in Neuroscience and Department of Psychological and Brain Sciences, Indiana University.

Huntington's disease (HD) is an inherited, autosomal dominant condition caused by an expanded trinucleotide (CAG) repeat resulting in degeneration of the striatum and corticostriatal pathway. Symptoms include cognitive deficits and adventitious movements (e.g. chorea, tremor, dystonia). A behavior related deficit in release of an antioxidant vitamin, ascorbate (Vitamin C; AA), has been observed in the striatum of symptomatic male mice expressing the human mutation for HD (Rebec et al., 2002). In a recently developed knock-in mouse model (KI) of HD, we showed that this striatal AA deficit is sex specific (Dorner et al., 2007). Female KI mice did not exhibit the decrease in AA release upon behavioral activation that was observed in males. This may be due to sex differences in activity of the gonadal steroid hormone, 17- β -estradiol (E2). E2 modulates brain AA levels and prevented ischemia-induced AA loss in the hippocampus (Kume-Kick & Rice, 1998). Like ischemia, HD also results in oxidative stress which may account for the striatal AA loss observed in male mice. E2 may prevent this loss in female HD mice. In this study we used slow-scan cyclic voltammetry to measure striatal ascorbate release in ovariectomized (OVX) KI mice treated with subcutaneous silastic capsules containing either E2 or placebo. Preliminary results suggest that E2 may protect female OVX KI mice from a striatal AA release deficit. These findings likely account for the sex differences that we have observed in striatal AA release and behavior in KI mice. E2 likely plays a critical role in motor function and neuroprotection and may represent a therapy for movement disorders and neurodegenerative conditions that is currently not well investigated.

11. Timothy Greives (tjgreive@indiana.edu)

LONG-TERM KISSPEPTIN DOES NOT ALTER PHOTOPERIOD-INDUCED GONADAL REGRESSION IN SIBERIAN HAMSTERS (*PHODOPUS SUNGORUS*).

Timothy Greives and Gregory E. Demas.

Center for the Integrative Study of Animal Behavior, Department of Biology, Indiana University.

Seasonally breeding animals must integrate environmental signals to appropriately time reproduction. In temperate breeding rodents, photoperiod acts as such an environmental signal; long "summer-like" days induce reproductive development and maturation whereas short "winter-like" days induce gonadal regression. Recently, the neuropeptide kisspeptin has been linked with reproductive onset (i.e., puberty) in laboratory animals. Because seasonal breeders undergo seasonal changes in reproductive development similar to puberty, we sought to test the hypothesis that changes in kisspeptin coordinate reproduction in the seasonally breeding Siberian hamster (*Phodopus sungorus*). In an attempt to reverse gonadal regression, we provided long-term kisspeptin or vehicle to short-day housed fully regressed male hamsters in two separate studies. Experiment 1, fully-regressed hamsters received chronic kisspeptin via osmotic mini-pumps for 4 weeks. In Experiment 2, daily injections of 10 μ M kisspeptin, a dose known to elevate LH levels in this species, or vehicle, were administered to regressed short-day hamsters for 6 weeks. Next, we tested the ability of kisspeptin to block gonadal regression. In Experiment 3, hamsters were housed in short days and subsequently received daily injections of 10 μ M kisspeptin or vehicle for 6 weeks. In experiments 1 and 2, exogenous kisspeptin did not reverse gonadal regression; animals receiving both chronic and daily kisspeptin treatment had gonad masses significantly smaller than long-day controls. In Experiment 3, kisspeptin treatment did not block regression compared with vehicle treatment; both groups had significantly smaller gonads than long-day controls. Collectively, the results of these studies provide evidence that kisspeptin alone is likely not sufficient for altering reproductive status in the presence of a strong inhibitory environmental signal.

12. Winnie W. Ho (wwho@indiana.edu)

THE ROLE OF SEROTONIN IN ZEBRAFISH BEHAVIOR.

Winnie W. Ho, G. Troy Smith and Emilia P. Martins.

Department of Biology and Center for the Integrative Study of Animal Behavior, Indiana University.

