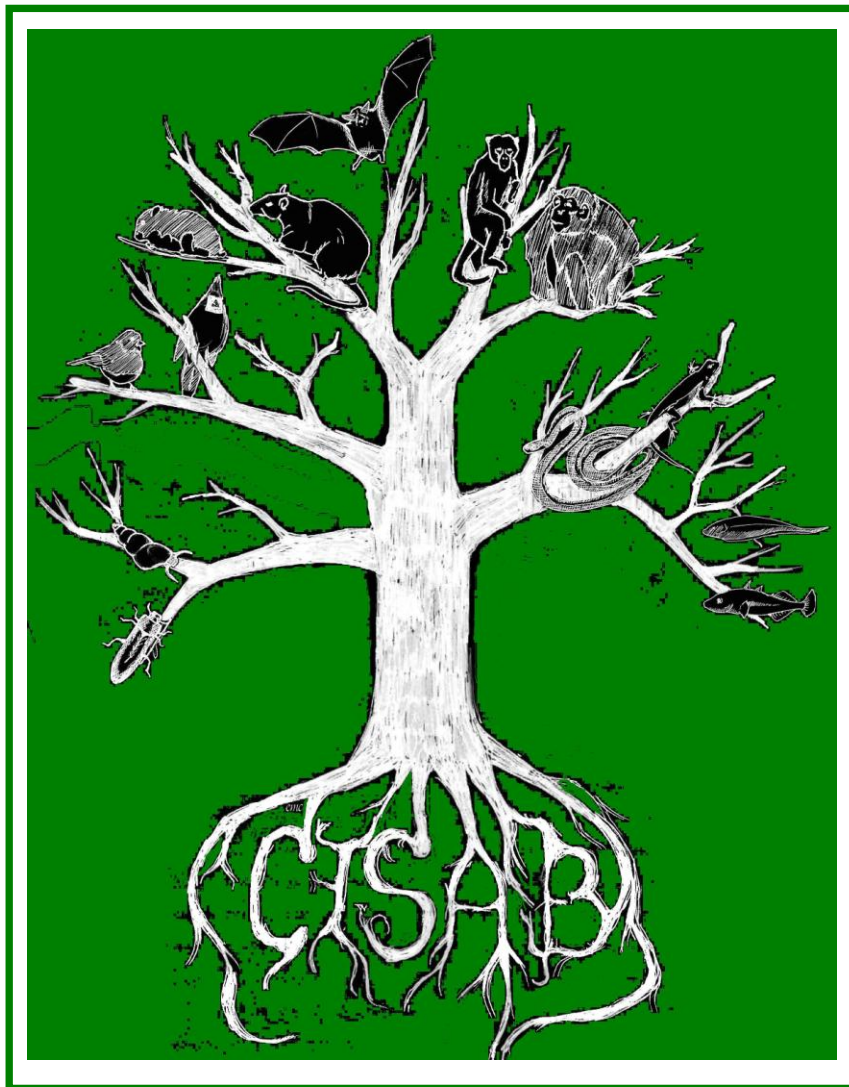


The 13th Annual Indiana University Animal Behavior Conference



April 17, 2006
IMU Frangipani Room

**The 13th ANNUAL INDIANA UNIVERSITY
ANIMAL BEHAVIOR CONFERENCE**

**Sponsored by
The Center for the Integrative Study of Animal Behavior (CISAB)**



**April 17, 2006
IMU Frangipani Room
8:00 A.M. – 5:00 P.M.**

The 13th Annual Indiana University Animal Behavior Conference Schedule

8:00 — 8:50 **Set up posters, load talks**

8:30 — 8:50 **Light breakfast**

8:50 — 9:00 **Welcome from CISAB director, Emilia Martins**

9:00 — 10:30 **Session 1 (Moderator: Timothy Greives)**

9:00 — 9:15 Bob Brodman
One Weird Salamander: Ecology and Natural History Observations of *Siren intermedia nettingi* (Western Lesser Siren) in Northern Indiana

9:15 — 9:30 Nicole Benda
Fitness Consequences of Non-host Oviposition by a Specialized Herbivore

9:30 — 9:45 Elizabeth Lehman
Tetrodotoxin as a Maternally-Endowed Defense Against Egg Predation in the Rough-Skinned Newt

9:45 — 10:00 Erin Ables
Rats Assess Degree of Relatedness from Human Odors

10:00 — 10:15 Jennifer Miller
The Origins of Sociality in Brown-headed Cowbirds (*Molothrus ater*)

10:15 — 10:30 Julienne Rutherford Goehl
A Hard-knock Life: Marmoset Triplets and Intrauterine Parent-offspring Conflict

10:30 — 10:45 **Morning Break**

10:45 — 12:00 **Session 2 (Moderator: Bronwyn Bleakley)**

10:45 — 11:00 Michael Black
Aggressive Behavior and Steroid Metabolism during Sex Change in *Lythrypnus dalli*

- 11:00 — 11:15 Devin Zysling
Effects of Metabolic Stress on Immune Function in Long- and Short-day Housed Siberian Hamsters (*Phodopus sungorus*).
- 11:15 — 11:30 Melissa-Ann Scotti
Seasonal Aggression in Female Siberian Hamsters (*Phodopus Sungorus*)
- 11:30 — 11:45 Cynthia Corbitt
Photoperiodic Response in Male Dark-eyed Juncos (*Junco hyemalis*) with and without Dietary Phytoestrogens
- 11:45 — 12:00 Alexis Edwards
Genomic Response to Artificial Selection on Aggression in *Drosophila*
- 12:00 — 1:30 Lunch and Poster session**
- 1:30 — 3:30 Session 3 (Moderators: Emily Chester & Eduardo Fernandez)**
- 1:30 — 1:45 Kathryn Lenz
Maternal Licking Influences Dendritic Development of Motoneurons in a Sexually Dimorphic Neuromuscular System
- 1:45 — 2:00 Cary Leung
Morph and Sex Differences in Vasotocin Receptor Density in White-throated Sparrows
- 2:00 — 2:15 Kevin Ball
Enduring Behavioral and Structural Plasticity in Nucleus Accumbens following MDMA (ecstasy) Administration in Rats
- 2:15 — 2:30 Eduardo Fernandez
The Effects of Foraging Devices as Enrichment in Captive Walruses (*Odobenus rosmarus*).
- 2:30 — 2:45 Jeffrey Lucas
Seasonality in Avian Auditory Processing
- 2:45 — 3:00 Angela McDowell
Chronic Stress in Rats Impairs Learning in an Instrumental Appetitive-to-aversive Transfer Task

3:00 — 3:15 Andrea Gillman
The Role of Circadian Rhythms and Pavlovian Conditioning in Nicotine
Addiction

3:15 — 3:30 William Tietjen
Sublethal Effects of Neurotoxic Pesticides on Spider Behavior

3:30 — 3:45 Afternoon Break

3:45 — 3:55 Awards Ceremony – Emilia Martins

3:55 — 4:55 Plenary Speaker (introduced by Hanna Kolodziejcki)

**Lauren V. Ritters
Department of Zoology, University of Wisconsin**

**Why does the caged bird sing? Social and neuroendocrine
regulation of birdsong**

7:30 — 9:30 Evening Reception

**Laura Hurley & Troy Smith's home
3660 E. Robin Road
(Please see a flyer with a map at the conference)**

TALK PRESENTER AND ABSTRACTS
(in order of presentation)

SESSION 1

1. Brodman, Bob (bobb@saintjoe.edu)

ONE WEIRD SALAMANDER: ECOLOGY AND NATURAL HISTORY OBSERVATIONS OF *SIREN*
INTERMEDIA NETTINGI (WESTERN LESSER SIREN) IN NORTHERN INDIANA

Bob Brodman
Saint Joseph's College

The lesser siren (*Siren intermedia nettingi*) is a two-legged gilled salamander with an unusual distribution. Very little is known about the natural history and ecology of this species and what is known is primarily from southern populations inhabiting the Atlantic and Gulf Coastal Plains. I made observations of population trends, body size, diet, habitat preference, and aestivation of lesser siren populations in the northernmost parts of its range over an eight year period. Sirens were sampled from 21 aquatic sites using minnow traps. The number of sirens captured fluctuated with spikes in abundance in 1998 and 2001 followed by declines over the following two years. The mean TL and proportion of adults to juveniles significantly increased over time. Sirens were significantly more abundant at sites that had greater abundance of crayfish and fish, and very poorly drained loamy fine sand substrates with near neutral pH. Sirens kept in captivity were observed to eat a wide variety of prey, including fish, tadpoles and crayfish that were too large to be swallowed whole. Sirens were observed to kill and eat large prey and also to scavenge carcasses by taking bites of flesh. Natural prey items were identified from the stomach contents and dragonfly naiads, caddisflies, aquatic beetles, and ostracods made up 75% of the prey items. Juveniles ate significantly more caddisflies, ostracods, and snails, and significantly fewer tadpoles than adults. Parasitic nematodes were found in four of the adult sirens. In a laboratory experiment adult sirens entered aestivation sooner than juveniles, however all of the sirens in drying treatments entered aestivation when there was 1-5 cm of standing water over the substrate. Drying treatments had a significant affect on the survival of sirens with the greatest mortality occurring in the fastest drying treatment.

