25th Annual International Conference on Comparative Cognition

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Melbourne Beach, Florida

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PROGRAM NOTE: All times are P.M. unless otherwise noted. Five minute talks are designated by a Talk Number with a grey background. Five minute talks are followed by two minutes for discussion. Ten minute talks are followed by four minutes for discussion. Symposium talks are 15 minutes, including discussion.

Wednesday Afternoon

3:30 PM Welcome Reception and Check-In

7:00 PM Opening Remarks (Olga Lazareva)

7:05 PM Memory (Chair: Noam Miller)

7:05 PM **I do (not) declare: implicit memory in rats**

Noam Miller, Ramy Ayoub, Gehan Sentinathan, & Paul Mallet (Wilfrid Laurier University)

1 Human long-term memory has been shown to consist of several distinct types and this structure is sometimes assumed to extend (with modifications) to non-humans as well. We expanded on a recent paradigm that claims to explore the difference between implicit (non-declarative) and explicit (declarative) learning in rats. Rats were placed in a 5-choice operant chamber and were required to make nose-poke responses to sequences of two lit holes. A small proportion of sequences were predictable (e.g., hole A was always followed by hole C) and we explored the claim that rats learn these sequences 'implicitly'. We varied the proportion of predictable sequences between groups and found that more common predictable sequences enhance learning. On interspersed test trials, we required the rats to produce the second response with no cue, and found that more common predictable sequences were produced with fewer errors. Finally, we reversed the predictability of some sequences and found that rats with more experience of predictable sequences learned the reversals more quickly. We discuss how these results relate to the implicit/explicit memory distinction in non-human animals.

7:19 PM **Hippocampal removal attenuates habituation to videos in monkeys**

Ryan J. Brady (Emory University), Ben Basile (National Institute of Mental Health), & Robert R. Hampton (Emory University)

2 Monkeys in our lab with large hippocampal lesions showed no deficits in memory tasks designed to test different elements of episodic memory. These results challenge the classic notion that damage to the hippocampus results in severe amnesia. One possibility is that our paradigms, which required explicit choice after extensive training, may have engaged active memory maintenance that involved structures other than the hippocampus, such as the pre-frontal cortex. To test this hypothesis, we designed a passive memory test that did not require explicit training. Monkeys pressed a button to play one of ten 7-second video clips. After the video completed, pressing the button would initiate another video clip. The same ten videos were used for five consecutive days, and then ten new video clips were introduced six additional cycles. Monkeys with hippocampal lesions showed significantly slower habituation to repeatedly watching the same videos than did control monkeys. Both groups dishabituated each time new videos were introduced. These results, like those from preferential viewing tests (Pascalis & Bachevalier, 1999; Nemanic et al, 2004) suggest that the hippocampus may be important for memory of incidentally encoded events.

7:26 PM **One-trial and habit memory in black-capped chickadees (*Poecile atricapillus*)**

Emily Kathryn Brown (Emory University), David F. Sherry (Western University), & Robert R. Hampton (Emory University)

3 Memory systems are characterized by their unique functional properties. One-trial memory is quickly acquired, but vulnerable to interference. Habit memory is slowly acquired, but robust against interference. Black-capped chickadees cache food which they later recover using one-trial memory. If food caching has led to selection for one-trial memory, then chickadees may rely relatively more on one-trial memory than do other species. Birds completed touch screen memory tests of one-trial and habit memory. On one-trial memory trials, they pecked a single marked location in a photographic background scene at study and had to select that location from an array of three locations at test. Test stimuli appeared in 24 configurally-unique arrays. On baseline trials, the sample location for each trial was pseudo-randomly selected. On habit matching trials, the same sample was repeated across trials. On habit discrimination trials, there was no sample, and the correct response was consistent across trials. We measured the accrual of habits with probe trials in which no sample was presented. Chickadees showed

no evidence of having acquired habits in habit matching trials, but showed robust habits after discrimination training. We discuss the possibility that one-trial memory suppresses habit formation in chickadees.

7:33 PM **Does memory for stimulus sequences represent a divide between humans and other animals?**

Johan Lind, Magnus Enquist (Stockholm University), & Stefano Ghirlanda (Brooklyn College and City University of New York)

4 Humans have language, music and mathematics and stand out in cultural domains in comparison with other animals. However, it has been difficult to identify cognitive capacities specific to humans. Most research has studied how information is processed after it has been acquired to generate flexible behavior in various problem solving tasks. However, another avenue is to look for species differences in the initial acquisition and coding of information. We show that non-human species have a limited capacity to discriminate sequences of stimuli. Collating data from 108 experiments on stimulus sequence discrimination (14 bird and mammal species), we demonstrate systematic errors that can persist after thousands of learning trials in tasks that humans learn to near perfection within tens of trials. To elucidate causes behind this poor performance, we formulate and test a mathematical model of non-human sequence discrimination, assuming that animals represent sequences as unstructured collections of memory traces. Our model predicts non-human performance with a 5.9% mean absolute error across 68 datasets. Because human cognition requires accurate encoding of sequential information beyond what is afforded by memory traces, we conclude that improved coding of sequential information is a key cognitive element that may set humans apart from other animals.

7:47 PM **The Effects of Chronic Perceived Predation Threat on Spatial Memory Retention in Black-capped Chickadee's (*Poecile atricapillus*)**

Chlöe Carter, & Scott MacDougall-Shackleton (Western University)

5 Black-capped Chickadees rely on spatial memory to recover food caches that are critical to survival. Chronic stress has been found to negatively affect spatial memory function in rodents. Predators are a common stressor in a bird's environment, and just the perception of a predator is enough to elicit a stress response. The purpose of the current study is to investigate the effect of exposure to chronic acoustic predator cues on spatial memory retention in wild-caught chickadees. It is predicted that the birds treated with chronic acoustic predator stimuli will perform poorly on long-term spatial memory tasks due to prolonged elevated levels of circulating corticosterone, which will be detrimental to brain areas involved in memory. Birds used in this experiment were trained on specific rewarded locations, tested before and after a chronic (daily over 14 days) exposure to a set of acoustic stimuli (either a predator or non-predator set). Preliminary pilot data indicated that the birds were able to accurately retrieve memory of their training after 14 days. Insight gained from this research will contribute to our understanding of how the perception of predators influences behavior and memory.

7:54 PM **Olfactory Memory Capacity and Duration in Domestic Dogs (*Canis familiaris*)**

Ka Ho (Gordon) Lo, Krista Macpherson, & William A. Roberts (Western University)

6 Understanding olfactory memory in dogs (Canis familiaris) has many important practical implications, including military and service dog training. Although dogs are well known to have enhanced olfactory capabilities based on advanced anatomical and physiological nasal structures, the question of canine olfactory memory capacity has yet to be formally addressed in research. This study developed an effective methodology for studying the acquisition and retention of olfactory memory in dogs. Using a four-box apparatus, dogs discriminated between multiple odour sets, with each odour set having three identical, unrewarded (S-) odours and one rewarded (S+) odour. Dogs were trained on 20 such odour pairings, and ultimately tested for their ability to recall the S+ in each odour pair. Even after as long as 90 days, dogs were highly accurate in their ability to recall the S+. Comparative data for studies with rats and humans using similar methodology will also be discussed.

8:01 PM *Break*

8:06 PM Spatial Cognition (Chair: Aaron Blaisdell)

8:06 PM **The Effects of Stimulus-Response Compatibility on Rate of Learning and Transfer of Stimulus Control During Spatial Occasion Setting With Humans and Pigeons.**

Joshua E Wolf (Arcadia University), Lauren M Cleland, Elle Repeta, & Kenneth J Leising (Texas Christian University)

7 The survival of an organism relies heavily on the ability of that organism to quickly and accurately respond in the presence of different stimuli in its environment. The importance of this ability is increased when what has been learned influences responding to new stimuli or stimulus combinations (e.g., highway signs in a different part of

the country). The current experiments examined how Stimulus-Response Compatibility (SRC) (i.e., the congruencey between where an organism is required to respond and where the organism reflexively responds) influences how humans and pigeons respond to stimuli during a Spatial Occasion Setting touchscreen task. The results of the current set of experiments indicate that differing levels of compatibility between the required response and the spatial positioning of stimuli influenced performance on measures typically associated with SRC tasks (response time and accuracy) but did not influence occasion setting performance measures (acquisition rate, transfer of conditional control).

8 8:20 PM **Age Affects Spatial Working Memory in Pigeons**

Kevin Leonard, Davin Iverson, Meara Stow, Christina Meier, & Debbie Kelly (University of Manitoba)

Spatial memory involves the ability to retain and use environmental cues to find and return to places of previous reinforcement. Tests of spatial reference memory typically involve searching in stable spatial locations, whereas tests of spatial working memory include an additional complexity of navigating dynamically changing environments, or searching for a changing goal location within a static environment. Two visual cues important to many animals during spatial tasks are featural cues (e.g. colour, texture) and geometric cues (e.g. distance, direction). Previous studies have shown age-related decline in the use of these cues during tests of spatial reference memory. Less research, however, has investigated whether aging results in cue-specific decline in abilities during spatial working memory tasks. We trained adult and aged pigeons to search for a food reward in the corners of a rectangular arena with distinctive featural cues in each corner. The rewarded corner was stable within a session, but changed between sessions. Our results show aged pigeons made more perseverative errors, and were more likely to use non-spatial strategies than adult pigeons. Aged pigeons tended to perseverate on the featural cue which was first reinforced, whereas adult pigeons showed evidence of adaptively attending to the environmental cues.

9 8:27 PM **Spatial memory for isolated arm locations on the radial maze**

Hayden MacDonald, & William A Roberts (University of Western Ontario)

Although response stereotypy and memory strategies have been previously studied in the radial maze, there has been little consideration for how patterns or particular configurations of arms may affect spatial working memory. In Experiment 1, eight Long Evans rats (Rattus norvegicus) navigated an 8-arm radial maze in a 2-phase win-shift paradigm, in which test phase rewarded arms were arranged in either a randomized, adjacent, or alternating pattern. Rats showed the best working memory retention on the alternating pattern, with this effect most apparent at a retention interval of 4 hours. This finding suggested that a rewarded arm (previously unentered) isolated between two or more non-rewarded arms (previously entered) was particularly memorable. In Experiment 2, 10 rats were tested in a 12-arm maze with the number of spatially isolated arms varied in several different patterns. Again, rats were more accurate on isolated arm choices than on non-isolated arm choices within test-phase trials. The results imply that rat spatial working memory is enhanced when correct spatial locations are isolated from one another as opposed to grouped on the radial maze.

10 8:34 PM **Allocentric Mechanisms of Navigation in Fiddler Crabs**

Stephen G Volz (Brooklyn College), & Frank W Grasso (CUNY Graduate Center)

The demands of navigation have resulted in various mechanisms to solve similar spatial problems. In the case of invertebrates, there are recent findings that suggest a degree of plasticity once thought to be the exclusive to vertebrates. Fiddler crabs offer a chance to examine multi modal navigation in one an arthropod evolutionary lineage that is basal to the well-studied eusocial insects (e.g., ants and bees). Fiddler crabs have long been known to employ an egocentric representation of space. Recent limited evidence suggests that fiddler crabs may also be attending to allocentric information. Using non-homing, place preference tasks we demonstrated the existence of allocentric navigation mechanisms in this species. In two studies our results indicate both that these animals use and reconcile multiple navigational mechanisms. We discovered evidence for a visually-guided taxis in these animals to approach checkered stimuli ($F(1,44)=8.505$ $p=.006$), and evidence of an allocentrically informed associative process in navigating fiddler crabs ($F(4,176)=5.368$ $p<.001$), a finding not before seen in a laboratory study of these animals. These results suggest that fiddler crabs possess some form of cognitive representation of the external world, which is informed by multiple sensory modalities, and extends beyond path integration.

11 8:48 PM **Ability to use geometry for orientation declines in aged pigeons**

Christina Meier, & Debbie M. Kelly (University of Manitoba)

Navigating in space often requires encoding visual cues such as featural or geometric information. In the pigeon brain, these cues are processed in a lateralized fashion: features have been shown to be primarily encoded by the left hemisphere, whereas geometry is encoded by both hemispheres. Due to the near-complete crossover of optic nerves and lack of large interhemispheric commissures in the avian brain, visuospatial information is processed

mainly unilaterally; input to the left eye determines the information available to the right hemisphere and vice versa. Therefore, we used an eye-capping procedure to examine the lateralized processing of visual cues across the lifespan. Juvenile, adult and aged pigeons searched for food in a rectangular arena with a distinctive feature presented along one wall. The spatial location of the food reward was held constant. Following task acquisition, tests were administered manipulating the featural or geometric information. We found the use of geometric cues decreased with advanced age. Although all age groups readily used the feature cue for orientation, aged pigeons orientated less by features when input was limited to the right eye (left hemisphere). How aging influences the processing of featural and geometric information by the two brain hemispheres will be discussed.

9:02 PM *Break*

9:07 PM

Cognitive Processes I (Chair: Jon Crystal)

9:07 PM **Implications of Cephalopod Biomechanics for Studies of Octopus Learning, Memory and Behavior**

Frank W. Grasso (BCR Lab, Brooklyn College)

12

The advanced learning and cognitive abilities of coleoid cephalopods (Octopuses, Cuttlefishes, Squids) are well documented. Arguably as complex as mammals in brain organization and behavioral repertoire, cephalopods' distinct brain organization (diverged from vertebrates over 500 MYA) offers us lessons on the limits and extent of the convergent evolution of brain and behavior. As modern research protocols are applied to the study of adaptive behavior in cephalopods something that is often overlooked is the consequences of their hyper-redundant biomechanics for the design and interpretation of learning studies. Compared to vertebrate species which have skeletal systems, biomechanically hyper-redundant, soft-bodied cephalopods, have many orders of magnitude more mechanical solutions (topography) available to achieve a given action. These biomechanics concomitantly require fundamentally different neural motor-control systems compared to the corresponding vertebrate systems for which protocols for studying basic Pavlovian and operant conditioning phenomena (e.g., blocking, latent inhibition, conditioned inhibition, spontaneous recovery, autoshaping, choice, stimulus control, etc.) were developed. We will review the biomechanics of octopus object manipulation, the organization of the cephalopod brain and cephalopod learning and cognition studies. We will use these to discuss the implications of the cephalopod bauplan for comparative studies of the structure of embodied learning and memory systems.

9:21 PM **Transfer of location change detection to novel changes with pigeons**

Kenneth Leising, Justin Jacqmain, Lauren Cleland, Jackson White, Sarah Jones, Cheyenne Elliott (Texas Christian University), & Anthony Wright (University of Texas Medical School)

13

Change detection procedures are commonly used to assess the capacity (number of items) of working memory. In our study, we trained pigeons to complete a location ("where") change-detection task. Pigeons were trained to peck a visual item (colored circle) presented on a touchscreen that changed location across a brief delay (0, 100 or 1000 ms). Performance remained above chance with increasing numbers of items (up to 16) and the use of monochromatic (grey) circles. Performance was then tested with novel changes (size, shape, and color). Transfer tests indicated that pigeons did not generalize location change to other kinds of changes. Following transfer testing, pigeons were retrained with location and color change-detection trials. After only a few sessions, all subjects were performing at above chance on color-change trials.

9:35 PM **Flower handling and Darwin's interference hypothesis of flower constancy**

Caroline Strang, & David Sherry (University of Western Ontario)

14

Foraging bumblebees collect nectar and pollen from a wide variety of flowers. Individual bumblebees, however, show flower constancy - consistently visiting the same species of flower. Darwin hypothesized that constancy resulted from the high cost of learning to extract nectar from different kinds of flowers, but subsequent research showed that the cost of switching between flower types is actually small. We revisited Darwin's hypothesis to see why high initial learning costs do not also result in a high cost of switching. We developed two tasks that modelled flower handling. Bumblebees (Bombus impatiens) were required to learn and then switch between the tasks. Bees learned the motor pattern required for each task, but showed no cost of switching; in some conditions bees showed facilitation following a switch compared to naïve learners. We conclude that initial flower learning costs are high because bees simultaneously learn general flower properties and form associations between flower type and behaviours in their flower handling repertoire. Switching costs are low because the association between flower type and handling behaviour is flexible and the learned general properties of flowers remain the same.