The zebrafish (*Danio rerio*) is emerging as a strong vertebrate model for behavioral studies; however, little is known about the physiological mechanisms that underlie zebrafish behavior. In this study, differences in swimming activity and feeding behavior appeared to be mediated by serotonin which has multiple effects on behavior including aggression, fearfulness, and appetite across many taxa. Fish treated with fenfluramine, a serotonin releaser, were less active following a startling stimulus and were less likely to feed compared to saline controls. Fenfluramine treatments required approximately 90 minutes to take effect and generated behavioral outcomes that were within the range of natural variation in zebrafish. Behavioral differences between fish strains found in this study were consistent with previous results. Slight differences in strain responsiveness to serotonin were observed, suggesting a mechanism by which population-level behavioral divergence may occur.

13. Shawn D. Hurst (tjgreive@indiana.edu)

BRAIN SEXUAL DIMORPHISM IN THE GENUS PAN.

Shawn D. Hurst.

Department of Anthropology, Indiana University

Chimpanzees (*Pan troglodytes*) are among the most aggressive primate species. They have a rigid social dominance hierarchy, engage in lethal inter-group interactions, and sometimes kill members of their own community. By contrast, bonobos (*Pan paniscus*) are far less aggressive, with none of these violent behaviors. Similar to chimpanzees, in human society violent behavior is most often perpetrated by males. Although it is known that the human brain is sexually dimorphic, little is known about brain sexual dimorphism in apes, how sexually dimorphic the human brain is compared to our two closest relatives, or how aggressive behavior is related to brain sexual dimorphism in hominoids. Because chimpanzee males exhibit higher testosterone levels and show greater sex differences in aggressive behaviors than bonobo males do, this study used magnetic resonance images (MRIs) to assess sexual dimorphism in the brain regions of chimpanzees and bonobos homologous to the sexually dimorphic regions of the human brain. This project sheds light on the role that testosterone plays in brain development and aggressive behavior in hominoids, and provides a basis of comparison for previous human brain sexual dimorphism research.

14. Saul S. Nava (snava@indiana.edu)

POPULATION DIVERGENCE IN VISUAL PERFORMANCE IN PUERTO RICAN
SPHAERODACTYLUS GECKOS.

Saul S. Nava.

Department of Biology and Center for the Integrative Study of Animal Behavior, Indiana University.

Motion is an important component to the visual ecology of many animals. Motion detection is utilized in prey, predator, and mate detection as well as communication. Environmental conditions, such as light intensity, habitat structure, and spectral quality, are likely to have a great effect on an animal's ability to detect various signals. The sensory drive hypothesis predicts that populations inhabiting different visual habitats will differ in visual sensitivity and performance. I examined how total light intensity affects motion perception in the multiple populations of the endemic Puerto Rican species of diurnal geckos, *Sphaerodactylus macrolepis*. By examining variation between habitats, (i.e. light intensity in dense forests vs. coastal habitats) and by quantifying visual performance, my goal was to test whether populations from different photic environments have diverged in visual performance. I tested motion detection by recording latency to the visual grasp response to various light intensity treatments. I found that populations from distinctly different photic environments differ in motion sensitivity and that shifts in visual performance are associated with photic environmental conditions. Populations from mesic, montane (low insolation) environments were better able to detect motion at low light levels and populations from xeric, coastal (high insolation) environments were better able to detect motion at high light levels. This data supports predictions from the sensory drive hypothesis and offers novel evidence for potential mechanisms for behavioral divergence between populations inhabiting divergent habitats.

15. Mayte Ruiz (mayruiz@indiana.edu)

MALES VARY THEIR COURTSHIP ATTENTION IN RESPONSE TO
FEMALE REPRODUCTIVE STATE.

Mayte Ruiz, Erica Davis, and Emilia Martins.

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When presented with two novel females, many male organisms will preferentially court the one that is most receptive or most fecund. Here, tests were conducted to determine whether male *Sceloporus graciosus* interacting with familiar females also vary their behavior depending on the reproductive context of the female, and whether the distinction affects the total amount of courtship directed towards non-inseminated and/or more fecund females. Each male was allowed to interact separately, but repeatedly, with each of two females over the course of three weeks, at which point male courtship behavior with each of the two females was assayed. Pairing interactions were then continued until the female laid eggs. Results show that the number of male courtship displays produced during the behavioral assay was positively correlated with latency to egg laying. Courtship behavior was also negatively correlated with the number of eggs laid. Results suggest that males are displaying more often towards females that have not yet been inseminated.