2. Benda, Nicole (ndbenda@ncsu.edu)

FITNESS CONSEQUENCES OF NON-HOST OVIPOSITION BY A SPECIALIZED HERBIVORE

Nicole Benda, Fred Gould, and Coby Schal
Department of Entomology and the W. M. Keck Center for Behavioral Biology,
North Carolina State University

Many herbivores exhibit specialized behavior and/or physiology regarding their host plants. Larvae of *Heliothis subflexa* are frugivorous specialists on plants in the genus *Physalis* and will not survive on plants outside this genus, ie. on "non-hosts". The narrow host range, small size, and low mobility of newly-hatched larvae relative to the adult females would predict that eggs are oviposited on *Physalis* fruit to ensure that the larvae find their food source. However, I found that *H. subflexa* females oviposited most of their eggs on vegetative parts of the *Physalis* plant ($71 \pm 34\%$ stdev) ($n=65$ moths with >1 minutes of observation). In addition, HS females oviposited eggs on non-hosts ($19\% \pm 24\%$ stdev). To examine the fitness cost of these non-host ovipositions, I quantified the distance between non-hosts used for oviposition and host plants. I also quantified the effect of hatching on non-host-plants on the establishment rate of neonates. I used these values to estimate that non-host ovipositions reduce the female's fitness by 8.4-12.6%. Explanations for this seemingly non-adaptive behavior may include avoidance of parasitism, predation, and/or host-plant defenses.

3. Lehman, Elizabeth (ellehman@indiana.edu)

TETRODOTOXIN AS A MATERNALLY-ENDOWED DEFENSE AGAINST EGG PREDATION IN THE
ROUGH-SKINNED NEWT

Elizabeth M. Lehman
Department of Biology, Indiana University

Antipredator defenses include behaviors to evade capture, physical structures to deter predation, and noxious or toxic chemicals aimed at predators. While adults are often well protected, early life history stages (e.g., eggs) often are more vulnerable. In these cases, parents may provide defenses either through their behavior or through chemicals provided to the embryo. Nest defense behaviors have been well studied, but relatively little is known about chemical defenses in eggs. Studying the defenses of early life history stages is particularly interesting because of the influence early survivorship can have on population growth rates. Rough-skinned newts, *Taricha granulosa*, possess tetrodotoxin (TTX), a neurotoxin that inhibits the propagation of nerve signals, leading to paralysis and potentially death in most organisms that ingest it. TTX acts as a chemical defense against predatory garter snakes in adults, and is also present in newt eggs. Field work has shown that caddisfly larvae prey upon newt eggs, despite the presence of TTX. Because adults do not defend eggs, TTX may be eggs' only defense against predation. It was previously unknown to what degree caddisfly larvae consume eggs of varying toxicity and how TTX affects them. Here I report the results of several studies, including field and laboratory studies of predation as a function of toxicity, and the influence of predator cues on developing newt embryos. The relationship between newt eggs and their caddisfly predators, the effect of TTX on this relationship, and the potential for co-evolutionary interactions in this system will be discussed.

4. Ables, Erin (eables@indiana.edu)

RATS ASSESS DEGREE OF RELATEDNESS FROM HUMAN ODORS

Erin Ables
Department of Psychological and Brain Sciences, Indiana University

Despite widespread interest in human olfactory communication, the mechanisms underlying human odor production are still not understood. Previous studies have demonstrated that human odor cues are related to variations in the major histocompatibility complex, but it is unclear whether odors are associated with overall genotypic variation. In this study, we investigated whether more closely related people produce more similar odor cues. Rats were first habituated to a referent human odor and were then presented with two test odors obtained from individuals related in different degrees to the referent. Investigation times for each odor were compared. Because rats investigate novel odors longer than familiar odors, we were able to determine which test odor the rats perceived as more similar to the referent human odor. For six of ten families which donated odors, rats investigated the odor of the less closely related individual significantly longer than the odor of the more closely related individual, and investigation durations were in the expected direction for all families. These results suggest that similarity of human odor cues is associated with degree of genetic relatedness, with more closely related humans producing more similar odor cues. This study supports the hypothesis that odor cues provide information regarding the degree of relatedness of individuals and may thus affect a wide variety of human behaviors, including kin recognition, nepotism, and mate choice.

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

THE ORIGINS OF SOCIALITY IN BROWN-HEADED COWBIRDS (*MOLOTHRUS ATER*)

Jennifer L. Miller

Department of Psychological and Brain Sciences, Indiana University

Five variables were studied relating to the emergence of sociality in hand-reared cowbirds: proximity, gender assortment, reactions to adults, head-down displays, and vocalizations. I was especially interested in female sociality because adult females influence male courtship song content and use through proximity, attention, and displays. I found that young females failed to show same-sex affiliation typical of the species at any point in the study. Brief introduction of adults did not affect social patterns. Adults used more head-down displays than juveniles, who used more displays with familiar peers. Directed and undirected singing emerged concurrently; directed singing was positively correlated with earlier hatching. This is the first demonstration of the need for early learning in the development of female sociality.

6. Rutherford Goehl, Julienne (jnruther@indiana.edu)

A HARD-KNOCK LIFE: MARMOSET TRIPLETS AND INTRAUTERINE PARENT-OFFSPRING CONFLICT

Rutherford Goehl, J.N. and Tardif, S.D.

Department of Anthropology, Indiana University and Southwest National Primate Research Center

The observation that parent and offspring may be in conflict over the allocation of resources due to genomic nonidentity is increasingly being extended to the intrauterine period. Haig (1993) has hypothesized that faced with intrauterine resource restriction fetuses may solicit placental overgrowth to meet their demands. The common marmoset (*Callithrix jacchus*) regularly gives birth to twins, and triplet litters are common in captivity. Because individual survivorship within litters is lower for triplets than for twins, we predict that a triplet fetus should employ tactics for increasing its individual share of maternal resources. Litter size variation is explored in relation to placental and fetal weights to answer the following questions: 1) Can an increase in litter size function as intrauterine resource restriction? 2) Do twins and triplets differ in their access to the placenta? 3) Do differences in fetal/placental (F/P) weight ratios reflect differences in intrauterine "strategies"? Mothers of triplets do not increase energy intake compared to the non-pregnant, non-lactating period. As a result of this and of mechanical limitations of the uterus, triplets are born smaller than twins. Marmoset triplets, compared to twins, are associated with a significantly lower F/P weight ratio, which is primarily a function of increases in placental weight rather than reductions in fetal weight, consistent with solicitation of relative placental overgrowth. Twin and triplet fetuses may pursue different intrauterine strategies for maximizing allocation of the placenta, and thus circulating maternal resources, via the insulin-like growth factor (IGF).

This research supported in part by NIH grants R01-RR02022 and P51-RR1396 (SDT), an Indiana University Graduate School Doctoral Grant-in-Aid of Research (JRG), and an American Society of Primatologists Research Grant (JRG).