A Modified Stroop Test to Assess Gorillas' responses to Emotional Stimuli

9:42 PM

Jennifer Vonk, Jessica Leete, & Molly C. McGuire (Oakland University)

15

EWe used a modified emotional Stroop task previously used with chimpanzees to assess responses to emotional stimuli in three male gorillas. Subjects were first trained to select a blue-bordered rectangle when paired with a yellow-bordered rectangle, so that the blue border was associated with reward. Arbitrary blue and yellow shapes were then placed within the blue and yellow borders and gorillas generally responded more slowly on the incongruent (yellow items within blue borders) compared to the congruent trials (blue items within blue borders), validating the procedure. Subsequently, images of familiar objects were placed within the borders. When a single object was presented within both borders on a single trial, response times indicated whether the object was perceived as positive or negative. Then, congruent and incongruent trials were created by pairing positive objects with blue borders and negative objects with yellow borders (congruent) and positive objects in yellow borders and negative objects in blue borders (incongruent). Two of the gorillas responded more quickly on congruent trials, but the third responded more quickly on incongruent trials. However, gorillas generally responded to the experimenter-perceived "positive" items more quickly than to the "negative" items, validating assumptions about the gorillas' preferences.

9:56 PM

Relations and rewards: Hippocampal involvement in simple relational task and in inferential relational task

Martin J. Acerbo (Iowa State University), & Olga F. Lazareva (Drake University)

16

We studied hippocampal involvement in two relational tasks, transitive interference (TI) and transposition. In the first study, we investigated the effect of hippocampal lesion on TI in pigeons while controlling reinforcement history so that reliance on associative values leads to a choice of a stimulus D in the pair BD instead of a choice of B expected by inferential mechanisms. We found that hippocampal lesion impaired performance only in the pair BD and only in the birds relying on inferential mechanisms. In the second experiment, we explored immediate early gene expression following a simple relational task, transposition. We found higher expression of ZENK in the right hemisphere of hippocampus for the birds trained to use relational information. In contrast, birds trained to memorize specific circle size showed a higher expression of cFos in nucleus accumbens, an area associated with processing stimulus-reward information. Together, these results demonstrate that avian hippocampus is involved in the tasks that are not explicitly spatial in nature and that do not require inferential operations.

10:10 PM

Information seeking in arctic foxes (*Vulpes lagopus*) and binturongs (*Arctictis binturong*)

Taryn Eaton (Oakland University), Patricia Billette (The Creature Conservancy), Jessica Leete, & Jennifer Vonk (Oakland University)

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Mounting evidence over the last fifteen years suggests that at least some nonhuman animals possess metacognitive abilities. Some of this evidence has come via information seeking tasks in which animals are provided the opportunity to seek knowledge selectively on trials when they have not been given access to critical information, showing that they know what they do not know. In the current study, two arctic foxes and two binturongs were presented with a wooden box with two compartments, the top of which was transparent. On half of the trials (i.e., seen trials), subjects witnessed which side of the box was baited. On the other half of the trials, subjects could not witness the baiting before making a choice. If foxes and binturongs are metacognitive, they should selectively look into the top of the box before opening a compartment only on unseen trials. Despite attempts to control for scent cues, one fox was equally successfully on seen and unseen trials without looking. Due to this unexpected result, a modified procedure is being used to continue testing with all subjects.

10:17 PM

The Conundrum of Causal Reasoning in Elephants

Beri Brown (The University of Southern Mississippi), Heather Hill (St. Mary's University), & Stan Kuczaj (The University of Southern Mississippi)

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Causal reasoning is marked by the ability to mentally reconstruct the missing part of a sequence in order to reproduce an outcome. While research on causal reasoning has been done with children, the results of the studies have been inconsistent. A standardized paradigm for comparative causal reasoning studies does not exist. Nissani (2006) investigated causal reasoning in a tool-use task with elephants and concluded that elephants were not capable of causal reasoning. The current study, a modified replication, yielded results that were not congruent with Nissani's (2006) manuscript. Additionally, it was very unlikely that the Nissani (2006) study truly looked at causal reasoning or tool-use, and instead assessed a response acquired through associative learning. Based on the results of the current study, it appears that elephants are capable of a level of causal reasoning, although more research is necessary.

Thursday Afternoon

12:00 PM Ron Weisman Outstanding Student Presentation Competition: Paper (Chair: Dave Brodbeck)

19

12:00 PM **Identifying the social contexts present for mouthing behaviors in bottlenose dolphins (*Tursiops truncatus*)**

Erin E. Frick, Stan A. Kuczaj II (University of Southern Mississippi), & Holli C. Eskelinen (Dolphins Plus Marine Mammal Responder)

Acoustic signals are of vital importance to dolphin communication systems, yet communication is multifaceted and multimodal (e.g., postural, visual/tactile signals, acoustic cues). In particular, nonverbal mouthing behaviors may serve a communicative role in group-living species such as cetaceans. However, in-depth analysis of the behavioral context of mouthing in cetaceans has not been explored at length. We examined mouthing behaviors in a group of bottlenose dolphins using 2,696 minutes of underwater acoustic and video recordings collected from 2010 – 2014. Behaviors of concern ranged from visual (open-mouth display), both visual and acoustic (jaw claps), to tactile (mouthing, biting). Latent class and profile analyses were used to uncover underlying patterns amongst 35 behaviors, coded immediately prior and following (± 3 sec) as well as during each focal mouthing event. Most types of open-mouth/mouthing displays are reported primarily as aggressive in the literature, but our results suggest these behaviors may serve a variant role in different contexts as well. There were substantial individual differences within and across age-class and sex of the mouthing dolphin across contexts. Nonetheless, these observations suggest that mouthing behaviors may play a larger role in communication between conspecifics, further highlighting the importance of considering behavioral context when assessing communication.

20

12:07 PM **Body size of caller is a better predictor of call frequency in black-capped chickadees (*Poecile atricapillus*) than sex**

Kimberley A. Campbell, Raphael Gastrock, & Christopher B. Sturdy (University of Alberta)

Vocalizations may transmit behaviourally-relevant information about the signaler, such as their rank, motivation, or physical condition, with varying degrees of reliability. In black-capped chickadees (Poecile atricapillus), their fee-bee song differs between the sexes. However, their chick-a-dee calls, which are used in numerous, non-mating conditions throughout the year, do not. We hypothesized that outside of the mating season it may be less crucial to identify the sex of a vocalizer and therefore sex-specific signals are less likely to exist outside of songs. Consequently, acoustic differences in chick-a-dee calls (such as frequency or duration measures) may be driven by an individual's body size rather than sex. To test this interaction, we conducted bioacoustic analyses on seven acoustic measures of black-capped chickadee chick-a-dee calls using tarsus length as a representation of body size. We found a significant negative relationship between frequency and body size (i.e., larger birds produced lower frequency vocalizations), and no significant relationship between sex and any acoustic measure. Since calls are used in a number of contexts that do not require a sex-specific response (e.g., indicating a food source or warning of a predator), it is possible that it is not critical to determine the sex of a caller.

21

12:14 PM **Agonistic Grooming in a Primate (*Otolemur garnettii*)**

Jennie Christopher, & Heidi Lyn (University of Southern Mississippi)

Grooming is ubiquitous among primate species and has played an integral part of assessing social relationships between primate conspecifics for more than half a century. Beyond the mother-infant caregiving grooming behavior exhibited by many species, grooming between adults of a species has been traditionally used to denote affiliative relationships between individuals. This is especially true among primate researchers. However, our results show grooming used agonistically in a prosimian primate. Five female Garnett's bushbabies (Otolemur garnettii) were housed together and all grooming interactions were observed within the context of the antecedent and consequent behaviors. While the form of the grooming was typical for the species, the function was inconsistent with other affiliative behaviors. The most frequent behavior immediately post-grooming was displacement of the subordinate animal. Additionally, the frequency of overt aggression increased post-grooming, supporting the conclusion that grooming was primarily an agonistic behavior in this context. The results illustrate the methodological problem encountered when viewing grooming as an event, rather than part of a behavioral context. These kinds of deficient conclusions may be avoided by assessing grooming functionality without the previously held presumption of affiliation.

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12:21 PM **Pigeon Categorization of Human Cardiac Images**

Victor Navarro, Edward Wasserman (The University of Iowa), & Piotr Slomka (University of California Los Angeles)

Pigeons are remarkably proficient at categorizing visual stimuli. Not only can they categorize flowers, cats, cars, and chairs, or tell a Monet from a Picasso, but they can also categorize human breast tissue images as benign or malignant. We further explored pigeon categorization of medical images in the present experiment. Using a 2AFC task, we trained pigeons to categorize 24 each of normal and abnormal, colored images of human Myocardial Perfusion SPECT data. The pigeons successfully learned to categorize the images, becoming sensitive to the degree of perfusion damage present in each image. Furthermore, they successfully transferred their categorization performance to novel images, confirming that they did not rely on exemplar memorization. In a subsequent test,

we examined whether color cues were controlling categorization, by presenting pigeons with grayscale versions of the images they had seen during training. Pigeons failed to transfer their performance to these images, suggesting they had used color cues to categorize the images. Nevertheless, pigeons learned to categorize the grayscale images when given differential reinforcement, thus demonstrating that they could categorize without relying on color cues. We discuss the potential cues controlling our pigeons' behavior and the implications of these findings for the animal categorization literature.

23 12:28 PM

Episodic memory replay is hippocampal dependent

Danielle Panoz-Brown, Vishakh Iyer, Lawrence M. Carey, Christina M. Sluka, Gabriela Rajic, Jesse Kestenman, Meredith Gentry, Sydney Brotheridge, Isaac Somekh, Hannah E. Corbin, Kjersten G. Tucker, Bianca Goncalves De Almeida, Severine B. Hex, Krysten D. Garcia, Andrea G. Hohmann, & Jonathon D. Crystal (Indiana University)

Vivid episodic memories in people have been characterized as the replay of multiple unique events in sequential order. We recently showed that rats remember the order in which a stream of events occurred by relying on episodic memory replay. Research in people and in rodents has shown that the hippocampus plays a critical role in episodic memory. However, whether episodic memory replay is dependent on the hippocampus remains unknown. Using a chemogenetic approach employing designer receptors exclusively activated by designer drugs (DREADDs), here we show that rats remember the order in which multiple episodes occurred by engaging hippocampal-dependent episodic memory replay. Rats were presented with a list of trial-unique odors, and reported, via their behavior, items that occupied multiple positions within the list. The DREADDs activating drug clozapine N-oxide (CNO), but not vehicle, reversibly impairs episodic memory replay in rats previously injected bilaterally in the hippocampus with a recombinant viral vector containing the inhibitory chemogenetic actuator AAV8-hSyn-hM4Di-mCherry. By contrast, non-episodic memory assessments were unaffected by CNO, showing selectivity of this hippocampal-dependent impairment. Histology verified that DREADD expression was localized throughout the hippocampus. Our findings suggest that episodic memory replay is hippocampal dependent and quite old in the evolutionary timescale.

24 12:35 PM

Does sociality influence cache protection strategies in corvids?

Alizée Vernouillet, Dawson Clary, & Debbie M. Kelly (University of Manitoba)

Caching species rely on hidden food stores to survive when resources are scarce. During caching, individuals can lower the risk of losing caches by identifying potential thieves and engaging in cache protection strategies. Some species use these strategies when in the presence of conspecifics, but it is unknown whether these behaviours generalize to heterospecifics. We compared cache protection strategies between two corvid species: highly social pinyon jays and relatively non-social Clark's nutcrackers. Birds cached pine seeds in two visually distinctive trays under four conditions: Alone, observed by a Conspecific, observed by a Heterospecific, and in the presence of an Object. When observed by a conspecific, both species displayed cache protection strategies, with pinyon jays allocating more pine seeds to safer locations, and nutcrackers generally reducing the amount of pine seeds cached. Interestingly, when observed by a heterospecific, pinyon jays continued to cache primarily in safe locations, whereas nutcrackers did not display any cache protection strategies. This finding shows inter-species difference in the ability to assess potential threats on their caches that may be due to sociality. This study is the first to investigate whether corvids can identify a heterospecific as a threat to their caches.

25 12:42 PM

Species differences in laterality of eye use for bottlenose (*Tursiops truncatus*) and rough-toothed (*Steno bredanensis*) dolphins while viewing predictable and unpredictable stimuli

Malin Lilley, Amber de Vere (The University of Southern Mississippi), & Deirdre Yeater (Sacred Heart University)

Cetaceans display laterality of eye use across social, feeding, and experimental contexts, which is thought to reflect specialization of hemispheric brain function. On average, cetaceans preferentially use the right eye in contexts requiring visuospatial cognitive abilities or while viewing unfamiliar stimuli, and the left eye in social contexts. The present study extended this theory to examine laterality of eye use in bottlenose and rough-toothed dolphins while subjects viewed unpredictable and predictable stimuli. Species differences revealed that bottlenose dolphins had a significant right eye preference while viewing the unpredictable stimuli and a non-significant right eye preference while viewing the predictable stimuli, while rough-toothed dolphins did not display significant species-level eye preferences in either condition. Subjects of both species also used both eyes more while viewing the unpredictable stimulus. The results of this study extend bottlenose dolphins' right eye preference to include viewing an unpredictable visual stimulus and highlight the importance of binocular vision for dolphins. Additionally, this study supports the need for additional research on laterality in rough-toothed dolphins due to the small sample size of the present study and lack of species-level preferences, bringing into question if rough-toothed dolphin lateralization may be different than lateralization in other cetacean species.

26 12:49 PM

How conspecific odor cues affect the behavior of the Chambered Nautilus (*Nautilus pompilius*)

Naomi Lewandowski (The Graduate Center), Mahwish Ashfaq, Chaya Fastow, Wajeh Syed, Chelsea Quaies, Ling Yang, Muhammed Ahsan, Daria Postavnaia, Malika Mirsagatova, & Jennifer Basil (Brooklyn College)

Nautilus spends the majority of its life in the deep ocean and, as a result, relies on chemosensory cues (likely olfactory) to find food and detect conspecifics (Saunders and Landman, 1987; Basil et al., 2002). Little is known about Nautilus social interactions, therefore we investigate their responses to conspecific scent. I hypothesize that Nautilus respond differently to female, male, and individual chemosensory cues. A Y-maze was used to A.) present individuals (N=6) with simultaneous scents from two conspecifics (one scent in each arm) in every combination of males and females; B.) present individual nautiluses (N=9) with simultaneous scents from two members of the opposite sex. I measured the final maze arm/scent choice in each trial. The responses of nautiluses to male and female scent is consistent with my hypothesis and suggests a female choice-driven system. Recently completed experiments will revisit these pairings and examine the details and patterns of these choices.

12:56 PM **The convergent validity of personality in California sea lions (Zalophus californianus), but not harbour seals (Phoca vitulina); a comparative interpretation of the utility of trait rating.**

Amber de Vere, Malin Lilley (University of Southern Mississippi), & Lauren Highfill (Eckerd College)

27

Many assessments of animal personality are limited by their use of only one method, and to date, the convergent methodological validity of personality has not been examined in marine mammals. The trait rating method was therefore applied to a captive population of two pinniped species (Phoca vitulina, Zalophus californianus), and compared to a previous behavioural coding assessment of the same animals. Regularised exploratory factor analyses elucidated three factors for each species. California sea lion factors were labelled: Agreeable, Curious, and Fearful, while harbour seal factors were labelled: Nervous, Agreeable, and Playful. Evidence for cross-method convergence was found only in sea lions. One behavioural dimension was significantly negatively correlated with the Fearful rating factor ($r=-0.727$, $p=0.011$). The second was positively correlated with the Curious factor ($r=0.582$, $p=0.060$). In contrast, no correlations (ns $p>0.05$) were found for harbour seals. One explanation for these findings is that social marine mammals, such as California sea lions, may exhibit more reliable external manifestations of personality traits that humans are able to recognise. This study therefore provides the first evidence of convergent validity of personality in any marine mammal species, and raises questions about the evolution of external indicators of personality traits in closely related taxa.

