KRYSTEN GARCIA, John Hopkins University, Baltimore, MD

Hippocampal Dependency of Episodic Memory Replay in Rats

(Drs. Jonathon D. Crystal and Danielle Panoz-Brown, Dept. of Psychological & Brain Sciences)

Animal models of memory allow for research into the underlying mechanisms of memory impairments and are a necessary foundation for developing treatments for memory disorders. In order for these treatments to be clinically effective, these models need to reflect aspects of human memory. One characteristic aspect of human memory is the ability to replay unique events in sequential order, known as episodic memory replay. It is not known whether animals have this feature as well. The aim of this study is to show that rats use this episodic memory replay to remember the sequence of multiple unique events. Another aim of this study is to show that episodic memory replay is hippocampal dependent. Rats were presented with a variable-length list of odors and subsequently assessed on their memory of the order of the odors. An AAV (Adeno-Associated Virus) vector was used to induce expression of an hM4Di DREADD (designer receptors exclusively activated by designer drugs) into the rats' hippocampus and episodic memory replay was assessed after injections of CNO (Clozapine-N-Oxide) and vehicle. Rats were well above chance in the memory task prior to injections, providing evidence that rats use episodic memory replay to remember the order of events. Rats' performance on the task was significantly lower on CNO than on vehicle, providing evidence that episodic memory replay is dependent on the hippocampus. This study is the first to show that non-human animals are capable of using episodic memory replay to remember a sequence of events.

THERESA JONES, Mary Baldwin University, Staunton, VA

(Dr. Farrah Barrah-Visser, Ashwini Ramesh)

How do Parasites Choose Their Hosts?

Parasites choose their hosts- as individuals, based on abiotic and biotic factors such as health and behavior of the host, as well as the size of the group they live in. There are also many conspecific factors that affect a parasite's decision to infect a host. These factors include ease of finding mates, others indicating a high quality habitat and level of interspecific competition within a habitat. We want to understand how parasites distribute themselves among their environment when group size is changed, as well as host availability. Entomopathogenic nematodes within the same species have similar infection patterns; but we want to see the differences in infective behavior of conspecific nematodes. Our experiment consists of a parasite host model, with species *S. kraussei* and *S. costaricense* nematodes, and *G. mellonella* wax moth larvae as the host organism. The study design consists of treatments where with two types of nematodes, we have different arenas with a cross of high or low host availability, and high or low parasite density. For our experiment, we obtained 8 arenas per nematode species, yielding a total of 16 arenas per set up with combinations of host availability and parasite density. The hosts underwent infection for 72 hours, and dissection 120 hours after the infection date. Quantitative measures were the number of nematodes per host and presence of an F1 generation. Upon collecting results, I expect for the high availability arenas to have more uniform distribution as opposed to the low host availability arenas; because the amount of resources affects how many organisms choose a habitat. Also, I expect there to be a more concentrated distribution of nematodes amongst the low-density arenas because there are more resources available. With this experiment, we can understand the behavioral aspect of how different sized groups of parasites choose their hosts when placed in a habitat with a variable amount of resources.

M. OMAR KANE, mar Kane, Salve Regina University, Newport, RI

Effects of Early Life Stress on Glucocorticoid Receptor Expression and Emotional Learning in Adolescent Rats

(Dr. Cara Wellman and Rachel Skipper, Dept. of Psychological & Brain Sciences)