SESSION 2

7. Black, Michael (seawater@gsu.edu)

AGGRESSIVE BEHAVIOR AND STEROID METABOLISM DURING SEX CHANGE IN *LYTHRYPNUS DALLI*

Michael P. Black*, Jacques Balthazart¹, Michelle Baillien¹, Christel Dejace¹, Callie L. Mizell², and Matthew S. Grober²

*Center for Behavioral Neuroscience, Dept. of Psychology, Georgia State University

¹ Center for Cellular and Molecular Neurobiology, University of Liege, Belgium

² Center for Behavioral Neuroscience, Dept. of Biology, Georgia State University

Removing the male from a social group induces sex reversal in a dominant female bluebanded goby (*Lythrypnus dalli*). Although many body systems are radically transformed, the first observable change is in behavior. Aromatase, the enzyme that converts testosterone to estrogen, could play a pivotal role in mediating these early behavioral changes and these experiments were designed to test that hypothesis. Brain and gonadal aromatase activity (AA) are significantly higher in females than males, which should function to maintain estrogen-biased steroid levels in females. In most cases, behavioral sex change begins within 10 minutes of male removal, so we hypothesized that rapid down regulation of brain AA initiates the early changes in sex-typical behavior by shifting the animal away from the estrogen-biased environment characteristic of female brains. Within hours of male removal, brain AA decreased by over 40% and was inversely related to aggressive behavior but had no significant relationship with time after male removal. Over this same time period, gonadal AA was unchanged. At a faster time scale of 30 minutes or less, the aggressive behavior changed, but the brain AA did not. It is hypothesized that increased aggression results in decreased brain AA. If this is true, decreased AA in the brain could be a link between early aggressive behavior and sex change, as androgen:estrogen ratios should decrease with decreased AA, leaving more testosterone available to be converted into 11-ketotestosterone, a hormone known to masculinize females in *L. dalli*. These results are novel because they are the first to: 1) demonstrate socially-induced decreases in bAA levels corresponding with increased aggression, 2) provide evidence for this process as a possible neurochemical mechanism linking behavior to subsequent gonadal sex change and 3) show differential regulation of bAA versus gAA resulting from social manipulations.

Supported by NSF agreement #IBN-9876754 to MSG and MH50388 and ARC 99/04-241 to JB.

8. Zysling, Devin (dzysling@indiana.edu)

EFFECTS OF METABOLIC STRESS ON IMMUNE FUNCTION IN LONG- AND SHORT-DAY
HOUSED SIBERIAN HAMSTERS (*PHODOPUS SUNGORUS*).

D.A. Zysling and G.E. Demas
Department of Biology, Indiana University

Individuals of many species are faced with marked seasonal variation in environmental conditions and must adapt to potentially large fluctuations in energy availability and expenditure. Seasonal changes in immunity have likely evolved as an adaptive mechanism to cope with such stressors. In addition, these changes may be constrained by seasonal fluctuations in energy availability. Mounting an appropriate immune response is energetically costly; increased immunity likely utilizes resources that could be otherwise allocated to other functions. Furthermore, accumulating evidence suggests that short “winter-like” days can attenuate the symptoms of infection, presumably to optimize energy expenditure and survival. The goal of this study was to assess the role of energetic trade-offs associated with seasonal variation in immune response. In addition to body fat stores, metabolic fuels such as glucose may affect immune function in seasonally breeding rodents. In this study we experimentally reduced glucose availability via repeated injections of the metabolic inhibitor 2-deoxy-D-glucose (2-DG) in long-day and short-day housed Siberian hamsters (*Phodopus sungorus*) and then examined antigen-specific (i.e., KLH) antibody production. We found that 2-DG-induced metabolic stress decreased antibody response in long-day animals compared with saline-injected controls. In contrast, no difference was observed between treatment groups in short-days. These data suggest that, although immune function is compromised during metabolic stress in long-days, short-day lengths may buffer organisms against glucoprivation. This effect may be due to differential responsiveness of long- and short-day hamsters to metabolic stress, mediated by changes in adrenal hormones; these data will be discussed.

9. Scotti, Melissa-Ann (mscotti@indiana.edu)

SEASONAL AGGRESSION IN FEMALE SIBERIAN HAMSTERS (*PHODOPUS SUNGORUS*)

Melissa-Ann Scotti and Gregory E. Demas
Department of Biology and Center for the Integrative Study of Animal Behavior, Indiana University

Among the suite of adaptations displayed by seasonally-breeding rodents, some species demonstrate reproductive regression and increased territorial aggression in short “winter-like” compared with long “summer-like” day lengths. For example, male Siberian hamsters (*Phodopus sungorus*) held in a short days (LD 8:16) express heightened levels of territorial aggression that are independent of gonadal steroid hormones. Similar findings have been reported for both male and female Syrian hamsters. Virtually nothing is known, however, regarding seasonal aggression in female Siberian hamsters. Thus, the present study was undertaken to determine if females express increased levels of aggression under short-day “winter-like” conditions. Specifically, females were individually housed in either short- (LD 8:16) or long-day (LD 16:8) photoperiods for 10 weeks. Assessment of aggression was accomplished by placing a long-day-housed female intruder in the home cage of a test animal and recording latency to attack as well as number of attacks. Prior to testing, estrous cycle stages were determined by vaginal cytology and females were tested during both the Diestrus I and Proestrus stages and matched with intruders in the same estrous stage. Short-day animals showed significantly higher levels of aggression than did long-day animals, and estrus stage did not affect aggression in long-day females. These results support previous findings of increased non-breeding aggression and suggest that short-day aggression is not likely mediated by gonadal steroids. Collectively these results suggest that endocrine regulation of seasonal aggression may be similar between the sexes.

10. Corbitt, Cynthia (cynthia.corbitt@louisville.edu)

PHOTOPERIODIC RESPONSE IN MALE DARK-EYED JUNCOS (*JUNCO HYEMALIS*) WITH AND WITHOUT DIETARY PHYTOESTROGENS

Cynthia Corbitt¹, Danielle Satre¹, Michael S. Reichert¹, Larry A. Adamson¹, George E. Bentley², and Gary A. Cobbs¹

¹ Department of Biology, University of Louisville

² Department of Biology, University of Washington

Many commercial bird diets are made with soy products that contain phytoestrogens (i.e., plant compounds that have weak agonist activity at estrogen receptors), but the effects of these compounds on bird physiology and behavior are largely unknown. The primary phytoestrogens present in soy are the isoflavones genistin and diadzin. Two groups of wild-caught male Dark-eyed Juncos (*Junco hyemalis*) were fed a diet either made with water-washed soy protein with 2.43mg/g total isoflavones (soy+) or made with soy protein that had been alcohol washed to extract isoflavones so that the protein contained only 0.032mg/g total isoflavones (soy-). A blood sample was drawn from each bird and cloacal protuberance (CP) width measured on the day (wk1) photoperiod was changed from short (8L:16D) to long days (LD, 16L:8D) and once weekly thereafter (wk2-13) for the duration of the experiment. Two 10-minute sessions were videotaped mid-way through the experiment for analysis of behavior (song rate, chatter, eating, drinking, preening, general movement). No treatment effects were detected in any of the behavioral measures. Both groups exhibited a photoperiodic response, as evidenced by increases in luteinizing hormone (LH) and CP width. The rate of CP growth was significantly affected by diet, with the CPs of soy- birds increasing faster than in soy+ birds, reaching statistical significance in the 6th week after exposure to LD; CPs of soy+ birds caught up by the 7th week. Although the effect is subtle, those studying subtle hormonal changes (e.g., due to endocrine disrupting chemicals) in songbirds perhaps should choose phytoestrogen-free experimental diets for their experiments.

11. Edwards, Alexis (acedward@ncsu.edu)

GENOMIC RESPONSE TO ARTIFICIAL SELECTION ON AGGRESSION IN *DROSOPHILA*

Alexis Edwards and Trudy Mackay

Genetics Department, the W.M. Keck Center for Behavioral Biology, North Carolina State University

Aggression is a complex behavioral trait of evolutionary significance, influenced by many genes of varying effect, as well as by the environment. An organism can express aggression to secure access to food, mates, and territory. As part of our effort to characterize the genetic architecture of aggression in *Drosophila melanogaster*, we conducted 28 generations of artificial selection to generate lines with increased and decreased levels of aggression. A genetically heterogeneous base population was established from 60 isofemale lines derived from wild-caught flies, and progeny were assayed for aggression levels. Males with the highest and lowest levels of aggression were mated to virgin females to establish two High and two Low selection lines, and two randomly mated Control lines. The heritability of aggressive behavior, averaged over both replicates, was 0.094. We evaluated correlated responses for a variety of traits including locomotor and mating behavior, as well as whole genome transcriptional response to selection. We identified genes whose expression differs significantly between replicate high and low aggression lines, and performed functional tests of effects of candidate genes implicated from the microarray analysis on aggressive behavior.