16. Melissa-Ann L. Scotti (mscott@indiana.edu)

A ROLE FOR ADRENOCORTICAL STEROIDS IN THE MEDIATION OF SEASONAL AGGRESSION IN SIBERIAN HAMSTERS (*PHODOPUS SUNGORUS*)?

Melissa-Ann L. Scotti, Jerrah E. Jackson, and Gregory E. Demas.

Department of Biology and Center for the Integrative Study of Animal Behavior, Indiana University.

In some species aggression remain high during the non-breeding season when testosterone levels are basal. Previously we demonstrated that Siberian hamsters (*Phodopus sungorus*) housed in “winter-like”/short-day (SD) photoperiod show increased aggressive behavior despite basal levels of testosterone. The mechanism by which photoperiod regulates aggression remains unknown. Adrenocortical hormones (e.g., cortisol) have been implicated in mediating seasonal aggression. The goal of this study was to examine the role of cortisol in the mediation of photoperiodic changes in the territorial aggression of male Siberian hamsters. Males were housed in long (LD 16:8) or short days (LD 8:16) for 7 weeks and then injected with 10mg/kg of cortisol dissolved in oil or vehicle everyday during week 8. Aggression was evaluated using a resident-intruder model of aggression. Brains from a subset of the control animals were removed. Western blots were performed on tissue from the amygdala, medial prefrontal cortex and hippocampus to determine if photoperiod and/or photoperiodic responsiveness affected the number of corticosteroid receptors in these regions. SD hamsters were more aggressive than LD (long-day) animals. Cortisol treatment did not affect aggression in LD individuals or SD non-responders (SD-NR) (i.e., individuals that do not become reproductively quiescent in SD). SD responders that received cortisol, however, were markedly less aggressive than those that received vehicle; the SD increase in aggression was abolished. These data suggest that SD responsive individuals are more sensitive to cortisol than reproductive individuals (i.e. LD and SD-NR). Collectively, the results of this study will shed further light on the potential role of adrenocortical steroids in mediating seasonal and other forms of aggression.

17. Julienne Rutherford (jnruther@indiana.edu)

USING ULTRASOUND TO ESTIMATE GESTATIONAL AGE AND LITTER SIZE IN MARMOSET MONKEYS (*CALLITHRIX JACCHUS*) FROM PLACENTAL MEASUREMENTS

Julienne Rutherford

Department of Anthropology, Indiana University

Ultrasound offers a window into fetal and placental development throughout gestation. In captive common marmoset monkeys, litter size is variable and both fetal and placental growth are correlated with litter size. Previous longitudinal studies employing ultrasound to monitor intrauterine growth in marmosets have not focused specifically on placental features in the context of litter size variation. Because the triplet marmoset term placenta exhibits structural differences and overall size characteristics that appear to differ in pattern and distribution compared to the twin placenta, ultrasound was applied to investigate litter size differences in placental dimensions during gestation. The current study sought to answer the following questions: 1) Do placentas differ according to litter size and total litter weight in terms of measurable dimensions such as thickness or cross-sectional circumference? 2) Do measurable placental dimensions provide a means of establishing or corroborating gestational age? A total of 120 ultrasound exams representing multiple pregnancies were included in the analyses; fetal and placental growth measures were taken from live and archived exams. Uterine diameter is a better predictor of litter size than are placental dimensions. Placental thickness correlates with fetal crown rump length ($r^2=0.790$, $p<0.01$), but not with biparietal diameter ($r^2=0.330$, $p=0.250$). Because of its correlation with both crown-rump length and gestational age estimates based on CRL, placental thickness can be considered another tool to estimate gestational age, especially when full visualization of fetal structures is not possible during ultrasound examination.

18. Lynn M. Siefferman (lsieffer@indiana.edu)

ENVIRONMENTAL & GENETIC EFFECTS ON STRUCTURAL PLUMAGE COLORATION IN
NESTLING BLUEBIRDS.