The relationship between stress and psychiatric disorders such as post-traumatic stress disorder (PTSD) has been widely studied in the fields of psychology and psychiatry. Studies have shown that stress enhances fear learning and impairs the retrieval of extinction memory. This is likely mediated by changes in brain areas like the amygdala, which processes the fear response. Rodent models of PTSD typically use adult animals, and have characterized the effects of stress during adulthood on adult brain function. Research on the effects of stress on adolescent brains and how this differs between males and females is severely lacking. It is imperative that future studies explore sex differences, and the effects of early life stress, to inform and improve clinical practices of treating psychiatric disorders. This study aims to observe the effect of stress on subsequent fear learning and glucocorticoid receptor expression in the adolescent brain, and furthermore, how these effects differ between males and females. We investigated this by using a 2x2 (stress x sex) factorial design where male and female rats underwent a 30-minute elevated platform stress on postnatal day 25 (P25) and unstressed controls underwent a similar handling procedure, without stress exposure. On P26, all animals received three tone-shock pairings. Fifty minutes later, brains were collected for immunohistochemistry, sectioned and incubated in GR antibody (M-20; Santa Cruz Biotechnology), and then immunoreactivity was detected using nickel-enhanced DAB. To quantify GR expression, optical density of each labeled cell within the basolateral amygdala was measured and expressed relative to background optical density. We found that after an early life stressor, males have an increase in their fear responding whereas females appear to be unaffected. Additionally, glucocorticoid receptor expression in males decreases after an early life stressor, whereas females again appear to be unaffected.

ALEXANDER KOO, Vassar College, Poughkeepsie, NY

Localizing the Source if Context-dependent 5-HT Release in the IC

(Dr. Laura Hurley and Chris Petersen, Dept. of Biology)

Behavioral and physiological context is essential to sensory processing. The neuromodulator serotonin (5-HT) within the inferior colliculus (IC) has been shown to modulate depending on the context. Most 5-HT in the IC is provided by the dorsal raphe nucleus (DRN), but no studies have looked at which DRN subregions have 5-HT projections to the IC. We therefore sought to localize the source of 5-HT in the IC within the DRN. Male CBA/J mice (*n*=6) received stereotaxic injections of Retrobeads, a retrograde tracer, into the IC. Five days post-op, mice were sacrificed and their brains were extracted and sliced. Sections were then labeled for tryptophan hydroxylase (TPH) via immunohistochemistry, and double-labeled cells in each DRN subregion were counted. We localized most double-labelled cells to the dorsolateral and dorsal subregions of the mid-rostrocaudal DRN. The rostral and caudal DRN as well as the dorsoventral subregion of the mid-rostrocaudal DRN contained relatively few neurons backfilled with Reotrbeads. The results suggest that the dorsal subregions of the mid-rostrocaudal DRN may play a role in processing context-specific auditory cues. To give functional support to our anatomical findings, we next examined whether the serotonergic DRN to IC projections are active during exposure to contexts that have previously been shown to modulate 5-HT levels within the IC. Mice (*n*=12) received stereotaxic injections of Retrobeads and were exposed to stressful, social, or control environments. Five days post-op, brains were extracted, sectioned, and labeled for TPH and c-fos via immunohistochemistry. Neurons triple-labelled for the Retrobeads, TPH, and c-fos were counted. While we have finished the immunohistochemical labeling for this portion of the project, we are still counting cells. However, we expect to find more serotonergic back-filled neurons in the dorsal subregions of the mid-rostrocaudal DRN to be active during the stressful and social contexts relative to the control group.

KETAIRA PHILLIPS, University of Central Florida, Orlando, FL

Modeling the Effect of Architectural Modularity in an Evolvable Neural Network

(Dr. Sue Carter, Allison Perkybile and Will Kenkel, Kinsey Institute and Department of Biology)

Prairie voles are a rodent species most notable for their monogamous behavior and their biparental care toward their young. The two hormones partially responsible for these behaviors are oxytocin and vasopressin. During mating, both parents receive a surge of oxytocin and vasopressin which help bond the two together. After the birth of their pups, the parents' hormones surge again to prepare them for parenting. Although both vasopressin and oxytocin are important in this process, these hormones are also play a role in the fear response. Vasopressin increases cortisol levels, which in turn increases levels of stress and promote fear learning. Oxytocin works in opposition to vasopressin, decreasing the effects of cortisol and lowering stress levels, and thus inhibiting fear learning and promote extinction. This study investigated the role of vasopressin in fear response by comparing the fear responses of father voles to virgin males. Fathers and virgin males were tested in an open field where they are exposed to one of three stimuli: the scream of a red-tailed hawk, the call and song of an eastern bluebird, or white noise. The red-tailed hawk is a natural predator of the prairie vole and therefore is expected to evoke a fearful response from the subjects. We expect that the eastern bluebird song as well as white noise should evoke no fearful response from the subjects. Autoradiography was also conducted on father and virgin brains to measure the amount of vasopressin V1a receptor present in the central amygdala and the retrosplenial cortex, both of which are important fear modulating regions of the brain. Results show no significant difference between the responses of father and virgin males to each audio clip played. Results of autoradiography show that there is no significant difference between the levels of vasopressin V1a receptors in the central amygdala or the retrosplenial cortex.

