

Awilda Acaron

University of Massachusetts, Amherst

Effects of social environment on boldness behavior in laboratory and wild zebrafish

Many studies have demonstrated that behavior has both a heritable and environmental basis. Traits may be inherited or innate, socially influenced by watching others behave or affected by external factors, like stress. Studies have also shown that younger animals are more likely to acquire behaviors from older individuals, consequently making the stage of development at which they are exposed to social stimuli another important factor that can affect behavior. In this experiment I determined whether the social environment of individuals can have an effect on boldness in laboratory and wild zebrafish (*Danio rerio*). I created mixed strain groups and varied the stages of development at which laboratory and wild zebrafish were housed together. These groups included: mixed as eggs, mixed three weeks after hatching and mixed at 5 months of age. A pure tank of each strain was used as a control. Each group was assayed for shoaling tendency, activity level in an unfamiliar environment, predator avoidance and feeding latency after stress. The results from these tests demonstrate that there is a significant difference in boldness between wild and domesticated strains, with the domesticated strain being bolder. The domesticated strains displayed higher activity level, less predator avoidance, and lower feeding latency. It was also demonstrated that the social environment and stage of development in which that individual was exposed to a particular behavior does not have an effect on the acquirement of behaviors. An explanation for this could be that boldness is innate and resistant to social learning. Future experiments could be done to see if other behaviors, for example reproductive behavior, are more influenced genetically or by their social environment.

REU Mentors: Jason A. Moretz/ Emilia P. Martins, Department of Biology

Aitalohei Amaize

Princeton University

Serotonin projections to the inferior colliculus: A retrograde tracing analysis of raphe nuclei in mice

The purpose of this study was to further understand the modulatory effects of the neuromodulator serotonin (5-HT) in the inferior colliculus (IC), an important midbrain structure involved in auditory processing. This was accomplished in mice via quantification of cell distributions in different raphe nuclei, which are known to send serotonergic projections to the IC. We examined the distribution of serotonin cells in the raphe nuclei in mice by using the retrograde transport of green fluorescent retrobeads, pressure injected (0.1-1 μ l) unilaterally or bilaterally into the inferior colliculus. This was combined with fluorescent immunostaining for serotonin after a 2-7-day survival period. Fifty-micron-thick brain sections were collected, immunostained for serotonin, and visualized with fluorescence microscopy. An abundance of retrogradely-labeled cells were present proximal to the IC injection site(s). Comparatively across different raphe nuclei, more retrogradely-labeled cells were found in the dorsal raphe nuclei (DRN) compared to fewer in the median raphe nuclei (MnR), with a few also appearing in the raphe magnus. Within just the DRN,

further quantification of labeled cells revealed that labeled cells were mostly located in the medial wing, while there were fewer cells in the lateral wings. These results show that 1) mice are similar to other animals in the sources of serotonergic projections to the IC and 2) projections to the IC mostly come from a specific region of the DRN.

REU Mentor: Laura Hurley, Department of Biology

Jackeline Anderson

Baylor University

Thermal environment influences morphology of developing Norway rats

Previously, Villarreal, Schlegel, and Prange (2005) reported that cool (17°C) housed rats develop shorter ears and tails than moderate (25°C) housed rats. In addition, they found cool-housed rats develop a preference for warmer air temperatures than moderate-housed rats. In order to elucidate possible biological mechanisms for the development of this seemingly counterintuitive thermal preference, we further assessed how the thermal environment influences morphological development of rats. Terminal morphology measures (body mass, body mass without coat, coat mass as a percent of body mass, and adrenal gland mass as a percent of body mass) of 32 22-day-old, 32 43-day-old, and 28 85-day-old rats were recorded. Results indicated that 22 and 43-day-old cool-housed rats had lower body mass with and without their coat than moderate-housed rats, $p < 0.05$. And 22 and 43-day-old cool-housed rats had higher coat mass as a percent of body mass than moderate-housed rats, $p < 0.05$. These results suggest the thermal environment substantially shapes the body morphology of juvenile rats. No differences were found on these measures in 85-day-old rats. In addition, no differences in adrenal gland mass as a percent of body mass were found at all 3 ages assessed. These results indicate that the morphological differences between cool and moderate housed-rats are not likely due to the cool temperature inducing a stress response. The results from this study have lead us to posit that the development of the previously observed thermal preference of cool-housed rats for warmer air temperatures than moderate-housed rats may be in part due to the lower body mass of juvenile cool-housed rats.

REU Mentor: Henry D. Prange and Jill Villarreal, Medical Sciences

Stefanie M. Baur

University of Evansville

Effects of chronic stress on water maze performance in rats

Chronic stress has been shown to have the ability to impair learning in humans and in rats. These effects appear to be mediated by damage to the hippocampus that results from stress hormone release during exposure to chronic stress. Research on humans and rats has found stress to be related to hippocampal damage as well as memory and learning impairment. This study examines the effects of chronic stress on spatial learning in rats. Spatial learning was assessed by performance in the delayed matching-to-place paradigm in a water maze. Previous research with this paradigm has validated impaired spatial learning resulting from hippocampal lesions, stress hormone treatment, and stress. For this study, chronic stress was induced through long-term, inescapable restraint. Stressed animals were found to have

deficits in Trial 1 performance for the nine Training Days and deficits in Trial 2 performance for 10-minute inter-trial intervals. Ongoing research will seek to statistically verify these results.