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Sexually selected traits are expected to exhibit genetic variation and to be honest indicators of individual quality. Eastern bluebirds (*Sialia sialis*) have brilliant, structural blue-ultraviolet coloration that has been shown to be sexually selected. Here, we use field experiments to estimate the heritable and environmental influences on the coloration of feathers grown by eastern bluebird nestlings. Our experiments took advantage of the growth of UV-blue wing feathers in nestlings that are retained as part of the first nuptial plumage. In the first experiment, we cross-fostered nestlings to create enlarged, control, and reduced broods with the purpose of manipulating parental feeding rates and measured the effect on nestling growth and plumage coloration. Brood size influenced feeding rates to offspring and offspring coloration but the effect varied with season. Nestlings reared in reduced broods were fed more often, weighed more, and displayed brighter structural plumage compared to nestlings reared in enlarged broods. Moreover, nestlings that hatched later in the season displayed brighter overall plumage and greater UV chroma. These data provide empirical evidence that environmental quality influences the development of the blue structural coloration of feathers. In a second field experiment, we cross-fostered offspring to compare morphology and coloration of siblings reared in different nests. Restricted maximum-likelihood method revealed that growth parameters and plumage brightness were significantly heritable. Moreover growth parameters, plumage brightness, UV chroma exhibited variation due to natal environment. These data indicate that variation in structural plumage coloration is influenced both by genetic and environmental processes.

19. Benjamin Smith (smithben@indiana.edu)

COMPUTATIONAL MODEL OF THE HERMISSEDA TYPE B PHOTORECEPTER.

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20. Helena A. Soini (hsoini@indiana.edu)

VENTRAL GLAND AND URINARY VOLATILE COMPOUND PROFILES MEASURED BY GC-MS
REFLECT SEASONAL CHANGES AND AGGRESSIVE BEHAVIOR
IN SIBERIAN HAMSTERS (*PHODOPUS SUNGARUS*).

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Chemical communication in the Siberian hamster (*Phodopus sungorus*) involves chemical cues from urine, the ventral gland and supplementary sacculi glands inside cheek pouches. In this study, we investigated volatile compound profiles in urine and the ventral gland in relation to seasonal changes including male aggressive behavior. The stir bar sorptive extraction (SBSE) method was used for sampling, while the urinary volatile profiles were recorded through capillary gas chromatography-mass spectrometry (GC-MS). The quantitative analytical method allowed comparisons of 38 preselected compounds in urine. A newly developed surface sampling technique was employed in sampling the ventral gland in-situ. Among a number of identified compounds, 25 were used for quantitative comparisons. In both urine and ventral gland, several volatiles showed changes in their levels due to a seasonal change and/or aggression. Significance of these findings related to chemical communication in this species will be discussed.

21. Cuauhcihuatl Vital (cvital@indiana.edu)

APPLYING COHESIVENESS AND CENTRALITY METRICS TO BEHAVIORAL DATA: A COMPUTER
SIMULATION ANALYSIS OF SOCIAL NETWORKS.

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In recent years, graph theory metrics have been used to analyze animal social interactions and their impact on the dynamics of social networks. These metrics were designed for larger social groups and more extensive sampling than are typical of animal behavior data. Herein, we consider several Cohesiveness and Centrality metrics, using computer simulation to explore how details of data collection (i.e. number of total interactions recorded) and community features (i.e. group size) can affect parameter estimates. We find that most network metrics can vary dramatically with sampling extent. With poor sampling, Average Degree and Diameter present less variance than do Density and Clustering Coefficient. The latter two metrics provide better estimates with comprehensive sampling. Centrality measures are more robust to variation in the number of recorded interactions than are Cohesiveness measures, but depend critically on the number of animals in the group. With poor sampling, Centrality metrics can detect differences between groups with small proportions of gatekeepers (0-20%), but are unable to describe differences between groups with larger proportions of gatekeepers. Computer software is made available to allow researchers to use similar simulations with their own social group and sampling schemes to develop optimal experimental designs and to determine the relevance of these factors to their own results.