BELEN ROGERS, Mount St, Mary's University, Emmitsburg, MD

Maternal Offspring Microbiome Transfer, Antibiotic Exposure, and Neurobehavioral Development

(Dr. Jeffery Alberts and Chris Harshaw, Dept. of Psychological & Brain Sciences)

Perinatal disruption of maternal microbiome, that which establishes offspring microbiome, has been shown to increase the likelihood that offspring display differences in social and emotional functioning. We used mice (*Mus musculus*) to model the effects of Antibiotic-induced disruption of the maternal-offspring microbiome (M-OM) transfer on offspring neurobehavioral development. To investigate this idea, dams were given Antibiotics (ABx) perinatally from gestation day 12 to post-natal day 14. Three tests appropriate for measuring the early development of offspring social behavior were conducted: olfactory preference for home cage odor; ultrasonic vocalization during maternal separation; and group huddling in response to cold. We ran separate mixed effects models and found a trend for main effect of both condition, ABx versus non-ABx exposed (p =.055) and weight (p =.082) on preference for home-cage odor. We found significant condition by weight interaction on postnatal day 12 (p <.05) for male offspring of ABx-exposed dams, who had a stronger preference for home cage odor. Offspring of ABx-exposed mothers vocalized more than offspring of non-exposed mothers. We ran a mixed effects model and found a main effect for condition (p <.04) and for weight on number of vocalizations produced (p <.008). In separate male/female models, the effect of condition and weight interaction was only significant for males (p <.05). Upon analyzing activity level within the huddles, we found that the effect of condition on activity level varied by sex on postnatal day 8 (p < 0.05). In particular, there was a significant effect of condition on activity for females (p < .0005), where female offspring of ABx-exposed mothers were less active. Because desire for warmth drives social behavior, we measured the physical development: tail length, rectal temperature, and body weight of each mouse as factors that affect thermoregulatory function. We found a difference in rectal temperature at day 7 between conditions, where the offspring of non-ABx exposed mothers were warmer than the offspring of ABx exposed mothers. In summary, we found a number of intriguing differences in behavior and development between conditions, particularly for males. Given that the purpose of this research is to model behavioral differences relevant to Autism Spectrum Disorders, these results are promising and will suggest a number of avenues for further investigation.

ISABELLA SALINAS, St. Mary's University, San Antonio, TX

Sex Differences in- and Chronic Stress Effects on- Microglial Morphology and ΔFos B Induction in Medial Prefrontal Cortex

(Dr. Cara Wellman and Justin Bollinger, Dept. of Psychological & Brain Sciences)

Microglia play a critical role in modeling and refining the central nervous system. There are region- and sex-specific differences in microglial morphology and function early in development that are hormone-dependent. These hormonally mediated alterations in microglia are associated with lasting sex differences in brain and behavior. We recently demonstrated a sex difference in microglial morphology in medial prefrontal cortex (mPFC) in adult rats, and sex dependent effects of chronic stress on microglial activation. Microglia are sensitive to neurotransmitters, including glutamate. Chronic stress reduces glutamatergic signaling in mPFC in males, but has no effect on glutamate in females. In male rats, ΔFos B induction, indicative of repeated glutamatergic cell signaling, correlates with chronic stress-induced microglial remodeling in mPFC. This has yet to be studied in females. Therefore, we examined the relationship between chronic stress-induced ΔFosB induction and microglial morphology, and the potential mediatory role of estradiol in mPFC in female rats. Animals underwent sham surgeries, ovariectomy (OVX), or ovariectomy with estradiol replacement (OVX+E). Following recovery, animals were handled or subjected to chronic restraint stress. Brains were then removed, sectioned, and immunohistochemically stained for ΔFosB or microglia. Immunolabeled cells in mPFC were stereologically counted with microglial morphology assessed using densitometric analysis. Chronic stress decreased microglial activation in sham and OVX+E females, but had no effect on microglia in OVX animals. Stress reduced the number of ΔFosB expressing cells in sham animals, but increased ΔFosB induction in OVX+E females. There were no effects of stress on ΔFosB induction in OVX animals. Microglial activation and ΔFosB induction were not correlated in females. These data indicate that stress induced microglial deactivation in mPFC is estradiol dependent in female rats.