SESSION 3

12. Lenz, Kathryn (kmlenz@indiana.edu)

MATERNAL LICKING INFLUENCES DENDRITIC DEVELOPMENT OF MOTONEURONS IN A SEXUALLY DIMORPHIC NEUROMUSCULAR SYSTEM

Lenz, Kathryn

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

Maternal licking of pups' perineal regions affects the development of the spinal nucleus of the bulbocavernosus (SNB), a sexually dimorphic motor nucleus in the lumbar spinal cord that controls penile reflexes involved with copulation. Maternal licking influences SNB motoneuron number, with reductions in licking resulting in fewer motoneurons. Reduced maternal licking also has functional consequences in adulthood, resulting in increased latency to ejaculation and post-ejaculatory intromission and longer inter-intromission intervals. In this talk, I will present the results of an experiment examining the effects of maternal licking on the development of SNB dendritic morphology.

Maternal licking of pups was reduced during the early postnatal period. At either postnatal day (P) 28 (when SNB dendritic length is normally maximal) or P49 (when SNB dendritic morphology is normally mature), SNB motoneurons of pups were retrogradely labeled with cholera toxin conjugated HRP, and dendritic arbor was reconstructed in three dimensions. At P28, the dendritic arbor of reduced maternal licking pups was not different from controls; however at P49, reduced licking pups showed a 23% reduction in dendritic arbor in the SNB, an effect that was especially pronounced in the rostral end of the nucleus, where reductions reached 48%. These results suggest that reductions in perineal stimulation provided by maternal licking could affect adult male copulatory behavior via alterations in SNB motoneuron morphology, and thus support maternal licking as an important factor in normal neural and behavioral development.

13. Cary H. Leung

MORPH AND SEX DIFFERENCES IN VASOTOCIN RECEPTOR DENSITY IN WHITE-THROATED SPARROWS

Cary H. Leung, Christopher T. Goode, Paul Ginart and Donna L. Maney
Department of Psychology, Emory University

The neuropeptide vasopressin (VP) and its avian homologue, vasotocin (VT), have been implicated in aggression across vertebrate taxa. Vasotocinergic fibers and receptors are found in regions of the brain that are related to aggression, such as the lateral septum (LS) and the amygdala. The White-throated Sparrow is particularly well-suited for studies of aggressive behavior because within this species, birds of the white-striped (WS) morph tend to be more territorial and sing more than tan-striped (TS) birds. We previously showed that VT is implicated in aggressive singing and that WS birds have denser VT fiber innervation of portions of the LS than TS birds. In this study, we compared VT receptor binding density between WS and TS White-throated Sparrows in both the LS and nucleus taeniae of the amygdala (TnA) by quantifying the binding of a ¹²⁵I-labeled VT antagonist in brain sections. We found that WS males have significantly more binding than TS males in the TnA. In addition, males showed significantly more binding than females throughout the LS, which parallels our earlier finding that males have greater VT fiber innervation of the LS than do females. Previous studies on rodents have not revealed sex differences in VP receptor binding, indicating that the regulation of the VT system of the LS in birds may differ from that of rodents. Furthermore, because morph differences in binding were only found between WS and TS males, VT receptor binding in the TnA may better relate to differences in aggressive behavior in males than females.

14. Ball, Kevin (ktball@indiana.edu)

ENDURING BEHAVIORAL AND STRUCTURAL PLASTICITY IN NUCLEUS ACCUMBENS
FOLLOWING MDMA (ECSTASY) ADMINISTRATION IN RATS

Kevin T. Ball, Cara L. Wellman, and George V. Rebec

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

Repeated, intermittent exposure to the indirect dopamine agonists amphetamine and cocaine is associated with a progressive and enduring augmentation of their locomotor-activating effects. This form of behavioral plasticity, termed sensitization, can be observed for months or years after the last drug exposure. This behavioral phenomenon is accompanied by similarly stable adaptations in the structure of nucleus accumbens (NAc) output neurons, including increases in dendritic length, branch number, spine density, and the number of multiple-headed spines. In this study we examined whether repeated exposure to non-neurotoxic doses of the club drug MDMA (ecstasy), which increases release of dopamine and serotonin, also results in long-lasting behavioral and morphological changes in NAc. In Experiment 1, adult, male rats received 2 daily injections of either 5.0 mg/kg (\pm)-MDMA or saline vehicle, ~6 hr apart, for 3 consecutive days, followed by 4 drug-free days for a total of 3 weeks. Following a 4-week drug-free period, rats received a challenge injection of MDMA (2.5 mg/kg), and the behavioral response was recorded for later analysis. To assess alterations in neuronal morphology, a separate group of rats, in Experiment 2, received the same MDMA or saline pre-treatment as in Experiment 1, but at the 4-week withdrawal time point brains were removed and processed using a modified Golgi method. Overall dendritic morphology (branch length, number, and organization), spine density (1st through 4th branch order), and density of multiple-headed spines was determined for medium spiny output neurons in both NAc core and shell subregions. Behavioral results revealed a significant increase in the locomotor response to the challenge injection of MDMA in MDMA-pretreated rats compared to saline controls. In Experiment 2, MDMA treatment produced no significant changes in overall dendritic length, branch number, or organization in NAc core or shell compared to saline-treated animals. MDMA-treated rats, however, displayed large increases in spine density across all branch orders in both NAc core and shell. Additionally, MDMA treatment resulted in an especially large increase in the overall number of multiple-headed spines. These results show that MDMA exposure results in a long-lasting form of behavioral sensitization that is evident 4 weeks following the last drug exposure. MDMA administration also was associated with marked morphological changes in NAc, suggesting that structural plasticity in this region may be a common neural adaptation underlying behavioral alterations following exposure to many abused drugs.

Supported by NIH grants DA 02451 (G.V.R.) and DA 020209 (K.T.B.)

15. Fernandez, Eduardo (eduferna@indiana.edu)

THE EFFECTS OF FORAGING DEVICES AS ENRICHMENT IN CAPTIVE WALRUSES (ODOBENUS ROSMARUS).

Eduardo J. Fernandez, William Timberlake
Department of Psychological and Brain Sciences, Indiana University and the Indianapolis Zoo

Walrus display a number of stereotypic and destructive activities in captivity. Many of these behaviors appear directly related to foraging activities, and can include flipper sucking, vibrissae/tusk contact against various parts of the enclosure, suction/ingestion of various non-edible objects, and repetitive swimming circles. In the wild, walrus spend a considerable amount of their time foraging across the ocean floor for molluscs and other food items, so their attempts to engage in these repetitive and abnormal behaviors appears to adhere to their typical foraging requirements. Two experiments examined feeding devices that allowed three captive walrus to forage within their enclosure. In Experiment 1, two 3.5' x 5' mats with inserted fish and clams were examined. In Experiment 2, two 20" plastic balls with several 1 3/8" holes were tested with food as well. In both experiments, decreases in stereotypic activity and increases in foraging device contact and non-patterned swimming were observed. Implications for the future of captive walrus, as well as the use of foraging devices with captive animals in general, will be discussed.

16. Lucas, Jeffrey (jlucas@purdue.edu)

SEASONALITY IN AVIAN AUDITORY PROCESSING
Freeberg TM, JR Lucas, GR Long, & A Krishnan
Department of Biological Sciences, Purdue University

Much is known about seasonal changes in vocal development, vocal production, and the neural underpinnings of vocalizations in songbirds. However, less is known about the extent of seasonal plasticity in auditory perception in songbirds. Here, we test for seasonal effects on the peripheral auditory system of three North American members of the Sylvioidea: Carolina chickadees (*Poecile carolinensis*), tufted titmice (*Baeolophus bicolor*), and white-breasted nuthatches (*Sitta carolinensis*). We measured two classes of auditory evoked responses (AERs) to tone burst stimuli: phase-locking and characteristics of the tone onset response. We found evidence of seasonal changes in both classes of AERs in chickadees and nuthatches. Seasonal changes in titmice were restricted to the tone onset response. Interestingly, changes detected in chickadees (and to a lesser extent in titmice) were generally in an opposite direction to changes seen in nuthatches, with chickadees exhibiting greater amplitude AER responses in the spring than in winter, and nuthatches exhibiting greater amplitude AER responses in winter than in spring.