22. Katherine E. Wagner (qwags@uchicago.edu)

THE INTERACTION BETWEEN ATTENTION AND DOMINANCE STATUS
IN THE CAPTIVE GUINEA BABOON.

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While directing attention to the social environment offers all primate observers significant fitness benefits, the variable access to such advantages conferred by position in a dominance hierarchy suggests that the particular morphology of this attention may be expected to vary with status. However, previous attempts to assess the interaction between status and attention in the primates have failed to demonstrate a robust relationship, as a result of a range of operational definitions of “gaze”. In response, the current study assessed with continuous sampling the distinct occurrence of social and environmental gazes in the 3 highest and lowest ranking guinea baboon males in a captive social group. While gaze frequency in general was similar across all subjects, the high and low ranking groups were differentiated when the targets of these gazes were introduced into the analysis. In particular, the high ranking males ($M=1.63$ gazes per minute, $SD=0.05$) directed significantly more gazes to conspecific females than did the low rank group ($M=0.83$ gazes per minute, $SD=0.63$), $t=13.11$, $p=.001$, while the low ranking males ($M=2.81$, $SD=0.80$) performed a significantly higher frequency of environmental scans than their high-rank counterparts ($M=1.51$, $SD=0.80$), $t=3.12$, $p=.045$. These results suggest that 1) high ranking males focus significant attention on group females, presumably to secure mating opportunities; 2) low ranking males display a attentional concern with the landscape in general, which may indicate a predominant concern with anticipating and avoiding conspecific aggression; and 3) males of differing status are distinguished not in gaze rate, but rather in the frequency with which the attention is directed to specific targets. Potentially, these dominance-based differences in gaze behavior offer a concrete empirical tool with which managers of captive primate populations may appraise hierarchical structure for use in maintenance decisions.

23. Adam Walker (agwalker@indiana.edu)

PREFRONTAL CORTEX ELECTROPHYSIOLOGY AND OPEN FIELD BEHAVIOR IN THE 140 CAG
MOUSE MODEL OF HUNTINGTON'S DISEASE.

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Huntington's disease (HD) is a dominantly inherited progressive neurological disorder. HD patients exhibit motor symptoms (such as chorea), cognitive impairment, and emotional disturbances. Characterization of the HD gene has allowed for the generation of knock-in and transgenic mouse models of the disorder. Our lab has previously shown that neurons in the striatum fire at a higher frequency and with altered spike synchrony in diseased animals. This could be caused by alterations in the glutamate signaling from the cerebral cortex, the main glutamate input to the striatum. Other studies have shown electrophysiological dysfunction of cortical neurons in slice preparations from HD mice. We used extracellular electrophysiology in awake and behaving mice to examine the properties prefrontal cortex (PFC) in wild type (WT) and knock-in (KI) mice from the 140 CAG mouse model of HD. We also recorded open field behaviors during the recording sessions and assessed the firing characteristic during behavioral engagement. Preliminary analysis indicates that there are differences in the bursting characteristics of PFC neurons between WT and KI mice. We also found differences between behavioral engagement and neural activity during behavior. Furthermore, these effects appear to differ between the sexes.

24. Tony Walker (tonlwalk@indiana.edu)

LIPOXYGENASE SIGNALING MAY UNDERLIE CONDITIONED INHIBITORY
LEARNING IN HERMISSENDA.