REU Mentor: Preston E. Garraghty, Department of Psychology

Andrew Garst

New Mexico Highlands University

Energy allocation and sickness behavior in Siberian hamsters

Many non-tropical mammals have evolved in fluctuating environments where resource availability can be vastly different across the seasons of the year. In response to these environmental changes, animals have evolved seasonal physiological and behavioral responses that allow them to anticipate and prepare for oncoming challenges in order to increase overall fitness. For example, during times of low resource availability (e.g. winter) animals will reallocate energy reserves into immediate survival challenges such as thermogenesis and reduce allocations to less critical responses (e.g. reproduction and immunity). In addition, many behavioral adaptations have co-evolved with energetic investment strategies to increase survival. Day length (photoperiod) is the primary cue mediating seasonal changes, and photoperiodic changes in the pineal hormone melatonin act as the biochemical signal mediating photoperiod responses. The purpose of the present study was to examine the physiological and behavioral costs of mounting an immune response and the role of melatonin in mediating these responses. Specifically we hypothesized that overall immune response and sickness behavior will be attenuated in melatonin (mel) implanted Siberian hamsters (*Phodopus sungorus*) as compared with control animals. Two experiments were conducted to test this hypothesis. Experiment 1 was tested the effects of food restriction on immune response in mel and control implanted animals. This was done by measuring antibody production response to an injection of the antigen keyhole limpet hemocyanin (KLH). Experiment 2 was conducted to determine the effects of lipopolysaccharide (LPS), an antigen that produces a robust sickness response, on a battery of sickness behaviors various in mel and control implanted animals. The results of these studies will be presented.

REU Mentor: Gregory E. Demas and Devin Zysling, Department of Biology

Derrick Parker

Louisiana State University

Does 1 + 1 really equal 2? Genotypic and phenotypic interactions in expressed social behavior of *Poecilia reticulata*.

The phenotype of a group of animals reflects both the behavior of individuals and potentially interactions among individuals. We examined whether the phenotype of the group reflects additive, non-additive or a combination of additive and non-additive effects on the behavior of individuals within the group. We also sought to investigate whether the group phenotype as a whole could be described as additive, or whether it is different than the sum of its parts. We utilized an inbred strain of common guppies, *Poecilia reticulata*, which provides virtually homozygous subjects, eliminating variation in behavior resulting from genetic variation and allowing us to isolate interactions at the phenotypic level. All guppies were exposed to a predator

stimulus and subjected to two test trials, once alone and once in a group, in random order. They were scored for time spent in close proximity to and oriented on the model, time spent foraging and agitated, and number of inspections. We found no net change in the mean phenotype displayed by individuals tested alone and individuals tested in a group. However, we did find evidence of non-additive effects within groups, with individuals differentially altering their behavior in response to the phenotype of other individuals within the group. Despite low repeatability an individual's behavior alone is the best predictor of its behavior in a group. Our study therefore suggests that group phenotype is additive and therefore predicted, at least in part, by the mean individual phenotype.

REU Mentor: Edmund Brodie III and Heather Bleakley, Department of Biology

Natasha Pettifor

New College of Florida

Mobile versus stationary viewpoints affect blocking and facilitation between beacon and landmark learning in the floor maze

Blocking, when preexistent learning about one cue inhibits learning about a new, redundant cue, is known to occur readily in the temporal domain. In the spatial domain, its presence is not as clear. It is generally accepted that spatial learning is more complicated than can be described by the basic theories of associative learning, and spatial information may be encoded and integrated in multiple system. This experiment sought to examine the effects of moving versus stationary release and beacon positions on the interactions between beacon and landmark learning in rats. A square floor maze with four symmetrical quadrants was used, each quadrant containing a reward cup. A release basket was positioned in the center of each maze wall. Four treatment groups of Sprague-Dawley rats were studied: Moving Release/Static Beacon, Moving Release/ Moving Beacon, Static Release/Static Beacon, and Static Release/Moving Beacon. Each group received two trials per day for twelve days of training under these conditions, followed by the addition of landmarks and eight subsequent days of training in which all release and beacon positions were made static. A series of tests followed the training days. Overall, groups receiving a moving beacon in the first stage showed significantly higher latencies; this corresponds with an overall higher number of reward cups checked on the path to the goal. Groups receiving a moving release position in the first stage appear to learn more about the relevance of the beacon to the goal, while those receiving a static release position showed favor towards landmark cues. In the absence of a beacon, however, moving release groups demonstrated knowledge of landmark cues. Overall, this indicates that rats may encode knowledge of both beacon and landmark position simultaneously while demonstrating preference for one cue set, and this encoding is facilitated by receiving varied perspectives on the spatial area to be learned.