1:03 PM *Break*

1:08 PM

Canine Cognition (Chair: Elliot Ludvig)

1:08 PM **Effects of domestication on canine cooperation**

Friederike Range (Messerli Research Institute), Zsófia Viranyi, & Sarah Marshall-Pescini (University of Veterinary Medicine Vienna)

28

It has been suggest that dogs acquired a more tolerant temperament compared to wolves during domestication, promoting cooperative interactions with humans and conspecifics (Emotional Reactivity Hypothesis). However, the socio-ecology of wolves and dogs, with the former relying more heavily on cooperative activities, predicts that at least with conspecifics, wolves cooperate equally or better than dogs. Here we present data of wolves and dogs in cooperative sting-pulling tasks with conspecific and human partners. Whereas wolves coordinated their actions and succeeded, dogs pulled the ropes in alternate moments, thereby never succeeding. Different conflict management strategies may explain these results with dogs' avoiding potential competition over the apparatus constraining their capacity to coordinate actions with their partners. In contrast, when cooperating with humans, wolves and dogs were both successful. However, while wolves were more likely to initiate interactions with their human partners, dogs usually waited until the human started moving and then followed. Our results call domestication hypotheses that suggest selection for increased cooperativeness in dogs as compared to wolves into question. Instead, we propose that dogs' and wolves' capacity to cooperate has been affected by their different social ecologies and by selection for accepting humans' leading role during domestication.

1:22 PM **Domestic dogs and the Solidity Principle**

Julia Espinosa (University of Toronto), Emma Tecwyn (Cardiff University), & Daphna Buchsbaum (University of Toronto)

29

The Solidity Principle (SP) dictates that solid objects cannot pass through each other or exist in the same location. Understanding the SP is central to successfully navigating one's environment, but previous research conflicts as to whether dogs understand the SP. We tested domestic dogs' understanding of the SP using a between-subject design. Dogs (N=48) watched a treat fall through the top of an apparatus consisting of a removable shelf with two vertically aligned search locations. The treat either landed on the shelf, or on the bottom surface but this landing location was occluded. We experimentally varied the amount of visual information by using: (1) short-narrow occluders, that partially occluded the treats' trajectory (2) long-narrow occluders that fully occluded the trajectory (3) long-full occluder that also limited visual signs of the shelf's presence/absence. We recorded dogs' first search

location. Dogs in the short-narrow ((t=14.56, p<.001) and long-narrow (t=17.14, p<.001) conditions showed higher-then-chance search, suggesting an understanding of the SP, whereas dogs in the fully-occluded condition performed at chance (t=-0.92, p=0.37). New data from a 4th occluder investigates aspects of full-occlusion that interfered with dogs' reasoning. This study sheds light on the emergence of physical concept understanding in non-primate social animals.

1:29 PM **Multi modal associative learning with awake canine fMRI**

Ashley Prichard (Emory University), Raveena Chhibber, Kate Athanassiades (Emory College), & Gregory Berns (Emory University)

30 Using awake-fMRI in 19 dogs, we measured neurobiological learning curves to previously neutral visual, olfactory, and verbal stimuli. Visual stimuli were two toys; olfactory stimuli were isoamyl acetate and hexanol; verbal stimuli were jabberwocky words. During scanning, one stimulus of each pair was associated with food (CS+) and the other with nothing (CS-). To generate learning curves for individual dogs, we examined activation within the caudate nucleus, amygdala, and parietotemporal region following the presentation of each stimulus. The learning curves showed that dogs formed stimulus-reward associations within a single MRI session, and showed differences between regions based on stimulus modality. In the amygdala, there was a significant difference for odor and visual stimuli ($p < .01$) and a significant difference between reward and no reward ($p < .01$). For the caudate, there was a significant difference between reward and no reward ($p < .05$), and for all three modalities ($p < .05$). Though previous awake fMRI studies have used pre-trained stimulus-reward associations, here we demonstrate the application of fMRI to measure the neurobiological rate of associative learning in the dog brain, and the potential for individual as well as mechanistic differences between modalities in learning acquisition.

1:36 PM

Cognitive Processes II (Chair: Marisa Hoeschele)

1:36 PM **The role of category density in relevant feature tracking**

Leyre Castro, Sol Fonseca, Cassandra Sheridan, & Ed Wasserman (The University of Iowa)

31 Prior categorization studies have shown that pigeons reliably track features that are relevant to a category discrimination (e.g., Castro & Wasserman, 2014, 2016). In these studies, category exemplars contained two relevant and two irrelevant features; therefore, category density (specifically, the relevant to irrelevant information ratio) was relatively high. Here, we reduced category density so that, in Phase 1, each exemplar contained only one relevant and three irrelevant features. This manipulation greatly increased the difficulty of the task; overall accuracy and relevant tracking rose to rather modest levels after 100 days of training. In Phase 2, we modified the exemplars so that they displayed just one relevant and one irrelevant feature. Now, accuracy and relevant tracking further improved. Moreover, this improvement was sustained when the pigeons were returned to the same exemplars that were shown during the original training phase. These results help illuminate factors affecting pigeons' tracking of relevant information in visual categorization.

1:50 PM **SNARC effect in pigeons, blue jays, and Japanese macaques**

Olga F. Lazareva (Drake University), Kristy Gould (Luther College), Regina Paxton Gazes (Bucknell University), Nora Balboa, Nicholas Matulik, Madelyn Lemons (Drake University), & Jamie Linert (Luther College)

32 The spatial-numerical association of response codes (SNARC) refers to a tendency to organize numeric and non-numeric information spatially. In Western populations, people typically respond faster and more accurately to small numbers or numerosities presented on the left and to large numbers or numerosities presented on the right. Recently, Gazes et al. (2017) demonstrated a reliable SNARC effect in several ape species although its direction was inconsistent across species, with some individuals preferring left-to-right organization and others favoring right-to-left organization. It remained to be seen, however, whether SNARC effect could be seen in other primates or in non-primate species. We will present evidence for SNARC effect in two bird species, pigeons and blue jays. This evidence suggests that the tendency to organize numerosities spatially is a fundamental and evolutionarily old feature of cognition that is likely widespread among vertebrates. Preliminary data for SNARC effect in Japanese monkeys will also be presented.

2:04 PM **Inhibition of the whole head: Pigeons' performance in a tracking stop-signal procedure**

Stephen E. G. Lea, Pizza K. Y. Chow, Christina Meier, Ian P. L. McLaren, & Frederick Verbruggen (University of Exeter)

33 In many cognitive tasks where humans are thought to rely on executive functioning, pigeons' behaviour can be explained by associative processes. A key form of executive functioning is inhibiting prepotent responses, typically investigated in humans by means of "Stop-signal" or "Change-signal" procedures. In these procedures, performance of a well-practised ("Go") response to a stimulus is occasionally interrupted by a signal to withhold or alter the practised response. Latencies in such tasks can usually be fitted by the "independent horse-race" model.

This assumes that the processes that cause the Go and inhibitory responses occur independently; the process that finishes first determines the response observed. We tested this model by training pigeons to track the circular movement of a coloured patch around a touchscreen by pecking it; the spot occasionally deviated from its normal path (the Change signal). The pigeons had to inhibit the habitual movement of their heads in order to land a peck on the spot in its unexpected position. The key predictions of the horse-race model were confirmed in the pigeons' latency data, so the results suggest that a successful fit of the horse-race model does not provide evidence for executive inhibition.

2:18 PM **Individual consistency on inhibition tasks: motor actions vs self-control**

Lisa Leaver (University of Exeter)

34 The ability to inhibit pre-potent responses or "motor self-regulation" is an important aspect of cognitive flexibility, and has become a frequently used assay of cognitive performance in a variety of species. However, broad comparisons of performances on inhibitory control tasks across species are controversial as the ecological relevance of these tasks remains unclear. I will present data on grey squirrels' (Sciurus carolinensis) performance on: a) a novel test of inhibitory control which requires them to inhibit a natural foraging behaviour in order to obtain food successfully, rather than using a standard detour-reach task which requires pre-training and some level of experience with the affordances of novel materials; and b) food-choice selectivity, a natural aspect of behaviour that necessitates an animal to assess its options in order to make an optimal choice before caching or consuming food. I test the construct validity of these two tasks of inhibitory control by assessing whether performance on these tasks is related. I also discuss results with reference to individual differences and highlight the importance of considering ecological relevance when interpreting an animal's cognitive performance.

2:32 PM *Snack Break*

3:02 PM # Communication (Chair: Stephen Lea)

3:02 PM **Cetacean use of representational acoustic signals: Evidence for convergence with human names?**

Jason N. Bruck (Department of Integrative Biology: Oklahoma State University), & Vincent M. Janik (Sea Mammal Research Unit and Scottish Oceans Institute: University of St. Andrews)

35 Dolphins have developed a "signature whistle" system in which an individual broadcasts its identity using innovated individually distinct vocal contours. As signature whistles are both learned and used as a mechanism of social address, they are a unique mechanism in non-human animals to study parallels with human language. No other tested animal has been shown to use signals as labels as readily as humans and dolphins do, yet evidence for representation in signature whistles remains elusive. Many mammals maintain individual recognition through chemoreception. Although dolphins lack olfaction, they can taste. Dolphins produce chemoreceptively active compounds from various excreta including urine. In the wild, it is common for dolphins to divert course to swim through each others' excretion plumes with mouths open. Many have postulated that this serves a communicative function, and it is possible that dolphins use the urine of conspecifics to extract identity information. To date, multimodal individual recognition in dolphins has not been shown. We present results from a series of playback studies that provide evidence for chemically based social recognition through urine cues. Furthermore, results from acoustic/chemical cross-modal playbacks reveal that signature whistles are representational calls, serving as a potential example of convergence with human names.

3:16 PM **Threat perception: Impact of degradation and anthropogenic noise**

Christopher B. Sturdy, Jenna V. Congdon (University of Alberta), Allison H. Hahn (St. Norbert College), Daniel A. Yip, Kimberley A. Campbell, Erin N. Scully, & Erin M. Bayne (University of Alberta)

36 Smaller owls and hawks are higher threat to chickadees as they can easily maneuver through trees. Chickadees are known to produce mobbing calls to recruit and coordinate conspecifics and heterospecifics to attack predators. We conducted a go/no-go task to investigate the effect of signal degradation on threat perception. Stimuli included vocalizations of high-threat northern saw-whet owls (NSWO) and low-threat great horned owls (GHOW) broadcast and re-recorded across six distances. Chickadees were trained to go to NSWO or GHOW stimuli that were recorded at close distances, and tested with calls recorded at further distances (25m, 50m, 100m, 150m, 200m). We hypothesized that birds would perceive high threat vocalizations at longer distances compared to low threat vocalizations, but our results do not support our prediction. We also tested a variety of other stimuli. Chickadees responded less to synthetic versions of predator calls, but responded appropriately for their training condition. Finally, we were interested in testing whether chickadees would respond similarly to NSWO calls and acoustically similar truck alarms. Chickadees did not respond to alarms at high rates. Overall, these experiments

provide many insights into chickadees' threat perception, including the effects of signal degradation, synthetic stimuli, and anthropogenic noise.

37 3:30 PM

Synchronous Innovation in Bonded Male Bottlenose Dolphins

Beatrice Chenkin (University of Southern Mississippi and Roatan Institute for Marine Mammal Studies (RIMS) Intern), Kimberly Bagley (University of Tennesee and RIMS intern), Elliot Curd, Nicolas Osborn (RIMS intern), McKeely Kerr (Texas A M at Corpus Christi and RIMS intern), Elizabeth Balcom (Cornell and RIMS), & Teresa Bolton (Roatan Institute for Marine Mammal Studies.)

Whether it be the altruistic behavior of prairie dogs or the inner workings of a beehive, cooperative behavior is vital to the wellbeing of a social species. Exemplified through hunting and mating, the bottlenose dolphin (Tursiops truncatus) is among these species. To investigate these cooperative relationships, we studied three pairs of male bottlenose dolphins at the Roatan Institute for Marine Mammal Studies during paired innovative training sessions and natural free swims. The innovative sessions required the pair to freely select a behavior and present it in tandem. Only when the behavior was both innovative and presented in sync was it deemed successful. During natural swims, each time one of the six focal animals was observed, the animal in the closest proximity to him was recorded. We hypothesized that pairs seen together more during free time would produce more synchronous and innovative behaviors during training; however, we discovered that only one of the two pairs that were successful spent a significant amount of time together in free swims. Interestingly, the success rate of this pair was increased when the more dominant male led the innovative sessions. Additional research may, therefore, show that hierarchy plays a significant role in innovation.

38 3:37 PM

Communicating Contact: Do Functional Units Differ Across Taxa?

Heather M. Hill (St. Mary's University), Kathleen M. Dudzinski (Dolphin Communication Project), & Maria Botero (Sam Houston State University)

Social animals exchange contact regularly for affiliative, agonistic, and socio-sexual reasons. Understanding how, when and for what reasons individuals exchange contact can offer insight into how animals manage relationships and social groups. From the research perspective, what is the best unit of measure to facilitate comparison of the function(s) of shared touch both within and across taxa? Using data from two long-term studies of disparate species (terrestrial vs aquatic), we argue that the smallest unit of measure might differ elementally between taxa but may still represent the same functional aspect for comparison of shared touch. A preliminary examination of shared contacts between dyads suggested a mismatch between the datasets precluding direct comparison; however, shifting to each species' proposed functional unit of contact (bout of "shared grooming" vs. event of "physical contact) allowed a direct comparison between species, suggesting that chimpanzee and dolphin mothers initiate contact slightly differently with their infants. The evolutionary difference between dolphins and chimps may have allowed each species to maximize information included in each form of contact shared.

39 3:51 PM

A comparison of black-capped chickadee and human perception of arousal in vocalizations across all classes of terrestrial vertebrates

Jenna V. Congdon (University of Alberta), Allison H. Hahn (St. Norbert College), Piera Filippi (Vrije Universiteit Brussel/Ruhr-Universitat Bochum/Aix-Marseille University), John Hoang, Kimberley A. Campbell, Erin N. Scully (University of Alberta), Daniel L. Bowling (University of Vienna), Stephan A. Reber (Lund University), & Christopher B. Sturdy (University of Alberta)

Recently, Filippi and colleagues (2017) found evidence for acoustic universals (i.e., elements of vocalizations indicating state of arousal, present across multiple species' vocalizations) by demonstrating that humans can identify levels of arousal in vocalizations produced by multiple species across three biological classes: Amphibia, Reptilia (including Aves), and Mammalia. Thus, humans appear to have the ability to identify the emotional content contained in conspecific and heterospecific vocalizations. Humans and black-capped chickadees (Poecile atricapillus) are both considered 'vocal learners', and thus, may have similar abilities. In this study, we hypothesized that both chickadees and humans would discriminate between vocalizations of high and low arousal on similar operant discrimination go/no-go tasks; stimuli included vocalizations from nine animal groups: frogs, alligators, ravens, elephants, pandas, pigs, macaques, chickadees, and humans. Subjects were trained to respond to high or low arousal vocalizations, then tested with additional high and low arousal vocalizations produced by each species. Preliminary analyses support our predictions that birds and humans are capable of discriminating between these vocalizations across multiple species, and generalizing their training to novel stimuli based on arousal. Evidence that both chickadees and humans perceive arousal across species provides additional support for acoustic universals in vocalizations of arousal.

40 3:58 PM

Pragmatic Understanding of Bottlenose Dolphins' (*Tursiops truncatus*) Use of a Two-Way Communication System

Pepper Hanna (Lynchburg College), John Gory (Disney's The Seas), Stan Kuczaj II (University of Southern Mississippi), & Mark Xitco Jr. (US Navy Marine Mammal Program)

Pragmatics focuses on how a communication system is used to achieve a communicative goal, the social context of the communication, and the organizational structure of communications (McLaughlin, 1998). There is evidence of pragmatics within animal communication systems (e.g., Seyfarth et al. 1980). The current study used an

underwater keyboard to establish a two-way communication system between humans and dolphins. The purpose of this study was to determine if, under these conditions, dolphins displayed pragmatic abilities within communicative interactions with humans. The dolphins did show evidence of pragmatic understanding based on evidence of turn-taking both at the keyboard and in behavioral gestures. Dolphins engaged in multi-turn conversations and showed a decline in interruptions over time. Dolphins appeared to pay attention to the attentional state of the human listener and predominately used the keyboard when the human was facing toward them. Future studies that examine the specific keys activated by dolphins and humans can provide important information regarding the type of information that was exchanged during these interactions. Further studies are needed to examine any differences in dolphin responding based on their human partner's location and orientation when the dolphin used the keyboard.