17. McDowell, Angela (anlmcdow@indiana.edu)

CHRONIC STRESS IN RATS IMPAIRS LEARNING IN AN INSTRUMENTAL APPETITIVE-TO-AVERSIVE TRANSFER TASK

Angela L. McDowell, Katie M. Heath, Blair A. Dina & Preston E. Garraghty
Department of Psychological and Brain Sciences, Program of Neural Science, and Center for the Integrative Study of Animal Behavior, Indiana University

It has been previously demonstrated that chronic restraint stress impacts neural systems involved in learning. In the present study, we have examined the effects of chronic restraint stress on the acquisition of an avoidance response following appetitive training in comparison to control animals. Additionally, we examined the avoidance response after animals were allowed to recover from restraint stress. Rats were restrained for 6 hours/day for at least 21 days, and were then tested in a tone-signal appetitive-to-aversive transfer task immediately or starting 3 weeks after the last day of restraint. All animals bar-pressed to obtain a food reward (sugar pellet) or to avoid shock. Rats were trained on the appetitive task until they reached a set criterion of at least 90 correct responses on two consecutive days. Animals were then transferred into aversive training, where they were tested for 10 days. Plasma assays revealed a substantial increase in CORT levels in the restrained rats from baseline, indicating that the restraint procedures were effective. Behaviorally, the chronically stressed animals did not differ from controls in the acquisition of the appetitive response. In contrast, the stressed animals were significantly impaired in acquiring the avoidance response relative to controls following transfer from the appetitive training context. The stressed animals also had reduced efficiency ratios (avoidance/number of bar presses) relative to controls, indicating that they distributed their bar presses less efficiently within the training sessions. However, no differences were found between the non-recovered and 3 week-recovered 3 week restrained animals. These results suggest that learning processes in rats being trained in an instrumental appetitive-to-aversive transfer paradigm are dramatically, and negatively, affected by chronic restraint stress. This learning deficit may be mediated through an increase in CORT levels.

18. Gillman, Andrea (aggillma@indiana.edu)

THE ROLE OF CIRCADIAN RHYTHMS AND PAVLOVIAN CONDITIONING IN NICOTINE ADDICTION

Andrea Gillman and William Timberlake
Department of Psychological and Brain Sciences, Indiana University

Feeding, drinking, and wheel running were recorded for sixteen female Sprague-Dawley rats housed in chambers with attached wheels for 56 days under constant low-light and rate limited food. Rats received daily nicotine and saline injections eight hours apart; the order differed by group. An auditory stimulus was paired with one injection time. Wheel running and drinking activity peaks were entrained to injections of nicotine but not saline. Test 1 (no auditory stimuli or injections) showed two day persistence of activity around the nicotine injection time. Test 2 (no injections) showed anticipation of the auditory stimulus at the previous presentation time. Test 3 (alternating nicotine injection time) showed activity approximately 24 hr after each injection. Circadian time and environmental cues predicting nicotine both increased wheel running activity in rats.

19. Tietjen, William (btietjen@bellarmine.edu)

SUBLETHAL EFFECTS OF NEUROTOXIC PESTICIDES ON SPIDER BEHAVIOR

William J. Tietjen

Department of Biology, Bellarmine University

Most research on sublethal effects of pesticides has concentrated on economically-important arthropods and vertebrate species. Although previous studies have investigated the lethal effects of pesticides on spiders, few have documented the sublethal effects on spider behavior. This is surprising, given the likely importance of spiders as insect predators and control agents.

Purpose of Investigations:

- * Develop methods for dosing spiders under laboratory conditions.
- * Develop assays to record changes in behavior for a variety of spider species from different guilds (orb weavers, tangle-web weavers, non-web-weaving spiders).
- * Record changes in behavior of spiders and determine if spiders recover from sublethal effects.
- * Compile a "directory" of behaviors, spider species, and methods related to the effects of pesticides on spider behavior.

PLENARY SPEAKER

WHY DOES THE CAGED BIRD SING? SOCIAL AND NEUROENDOCRINE REGULATION OF BIRDSONG

Lauren V. Riters

Department of Zoology, University of Wisconsin

Vocal communication in many animal species is critical for successful social interactions. Although in some animal models, such as songbirds, a growing body of literature exists on brain regions involved in vocal learning and production (i.e., the song control system), little is known about neurobiological mechanisms regulating the *motivation* to communicate. In European starlings, during the breeding season when testosterone concentrations are high, song is highly sexually motivated and elicited by the presence of a female. In contrast, outside of the breeding season when testosterone is low, males continue to sing at high levels when in large flocks, but the presence of a female does not affect song production. Thus similar behavioral output is motivated by very different stimuli depending on an animal's endocrine state. Given that song during the breeding season can be highly sexually motivated, brain areas outside of the song control system, such as those involved in the anticipation of copulatory behavior or motivation in general are also likely to play an important role in this type of singing behavior. Furthermore, the fact that birds sing at high levels suggests this to be a highly motivated, rewarding behavior. Research from our laboratory implicates brain regions involved in sexual behavior, motivation, and reward as playing important roles in the motivation to communicate.

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

1. Akst, Jennifer (jakst@indiana.edu)

WHO CLAIMS THE CLAMS: KLEPTOPARASITISM IN HERRING GULLS

Jennifer Akst

Department of Biology, Indiana University

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. Avila, Lena (lavila@indiana.edu)

**IS PREDATION PRESSURE DRIVING THE EVOLUTION OF TTX RESISTANCE AND
APOSEMATISM IN *THAMNOPHIS SIRTALIS*?**

Lena Avila & Edmund D. Brodie III

Department of Biology, Indiana University

The *Thamnophis sirtalis* (garter snake) – *Taricha granulosa* (newt) system is an example of a reciprocal interaction where predation by the snake has led to increased tetrodotoxin (TTX) toxicity in the newt which has in turn led to increased resistance in the snake. *T. sirtalis* is one of the most generalist predators among *Thamnophis* and there is no evidence suggesting that newts comprise a significant proportion of *T. sirtalis*' diet, so they need not risk ingesting a potentially fatal meal for nutritional reasons. Therefore, other selective agents such as higher level predation on the snakes may be driving the reciprocal relationship between resistance and toxicity in this system. The ability of *T. sirtalis* to consume toxic newts and sequester the toxin in their liver for up to seven weeks makes them a potentially harmful prey item for avian predators. In addition, among populations of TTX resistant garter snakes, resistance is correlated with red coloration, which may function as an aposematic cue to visual predators such as birds. We hypothesize that *T. sirtalis* have evolved the ability to eat toxic newts at least in part due to multi-level trophic interactions which has led to the evolution of aposematism in some populations. This will be tested through correlation, phylogenetic and comparative analysis of the potentially aposematic signal as well as testing the adaptive function of the signal in the field with both robotic and stationary models.

3. Bleakley, Bronwyn Heather (hbleakle@indiana.edu)

DOES WHO YOU HANG OUT WITH MATTER? INDIRECT GENETIC EFFECTS ON SOCIAL BEHAVIOR IN GUPPIES, *POECILIA RETICULATA*.

Bronwyn H. Bleakley and Edmund Brodie III

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

Common guppies, *Poecilia reticulata*, “inspect” potential predators in the wild. Indirect genetic effects theory explicitly predicts that the phenotype (i.e. behavior) of an individual is not entirely dependent on its own genes and environment, but also the genes and expressed phenotypes, of its social partners. Inspection frequency has been modeled using tit-for-tat rules, suggesting that inspection by an individual may be impacted by the phenotype of social partners. Inbred guppies provide genetically homogenous lines, minimizing the variance in individual behavior resulting from underlying genetic differences. In highly inbred lines any observed variance in the behavior of individuals is expected to result from environmental variation, such as the environment provided by social partners. Phenotype is thus a property of a group interaction and genes carried in social partners. We utilized five inbred strains that vary in response to predatory cues to determine if the genetic composition of a social group influences the expression of inspection behavior in individuals and to obtain a measure of Ψ , which mediates interactions between individuals and the social environment.

4. Chester, Emily M. (emcheste@indiana.edu)

EFFECTS OF SOCIAL DEFEAT ON HUMORAL IMMUNE RESPONSE IN THE SIBERIAN HAMSTER

Emily M. Chester

Department of Biology, Indiana University

Prolonged exposure to physical stressors causes decreased immune function as a result the activation of the hypothalamo-pituitary-adrenal axis and the subsequent release of glucocorticoids. Likewise, social interactions affect the response of the immune system. Recent studies that social stressors, such as a defeat by a conspecific, lower the immune response. I have tested the effect of social defeat on the humoral immune response of Siberian hamsters (*Phodopus sungorus*). Experimental animals were either subjected to defeat, a fifteen-minute exposure to a dominant animal for five days, or to one of three control groups. One control group of animals was placed in a clean cage with no other animal present, and the second group was placed in another animal’s cage without the animal present to control for the odor of another animal. The third control group consisted of animals being placed in a cage with a resident present behind a partition, to control for the presence of the animal. All animals had a baseline blood sample taken and were challenged with the antigen keyhole limpet hemocyanin (KLH) before the onset of the defeat trials. Blood was taken on days 7 and 14 post immunization, and serum was analyzed for cortisol and anti-KLH immunoglobulin G (IgG). Results did not show any difference in cortisol levels or serum IgG concentration between groups. Investigations are ongoing to further elucidate the interaction between social stressors and immunity.