REU Mentors: William D. Timberlake and Eddie Fernandez, Department of Psychology

Sara Sanford

Ripon College

Effects of 5-alpha dihydrotestosterone on the frequency

modulation and duration of chirping behavior in *Apterionotus albifrons*.

Males and females of the species *Apterionotus albifrons* communicate through the sexually dimorphic EOD (electric organ discharge) frequency modulations they emit. Some of the short-term modulations are known as chirps, and males and females do seem to vary on the structure of these chirps. Androgens are thought to be at least partly responsible for the fact that males have a lower EOD frequency and that their chirps have a different structure than those of females. Androgen treatment has been found to lower the EOD frequency of females but has no effect on the rate or propensity of chirping in this species. The purpose of this study was to investigate whether the androgen 5-alpha dihydrotestosterone (DHT) has an effect on the structure of the chirps when implanted in both male and female *A. albifrons*. The DHT implants did not have the predicted effect on the EOD frequencies of the females, which would have served as an index of the effectiveness of the hormone treatment. This study did find, however, that females tended to increase the frequency modulation of the categorized low frequency modulations over time whereas the opposite was true of males. DHT implants tended to increase the frequency modulation of these low frequency chirps while control implants tended to decrease the frequency modulation of low frequency chirps over time. Even though the DHT implants did not have an effect on EOD frequency, these results suggest that it may have subtler effects on the structure of at least low frequency modulations. No effects were seen for the duration of chirps. This study should be repeated for conclusive findings about the effects of androgens on the structure of chirps in *A. albifrons* and analysis of the structure of chirp responses to specific stimulus frequencies should be pursued.

REU Mentor: Troy Smith, Department of Biology

Anand Shah

Indiana University

Electrophysiological evaluation of mice knocked-in with 140 CAG repeats

Huntington disease (HD) is a progressive, neurological disorder that is genetically inherited. It is autosomal dominant, where onset of the disease occurs with inheritance of one HD allele. The knock-in HD mice have 140 CAG repeats and are characterized by onset as late as 1 year of age, a much slower progression of disease in comparison to other models like the R6/2 line, with little known about the affected striatal region of the brain. Assessing the striatal function in the slow progression model, striatal electrophysiological activity was recorded between knock-in mice with 140 CAG repeats and wildtype littermate controls and neuronal firing rate was evaluated. Results suggest that there are no significant differences between knock-in and wildtype mice but there is a trend of higher firing rate for wildtype, control mice. Gender was also analyzed resulting in a sex difference in firing rates in the knock-in mice and, independently, in the wildtype mice; knock-in males also show some difference in firing rates when compared with wildtype males. The yielded results offer new insights that vary from the hypothesized mechanisms underlying HD previously found in the R6/2 strain and implicate some role of gender and testosterone-dopamine interaction as an explanation for the sex difference found in this relatively new HD model.

REU Mentor: George V. Rebec, Department of Psychology

C. Brian Smith

Pacific University

Song-sharing in lizards?: An exploration of display type-matching using a robotic lizard.

Neighboring male Sagebrush lizards, *Sceloporus graciosus*, produce and exchange species-typical push-up displays which vary in both syntax and delivery. This study tests for 1) the possibility of display-type matching in this species, and 2) behavioral differences in response to repeated exposure to two signal types. Two signal types (typical, atypical) were delivered to subjects using a mechanized lizard both in short-term tests and in repeated exposures for ten days. In short-term tests, lizards paid more attention to the robotic lizard when it produced atypical displays than when it produced the species-typical headbob display. After repeated exposures to the robotic lizard, subjects gave similar responses regardless of the display it produced, including a general increase in activity in comparison to behavior during short-term tests. Repeated exposures to different signals revealed only slight suggestion of differences between the displays produced. These findings suggest that lizards change behavior after repeated exposure to push-up displays, but provide little evidence for display-type matching.

REU Mentor: Emilia P. Martins, Department of Biology

Elizabeth Wheat

Oberlin College

An assessment of classical eyeblink conditioning in rats using a tone and light CS and three interstimulus intervals

The modality of the conditioned stimulus (CS) and length of the interstimulus interval (ISI) used in classical eyeblink conditioning can affect an animal's ability to produce a conditioned response (CR) which is correctly timed to coincide with the onset of the unconditioned stimulus (US). The current study explores this relationship between CS modality, ISI length and CR production. Rats were trained using one of two CS modalities, either a light or a tone, and one of three ISI lengths, either 280 ms, 580 ms or 880 ms, yielding six conditioning groups. Animals trained with the 280 ms or 580 ms ISIs show robust learning across all seven conditioning days regardless of CS modality. CRs in the 280 ms groups were the most accurately timed, with timing accuracy sharply decreasing at longer ISIs. Furthermore, the acquisition curve for animals trained with the tone and the 880 ms ISI was unusually high and almost flat, suggesting that there may be a confounding effect of the tone which is artificially heightening the CR count.

REU Mentor: Joseph E. Steinmetz, Department of Psychology