4:05 PM

Auditory Discrimination (Chair: Stephen Lea)

4:05 PM

Animal musicality: Is vocal imitation important in perceiving octave equivalence?

Marisa Hoeschele, & Bernhard Wagner (University of Vienna)

41

Octave equivalence, or treating a doubling in frequency as the same note, is universal across human musical systems. Octave equivalence makes a lot of sense when we consider ourselves in a biological light: (1) Humans with differing vocal ranges imitate one another (e.g., children imitating their father) (2) Vocalizations shifted by an octave are the closest approximation of harmonic structure of the original vocalization. One way to understand the origin of octave equivalence in our species is to see whether other species might have it, and if so, what else they share in common with humans. Previously, I found no evidence of octave equivalence in a vocal learning songbird species, but perhaps this was due to the fact that they do not need to imitate vocalizations outside of their vocal range. Here we tested whether budgerigars perceive octave equivalence. Budgerigars are a parrot species that can mimic sounds outside of their vocal range including human speech. We found no evidence of octave equivalence in this species either. Though birds appear not to have octave equivalence regardless of whether or not they can mimic sounds outside their vocal range, there were surprising parallels across these species that I will discuss.

4:19 PM

Discrimination of season in chick-a-dee calls

Erin N. Scully, Kimberley A. Campbell., Jenna V. Congdon, Christopher B. Sturdy (University of Alberta)

42

While black-capped chickadees (Poecile atricapillus) primarily produce their fee-bee song in spring, they produce their chick-a-dee call year-round with call production peaking in the fall (Avey et al., 2008; Avey et al., 2011). This call serves multiple functions, including food location, flock communication, and predator alarm. As seasons change, the meaning of the call may also change; for example, flock communication could be more important in the winter than in the spring. To determine if the chick-a-dee call varies acoustically across seasons, in a predictable manner, we conducted an operant go/no-go discrimination task looking at black-capped chickadees' ability to categorize calls produced in two different seasons (i.e., fall and spring). We found that True and Pseudo groups learned to discriminate at the same rate, suggesting that neither group demonstrated category learning, relying instead on rote memorization. There was a significant interaction between stimulus type (training vs. novel) and season ($p=0.000$). However, there was not a significant effect of group ($p=0.258$). These results suggest that while chickadees can be trained to discriminate between chick-a-dee calls produced in different seasons, they do not naturally discriminate these calls.

4:26 PM

Break

4:31 PM

Symposium - Cold-blooded Cognition (Chair: Anna Wilkinson)

4:31 PM

Forays into Cold-Blooded Cognition with Tiger Salamanders *(Ambystoma tigrinum*)

Shannon M. A. Kundey, Alexander Sexton, Danielle Ali, & Hanne Christensen (Hood College)

43

Relative to explorations involving mammals, few have studied amphibians' cognition. This is unfortunate given their diversity and potential to aid understanding of the general processes and variations in those processes underlying cognition. Researchers have usually written off amphibians as instinct driven and uninteresting with respect to cognition. However, recent research demonstrates that this conclusion is premature. Amphibians have begun to be recognized for their communicative and problem solving abilities; however, rigorous investigations have only recently begun to be undertaken. Here, we discuss our work investigating response learning, usage of

visual cues, and retention in tiger salamanders (Ambystoma tigrinum), as well as our more recent forays into other areas of cognition with this species.

4:46 PM

Do reptiles (*Geochelone carbonaria* and *Pogona vitticeps*) perceive visual illusions?

Maria Santacà, Maria Elena Miletto Petrazzini, Christian Agrillo (University of Padova (Italy)), & Anna Wilkinson (University of Lincoln (United Kingdom))

44

Visual illusions have widely been used to compare visual perception among vertebrates but there is no study in reptiles. We investigated whether red-footed tortoises, Geochelone carbonaria, and bearded dragons, Pogona vitticeps, perceive the Delboeuf illusion. We further investigated whether bearded dragons perceive the Müller-Lyer illusion. Both illusions regard relative size perception. Reptiles were observed in the spontaneous tendency to choose the larger food quantity. We arranged different trials: control trials (two different-sized food portions in identical context) and test trials (same food quantity in different contexts representing the illusory patterns). In the first experiment, tortoises exhibited a poor performance in control trials thus preventing us to draw any conclusion about their perception of the Delboeuf illusion. Bearded dragons instead discriminated the larger food quantity in control trials and proved to be sensitive to this illusory pattern as humans. Given these results, we further investigated the sensitivity to size illusions in bearded dragons. They discriminated the larger food quantity in control trials and proved to perceive even this illusory pattern as humans. Our study provides the first evidence of the perception of two visual illusions in a reptile species and suggests the possibility of different quantitative discrimination abilities in reptiles.

5:01 PM

QUANTITY DISCRIMINATION IN REPTILES (*Podarcis sicula*)

Maria Elena Miletto Petrazzini (University of Padova), Isabel Fraccaroli, Francesco Gariboldi (University of Ferrara), Christian Agrillo, Angelo Bisazza (University of Padova), Cristiano Bertolucci, & Augusto Foà (University of Ferrara)

45

The ability to discriminate between quantities is highly adaptive and fundamental for several aspects of the relationship between animals and their natural environment. For instance, being able to select the largest amount of food is of prime importance for optimising foraging behaviour in several species. To date, quantity discrimination has been extensively investigated in all vertebrate groups except reptiles. In the present study we used a spontaneous choice test to assess quantitative skills of ruin lizards. Lizards presented with a choice between two food items (1 vs. 1) differing in size (0.25, 0.50, 0.67, and 0.75 ratio) proved able to select the larger one in any contrast. Conversely, lizards presented with two groups of food items differing in number (1 vs. 4, 2 vs. 4, 2 vs. 3, and 3 vs. 4 items) were unable to select the larger group in any comparison. The lack of discrimination in the presence of sets containing multiple items represents an exception in numerical cognition studies raising the question as to whether quantitative skills in reptiles differ from those observed in the other vertebrate groups.

5:16 PM

Cold-blooded cognition meets ecosystem ecology: The impact of cognition on seed dispersal processes

Anna Wilkinson (University of Lincoln), Francesca Soldati, Oliver H. P. Burman, & Thomas W. Pike and Elizabeth A. John (UK)

46

The interdependence between frugivores and fruit-producing plants is central to many ecological processes. Few plant populations could persist in their present state without animal-mediated seed dispersal and there is growing concern over the impact of defaunation of ecosystems on these important mutualistic services. Currently, the importance of a disperser is assessed by examining the amount of fruit eaten, the number of seeds processed, and the number of viable seeds in faeces alongside estimations of dispersal distance. However, this approach lacks predictive power in the face of ecosystem disruption, because it does not take into account crucial factors which determine how animals find and return to food sources - the cognitive processes underlying their behaviour. In this talk, I will cover some laboratory experiments which consider the impact that cognition may have on this key ecosystem service using the red-footed tortoise (Chelonoidis carbonaria), an important disperser in its environment, as a model species.

5:31 PM

Attention and Perception (Chair: Heather Hill)

5:31 PM

Illusion or reality: Do dogs demonstrate susceptibility to a vertically presented Ponzo illusion?

Sarah-Elizabeth Byosiere, Lynna C Feng (La Trobe University), Joyce Wuister (Wageningen University and Research Centre), Philippe A Chouinard, Tiffani J Howell, & Pauleen C Bennett (La Trobe University)

47

One way to uncover visual capabilities in animals is to assess perception of geometric illusions. In a previous study, we demonstrated that dogs were not susceptible to the Ponzo illusion. However, two important variables were not considered. First, the illusory background was presented horizontally, whereas the traditional presentation is vertical. Second, it is not known if dogs can differentiate physical size differences small enough to facilitate perception of the Ponzo illusion. To investigate these issues, we tested the same dogs from our previous study on a vertical version of the Ponzo illusion and on a size discrimination task. One-sample t-tests revealed that dogs did not demonstrate illusion susceptibility at the group level [$t(5) = 2.25$, $p = 0.074$, $SD = 6.52$, Cohen's $d = 0.92$]. However, individual differences in susceptibility were observed. All eight dogs were able to discriminate between

circles that differed in diameter by 20%, four discriminating 10% size differences, and none being able to discriminate 5% size differences. These findings suggest that some dogs are capable of perceiving the minimum size difference hypothesized to be required in humans to perceive the Ponzo illusion. Nonetheless, susceptibility to the illusion remains variable and weak even when presented vertically.

5:38 PM **Visual search of hierarchical stimuli by pigeons**

Suzanne L. Gray, Muhammad A. J. Qadri, & Robert G. Cook (Tufts University)

48 Pigeons have been shown to bias attention toward local cues over global cues in many situations. To explore further, we investigated how this bias operates during successive search and selection in a complex visual array. We trained three pigeons to search among 16 hierarchically-organized stimuli using four letters (N, P, T, X) in which target letters were presented locally or globally in every display. Across acquisition and transfer results, pigeons demonstrated a bias toward processing local information before global information, consistent with previous research. Of new theoretical interest, analyses of the sequential choice behavior revealed that pigeons showed no sustained shifts of attention.

8:30 PM Poster Session I (8:30 - 11:00)

See Poster Abstracts Starting on Page 28

Poster Presenters: Please set up your posters between 8:00 and 8:30

Friday Morning – Manatee Room 10:30 AM

Meet the Editors Q & A (Chair: Olga Lazareva)

Do you have questions about the publishing process? Come to the Manatee Room for a round table Q & A session with editors from some of our favourite journals: *Animal Behavior and Cognition, Animal Cognition, Behavioural Processes, Learning & Behavior, Journal of Experimental Psychology: Animal Learning and Cognition*. A poster identifying each Editor/Journal will be on display at the entrance to the Manatee room. This session will end promptly at 11:30

Friday Afternoon

12:00 PM Social Learning, Behaviour, and Development (Chair: Lisa Lever)

12:00 PM **Learning what material to choose: Bird nests as a source of information**

Alexis J. Breen, Clemence Bonneaud, Susan D. Healy, & Lauren M. Guillette (University of St Andrews)

49 One source of public information may be the enduring products of others' behaviour, such as bird nests. Nests available in the environment may provide information for first-time builders, especially regarding material with which to build. Here, we addressed whether experience viewing a pre-built, complete nest affects zebra finches' first-time nest-material choice. To do this, we provided male zebra finches (the builder) and his mate, the opportunity to view—but not interact with—a fully constructed nest of a material colour that he did not initially prefer. We then tested whether the male built his first nest with the material colour that matched the nest previously observed, or his initially preferred material. We also examined whether birds that experienced a change in environment (outdoor aviary versus laboratory) were more likely to copy the material that matched the nest they observed. Finally, to test if male zebra finches do indeed build their first nest with the colour of material that they initially preferred, we examined the first-time nest material choice of inexperienced zebra finches that were not given the opportunity to view a nest. We discuss our findings and their implications for animal construction behaviour in general.

Social learning in free-ranging Kune Kune piglets

12:14 PM

Ludwig Huber, Ariane Veit, & Marianne Wondrak (Messerli Research Institute)

50

Early studies of observational learning in commercially farmed pigs revealed only modest information transfer from littermates. However, learning from siblings (horizontal information transfer) may be less relevant and efficient than learning from the mother (vertical information transfer). Here we tested piglets of the New Zealand Kune Kune breed that were kept in semi-natural (free-ranging) conditions and formed a natural group (sounder) of a few sows with their offspring. When confronted with a food box that could be opened by pushing a sliding door to the side, a group of six non-exposed piglets did not show a side bias during their first encounters with the apparatus, but later formed an enduring representation of the self-acquired technique. Two further groups of six piglets each were first exposed to their mother or aunt pushing one of two differently colored bars to either the left or right side to open the door, and were then tested after one minute, one hour and one day. These groups used the demonstrated opening technique by recalling the movement of the door even after 24 hours, but did not push at the same side or bar. This was evidence for object-movement re-enactment rather than local or stimulus enhancement.

12:28 PM

The Influence of Direct and Indirect Experience on Reputation Formation in Domestic Cats (*Felis silvestris catus*)

Jennifer Lieb, Jessica Leete, Taryn Eaton, & Jennifer Vonk (Oakland University)

51

Evidence of social eavesdropping from fish, birds, dogs, and humans suggests that many animals form reputations of another individual through indirect observations. We tested the domestic cat's ability to infer an individual's reputation through either direct or indirect exposure. Seven dyads were tested. One cat from each dyad interacted with an experimenter who behaved in a friendly manner and a different experimenter who behaved in a more aggressive manner while the other member of the dyad observed through a two-way mirror. Following three such 'experience' trials with each experimenter, both cats were given two opportunities to interact with each experimenter behaving in a neutral manner. Only one experimenter was present on each trial. Latency to approach and duration of time spent near the experimenter were recorded. The cats' behaviors were also coded as indicators of positive and negative affect during each interaction. Generally, cats did not show strong reactions to either experimenter - suggesting that they may not form reputations of human experimenters following brief direct or indirect encounters.

12:35 PM

Individual differences in endogenous and exogenous oxytocin on infant macaques' (*Macaca mulatta*) attention to threatening facial expressions

Yeojin A. Ahn (University of Miami), Annika Paukner (Eunice Kennedy Shriver National Institute of Child Health and Human Development), Stefano S. K. Kaburu (University of California Davis), Pier F. Ferrari (Institut des Sciences), & Elizabeth A. Simpson (Cognitives–Marc Jeannerod)

52

Oxytocin is a neuropeptide tied to attachment and sociality; however, little is known about infants' naturally occurring levels of oxytocin and whether they are associated with social cognition. The current study investigated whether newborn monkeys' social behavior and physiology are associated with their attention to facial expressions. We classified newborns as imitators (n=18) and non-imitators (n=26), based on their performance in a facial gesture neonatal imitation task in the first week of life. Then, at one month, infants were nebulized with saline (control) or oxytocin. We tracked their attention to videos of animated adult macaques displaying various expressions. We found effects only for the threatening expression. Infants' endogenous oxytocin levels were positively associated with their looking time to the eyes ($r=0.643$, $p<0.01$). Imitators looked significantly more to the mouth region of the face than non-imitators ($t(24)=2.07$, $p=0.05$, $d=0.70$). These effects were eliminated when infants were administered oxytocin. Imitators looked more to the mouth in the saline compared to the oxytocin condition, $t(14)=5.009$, $p<0.01$, $d=1.03$. Finally, neonatal imitators, compared to non-imitators, had higher salivary oxytocin levels, $t(36)=2.01$, $p=0.052$, $d=.33$. These results suggest that exogenous administrated oxytocin may affect infant monkeys' face-processing mechanisms and highlight the importance of considering individual differences.

12:42 PM

An interspecific case of strong reciprocity in the wild.

Alex Kacelnik (Oxford University), Juan Carlos Reboreda (University of Buenos Aires), & Ros Gloag (University of Sidney)

53

Strong reciprocity is defined as acting to respond a received (positive or negative) social input by directing behaviour to the originator of the input, when doing so causes the actor a net fitness loss. Defined that way, strong reciprocity is maladaptive and not expected to be evolutionarily stable in the wild. The concept has been studied in human economic interactions such as road rage, where researchers often explain it mechanistically by reference to the actor's utility function, or functionally by group selection. We feel that there are no satisfactory theoretical accounts for such phenomena, and yet we'll present what we believe is an unusually striking example of it in the wild. Shiny cowbirds are brood parasites that lay eggs in nests of chalk-browed mockingbirds. On arrival at a nest female cowbirds attempt to destroy one or more eggs, lay their own, and escape, only rarely returning. We report that mockingbirds pursue and attack cowbirds when they are attempting to escape, neglecting nest defence and as a consequence suffer additional parasitism by opportunistic cowbirds. Their behaviour is (proximally) consistent

with excessive, self-damaging, anger, but we are still working on potential explanations for its evolutionary stability.