5. Conway, Theresa (thconway@indiana.edu)

INVESTIGATING FLY VISION: DOES PHYSICS OR BIOLOGY LIMIT VISUAL
PROCESSING IN THE BLOWFLY?

Theresa B. Conway, Dr. Robert de Ruyter van Steveninck
Department of Physics, Indiana University

As a blowfly flies through its environment, visual signals composed of photons enter its compound eyes and the fly must make critical in-flight decisions based on this input. This poster explores limitations in the fly's ability to process visual signals. The visual signal contains noise as a result of its random nature and characterization as a Poisson process. The relevant question is if photon noise or internal noise in the fly's brain limits its ability to abstract important features from the stimulus.

In this investigation, a motion sensitive neuron in the blowfly visual system is studied. In order to see if photon shot noise limits the fly's ability to process visual signals, various levels of random noise were added to the stimulus while the fly's neural response was recorded. This technique allows a quantitative comparison between photon counting noise and the artificial pixel noise. Preliminary results show that the added external noise increases the fly's variability in detecting motion in a measurable way at artificial noise levels comparable to photon counting noise. If it is true that photon noise dominates biological noise in visual processing, then the fly can be considered an optimal processor.

6. Cooper, Idelle (idcooper@indiana.edu)

ROLE OF NATURAL SELECTION IN FEMALE-LIMITED DIMORPHISM

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Causes of phenotypic differences between sexes have long attracted the attention of biologists. Unlike sexual selection, the role of natural selection in maintenance of sexual dimorphism remains poorly understood. Natural selection, and not sexual conflict, appears to play a major role in the evolution of sexual dimorphism in Hawaiian *Megalagrion* damselflies. *Megalagrion calliphya*, which contains a female-limited dimorphism, varies geographically in male color and female morph frequency.

7. Dagley, Rebecca (rdagley@indiana.edu)

UNILATERAL SONG PRODUCTION IN CARDINALS: EFFECTS OF CHRONIC DENERVATION

Rebecca Dagley, J. Martin Wild and Roderick A. Suthers

Department of Biology, Indiana University

Birdsong, unlike human speech, is produced by the coordination of two sound sources (the two sides of the syrinx), each of which is independently innervated by the ipsilateral tracheosyringeal nerve (nXIIts). The two halves of the syrinx can phonate simultaneously or sequentially to create species-specific sounds. In all species examined, the left side produces lower frequencies and the right side produces higher frequencies. Birds sustaining impairment of one side of the syrinx in adulthood are only able to sing frequencies within the range produced by the intact side. We impaired one side of the syrinx (right or left) in cardinal nestlings by denervation and bronchus plugs to determine if young birds are able to learn to produce the full range of frequencies using a single intact side of the syrinx. Preliminary results suggest that adult songs of these birds are not significantly different from that of controls in frequency range or frequency bandwidth. There are no evident neuroanatomical changes in the descending motor control pathway. It remains to be determined if there are any behavioral advantages for using two sides of the syrinx to produce song rather than singing on only one side.

8. Dina, Blair (bdina@indiana.edu)

A MODEL OF AUTISM IN RATS: EFFECTS ON LEARNING AND MEMORY

Blair Dina

Department of Psychological and Brain Sciences, Indiana University

Recent research indicates that embryonic exposure to an antiepileptic compound called Valproic Acid (VPA) may provide a useful animal model of autism. Rats exposed to VPA in utero show a reduction in numbers of cerebellar Purkinje cells, overall cerebellar volume, and in cell numbers in cranial nerve motor nuclei. We aim to evaluate learning and memory in rats that are born to VPA-treated dams, and to ultimately correlate expected learning deficits with the brain abnormalities. The assessment of learning in "autistic" rats will be accomplished through three learning paradigms. The first of these learning paradigms is an instrumental appetitive-to-aversive transfer task which may depend on normal function in medial prefrontal cortex. The second learning paradigm involves aversive learning without prior appetitive experience, and serves as an essential control for the transfer task and as an assessment of a manipulation's effects on simple aversive associative learning. The last paradigm is a spatial memory task that is known to depend on normal hippocampal function. We hope to begin to systematically characterize the cognitive consequences of autism by evaluating performance in this set of tasks.

9. Dorner, Jenelle (jdorner@indiana.edu)

EFFECTS OF AMPHETAMINE ON STRIATAL ASCORBATE RELEASE AND BEHAVIOR IN
MOUSE MODELS OF HUNTINGTON'S DISEASE

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Release of ascorbate, an antioxidant vitamin, in the striatum increases with behavioral activation. Ascorbate depletion from striatal extracellular fluid, moreover, impairs motor responding. Interestingly, a behavior-related deficit in striatal ascorbate release occurs in symptomatic R6/2 male mice expressing the gene for Huntington's disease (HD) (Rebec et al., 2002, *J. Neurosci.*, 22, RC202, 1-5). This deficit also occurs during behavior in male knock-in (KI) mice that express 140 CAG repeats in the huntingtin gene (Dorner, et al., 2004, Soc. for Neurosci conference, Program No. 564.19). However, this deficit was not observed in female KI animals. To assess the mechanisms underlying the ascorbate deficit, we treated both R6/2 and 140 knock-in mice and their corresponding controls with d-amphetamine sulfate (5mg/kg sc), a drug known to release ascorbate from corticostriatal terminals (Basse-Tomusk and Rebec, 1990, *Pharmacol. Biochem. Behav.*, 35:55-60). Unlike controls, both lines of HD mice showed deficits in both amphetamine-induced behavioral activation and ascorbate release. In addition, female mice showed significantly higher levels of striatal ascorbate in response to amphetamine as compared to males. Because amphetamine promotes striatal ascorbate release by increasing corticostriatal glutamate transport, our results suggest that alterations in striatal glutamate transmission may underlie the dysregulation of ascorbate release in behaving HD mice. Moreover, sex specific differences in striatal ascorbate release and behavior suggest that increased ascorbate levels and/or gonadal steroid hormones may result in neuroprotective effects in female animals.

10. Greives, Timothy (tjgreive@indiana.edu)

KISSPEPTIN INDUCES GONADOTROPIN RELEASE IN LONG- AND SHORT-DAY SIBERIAN
HAMSTERS (*PHODOPUS SUNGORUS*)

Timothy J. Greives, Alex O. Mason, Melissa-Ann Scotti, Ellen D. Ketterson, Lance J. Kriegsfeld and
Gregory E. Demas

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Temperate zone species exhibit seasonal breeding to coordinate reproduction with optimal environmental conditions. Photoperiod acts as a strong proximate factor, triggering gonadal regression or hastening recrudescence via actions on the hypothalamo-pituitary-gonadal (HPG) axis. Kisspeptin, a recently identified peptide hormone, induces the secretion of pituitary LH and FSH in rats, mice, sheep, and primates. Thus, seasonal changes in secretion or sensitivity to kisspeptin may mediate seasonal changes in reproduction. The goal of our study was to characterize possible seasonal variation in the functional responsiveness of the HPG axis to kisspeptin and to test the hypothesis that prolonged kisspeptin could override the short-day inhibition of reproduction in seasonally breeding rodents. Adult Siberian hamsters (*Phodopus sungorus*) were held in long (LD 16:8) or short days (LD 8:16) for 8 weeks and changes in LH was then measured in response to i.p. injections of either kisspeptin or saline. Next, hamsters were implanted with osmotic mini-pumps filled either with kisspeptin or saline and maintained on their respective photoperiods for 4 additional weeks. LH levels and gonadal masses were subsequently measured. Kisspeptin injections significantly elevated LH levels in both long and short day hamsters; prolonged treatment with kisspeptin, however, did not affect LH or gonadal mass. These data indicate that kisspeptin induces LH secretion in hamsters, and the HPG axis remains sensitive to kisspeptin regardless of photoperiod. Ongoing studies will examine the precise role of kisspeptin in mediating reproduction in seasonally-breeding animals.