TIANA SANDERS, Mary Baldwin University, Staunton, VA

Telomeres Predict Life History Trade-Offs in Wild Female Tree Swallows

(Dr. Kim Rosvall and Sarah Wolf, Dept. of Biology)

Life-history trade-offs are critical in determining how organisms allocate limited energy resources, and understanding how individuals may resolve these trade-offs warrants further investigation. One factor that may provide insight is telomere length. Telomeres are noncoding sequences on the end of DNA strands that serve to protect genomic integrity and are known to correlate with age, stress, and behavior. However, studies of aggressive behavior, specifically in females, and the trade-offs aggression may have with other phenotypic components has not yet been researched as thoroughly. In this study, we hypothesize that telomere length predicts how an individual resolves trade-offs between aggression, parental care, and self-maintenance in wild female tree swallows (*Tachycineta bicolor*). To test this hypothesis, we evaluated aggression using simulated territorial intrusions, quantified telomere length in whole blood samples, and measured variables associated with parental care and self maintenance after administering either a saline or lipopolysaccharide (LPS) injection, which elicits an acute sickness response. Our results indicated that telomere length can predict trade-offs between aggression, parental care, and self-maintenance; however, this relationship may be condition-dependent. Specifically, the degree to which telomere length predicts trade-offs in response to stress may depend on the severity of stress and the overall condition of the individual. Furthermore, the typical aggression-parental care trade-off in tree swallows was only found in individuals with longer telomere lengths, suggesting that younger individuals exhibiting the extreme trade-offs were selected against, leading to lower phenotypic variation in older individuals with shorter telomere lengths. The likelihood of certain trade-offs may be related to particular phenotypes associated with telomere length; however, more research is necessary to determine the causation of this pattern. These findings are enlightening to answering the question of how individuals resolve life-history trade-offs.

GRASCEN SHIDEMANTLE, Slippery Rock University, Slippery Rock, PA

Agression and Chirp Behavior in Free-Swimming Dyadic Encountrers of *Apteronotus albifrons*

(Dr. G. Troy Smith and Megan Freiler, Dept. of Biology)

Communication is key to the success and fitness of many taxa since it enables them to find mates, fight off intruders, locate food, and more. Weakly electric fish communicate with abrupt modulations of their electric organ discharge frequency (EODf), known as chirps. Chirps have long been generally defined as aggressive signals. However, recent research indicates that this may be an oversimplification of chirp function. This study aims to elucidate the function of chirps in the context of free-swimming dyadic encounters between the territorial fish, *Apteronotus albifrons* (black ghost knifefish). This study will also help to provide a better understanding of hormonal changes during aggressive interactions in this species. In order to examine these relationships we introduced two unfamiliar conspecifics in a novel environment, to compete for the new territory. Behaviors and chirps were analyzed along with levels of endogenous 11-ketotestosterone (11-KT) and cortisol preceding and following the trial. Our results indicate that chirps are associated with aggression, but cannot conclusively be categorized as strictly aggressive signals. Interestingly, it was also found that dominant female fish are more aggressive than male dominant and subordinate fish. This contrasts with behaviors in the closely related *Apteronotus leptorhynchus* (brown ghost knifefish), where males are typically more aggressive than females. Finally, no difference was found between baseline 11-KT or baseline cortisol levels of either dominant or subordinate fish and no significant change in either hormone occurred in either group following the trial. This study provides further evidence of the function of chirps in *A. albifrons*, uncovered a difference between *A. albifrons* and *A. leptorhynchus* social behavior, and found the hormonal changes that result from aggressive encounters in *A. albifrons.*