12:56 PM **Early lateralized interactions between infant and mother Colombian spider monkeys (Ateles fusciceps rufiventris)**

Megan A. Taylor, Emily M. Diaz, & Eliza L. Nelson (Florida International University)

54 Among human mothers there is a widely reported left preference for cradling. The left positioning bias is thought to optimize monitoring, as the right hemisphere has been linked to enhanced social processing. The Colombian spider monkey (Ateles fusciceps rufiventris) is an important model for examining the evolutionary roots of this bias in primates given that spider monkeys share the same fission-fusion social structure as humans, and infants spend the first several months of life on the mother. To date, no work has tracked mother-infant interaction asymmetries across development in spider monkeys. In this study, 83 hours of observation were collected from 3 pairs of mother-infant dyads using scan sampling at 3-minute intervals during 90-minute blocks in the morning, midday, and evening. The infant's position on the mother (left hip, right hip, belly, back) was recorded. Preliminary analyses revealed that infants spend significantly more time positioned on the mother's belly compared to the other positions (39.4%, $X^2(3) = 204.475$; $p < .001$), which supports the importance of face-to-face interactions. Given this finding, future work will examine infants' head orientation while carried to determine whether infants capitalize on the left visual field/right hemisphere bias.

1:03 PM **Experimental methodology influences the expression of prosocial behavior with quantitatively-defined strong and weak affiliative partners in brown capuchin monkeys (*Cebus apella*)**

Sara M. Faiad, Cilicia K. MacArthur, & Peter G. Judge (Bucknell University)

55 Prosociality refers to behavior of one animal that benefits another. Monkeys' exhibition of prosocial behavior and the influence of the strength or weakness of the affiliative relationship between partners on prosociality remains unclear. We tested capuchin monkeys' tendency to behave prosocially during a food-sharing task and a prosocial choice task (PCT) in which a monkey could choose between tokens that produced selfish or prosocial outcomes. In both tasks, each individual was paired with a socially-strong partner and a socially-weak partner. Social index scores, which are based upon the duration of affiliative behavior between individuals, were used to determine socially-strong and socially-weak dyads. On the food-sharing task, of four adult females, two behaved prosocially more often than expected for a socially-strong partner and behaved prosocially less often than expected for a socially-weak partner. On the PCT, none of eight subjects behaved prosocially more often than chance with either partner. Results indicated that capuchin monkeys were capable of behaving prosocially during a food-sharing task, but not during a PCT, demonstrating that methodology may hinder the expression of prosociality. Further, social index scores, a quantitative measurement, may have provided a more accurate assessment of relationship strength than a qualitative measure, such as kinship.

1:10 PM *Break*

1:15 PM

Associative Processes (Chair: Rebecca Rayburn-Reeves)

1:15 PM **Counting vs. Timing of Intertrial Intervals during Associative Learning**

Anna Tsvetkov1, Cody W Polack (SUNY at Binghamton), Dyedra Morrissey, Robin Murphy (Oxford University), & Ralph R Miller (SUNY at Binghamton)

56 Dispute exists concerning the relative influence on conditioning of number of Cue-Outcome pairings vs. accumulated Cue duration between Outcomes. Recent work suggests Cue duration between Outcomes is more critical than number of pairings, whereas during extinction number of trials carries more weight than duration of Cue exposure. The contingency framework (i.e., Δp) assumes the importance of relative numbers of different trial types. Most contingency studies have varied frequency of A (Cue-Outcome), B (Cue-NoOutcome), and C (NoCue-Outcome) events, while holding D (NoCue-NoOutcome, aka ITIs) events constant. Counting A, B, and C events is easy, but counting D events, particularly consecutive D events, is challenging. In some preparations, trial markers are used to facilitate counting D events. Without trial markers, animals presumably segment D events based on the duration(s) of presented stimuli (i.e., A, B, and C). Prior contingency experiments usually varied frequencies of A, B, and C events. The present research focused on the role of D events. We report experiments illuminating how number of D events, D-event trial markers, and duration of D events influence learning of Cue-Outcome contingencies.

57 **Measuring multiple components of affect in chickens using a novel, four-chambered Conditioned Place Preference Test**

1:40 PM

Elizabeth Paul, Joanne Edgar, Gina Caplen, & Christine Nicol (University of Bristol)

While approach-avoidance tests and some preference tests gauge animals' immediate behavioural responses to stimuli, the Conditioned Place Preference (CPP) test goes further by establishing whether an "affective" response has been generated, such that a learned preference for, or aversion to, the location in which the stimulus was encountered is established. Using a novel, four-chambered CPP test, we investigated the affective responses of domestic chickens to four potentially aversive stimuli: 1. Puffs of air; 2. Sight of (robotic) snake; 3. Sprays of water; 4. Sound of conspecific alarm calls. The four-chambered CPP test was designed to give information on four key features of animals' affective responses: valence, scale, persistence and generalisation. We found conditioned avoidance of locations associated with the air puffs and water sprays (Friedman's $\chi2(3)=13.323$ $p>.005$; $\chi2(3)=14.235$ $p>.005$), but not with the snake and alarm calls. The scale of the learned avoidance was similar for the air puff and water spray stimuli, but persistence and generalisation differed. We conclude that the four chambered CPP test can have a valuable role to play in making multi-feature measurements stimulus-generated affective responses, and highlight the value of such measurements for improving our understanding of the structure of affect in animals.

1:47 PM

Pavlovian Diet: Investigations on Flavor-Calorie Associations and Their Role in Weight Gain and Food Consumption

Benjamin M. Seitz, Mary E. Flaim, & Aaron P Blaisdell (UCLA)

58

Food cues play an important role in eating behaviors. Seth Roberts proposed a theory that flavor-calorie associations play a central role in weight regulation. Specifically, strengthening flavor-calorie associations increases the body-fat set point; while weakening flavor-calorie associations lowers this set point. The difference between the subject's current body weight and the set point determines appetite and thereby weight gain or loss. He reported anecdotal evidence for this using self-experimentation. We initiated a more rigorous test of this hypothesis in rats. Rats were given ad libitum access to standard chow, with the exception of a 4-hour flavorless window during which food and water access were restricted. In the middle of this window, rats were given one-hour access to a small amount of one of four liquid solutions containing a) sucrose, b) Mio Flavoring, c) sucrose and Mio Flavoring, or d) neither additive. While no effect on food consumption was found, rats given access to both flavored water and flavored sucrose water showed retardation in standard weight acquisition as observed in rats given the non-flavored liquid solutions. The presence of sucrose in the solutions had no effect on weight acquisition challenging conventional assumptions of caloric intake and its relation to weight acquisition.

1:54 PM

The Modified Law of Effect and the Partial Reinforcement Extinction Effect

Aaron P. Blaisdell, Benjamin M. Seitz, Ramon Diaz, & Mary E. Flaim (UCLA)

59

We present our recent modification to Thorndike's original Law of Effect (1911) that expands its explanatory power (Blaisdell, Stolyarova, & Stahlman, 2016). In addition to providing an account for the inverse relationship between reward probability and response variation, the Modified Law of Effect (MLOE) also provides an account for the partial reinforcement extinction effect (PREE). The PREE is the finding of more rapid extinction to an instrumental or Pavlovian response that had previously been reinforced continuously (CRF) compared to a response that had only been partially reinforced (PRF). According to the MLOE, a CRF cue acquires a strong excitatory S-R but very weak or no inhibitory S-R; while a PRF cue acquires strong excitatory and inhibitory S-R associations. During extinction, the inhibitory S-R association will increase rapidly for the CRF cue but much more slowly for the PRF cue (because learning is negatively accelerating). We tested the MLOE account of the PREE using a within-subject operant procedure in pigeons in which we manipulate whether or not an inhibitory S-R association develops to the PRF cue.

2:08 PM

Break

2:13 PM

Discrimination Learning (Chair: Chris Sturdy)

2:13 PM

Visual Discrimination of Rotated 3D Objects in Goldfish (*Carassius auratus*)

Caroline M. DeLong, Kathryn Gardner, Henry Rachfal, Evan Morrison (Rochester Institute of Technology), & K. Tyler Wilcox (University of Notre Dame)

60

The ability to visually recognize objects despite differences in orientation would be advantageous for fish because they frequently view objects from many aspect angles. We tested the ability of five goldfish to recognize 3D stimuli from multiple aspect angles in different rotation planes using a two-alternative forced choice task. The fish were trained to discriminate between two objects (plastic models of a frog and turtle) at 0 degrees in the x-plane.

Mean choice accuracy during training was 86%. Then, they were tested with the same objects at novel aspect angles (90, 180, and 270 degrees). In Experiment 1, the objects were rotated in the x-plane (picture plane). Choice accuracy exceeded chance at 90 (M = 97%), 180 (M = 96%), and 270 (M = 96%) degrees. In Experiment 2, the objects were rotated in the y-plane (depth plane). Choice accuracy exceeded chance at 90 (M = 86%), 180 (M = 90%), and 270 (M = 96%) degrees. Overall performance in the current study (M = 95%) exceeded performance with rotated 2D objects in our past study (M = 66%). It may be easier for fish to recognize objects despite differences in orientation when objects are 3D vs. 2D.

2:27 PM **61**

Accuracy, Position, and Orientation: Behavior in rats during the midsession reversal task

Mary Kate Moore, Thea Smith, Daniel Crafton, Kelly Marden, & Rebecca Rayburn-Reeves (Georgia Southern University)

Previous findings utilizing a simultaneous, visually-based discrimination reversal featuring a single contingency reversal at the midpoint of the session have shown that pigeons exhibit anticipatory and perseverative responses before and after the reversal. These findings suggest pigeons use a less effective cue (e.g. time, counting) to determine behavior rather than a more optimal cue with a better chance of maximizing reinforcement (e.g. local feedback from most recent trials). In this study, 12 Long Evans rats (Rattus norvegicus) were tested with an 80-trial, simultaneous spatial discrimination MSR task in which response levers were positioned on the opposite wall from the pellet dispenser. We hypothesized that this manipulation would reduce the effectiveness of position cues in order to test whether control by time-based or reinforcement-based cues would increase. Results revealed few anticipatory and perseverative errors, suggesting that cues from recent response-reinforcement contingencies were controlling behavior. Preliminary results gathered from video data on the last ten sessions also showed variability in how rats behaved during the ITI, with some orienting and positioning themselves in front of the correct lever prior to the start of the following trial. This variability poses some interesting questions related to previous research with rats on the MSR.

2:34 PM **62**

The Effects of Regional Hypoxic Incubation Conditions on Color Discrimination and Reversal in Leopard Geckos (*Eublepharis macularius*)

Matthew S. Murphy, & Scott L. Parker (Coastal Carolina University)

Although the effects of hypoxic conditions during incubation on physical development in reptiles are documented, there is little known about the effects on cognitive processes and learning. Leopard gecko eggs were exposed to regional hypoxic conditions (4% O2) for 15 days during incubation, beginning either within 24 hours of or 15 days after oviposition. Clutch-matched eggs were exposed to control conditions (21% O2). Approximately 14 days after hatching, subjects were trained in a color discrimination task and subsequent reversal in a t-maze. Results may suggest an impairment in associative learning in treatment subjects. Differences in speed of learning and attrition will be discussed, as well as the viability of geckos as an animal model, and future directions of inquiry.

2:48 PM **63**

Olfactory discrimination with a humanitarian purpose: African giant pouched rats as detectors of landmines and tuberculosis

Cynthia D. Fast (APOPO), Robin Andrews (University of South Wales - Prifysgol De Cymru), Kate Webb, Sydney Brotheridge, Dian Kuipers, & Christophe Cox (APOPO)

Since 1997, APOPO, a Belgian non-profit organization, has studied olfaction in the African giant pouched rat (Cricetomys ansorgei) to train these rats to use their incredible sense of smell for humanitarian purposes. Our rats (dubbed HeroRATs) are trained to detect buried landmines in former conflict zones and to sniff out the world's deadliest infectious disease, tuberculosis (TB), in human sputum samples. Rats undergo approximately 9 months of training at our headquarters in Tanzania before being deployed to operations in Angola, Cambodia, Ethiopia, Mozambique, or other areas in Tanzania where they have released more than 22,000,000 m2 of land and increased TB case detection by more than 40% over standard point of care clinics. Despite this proven track record, recent results from our Research and Development Team suggest that the rats' ability to detect TB may be even greater than previously estimated. Using a more sensitive behavioral measure than is currently used in our TB-detection operations, we discovered that the rats respond differently when they correctly reject a negative sample compared to when they miss a positive sample ($p < .001$). Applying these empirical results to training and operational procedures promises to bolster the overall humanitarian impact of APOPO's HeroRATs.

2:55 PM

Concept Learning (Chair: Chris Sturdy)

2:55 PM **64**

Sameness May Be a Natural Concept That Does Not Require Learning

Thomas R. Zentall, Danielle M. Andrews, & Jacob P. Case (University of Kentucky)

The procedure for demonstrating concept learning is to train with one set of stimuli to identify the concept and test for transfer to new exemplars of the concept. There are two problems with this approach. First, it may be difficult to distinguish between primary stimulus generalization and concept transfer, especially if there are a large number of training stimuli. Second, pigeons tend to be neophobic. Thus, when presented with novel stimuli results may

underestimate the degree of concept learning. We trained pigeons on four-color matching or mismatching. For each sample color, only one color was used as the mismatching comparison. On test trials, we replaced either the correct or the incorrect comparisons with a new but familiar color that on other trials had served as a sample or a mismatching comparison. For pigeons trained to match, replacing the correct comparison but not the incorrect comparison resulted in a large decrement in accuracy. However, for pigeons trained to mismatch replacing the incorrect comparison but not the correct comparison resulted in a large decrement in accuracy. Results suggest that sameness is a fundamental concept for pigeons and it may be for other animals as well.

3:09 PM **Do Capuchin Monkeys (*Sapajus* sp) form abstract rules from minimal input?**

Elisa Felsche (University of St Andrews), Patience Stevens (Carnegie Mellon University), Christoph Völter (University of St Andrews), Daphna Buchsbaum (University of Toronto), & Amanda Seed (University of St Andrews)

65 Abstract concepts are acquired early in human development, but the debate about whether non-human animals have similar capabilities remains unsettled, both because of mixed results and different interpretations of positive results following long training regimens. We developed a forced-choice task based on a study of abstract rule learning in infants (Dewar & Xu, 2010) for capuchin monkeys (Sapajus sp). After seeing evidence (food items) sampled from three containers sorted either by item type or by item size, participants (n=11) were presented with two new test containers and respective example items (a small, high-valued reward and a large, low-valued reward). Subsequently, subjects chose between two covert samples from these containers. If monkeys learned the abstract rule governing the containers' contents, different choices are expected to maximize the chances of receiving a large over a small item (size condition) or a high-valued over a low-valued item (type condition). None of the monkeys showed this pattern, instead choosing indifferently in each condition. Further, performance was at chance level in a follow-up task with reduced cognitive demands. These results hint towards a recent evolutionary emergence of abstract concepts. Data collection with children is ongoing but preliminary results suggest better performance when compared to monkeys.

3:16 PM *Snack Break*

4:00 PM In Honour of the Contributions of Marcia Spetch (Chairs: Debbie Kelly and Suzanne MacDonald)

4:00 PM **Twenty years of comparative spatial cognition**

Debbie M. Kelly (University of Manitoba)

66 Dr. Marcia Spetch is an internationally recognized expert in the field of comparative cognition, Fellow of the Royal Society of Canada, and was my graduate supervisor! My presentation will provide a glimpse of the research on pigeon spatial cognition that started our collaboration, and built the foundation for my current comparative research program on spatial cognition. The focus of my presentation will be on studies examining how humans use featural and geometric information when reorienting in real-world rectangular environments and virtual reality replicas. I will also discuss some recent research showing that as we age, our encoding of spatial cues may change. Generally, the results from these studies support a similar use of features and geometry across environment types by younger adults, but also highlight some important considerations when using virtual reality to study spatial cognition – particularly when trying to understand age-related spatial degeneration.

4:14 PM **The Development of Object Permanence in Raccoons (*Procyon lotor*)**

Suzanne MacDonald, & Jennifer Colbourne (York University)

67 Understanding that an object still exists when it is removed from view is a fundamental cognitive ability that underlies all studies of memory, spatial and otherwise. This concept of object permanence develops relatively quickly in most mammals, including dogs, cats, monkeys and primates. However, it has not yet been explored in raccoons (Procyon lotor), a nocturnal omnivore often perceived to be especially 'intelligent'. We describe our search for this basic, yet elusive, ability in this species, first with 11 young raccoons (between 10-16 weeks of age) and then with four adult raccoons (between 4 -12 years of age). Contrary to our predictions, young raccoons performed at chance levels, even in the simplest version of the task. Our results illustrate the importance of including comparative and developmental approaches when studying basic cognitive abilities.