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Learning that one stimulus predicts the absence of another is an important form of associative learning, conditioned inhibitory (CI) learning (Rescorla, 1969); however, little is known about the molecular mechanisms. Recent research has shown that Hermissenda learn that light (visual stimulation) predicts the absence of turbulence (vestibular stimulation). As a result, Hermissenda provides a convenient and well-known animal model for studying CI learning. In Hermissenda, a major site of plasticity is the type B photoreceptors. In these cells, CI learning decreases light evoked spike frequency (Britton & Farley, 1999) and application of arachidonic acid (AA) increases K⁺ currents to reduce spike frequency, thus mimicking the effect of CI learning (Farley, Smith, & Smith, 2003). To further explore AA signaling, we focused on metabolites generated by lipoxygenase enzymes. We found that application of AA alone reduced spike frequency by 15.7% +/- 8.3% (n=11). To determine which lipoxygenase isoforms generate active metabolites, we used selective inhibitors of the 5-lipoxygenase (MK-886) and the 12-lipoxygenase (baicalein) enzymes and the metabolites generated by the 5-lipoxygenase (5S-HPETE) and the 12-lipoxygenase (12S-HPETE) enzymes. Application of baicalein prior to AA blocked the effect of AA (n=8), but MK-886 did not (n=5). Application of 12S-HPETE reduced spike frequency by 24.4% +/- 9.2% (n=6), but 5S-HPETE had no significant effect (n=1). These experiments indicate that 12-lipoxygenase signaling underlies the effect of AA. To determine if lipoxygenase metabolites underlie CI learning, we subjected Hermissenda to 90 trials of explicitly unpaired light and turbulence (30 sec, 9 min ISI). After CI learning, application of AA and 12S-HPETE reduced spike frequency by 98.5% +/- 0.3% (n=3) and 95.8% (n=1) respectively, but 5S-HPETE had no significant effect (n=1). Because the effect of AA and 12S-HPETE is greatly enhanced after CI learning, these experiments indicate that 12-lipoxygenase signaling may underlie conditioned inhibitory learning related changes in Hermissenda.

25. J. Gastón Zamora (jgzamora@indiana.edu)

EVOLUTION OF REPRODUCTIVE LIFE-HISTORY TRAITS OF THE CREVICE-DWELLING LIZARD
GENUS XENOSAURUS: A PHYLOGENETIC APPROACH TO ANALYZE THE LIFE HISTORY.

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Reproductive traits such as size at maturity, mean size of adult females, litter size, offspring size, and relative clutch mass are basic components of any life history, and affected by both proximate (i.e., environmental) and ultimate (i.e., phylogenetic) factors. We analyzed variation and covariation patterns of the reproductive life-history traits within a monophyletic group of lizards, *Xenosaurus*, using the phylogenetic comparative method (PCM). The main objectives were: i) to confirm the existence of the "slow-fast" continuum turn-over gradient, ii) to test that the same gradient is found when the effects of phylogenetic relationships and body size are removed statistically, and iii) to estimate the relative importance of environmental effects. We examine also the impact of one selective factor (i.e., altitude) on reproductive life-history traits. Our preliminary results suggested the presence of ecological and evolutionary correlations between reproductive life-history traits including both a positive correlation between the size at maturity and female body size and a negative trade-off between litter size and offspring body size. Litter and offspring size also exhibit strong phylogenetic effects, suggesting that these may be under strong stabilizing.

26. Devin Zysling (dzysling@indiana.edu)

TIME COURSE OF PHOTOPERIODIC CHANGES IN REPRODUCTION AND IMMUNE FUNCTION IN
THE SIBERIAN HAMSTER (*PHODOPUS SUNGARUS*)

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Non-tropical animals display marked seasonal fluctuations in their environments. Photoperiod is the primary environmental signal organisms use to predict such changes. Physiological adaptations, including seasonal changes in reproduction and immunity, have evolved to maintain a positive energy balance year-round. Short days (SD) trigger gonadal regression and decreased body mass. In addition, there is a growing body of evidence demonstrating seasonal and photoperiodic fluctuations in immune response in many species. In the present study we examined whether seasonal changes in immune function track changes in reproduction (i.e., gonadal hormones, reproductive mass) or energetics (i.e., body fat) in the Siberian hamster (*Phodopus sungorus*). Previous work suggests that short-day changes in body mass precede changes in reproductive mass in this species. Using this paradigm, we placed animals into a short day photoperiod and sampled immune function, reproductive state, and body fat every two weeks for an eight week period. We hypothesized that if immune responses were tracking energetic stores as opposed to reproductive condition, the “immune curve” (i.e., antibody production) would more closely resemble the curve demonstrating changes in body fat. Preliminary data suggest that changes in both reproductive and body fat mass occur by week four. A decrease in antibody response was seen by week eight; however there was no difference between long- and short-day housed hamsters as seen in previous studies. These results will be discussed in the context of trade-offs between reproduction and immune function.