11. Heath, Kathryn (kmheath@indiana.edu)

EFFECTS OF CHRONIC STRESS ON LEARNING IN RATS
Kathryn Heath & Michelle Sarin
Indiana University

Previous studies have shown that stress can damage the hippocampus and prefrontal cortex. These areas of the brain are important for learning and memory. The animals were exposed to restraint stress for 6 hours daily for 3 weeks prior to testing. We used the Morris Watermaze and Delayed Match-to-place as paradigms to evaluate spatial learning and memory. We used an instrumental task to examine the effects of stress on the acquisition of an avoidance response in animals that have had prior appetitive training in comparison to control animals. We found that the rats exposed to stress exhibited spatial learning and working memory deficits as well as impairments in avoidance acquisition following transfer from appetitive training.

12. Heidinger, Britt (bheidin@indiana.edu)

ATTENUATION OF THE STRESS RESPONSE MEDIATES AN INCREASE IN REPRODUCTIVE PERFORMANCE WITH AGE IN THE COMMON TERN (*STERNA HIRUNDO*)

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Department of Biology, Indiana University

Reproductive performance often increases with age. However, the physiological mechanisms that mediate this commonly observed pattern are poorly understood. One mechanism that may be important in regulating age-related changes in reproductive performance is the stress response. In response to stressors, vertebrates release glucocorticoids (CORT) that stimulate a physiological cascade that enhances survival, but shifts investment away from reproduction. Therefore, modifications of the stress response may mediate age-related changes in reproductive performance. We tested this hypothesis in a free-living population of the common tern (*Sterna hirundo*) using a standardized, handling stress protocol. In addition, we investigated the effects of exogenously elevated CORT levels on parental behavior. We found that the magnitude and amount of CORT released throughout the stress response declined significantly with age and that adults that received CORT injections spent significantly less time incubating than adults given control oil injections. These results support the hypothesis that an attenuation of the stress response mediates an increase in reproductive performance with age.

13. McGlothlin, Joel (jmcglath@indiana.edu)

PHENOTYPIC INTEGRATION OF ATTRACTIVE PLUMAGE AND TESTOSTERONE RESPONSE IN
DARK-EYED JUNCOS

J. W. McGlothlin, J. M. Jawor, J. M. Casto, J. L. Phillips, E. D. Ketterson
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Allocation of effort toward mate acquisition often comes at the expense of self-maintenance and parental care. Sexual selection theory predicts that males should differ in the optimal resolution of this trade-off because higher-quality males are able to benefit more from higher levels of mating effort. Selection should thus favour the integration of physiological mechanisms that mediate allocation to mating effort with signals used in the context of mate acquisition. In many songbirds, the production of behaviour related to mating effort is stimulated by social interactions that also cause short-term elevation of testosterone. We show that in male dark-eyed juncos (*Junco hyemalis*), the intensity of such elevations is correlated with the size of a plumage signal used in courtship and competition, a white patch on the tail. We artificially stimulated testosterone elevations by injecting gonadotropin-releasing hormone (GnRH), and found that males with whiter tails showed larger responses, whereas pre-injection testosterone was unrelated to plumage. Further, these elevations were highly correlated with those produced during territorial defence. This pattern suggests that selection has favoured the integration of attractive morphology with a flexible physiological mechanism underlying allocation to mating effort, thus linking a static plumage signal to dynamic production of mate-acquisition behaviour.

14. Miller, Benjamin (benmille@indiana.edu)

THE EFFECTS OF CEFTRIAXONE ON GLT1 EXPRESSION IN R6/2 MICE AND ITS
NEUROTHERAPEUTIC POTENTIAL FOR HUNTINGTON'S DISEASE

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Huntington's disease (HD) is a late-onset genetic disorder consisting of an unstable expansion of trinucleotide repeats within the coding region of the huntingtin gene. The hallmark pathology of HD is the preferential degeneration of the GABAergic neurons in the striatum and components of the corticostriatal pathway, which leads to loss of motor control, cognitive decline, and psychosis. Recent advances have demonstrated that perturbations of glutamate signaling in the brain begin before symptom onset and likely contribute to glutamate-induced excitotoxic processes. Decreased mRNA and expression levels of the astroglial glutamate transporter (GLT1) in the striatum and cortex of HD mouse models coincides with decreased glutamate uptake. The GLT1 transporter is the predominant glutamate transporter that provides the majority of extracellular glutamate clearance, and aids in neuroprotection by significantly reducing excitotoxicity. Rothstein and colleagues report that ceftriaxone, a β -lactam antibiotic, is a potent stimulator of GLT1 expression. Enhancement of GLT1 expression increases astroglial transport of glutamate and prevents glutamate excitotoxicity.

The goal of this study was to test the hypothesis that an increase in GLT1 expression with ceftriaxone treatment would attenuate the progression of the HD behavioral phenotype in the R6/2 transgenic HD mouse model. Preliminary results have shown that ceftriaxone upregulates GLT-1 expression in the striatum of wild type and R6/2 mice and cortex of wild type mice. There is also a clear trend, however, for increased levels of GLT-1 expression in the cortex of R6/2 animals. Behavioral assessments showed trends toward improvement on the rotarod and plus maze assessments in R6/2 mice treated with ceftriaxone. Moreover, in symptomatic R6/2 mice, treatment with ceftriaxone resulted in a significant reduction in clasping (a dystonic posturing associated with the HD phenotype) after one week of treatment. These preliminary results suggest that ceftriaxone upregulates GLT-1 in R6/2 and wild type mice and may improve the behavioral phenotype associated with HD. Since the dysfunction of glutamate handling occurs early in HD progression, this novel therapeutic approach may serve to attenuate the onset of HD symptoms and pathogenesis. Furthermore, this research may illuminate how GLT1 protein levels in the cortex and striatum modulate behavior.

15. Nolen, Mark (mtnolen@purdue.edu)

SIMULTANEOUS MOBBING OF A PREDATOR BY WOODLAND BIRDS: WHAT IS THE ROLE OF HETEROSPECIFIC VOCAL BEHAVIOR DURING MIXED-SPECIES MOBBING?

Mark T. Nolen

Department of Biological Sciences, Purdue University

The mobbing behavior of small forest birds typically involves a group of individuals surrounding a predator while producing loud, repeated, and often broadband frequency vocalizations apparently directed towards the predator or conspecifics (mates, relatives, or flock members). The typical response to mobbing calls is one of approaching and sometimes joining in the mob with similar calls. Previous studies have shown that playback of mobbing calls attracts heterospecifics, as well as conspecifics. However, the role of interactions with heterospecifics in initiation and continuation of a mob is unknown; as is whether or not mobbing signals have evolved as heterospecific recruitment signals. I employ playback experiments using simulated predators (Eastern screech-owls) and simulated mob initiation (heterospecific playback) to address these questions. Carolina chickadees (*Poecile carolinensis*), Eastern tufted titmice (*Baeolophus bicolor*), and White-breasted nuthatches (*Sitta carolinensis*) co-occur in most woodlands of the eastern U.S. and each is a frequent and vocal respondent to the presence of the Eastern screech-owl (*Megascops asio*). Preliminary results suggest a possible interdependency of mobbing behavior and production of mobbing calls among heterospecifics at two scales. Initially, the onset of mobbing calls by one species sometimes provokes immediate mobbing by heterospecifics. Subsequently, immediate and overlapping responses among conspecifics are common, and such overlapping responses are occasionally apparent among heterospecifics. These and other initial results are discussed in relation to alternative hypotheses as follows: (1) interspecific eavesdropping versus interspecific communication and (2) independent escalation of mobbing behavior versus an information cascade among individuals. Additional ways of addressing these hypotheses are suggested.