68 4:28 PM **Landmark integration based on reliability for localizing a goal in spatial search tasks**

Neil McMillan, Yu Du (University of Alberta), Christopher R. Madan (University of Nottingham), Pierre Nadeau-Marchand (Université de Moncton), & Marcia L. Spetch (University of Alberta)

Spatial goal localization can be made more precise by the use of multiple landmarks, but this can result in conflict if the landmarks indicate different goal locations. In recent studies from the Spetch lab, humans and pigeons have been shown to prefer a landmark located closest to a hidden goal. Most recently, we studied how pigeons weigh landmarks based on different kinds of reliability in a one-dimensional spatial search task on a touchscreen. Subjects were presented with two distinct cues on a line, and required to peck on a hidden location between the cues in order to obtain reinforcement. During baseline training, both cues could be used to predict the location of the goal, but one cue was made more reliable (based on proximity, location precision, or availability) across three experiments. During probe testing with both landmark cues shifted away from the goal, some birds' initial searches deviated toward the nearer or more precisely-located landmark, but not toward a landmark trained over more trials. I will discuss these results in the broader context of current understanding of how landmarks are integrated in spatial cognition.

4:42 PM **Risky choice in pigeons and humans**

Christopher Madan (University of Nottingham), Jeff Pisklak (University of Alberta), Elliot Ludvig (University of Warwick), & Marcia Spetch (University of Alberta)

69 Many studies of risky choice in humans have found greater risk seeking for relative losses than gains, in line with prospect theory. However, these studies require that the odds and outcomes for the risky options be described—a procedure that cannot readily be used in comparative studies. When humans instead learn the odds and outcomes through experience, they are sometimes more risk seeking for relative gains than losses. In a series of experiments, we systematically evaluated risky choice in pigeons using both open-field foraging and operant procedures. We also examined risky choice in humans using a minimally modified variant of the pigeon operant procedure, such that both tasks were as closely matched as possible. Risky choice was highly consistent across species and experimental procedures when the outcomes included a zero outcome (i.e., no money or food), but more variable when all choices led to a positive payoff. By investigating risky choice using a comparative approach, our findings suggest common biases across species that may be associated with adaptive memory systems.

4:56 PM **Sub-optimal choice as chasing anticipated prediction errors**

Elliot A. Ludvig, Jian-Qiao Zhu, & J. A. Max Rodriguez Cabrero (University of Warwick)

70 Many animals make sub-optimal choices, preferring less reward to more, when probabilistic outcomes are preceded by cues that resolve the uncertainty in advance. For example, pigeons will select a 50% chance of delayed reward over a 100% chance of that same reward, when the uncertainty about the 50% reward is immediately resolved by a cue. One theory for this sub-optimal choice is that animals have a preference for signals for good news. Here, we formalize this theory in a reinforcement-learning model, as a preference for positive anticipated prediction errors (APE). In the model, animals are assumed to anticipate the immediately next stimulus and exhibit a biased preference towards those that generate prediction errors. We show how the APE model provides a framework for understanding the effects of delay, probability, and magnitude of reward on sub-optimal choice. Based on model predictions, we designed two novel experiments with humans, which show how people also incur a monetary cost to find out early about upcoming rewards in a gambling task, yet avoid early information about aversive outcomes. This simple anticipatory mechanism is a strong candidate for explaining a wide range of sub-optimal behavior under uncertainty.

5:10 PM **Panorama learning and cue choice in the Australian desert ant, *Melophorus bagoti***

Cody A. Freas, & Ken Cheng (Macquarie University)

71 Animal navigators acquire and use multiple cue sets within their environment, which designate direction and distance estimates to goals. Navigational cues can conflict, requiring the navigator to integrate these cues before moving. Foraging ants are expert visual navigators known to use both learned panorama cues and path integration to navigate. Here, we explore panorama learning, memory retention and panorama cue strength in the Central Australian desert ant Melophorus bagoti. Foragers retain robust memories of both the nest skyline and multiple non-nest site skylines. Yet these foragers also show reduced navigational performance and evidence of retroactive interference after changes to the skyline at the same site. When presented with cue conflicts between the panorama and their path integrator, foragers choose dynamically based on experience and cue reliability in accordance with the Temporal Weighting Rule. Panoramas need to be learned both at the nest and while foraging: when foragers are restricted to the nest site, they are unable to extrapolate panorama cues from the nest to local sites. Ants only require one experience of the homeward route to learn the correct nest direction, but exposure to the outbound foraging path appears critical for efficient homeward route formation in this species.

6:00 PM Introduction

6:05 PM Master Lecture - Marcia Spetch

7:30 PM Banquet

Saturday Afternoon

12:00 PM Business Meeting of the Comparative Cognition Society

1:10 PM ☺ Group Photo Shoot ☺

1:30 PM Temporal Processing (Chair: James Rowan)

1:30 PM **Pigeons fail to anticipate the remaining within-session sequence when trained with multiple sequences**

Muhammad A. J. Qadri, Rebecca M. Rayburn-Reeves, & Robert G. Cook (Tufts University)

72 The traditional two-item midsession reversal task shows that pigeons respond to time-based cues in an anticipatory fashion. Previously, we demonstrated that this could extend to four-item within-session sequences, where each alternative is correct for 24 consecutive trials in a predictable sequence (i.e., A first, then B, then C, then D). In that preparation, pigeons show greater anticipation of the immediately upcoming correct response than distant upcoming correct responses. We added a second, consistent and predictable four-item sequence using four new and distinct choice alternatives (i.e, E first, then F, then G, then H). After these were trained with the same trial-based contingencies, we alternated these ABCD and EFGH sequences on successive sessions. Through testing and training the pigeons with trials composed of mixtures of both sequences, we determined that pigeons did not learn within-sequence associations among the elements. We will discuss potential methodological and cognitive sources that account for these results.

1:44 PM **Perception of Temporal Accents in Acoustic Patterns: Do Songbirds Feel the Beat?**

Brendon Samuels, Scott MacDougall-Shackleton, Jessica Grahn, & Molly Henry (Western University)

73 In the production and enjoyment of music, humans perceive patterns of regular accents that are often identified as "feeling the beat". Beat perception is fundamental to the synchronization of human motor behavior to external stimuli, such as tapping, clapping or dancing to a piece of music. This perceptual phenomenon was once thought to be unique to humans. However, some evidence suggests that other vocal-learning species, such as parrots, may also perceive a beat in rhythmic stimuli. Beat perception in non-human animals has primarily been tested by means of measuring the synchronization of an animal's movements to rhythmic sounds, though it remains possible that beat perception may occur in an animal independent of this synchronization ability. I will describe a novel operant testing paradigm used to examine the capability of the European starling, a vocal-learning songbird, to discriminate between rhythmic acoustic stimuli that either induce a strong or weak sense of a beat in human subjects. This research may indicate the viability of a songbird model of beat perception. The paradigm developed here can be adapted to test other animals, and may ultimately yield new information about whether beat perception, a core element of human musicality, occurs in other species.

1:51 PM Cognitive Processes III (Chair: Ken Cheng)

74 **Behaviour-reading and mental state attribution influence food-sharing behaviour in male Eurasian jays (*Garrulus glandarius*)**

1:51 PM *Michael Mendl (University of Bristol), Ljerka Ostojic, Edward W. Legg, & Nicola S. Clayton (University of Cambridge)*

Ostojic et al (PNAS 2013) showed that male jays observing their female partner being pre-fed one of two foods then preferentially shared the other food-type with her. This could reflect that the male inferred specific-satiety in the pre-fed female and hence fed her accordingly (mental state attribution), or that he responded to changes in her behaviour (behaviour reading). We investigated the interplay between these two processes. The male saw a bowl of one food-type (waxworms (W) or mealworms (M)) enter the female's compartment, which he could not see into, and then come out empty, implying that she had consumed the food. At the same time, we manipulated what the female actually ate during this pre-feeding phase (W,M) such that the female's actual state and hence associated behaviour were either matching or conflicting with respect to the inferential cue. When matching, males shared according to the female's inferred desire, but when conflicting, no biased sharing was seen. Male sharing behaviour thus appears to depend on an interplay between inferential and behavioural cues, indicating that males are capable of desire-state attribution, and that behaviour-reading and mental state-attribution may be complimentary processes influencing social decision-making in non-human animals.

2:05 PM **The role of expectancy violation in a spider's predatory strategy**

Fiona R. Cross, & Robert R. Jackson (University of Canterbury (New Zealand))

75

Portia africana, from the salticid subfamily Spartaeinae, is known to execute pre-planned detours for reaching prey. Previous research has also shown evidence of expectancy violation by this spider, with individuals being less inclined, for example, to complete a detour path if they encounter a different number of prey from what had been seen beforehand. In this new research, we show further evidence of expectancy violation by P. africana and 14 other spartaeine species, now in the context of planned detours. Each trial began with a spider on top of a tower from which it could view two boxes: one containing prey and the other not containing prey. The tower sat on a platform surrounded by water and the only way the spider could reach the prey without getting wet was by taking one of two circuitous walkways from the platform: one leading to the prey ('correct') and one not leading to the prey ('incorrect'). After leaving the tower, the spider could not see the prey and sometimes had to first walk past the incorrect walkway. Spiders chose and completed the correct walkway significantly more often but, if they chose the incorrect walkway, they were significantly less inclined to complete it.

2:19 PM **The body inversion effect in chimpanzees (*Pan troglodytes*)**

Jie Gao, & Masaki Tomonaga (Kyoto University)

76

Bodies are important social cues to animals. The body recognition in humans is deteriorated by inversion. This inversion effect suggests the configural processing of bodies, different from the way used for other objects. However, this is not clear in non-human primates. We tested seven chimpanzees using upright and inverted chimpanzee body stimuli and other stimuli in matching-to-sample tasks to examine the body inversion effect. Experiment 1 used chimpanzee bodies and houses. Experiment 2 used intact bodies, bodies with blurred faces, and faces with blurred bodies. Experiment 3 used intact bodies, bodies without faces, only faces, and body silhouettes. They showed the inversion effect to all intact body conditions, indicating the configural body processing. They also showed the inversion effect to faces with blurred bodies in Experiment 2 and to silhouettes in Experiment 3, suggesting the roles of faces and body contours in the inversion effect. The results suggest that in chimpanzees, bodies are also cognitively special compared with other objects.

2:26 PM *Break*

2:31 PM Tool-use, Problem Solving, and Causality (Chair: Frank Grasso)

2:31 PM **Why are smart birds so stupid?**

Anders Brodin, & Utku Urhan (Lund University)

77

In 2014 MacLean et al. published a paper on self-Control in 36 species of mammals and birds. Based on performance in the transparent cylinder test, they suggested that absolute brain volume was the best predictor of cognitive ability in general, and self-control in particular, in mammals and birds. Since that, data on three species of corvids and one parid has been added. The parid is the great tit, a small passerine that performs extremely well in this test, on a level that is comparable with the great apes and the large corvids. With the data on corvids and the great tit added to the data set of MacLean et al. I show that relative, or residual brain volume, becomes a much stronger predictor than absolute brain volume in birds. The latter, in fact, becomes non-significant as a predictor

for the performance of birds in this cognitively demanding test. Surpringly, birds perform less well than predicted in the test, and I discuss possible reasons for this.

78 2:45 PM **Seasonal overwinter temperature has no effect on problem solving or neophobic behaviour in Black-capped chickadees (*Poecile atricapillus*)**

R. Jeff Martin, & David F. Sherry (Western University)

Non-migrant birds like the Black-capped chickadee (Poecile atricapillus) that inhabit northern climates endure stressful winter conditions including food scarcity and short foraging windows. Previous studies have shown that birds inhabiting harsh climates and facing challenging environmental conditions have cognitive advantages over birds from less harsh climates (e.g. Roth et al. 2010, Proc Roy Soc B). These cognitive differences have been found between populations from different geographic latitudes and different altitudes. Although temperature is likely a major component of environmental harshness in these comparisons, previous studies have not isolated the specific effects of temperature. I examined the impact of seasonal winter temperature on cognition in a population of Ontario chickadees. Birds were housed outdoors and exposed to either natural variation in winter temperature or warm conditions produced by heating birds' outdoor enclosures. Individual performance on tests of problem solving and neophobia were scored. Results suggest that ambient temperature alone has no discernible effects on problem solving ability or neophobia.

79 2:52 PM **Analyzing zebra finch incubation using a computer model**

Tanya T. Shoot (Western University), Sophie C. Edwards (University of St. Andrews), R. Jeff Martin (Western University), Susan D. Healy (University of St. Andrews), David F. Sherry, & Mark J. Daley (Western University)

Birds that experience variation in climatic conditions must maintain a stable nest temperature during incubation for successful hatching of offspring. Varying nest structure and incubation behaviour may be the methods birds use to regulate nest temperature. We used a modeling approach to investigate how birds adjust incubation behaviour to ambient temperature. Hidden Markov Models (HMM) have been used previously to predict the spatial distribution of animals based on the models' ability to classify movement behaviour. We used a HMM to predict zebra finch (Taeniopygia guttata) incubation behaviour and nest structure from a nest temperature data set. The full data set consisted of data logger nest temperature records and video recordings of incubation behaviour in two different temperature conditions. Nest temperature from data loggers was used to obtain predictions about the timing, duration and frequency of incubation which could then be compared to video recordings of incubation behaviour and the structure of nests. This research explores new uses of computational techniques in animal behaviour, animal cognition, and behavioural ecology, provides new information about behavioural regulation of nest temperature during incubation, and develops practical techniques for inferring behaviour from data loggers in the field and in the lab.

80 2:59 PM **Causal Interventions in the Mouse, *Mus musculus***

Mary Flaim (University of California-Los Angeles), Denise Cai (Icahn School of Medicine at Mount Sinai), Alcino Silva, & Aaron P. Blaisdell (University of California-Los Angeles)

Causal and associative reasoning share many similarities in terms of how learning occurs and the complexity of learning. Nevertheless, causal reasoning goes beyond and allows the subject to make accurate predictions about their interventions. Specifically, both preschool children (Schulz, Gopnik, & Glymour 2007) and rats (Blaisdell et al., 2006) have been shown to make different causal inferences following interventions on an effect of a cause versus on the cause itself. We report a study investigating whether male C57BL/6 mice also these causal inferences. Mice received pairings between two neutral stimuli, Light◊Tone in Phase 1 of training. In Phase 2 of training, mice received pairings of Light with food on some trials, and a Noise with food on other trials. At test, a lever was inserted into the chamber and mice received presentations of Tone or Noise and feeder activity was recorded. Presentations of Tone or Noise were independent of lever pressing on Observation tests, but contingent on lever pressing on Intervention tests. We report the conditions that influenced whether or not we found evidence for causal inferences in mice.

3:06 PM Numerosity (Chair: Jennifer Basil)

81 3:06 PM **Exploring the Solitaire Illusion in Guppies (*Poecilia reticulata*)**

Christian Agrillo (University of Padova (Italy)), Audrey E Parrish (The Military College of South Carolina (USA)), Michael J Beran (Georgia State University (USA)), & Maria Elena Miletto Petrazzini (University of Padova (Italy))

The Solitaire illusion is a numerosity illusion that occurs when the spatial arrangement of items influences quantity estimation. To date, this illusion has been reported in monkeys, although it seems to be weaker compared to its prevalence in humans, and no study has investigated whether non-primate species perceive it. In the present work, we asked whether a more distantly related species, fish, perceive the Solitaire illusion. To achieve this goal, adult guppies (Poecilia reticulata) were trained to select the array containing the larger quantity of black dots in the presence of two mixed arrays containing white and black dots. After reaching the learning criterion, guppies were

presented with novel dot quantities, including test trials with two Solitaire arrangements. The overall performance of subjects indicated that they perceived the illusion, although analyses at the level of individuals indicated inter-individual differences. These results align with recent evidence from non-human primates suggesting that distantly related species also may perceive this illusion even though numerosity misperception arising from the Solitaire arrangement appears to be less robust than in human and non-human primates.