ASHLEE WEBB, Boise State University, Boise, ID

Differences in Gonadal Response to GnRH in a Sympatric Bird

(Dr. Ellen Ketterson and Abby Kimmitt, Dept. of Biology)

Speciation usually occurs through allopatry, as gene flow is restricted due to geographic isolation. If diverging species come into contact, there may be mechanisms that have evolved that can maintain divergence. Seasonal sympatry is a unique case, in which diverging migratory and sedentary (resident) populations may overlap during part of the year but be allopatric during the remainder of the year. In this case, differences in reproductive timing may serve as a primary barrier to gene flow, as this may prevent interbreeding between populations during periods of overlap. Differences in reproductive timing may be driven by how the reproductive hormonal cascade, or the hypothalamic-pituitary-gonadal (HPG) axis differs between populations in how it responds to environmental cues. By studying hormonal responses in seasonally sympatric migrant and resident female dark-eyed juncos, we will be able to more fully understand the mechanisms of differences in reproductive timing and how that contributes to divergence between migrants and resident populations. Females from the two populations were given Gonadotropin-releasing Hormone (GnRH) injections, or hormonal challenges, in order to stimulate the synthesis of Testosterone (T) and measure the differences in their responses after repeated injections. We collected baseline blood samples as well as samples 30 minutes following a first and third injection. We expected to see an increase in T after one injection of GnRH in both subspecies. Additionally, we predicted that migrants would be less responsive to the injections, and that they may be unable to respond after one injection because negative feedback of sex steroids may attenuate the responsiveness of the HPG axis. On the other hand, resident females would continue to elevate T in response to hormonal challenges, because they should be closer to breeding condition. We found that both populations had higher levels of T after first and third injection in comparison to the baseline sample. Residents, however, had significantly higher T at time 30 than migrants, which indicates that the resident population may be closer to reproductive condition as its gonad was more responsive to the hormonal challenge. Neither migrants nor residents exhibited a change in T after the third injection, which suggests that negative feedback may be suppressing testosterone production. Further research is needed in order to understand possible mechanisms of negative feedback on the HPG axis between these two populations. With climatic changes affecting migratory routes, understanding more about how birds time their reproduction will help us to better predict and understand migration timing as well.

SAMANTHA WESTCOTT, Lyon College, Batesville, AR

Characterization of *smoke alarm* and its Role in Nociception

(Dr. W. Daniel Tracey and Stephanie Mauthner, Dept. of Psychological & Brain Sciences)

The concept of physical pain is a common experience across various species, a process often initialized by the sensory activities of pain receptors, known as nociceptors. *Drosophila* serves as an exceptional model for researching nociception due to its simplified nervous system and the unique, easily observed rolling behavior exhibited by the larvae in response to noxious stimuli. Studies of these *Drosophila* nociceptive behaviors have identified a gene called *smoke alarm (smal)* as a potential regulator of noxious thermal sensitivity in *Drosophila*. *smal* has been found to be expressed in the nociceptors and is predicted to encode a transmembrane protein with extracellular domains similar in sequence to mammalian discoidin domains that interact with collagen, leading to the hypothesis that Smal localizes to the nociceptor plasma membrane and anchoring them to the extracellular matrix through collagen interactions. A series of transformations of the smoke alarm cDNA short isoform across vectors were performed to generate a useful tool for viewing the localization of the gene product. A resulting *Drosophila* strain with a GFP-tagged *smal* transgene will enable visualization of the gene product through confocal microscopy. Further characterization of the *smal* gene will be achieved through behavioral assays of larvae with *smal* null alleles by introducing a 42˚C probe and comparing the reaction times of the mutant and wild type larvae. One of the *smal* deficiency tested appears to exhibit the hypersensitive rolling behavior. Expanding current knowledge on the molecular pathways in nociceptors, via study of *smal* can greatly improve current methods for treating hypersensitive pain responses in humans.