16. O'Neal, Dawn (daoneal@indiana.edu)

THE EFFECTS OF EXPERIMENTALLY ELEVATED TESTOSTERONE ON PARENTAL CARE IN FEMALE DARK-EYED JUNCOS

O'Neal, DM, Pavlis, K, Ketterson, ED

Department of Biology, Indiana University

Experimental elevation of plasma testosterone (T) in male dark-eyed juncos (*Junco hyemalis*) has been shown to decrease male parental care, but results in an overall fitness increased due to increased mating success. Potential benefits associated with higher levels of T in males may, however, be offset by deleterious effects in females. In an earlier study we reported that T does not suppress female parental behavior when females are incubating. In this study, we asked whether T interferes with female parental care when females are caring for nestlings. In particular we asked whether T affects nestling feeding or nestling defense. T levels in females were experimentally elevated to their spring maximum using subcutaneous implants. We measured female behavior in the field when young were six days old by videotaping feeding behavior at the nest and by quantifying responses to a mounted predator placed near the nest. T-implanted females showed a significant reduction in the number of nestlings fed per hour and in overall provisioning rate as compared to controls. T-implanted females also exhibited less nest defense than control females, and their nests were more likely to be lost to predators. The reduction in parental behavior due to elevated T indicates that both sexes are sensitive to suppression of parental behavior by T. Our results also suggest that the negative fitness consequences from reduced female parental care may act to constrain the evolution of higher levels of T in male juncos.

17. Soini, Helena (hsoini@indiana.edu)

SEASONAL VARIATION IN VOLATILE COMPOUND PROFILES OF PREEN GLAND SECRETIONS
OF THE DARK-EYED JUNCO (*JUNCO HYEMALIS*)

Helena A. Soini, Sara Schrock¹, Kevin E. Bruce, Donald Wiesler, Mike Wigen, Ellen Ketterson¹ and
Milos V. Novotny

Institute for Pheromone Research, Center for the Integrative Study of Animal Behavior, Department of
Chemistry, and Department of Biology¹, Indiana University

In birds, the uropygial (preen) gland produces lipids resembling those produced by mammalian sebaceous glands. These lipids are spread over the feathers as the bird preens. Some of the known functions of the preen oil in feathers are to protect them from wear, aid in waterproofing, and protect them against dermatophytes. Compositions of preen oil waxes have been traditionally investigated by hydrolyzing the waxes under basic conditions into acids and alcohols. Long-chain and branched acids and their esters as well as long-chain alcohols have typically been recovered after the wax hydrolysis. The recent investigations have indicated a shift in the composition of preen gland contents from monoester to the diester waxy components between the non-breeding and breeding seasons.

Relatively little is known about the volatile components in the preen oil. Certain volatile compounds present in feathers have been implicated as means of avian chemical communication through olfaction or chemical defense against predators. However, the effect of seasonal variation on volatile compounds produced by the preen gland has remained unexplored. In this study, we investigated volatile compounds of male and female preen gland secretions in the dark-eyed junco (*Junco hyemalis*) during the breeding and non-breeding seasons. Sorptive stir bar extraction methodology with gas chromatography-mass spectrometry (GC-MS) was utilized in these quantitative investigations. A novel *in-situ* stir bar surface sampling method was also applied to study volatile compounds on the surface of the wing feather.

Preen oil volatile profiles consisted of about 100 compounds. About 40 of these were positively identified. Large seasonal differences were found in the levels of several long-chain alcohols and branched ketones in both male and female junco preen oils. Qualitative and quantitative comparisons of the seasonal variations in the volatile compound profiles will be presented. Also, the biochemical and biological relevance of variation in the levels of these compounds will be considered.

18. Soini, Helena (hsoini@indiana.edu)

VOLATILE CONSTITUENTS OF HUMAN SKIN: GENETIC FACTORS AND BIOCHEMICAL INDIVIDUALITY

Helena A. Soini, Milos V. Novotny, Donald Wiesler, Iveta Klouckova, Kevin E. Bruce, Elizabeth Oberzaucher¹, Karl Grammer¹, Sarah J. Dixon², Yun Xu², Richard G. Brereton² and Dustin J. Penn³

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Human skin surface contains different types of glands that excrete numerous compounds, including polar and nonpolar lipids and peptides, but also small volatile organic compounds (VOCs) which can be olfactorily active. Human body odors can reflect physiological state and mood of individuals. Body odors appear to have their genetic attributes (e.g., MHC-related odors), while resident microflora can contribute to their occurrence. The studies of VOCs in human emanations have thus far been limited by the lack of quantitative techniques for comparing a large number of individuals. We have recently developed a high-throughput and highly quantitative technique for VOC profiling, which allowed to monitor precisely about 400 compounds by gas chromatography/mass spectrometry. Repeatedly collected VOC samples of 195 subjects were analyzed. Advanced chemometric methods were employed for evaluation of the VOC profiles. Numerous marker compounds distinguishing gender, families and individuals were located. Various oxygenated compounds were identified as prominent marker metabolites. Their biochemical and genetic significance will be shown.

19. Todd, Peter (pmtodd@indiana.edu)

SIMPLE RULES FOR SWITCHING BETWEEN RESOURCE PATCHES

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Humans and other animals encounter some resources in patches, such as berries on bushes or information on websites, and must decide when a patch has been sufficiently depleted that it is worthwhile seeking a new one. The Marginal Value Theorem (MVT) states that the optimal strategy is to leave a patch when the instantaneous rate of return from the current patch falls below the long-term mean return rate. Behavior of various animals has been successfully predicted by the MVT, but the actual mechanisms by which patch switching decisions are made are likely to be simpler heuristics. Here we tested whether the heuristics proposed for animals facing different resource distributions also account for human search behavior in patchy environments. We used one domain analogous to food search (a fishing task) and another domain that represented search for information from memory (an anagram task), and found that similar rules were used in both. In current work, we are exploring how patch-switching and patch-creating strategies may be adapted to each other through coevolution.

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EFFECT OF JUVENILE FEMALE'S PRESENCE OVER THE SOCIAL DYNAMICS OF A COWBIRD SOCIAL GROUP.

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The dynamics of a complex social group may sometimes be explained by the presence or absence of particular types of individuals. For example, when close relatives join different bird flocks which reside in close geographic proximity, the two flocks are more likely to interact and overlap in home range (Hatchwell et al. 2001). Female cowbirds in flocks with adult males spend more time interacting with males than they do when in flocks with only juvenile males (West et al. 2001). Females who approach and exhibit affiliative behavior towards males, provide feedback that can influence the quality of male songs (King et al. 2003). Because these songs are also used in male-male interactions, females that interact frequently with males can have a profound impact on social dynamics (King et al. 2003). Previous studies suggest that juvenile females are more likely than adult females to be "male-interactive", participating in dyadic encounters with males (West et al. 2002). Adult females, on the other hand, exhibit a more restricted pattern of interactions, interacting mainly with other females. In this study I look at the effect of juvenile females using metrics developed in graph theory. I focus on three hypotheses about the effect of juvenile females on adult females and overall group dynamics:

1. Cohesiveness: Different level of cohesiveness between adult and juvenile females. First, I expect adult females to form tighter-knit bonds with other females in the groups than do juvenile females which are more likely to interact with males.
2. Individual characterization: Juvenile females affect individual characteristics of adult females. Second, I hypothesize that the presence of juvenile females in a mixed age group will decrease the tendency of adult females to serve as gatekeepers or facilitators of information flow between sub-groups.
3. Modularity: Long-term effect of juvenile females on adult females. Finally even when adult females do not interact much with males, a temporary mixing with less-discriminating juvenile females might have a lasting effect on the behavior of adult females, influencing overall social dynamics and incidence of interactions between males and females.

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PRODUCTION OF LEARNED NONLINEAR PHENOMENA BY NORTHERN MOCKINGBIRDS

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It is hypothesized that nonlinear phenomena in animal vocalizations may have an adaptive function of increasing vocal complexity without the necessity of evolving equally complex mechanisms of neural control. However, little is known about the extent to which nonlinear components of vocal signals are behaviorally important. Many animals, including many species of birds, produce nonlinear acoustic phenomena, but since few taxa are vocal learners, the degree to which these phenomena are perceived, learned and under voluntary control has not been explored. We addressed these questions by tutoring nestling northern mockingbirds (*Mimus polyglottos*) with computer-synthesized sounds containing various nonlinear phenomena-including subharmonics, frequency jumps, deterministic chaos and biphonation-and investigated the peripheral motor dynamics associated with their subsequent production in songs. All 12 mockingbirds tutored in this way attempted to reproduce some or all of these nonlinear components as adults. Suggesting that not only are these sounds perceptually salient to juvenile mockingbirds, but that the birds can discriminate the differences between types of vocal 'roughness' and that their occurrence can be subject to some degree of voluntary, learned motor control. While bronchial airflow measurements are still needed to verify whether sounds were copied using both sides of the syrinx or only one, some acoustic clues to production are present, which suggest that mockingbirds may not rely on the passive, nonlinear properties of their syrinx, but rather exploit the two sides of the syrinx to approximate similar acoustic effects.