3:20 PM **Exploring the Density Bias in Nonhuman Primates**

Audrey E. Parrish (The Citadel), Kristin French, Courtney Creamer, Brielle T. James, & Michael J. Beran (Georgia State University)

82 The density bias is a phenomenon in which individuals overestimate or underestimate numerosity as a function of inter-stimulus distance. Human adults judge densely arranged sets as less numerous than sparsely arranged sets containing the same number of items. The opposite effect emerges for infants and callitrichid primates who prefer densely arranged food items. We presented rhesus and capuchin monkeys with a computerized relative quantity task to explore whether this bias was a more general phenomenon emerging in non-foraging domains. Both species performed above chance levels in selecting the larger of two dot sets given a true numerical difference and performed better when both sets were densely arranged than sparsely arranged. Consistent with previous primate work, capuchins preferred dense sets to sparse sets when there were an equal number of dots within each set. We also investigated whether capuchin monkeys might perceive the density bias in a foraging task using a two-choice discrimination paradigm. Monkeys selected the larger of two sets in control and test trials, and most monkeys preferred a densely-arranged set to the same number of food items in a sparsely-arranged set. Thus, the density bias appears to emerge across multiple domains and presentation formats for some primate species.

3:34 PM *Snack Break*

4:04 PM Choice (Chair: Ralph Miller)

4:04 PM **Do pigeons prefer pecking to the absence of pecking?**

Danielle Andrews, Thomas Zentall, & Jacob Case (University of Kentucky)

83 The principle of least effort suggests that animals should behave in a way that minimizes distance, effort, and time to reinforcement. Under this assumption, pecking should be somewhat aversive to pigeons because it requires both time and effort. It is well known that delay to reinforcement reduces the value of a reinforcer (delay discounting) but what about pecking as effort? Pigeons often peck when it is allowed but not required (e.g., fixed time schedules) but pecking may be adventitiously reinforced. In a recent experiment, we compared two schedules of reinforcement: fixed-interval (FI) in which reinforcement follows the first peck after the interval has elapsed and differential-reinforcement-of-other behavior (DRO) which requires pigeons abstain from pecking for a similar interval. The delay to reinforcement was matched on a trial-by-trial basis by extending the duration of the FI to match the DRO schedule. Of 12 pigeons, 6 preferred the DRO schedule and 6 were indifferent between the schedules. Those that were indifferent between the schedules had acquired the contingences as they responded appropriately to the two schedules. Individual differences in the preference of the pigeons may be related to their behavior during the DRO.

4:11 PM **Transitive Inference with four A stimuli**

Jacob P. Case, Danielle M. Andrews, & Thomas R. Zentall (University of Kentucky)

84 Transitive inference is the ability to infer the relationship between stimuli based on their trained relation between one or more other stimuli. Often the problem involves five stimuli, represented symbolically as A, B, C, D, and E. The stimuli are ordered in such a way that A is better than B, B is better than C, and so on. Training consists of learning the adjacent pairs, and testing with a choice between B and D. The transitive inference effect is the finding of a preference for B over D. One non-inferential account of a preference for B is that little is learned about the negative value of B in the AB pair because A is always the correct choice, whereas more is learned about the negative value of D in the CD pair because in the BC pair C is not the correct choice. In the present experiment pigeons were trained on a transitive inference problem with several A stimuli, the identity of which varied from trial to trial, to encourage learning about the negative value of B. The performance of this group was compared to a control group that received the traditional training with a single A stimulus.

Ego Depletion and Glucose Reversal in Rats: Evidence for a Metabolic Model of Self-Control?

4:18 PM

Julia E Meyers-Manor (Ripon College), & Jiayin Qu (Macalester College)

85

According to the strength model, exerting self-control consumes an energy resource and results in self-control depletion in subsequent tasks. However, past research reflects a contradiction in whether self-control depletion actually takes place and whether glucose can replenish self-control depletion. We proposed an imposition theory that aimed to reconcile the contradiction: (1) energy deprivation is the prerequisite condition; (2) the awareness of the deprivation modulates the extent. The results suggested that the rats showed more self-control depletion and the performance across different conditions was more consistent when they were on food deprivation compared to when they were not. There was also a marginal effect of the time of day of the deprivation. These results show a rat model of ego depletion is possible and suggest that metabolic models may be accurate in describing ego depletion in humans.

4:25 PM

Decision-making in humans and rats: Effects of physical effort on optimal choice

Tina Nelson, Kim Prescott, Thea Smith, Sarah Deslauriers, & Dr. Rebecca M. Rayburn-Reeves (Georgia Southern University Savannah GA)

86

Previous research has shown that humans will carry out a task as soon as possible, even when it results in a greater amount of physical effort (Rosenbaum et al., 2014). Specifically, humans will choose to carry a weighted bucket that is closer to the start point and carry it further rather than a bucket that is closer to the end point. The current study was designed to further assess why humans make this precrastination choice and what factors influence these choices. We recruited 50 undergraduate students to make a work effort decision between two buckets of equal weights placed at near and far intervals on the sides of a 16' runway. We found similar results as the previous study, but to a lesser extent. In Phase 2, we fatigued participants either physically or mentally prior to choice. In a comparative study, rats were tested using weighted wheels in a runway apparatus akin to the human task, where rats were given a choice between a close or far wheel from the start box over 12 trials. Results showed that for both species, adding weight to the items to be moved shifted choice to optimal performance.

4:32 PM

Greater baseline reinforcement rate increases both resistance to extinction and resurgence of operant behavior in zebrafish (Danio rerio)

Christopher A. Podlesnik (Florida Institute of Technology), Toshikazu Kuroda (Aichi Bunkyo University), Yuto Mizutani (Aichi Gakuin University), & Carlos R. X. Cançado (Universidade de Brasília)

87

Zebrafish (Danio rerio) is a promising animal model for studying how genes interact with environmental factors in determining behavior. In operant research with this species, a major question relates to whether their behavior follows the same principles as other model species (e.g., rats and pigeons). Previous studies showed that resurgence occurs in zebrafish after their behavior was reinforced and then extinguished. The present study investigated whether the magnitude of resurgence is a function of baseline reinforcement rate with zebrafish, as previously shown with rats, pigeons, and humans. In Phase 1, a multiple schedule delivered food reinforcers according to variable-interval 10-s and 60-s schedules for approaching a target sensor. In Phase 2, the target response was extinguished while reinforcing approach to an alternative sensor with a variable-interval 10-s schedule in both components. Resistance to disruption of target responding in Phase 2 was greater in the richer Phase-1 component. Finally, Phase 3 extinguished both responses in both components and also revealed greater resurgence in the richer Phase-1 component. These results are consistent with previous findings with other species, suggesting the processes underlying persistence and relapse are conserved across a diverse range of species.

4:46 PM

Symbolic Contingencies for Reward-Delay and Reward-Amount

Travis Smith, & Michael Beran (Georgia State University)

88

The present experiment was designed to assess whether more informative symbolic choice representations in an intertemporal choice task would allow capuchin (Cebus apella) and rhesus (Macaca mulatta) monkeys to make optimal choices across a range of reward delay and magnitude values that were combined and assigned to two options. Trials lasted 30-s total and an intertrial interval (ITI) kept trial spacing consistent. The pellet-amount information was cued by a box containing a number of circles corresponding to the number of pellets offered and the delay-to-pellet delivery information was cued by a stack of blue boxes with the delay corresponding with the height of the stack. Once an option was selected the top box in the delay stack for the selected option flashed and disappeared at a rate of 1 per sec, the stack decreased in height until the delay was over and pellets were delivered. Overall, when the optimal option was superior in both magnitude and delay it was overwhelming preferred (~ 96%), when only superior in magnitude it was often preferred (~ 85%), and when it was only superior in delay it was often not preferred (~ 36%).

4:53 PM

Effects of physical effort on decision-making in rats

89

Thea Smith, Daniel Crafton, Kimberly Prescott, Christina Nelson, Mary-Kate Moore, & Dr. Rebecca Rayburn-Reeves (Georgia Southern University)

When given a choice between two buckets of equal weight positioned at different distances from a starting location and asked to complete the easiest task, humans choose the closer option, even though it results in a greater amount of physical effort. This tendency to perform tasks immediately and at the expense of optimizing physical effort has been called precrastination (Rosenbaum et al., 2014) and may involve making decisions based on both mental and physical effort. Given that this effect has been shown in humans, and might depend on specific mental capacities unique to humans, the current study investigated whether it exists in non-human animals. We developed a 6', two-alley runway to assess whether rats develop a preference for a wheel placed closer or farther from a start box. At light weights, rats showed no preference for wheels based on distance; however, once enough weight was added, rats began showing almost exclusive preference for the farther wheel option. We then removed the weights in a reversal procedure and chance preference was again observed. These results suggest that rats may not display precrastination tendencies, but can learn to optimize physical effort when the difference between the two options is great enough.

5:00 PM **Symbolic Prosocial Choice Task in Neotropical (Ara) Macaws**

Jessica Leete, Jennifer Vonk (Oakland University), & Patricia Billette (The Creature Conservancy)

90

Few studies have investigated prosocial behaviors in birds, with most of these studies limited to corvids. Unlike ravens, jackdaws and azure-winged magpies, both of which are colonial breeders, and the latter - cooperative breeders – have exhibited prosocial tendencies. Some species of macaws from the genus Ara, are also colonial breeders and all are monogamous, thus, having reproductive ecologies that could have led to the selection of prosocial preferences. Using a symbolic Prosocial Choice Task, seven macaws were exposed to one of four targets per trial during training trials. Selection of each target represented one of four possible reward distribution outcomes (1/1, 1/0, 0/1, 0/0). In testing trials, macaws were presented with a forced choice of one of four possible target combinations: knowledge probe (1/0 versus 0/0); attention probe (0/1 versus 0/0); prosocial probe (1/1 versus 1/0); and spite probe (1/1 versus 0/0). Thus far, two macaws in testing select the 1/0 choice on the knowledge probe at above chance levels and one selects the 0/1 choice on the attention probe at above chance levels. Prosocial and spite choices are currently at near chance levels.

5:07 PM Closing Remarks (Olga Lazareva)

8:30 PM Poster Session II (8:30 - 11:00)

See Poster Abstracts Starting on Page 35

Poster Presenters: Please set up your posters between 8:00 and 8:30

Posters

Poster Session I - Thursday Evening

Do young rhesus monkeys know what others see?: A comparative developmental perspective

Alyssa M. Arre, & Laurie R. Santos (Yale University)

P1

Humans undergo robust ontogenetic shifts in theory of mind capabilities. It is still unknown whether this is a unique feature of human development or shared with other animals. As such, we tested a population of 240 infant and juvenile rhesus macaques (Macaca mulatta) using a looking-time method to explore what developing monkeys know about others' perceptions. Specifically, we explored whether younger monkeys predict that a person will reach for an object where she last saw it. Preliminary data analysis indicated that infant rhesus monkeys (younger than one year of age) do not show longer looking when an agent acts inconsistently with what she has seen regarding the location of a hidden object. On the contrary, juvenile monkeys (between two and five years of age) do look longer when an agent acts inconsistently with what she has seen than when she acts consistently. Further analyses will pinpoint the age at which this ability comes online, and will seek to further illustrate the developmental trajectory across the entire juvenile period (under five years of age). Our findings suggest that despite divergent socioecology, rhesus macaques show some delayed, but human-like, developmental parallels in their understanding of others' perceptions.

P2 **Creating a morphological atlas for *Canis Latrans***

Katherine Athanassiades, & Gregory Berns (Emory University)

Limited research has been conducted on the brain of Canis Latrans (coyote). Much of the known information are comparisons in size, shape, and weight to other mammalian brains. Due to the lack of previous research, little is known about the relationship between a coyote's behavior and neurological structure. What is lacking is a comprehensive atlas for the various regions and structures of the coyote brain. The purpose of this research is to create a comprehensive atlas that provides locations for various structures in the brain. From there, further research can be done that analyzes the brain structures and organization, with a goal of better understanding the complex natures of coyotes.

Personality and Cooperative Task Performance in Bottlenose Dolphin (*Tursiops truncatus*) Dyads

Kimberly C. Bagley, Preston Foerder (University of Tennessee at Chattanooga), Kelley Winship, & Teri Bolton (Dolphins Plus Marine Mammal Responder)

P3

Although cooperation is a common tactic amongst social animals for survival, under research conditions, not all animals cooperate with each other. Although there are increasing amounts of research, into personality, the exact traits across two animals that combine to produce cooperation have not been studied. Dolphins exhibit cooperation in the wild in food and mate acquisition. This study examined the relationship between cooperation and personality in bottlenose dolphin (Tursiops truncatus) dyads. Eleven bottlenose dolphins at the Roatan Institute for Marine Sciences (RIMS) were paired and presented with an apparatus that encouraged the dyads to cooperate by simultaneously pulling in opposite directions in order to release a food reward. Personality profiles of each dolphin were completed by the caretakers, in particular noting two different categories of interactions: dolphin-dolphin and dolphin-object. Although none of the dolphin pairs solved the problem, we are able analyze these categories in relation to the dolphins' mutual interactions with the apparatus. We hypothesize that these mutual interactions are related to the similarity of personality traits between dolphins and their individual willingness to interact with objects. These results could guide future research on the relationship between personality and cooperative problem-solving across species.

Effects of Enrichment on Long-Term Captivity in European Starlings (*Sturnus vulgaris*)

Sidney Beecy, Suzanne Gray, Muhammad Qadri, Brenna Gormally, Michael Romero, & Robert Cook (Tufts University)

P4

Undomesticated animals are prone to developing abnormal behaviors in captivity, such as stereotypies, but the physiological stress profiles of these animals can vary widely. This study examines the effects of social and environmental enrichment on the stress levels of eight starlings in long-term captivity. Originally, the starlings were housed in individual bird cages that were attached to experimental apparatuses. Enrichment was provided using an aviary approximately 9x larger in volume than a home-cage, containing perches, toys, food, and water. Two groups of four starlings spent three hours in the aviary twice a week. Blood was sampled at regular intervals to determine CORT profiles using a three-part measurement (baseline, stress-induced, and negative feedback) related to physiological stress. Additionally, the birds were video recorded weekly in their home-cages and in the aviary in order to examine behavioral effects. These methods are designed to identify a relationship between CORT profile and stereotypic presentation in these starlings and to determine if the implementation of the enrichment aviary reduces physiological stress, reduces behavioral stress, or both.

Rule-Based and Information Integration Visual Category Learning in Rats

Matthew B. Broschard, Jangjin Kim, Edward A. Wasserman, & John H. Freeman (University of Iowa)

P5

The COVIS (COmpetition between Verbal and Implicit Systems) model postulates two systems in humans that learn new categories: a declarative system that mediates rule-based (RB) tasks and a non-declarative system that mediates information integration (II) tasks. Humans and monkeys, but not pigeons, learn RB tasks faster than II tasks; however, it is unknown whether this advantage is unique to primates. Therefore, we trained rats on RB and II tasks using circular stimuli with black and white gratings that differed in spatial frequency and orientation. For the RB groups, category distributions were calculated according to the relevant dimension (either spatial frequency or orientation). These distributions were rotated 45 degrees for the II tasks. Similar to pigeons, no difference in learning rate was observed between RB and II groups. Testing sessions used broader distributions to assess category generalization. For all groups: accuracy decreased as the distance from the category mean moved toward the decision boundary, whereas accuracy increased as the distance from the category mean moved away from the decision boundary. These findings indicate that rats do not exhibit an advantage for RB learning and therefore might not utilize executive function in visual category learning to the same extent as primates.

Discrimination training and odorant concentration influence scent detection performance of *Cricetomys ansorgei*

Sydney M. Brotheridge, Haylee Ellis, Kate Sears, Cynthia D. Fast, & Christophe Cox (APOPO)

P6

APOPO's African giant pouched rats (Cricetomys ansorgei) sniff out tuberculosis (TB) in human sputum samples to increase detection of TB by >40% in resource-poor areas of Africa. The concentration of mycobacterium tuberculosis and other non-TB-related odors varies substantially across samples, making generalization across a range of TB-related odors crucial to the rat's TB-detection success. Using pure odorants, we investigated how training samples impact the rat's ability to generalize across a range of odorants. Experiment 1 trained rats to respond to a high (H+) or low (L+) concentration of an odorant. Probe trials across a range of concentrations revealed peak responding at the trained concentration. In Experiment 2, some rats were reinforced for responding to high, but not low, concentrations of the odor (H+/L-), while others received training with the reverse contingencies (H-/L+). Although H-/L+ was empirically more difficult to solve, these rats demonstrated superior generalization across a range of odor concentrations when

tested. Experiment 3 further examined this relationship while controlling for stimulus magnitude effects by varying the ratio of two odorants appearing in a mixture. The results of this project have implications for olfactory learning mechanisms and could inform best training practices to optimize rat scent detection applications.

Variations of the Odor Span Task used to Study In-Context Remembering in Rats

Shandy A. Nelson, Sarah Krichbaum, Nick Blackburn, Kyle Chenevert, Katherine Dyer, Haily Kelliher, Aliana Raulerson, MacKenzie Wantje, Nicole Webster, Bobbie Wolff, Mark Galizio, & Katherine Bruce (University of North Carolina Wilmington)

P7

The Odor Span Task (OST) is an incrementing non-match to sample procedure used to study remembering in rodents. In this task, responding to a novel odor stimulus is reinforced, but responding to a stimulus previously encountered within the session is not reinforced. The task can be adapted to study in-context memory in rats by adding a "where" component and presenting scents in more than one context during a session. Responding to scents the first time they are presented in either context is reinforced, and subsequent responding to those scents in each context is not. In several experiments, rats received OST training with some trials conducted in a circular arena (Context 1) and others in a modified Radial Arm Maze (Context 2). Probe trials were presented in which an odor was repeated, but in a context different from its initial presentation. On some probe trials, both familiarity and in-context memory could account for responding, but in other probes, only in-context memory would be effective. The results of these studies showed evidence for in-context memory in some conditions, but only familiarity-based responding in others. These results support further research to assess the critical determinants of in-context responding in the OST.

Enriching Tigers Young and Old: The Behavioral Effects of Environmental Enrichment and Age in a Large Sample of Captive Tigers (*Panthera tigris*)

Kate M. Chapman, & Chase Holiman (University of Arkansas)

P8

Environmental enrichment is typically used in zoos, laboratories, and refuges to reduce negative behaviors (e.g. stereotypy) and increase positive behaviors in captive animals. While previous studies have examined the effects of environmental enrichment on captive felids, significant effects are rare due to small sample sizes and the inclusion of multiple felid species. This study evaluated the efficacy of several types of enrichment in an age-diverse sample of 55 captive tigers (Panthera tigris) at Turpentine Creek Wildlife Refuge. Using focal-animal and time sampling, tiger behavior was assessed in both enriched and baseline conditions. The within-subjects paradigm included scent-only, scented organic object, scented inorganic object, unscented inorganic object and feeding enrichment. Tigers engaged in more active behaviors during three specific types of enrichment compared to baseline sessions; scent only, scented organic object, and food enrichment. Food enrichment generated the highest levels of activity. Lack of significant effects for other enrichment types may be due to high degrees of within-subjects and between-subjects variability. There was no correlation between age and activity level overall, which may reflect compensatory mechanisms in geriatric tigers and/or individual differences. However, group level comparisons revealed that juveniles were significantly more active than adult and geriatric tigers overall, as expected.

Individual and Group-Level Differences in Stereotypy in a Large Sample of Captive Tigers (Panthera tigris)

Chase Holiman, & Kate M. Chapman (The University of Arkansas)

P9

Animals often experience increased levels of stress in captivity, resulting in stereotyped behaviors (e.g. pacing) and reduction in species-typical behaviors. Environmental enrichment is used to reduce negative behaviors and increase positive behaviors in captive animals, but stereotyped behavior often remains. Anecdotal observations from researchers and care staff indicate that dramatic individual differences in stereotypy exists, even among siblings or co-housed individuals. This study used focal-animal and time sampling to assess individual and group level differences in stereotypy in a sample of 55 captive tigers (Panthera tigris) at Turpentine Creek Wildlife Refuge. Tigers of varying ages and phenotypes (i.e. orange, white) were observed during environmental enrichment sessions and baseline sessions over the course of several years. Rates of stereotypy were very low in this sample; mean stereotypy across all individuals and sessions was 3.14%, though the minimum/maximum stereotypy rate for a single subject/session ranged from 0%-37%. Fewer than half of the subjects exhibited stereotypy at all. Despite the low rates of these behaviors, more stereotypy occurred in baseline than enrichment sessions. This suggests that even in a comparatively low-stress population, the use of enrichment can further reduce stress-related behaviors and individual differences must be considered when developing animal management plans.

Same/Different Visual Discrimination using a Differential Outcomes Procedure with Rats

Lauren Cleland, Cheyenne Elliot, Sydney Wilson, Sarah Jones, & Kenneth Leising (Texas Christian University)

P10

In an instrumental differential outcomes procedure, different responses result in unique outcomes (e.g., R1-O1; R2-O2). This procedure facilitates performance in discrimination tasks. The current experiment examined the effect of differential outcomes on performance in a same/ different task with rats. In the task, a sample stimulus was displayed on an iPad and after a delay of 1000, 1500, 3000, or 6000-ms was followed by either the same or a different stimulus. After a touch to the second stimulus, two response locations were presented on the screen. One location represented a "same" response, while the other represented a "different" response. The experimental group was reinforced with one outcome for a correct "different" response and another outcome for a correct "same" response. The control group of rats was reinforced with only one outcome for both correct "same" and "different" responses. After training, rats were tested with novel exemplars to examine transfer of a same/different concept. No differential outcomes effect was found, but interestingly, both groups performed better with longer delays.

Using Raspberry Pi to explore cheaper alternatives of operant chambers and discrimination learning in rats

Daniel Crafton, Andrew Goetz, Mark Kate Moore, & Dr. Rebecca Rayburn Reeves (Armstrong State University)

P11

Non-human animal research, especially in rats, most commonly uses the remarkable operant chamber created by B.F. Skinner as the backbone for experiments. These chambers are prevalent in the majority of rat labs throughout the country. The problem that has surfaced with the increased popularity of these chambers, along with the associated software package, is that the costs of a single chamber equipped with basic hardware is extremely high. A simple startup for lab-based research using eight of these chambers, available from only a handful of companies, comes at a cost of several thousand dollars. We set out to explore alternatives of creating a more affordable, updated, apparatus for conducting cognitive and behavioral research with rats. We used a single board computer, called a Raspberry Pi, to create a program that measures operant responses using touchscreen technology. This allows researchers to conduct the same types of experiments conducted in the old operant chambers at a fraction of the cost. Preliminary data suggest that the touch screen apparatus provides a highly comparable method for generating behavioral patterns indicative of those obtained with operant chambers in rats.

Spatial Information Processing in Japanese Quail

Chelsey Damphousse, Diano Marrone, & Noam Miller (Wilfrid Laurier University)

P12

Location-specific expression of immediate early genes (IEGs) support the brain's representations of space. Within the mammalian hippocampal formation (HF), different patterns of IEG expression encode different environmental contexts. Little is known about how or whether the avian HF performs similar functions. To address this, we examined Egr1 expression in a non-flying species, Japanese quail, following controlled exploration of a novel environment. We find that Egr1 expression is both upregulated by spatial experience and that the pattern of Egr1 expression closely resembles that observed in mammals. Egr1 expression also varies across regions of the avian HF in a manner consistent with their proposed mammalian homologues. To assess the spatial memory capabilities of quail, we developed a testing battery with tasks assessing one or more of the three components of episodic-like memory: object identity, location, and context, with the final task involving a combination of all three elements. Quail succeed at object recognition but failed when the task required remembering more than one element. By determining the boundary conditions for spatial information that quail can reliably use to solve tasks, we are able to establish the groundwork for further examination of functional homologues between the avian and mammalian hippocampal formations.

Visual Discrimination in Archerfish: Development of Instrumentation and Protocols

Adam Davila (Villanova University), Alexander Brown (Lafayette College), & Michael Brown (Villanova University)

P13

Archerfish (Toxotes spp.) are known for their ability to accurately spit streams of water to down aerial prey. This spitting behavior has been trained as a response to stimuli, analogous to nosepoking, pecking, or pointing in other laboratory animals. This poster will detail some of our efforts to develop procedures to experimentally investigate archerfish choice behavior and cognition. There is little existing literature to draw upon when building apparatus, achieving appropriate motivational states (i.e., food deprivation), reinforcer preferences, automating data collection, and other factors that are well known in common laboratory animals. Over the last year, we have used a variety of procedures to elicit and measure spitting responses in archerfish. These include shaping fish to spit at water sensors so that we could automate the data collection process. The techniques we have used to train fish and preliminary results from visual discrimination procedures will be presented.

A Search for Symmetry in Rats Using a Go, No-Go Procedure

Katherine Dyer, Sarah Accattato, Logan Richardson, Katherine Bruce, & Mark Galizio (University of North Carolina Wilmington)

P14

Evidence of equivalence relations, especially the symmetry relation, has been difficult to find in animals. Urcuioli (2008) reported a successful search for symmetry in pigeons using successive matching-to-sample procedures that trained both identity and arbitrary relations. However, Prichard et al. (2015) were unable to replicate these results in rats with odor stimuli. One possible reason for that failure is that successive odor presentation may have produced compound odors that were different in training and testing. The current study was a replication of Prichard et al. with the insertion of a masking odor between the sample and comparison odors to prevent such compound formation. Five rats completed baseline training under these conditions and four of them showed potential evidence of emergent symmetry, with higher response rates on positive symmetry probe trials than on negative trials. However, after the first two probe sessions, responding to all probe trials decreased with no evidence of differential responding to the probe trials. These results provide some support for Urcuioli's (2008) theory of class formation, but suggest that extinction of responding on probe trials may limit the use of this strategy in rats.

Emotion Labeling with Visual Stimuli: The Effects of Physiological Responses on Conditioning

Elliott Cheyenne, Willie Cassidy, White Jackson, & Leising Kenneth (Texas Christian University)

P15

Emotion labeling occurs when one learns to identify, discriminate, and act upon internal sensations caused by external events. Emotion labeling can be facilitated by language but can also be learned by nonverbal humans using visual labels. The focus of our current studies was to investigate whether or not typically developing humans could learn to label their physiological responses to the delivery or omission of a reinforcer (points) following a touch to a discriminative stimulus. Results indicated that participants failed to learn the task across three experiments, and instead chose between

labels at random. We discuss potential causes of these failures to learn and future research using visual labels to facilitate emotional learning.

Meat or veggies? Assessing food preferences in domestic dogs with simultaneous choice tasks

Julia Espinosa (University of Toronto), Emma Tecwyn (Cardiff University), & Daphna Buchsbaum (University of Toronto)

P16

Establishing food preferences is a necessary step to many cognitive tests on canines, yet no work has so far compared a wide array of methodologies used to establish food preferences in simultaneous choice tasks. Such tasks involve simultaneous presentation of food items that are unequal in value and/or quantity, with subjects allowed to choose only one item. We provide the first systematic exploration of how different ways of presenting food items in a simultaneous choice task influence dogs' choice behaviour. In 4 experiments dogs chose between high-value (hot dog) and low-value (dried corn kernel) food items. Across studies we varied item presentation: resting in the experimenter's palms (Exp. 1), on plates (Exp. 2), contained in cups (Exp. 3), as large quantities contained in separate jars (Exp. 4). We did not observe differences in choice preferences across presentation forms. Further, each version of the simultaneous choice task revealed preferences at chance level when comparing high and low value food items, raising questions about the validity of simultaneous choice tasks. We discuss results in the context of methodological innovations for simultaneous choice tasks in canine cognition research, and the role of preferences in an individual's choices and behaviour.

Do Rhesus monkeys also experience face pareidolia?

Molly Flessert (Georgia State University), Jessica Taubert (Laboratory of Brain and Cognition (NIMH/NIH)), David A. Leopold (National Institute of Mental Health Section on Cognitive Neurophysiology and Imaging), & Leslie G. Ungerleider (Laboratory of Brain and Cognition (NIMH/NIH))

P17

Face pareidolia – the misperception of faces in inanimate objects – is an error of the face detection system and is often experienced by humans. Here, we tested five male rhesus macaques to investigate whether this phenomenon is unique to humans. During a looking preference task, 15 examples of face pareidolia, 15 content-matched object images, and 15 conspecific face images were presented in pairs to the subjects while we recorded their natural eye movement behavior. All subjects looked longer at illusory faces than at content-matched objects with no face-like configuration. Further analysis revealed that subjects frequently fixated on the "eye" and "mouth" regions for both illusory and conspecific face stimuli. This result is consistent with previous studies of primate gaze behavior when viewing real faces. On the other hand, contented-matched object stimuli produced more variable patterns of fixation, resulting in a clear distinction between this category and the two "face" categories. Additionally, a support vector machine classifier successfully predicted, based on the fixation density patterns for each stimulus, whether each subject was viewing an object with an illusory face or not. Overall, these results indicate that monkeys, like humans, experience face pareidolia.

Assessing the SNARC Effect in Rhesus Monkeys and Capuchin Monkeys

Kristin French, Travis Smith (Georgia State University), Audrey Parrish (The Citadel), & Michael Beran (Georgia State University)

P18

The Spatial Numerical Association of Response Codes (SNARC) effect occurs when quicker responses are given to one side of a spatial array for small numbers and to another side for large numbers when making numerical judgements. Evidence of the SNARC effect in nonhuman animals, including chimpanzees, rhesus macaques, and newborn chicks, suggests that it may have an evolutionary basis. The current study assessed the potential SNARC effect in capuchin monkeys and rhesus monkeys using methods adapted from the design of Rugani et al. (2015) and Diamond et al. (2015). Monkeys were first given a computer task in which they had to choose between identical quantities (2vs2, 8vs8, or 32vs32) placed at left and right on the screen immediately following error-free training with contacts to a centrally located set of 5 or 20 items. A second task required monkeys to choose either the smaller or the larger of two sets of 2 to 8 items. There were no SNARC effects found with either species during the first task, and only limited evidence of the SNARC effect in the second. These data indicate that the SNARC effect may not be a robust phenomenon in nonhuman primates.

Factors affecting Memory in an Incrementing Non-Matching-to-Sample Task in Rats.

Katherine Bruce, Sarah Accattato, Katherine Dyer, Haily Kelliher, Shandy Nelson, Logan Richardson, Thomas J. Wagner, Nicole Westrick, Bobbie Wolff, & Mark Galizio (UNC Wilmington)

P19

Available procedures to study working memory capacity in rodents generally use manual arena or maze tasks. For example, the odor span task uses an incrementing non-matching-to-sample procedure in which digging in cups scented with novel olfactory stimuli results in reinforcement on each trial, while responses to previously presented stimuli are not reinforced. The present study modified this procedure for use in an automated operant chamber using a 15-channel olfactometer. Rats were trained on a go, no-go procedure to make nose-poke responses in a port through which odorants were delivered. Responses to each odorant were reinforced on an FI 5-s schedule the first time it was presented, but once an odor had been presented, responses to that odor were no longer reinforced. Rats rapidly learned to differentiate between session-novel and session-familiar odors and responded at high rates to new stimuli and much lower rates to repeated stimuli. Determinants of remembering were assessed by manipulating a number of variables including frequency and recency of repeated odors, a mid-session delay, and a distractor task. Accuracy was affected by all these variables, but the greatest disruption was observed after a mid-session delay, with or without a distractor task.

Walking Direction and Attentional State Effects on Predator Avoidance Behavior in Eastern Gray Squirrels

Kristy Gould, Anika Hansen, Grant Goss, & Nicole Weber (Luther College)

P20

Two students each led multiple teams of students enrolled in an Animal Cognition psychology course in collecting behavioral data from Eastern gray squirrels on the campus of Luther College over two semesters. The research was based on Bateman & Fleming (2014) who investigated the role of humans as potential "predators" on squirrels in a public park. Direction walked and attentional state of the "predators" were manipulated in both the 2014 study and our study. Our study included walking either directly toward the squirrel or at a 45-degree angle while looking down, at a cell phone, up, or directly at the squirrel. The distance from the "predator" to the squirrel when it became alerted, the distance from the "predator" to the squirrel when the squirrel fled and the distance fled were measured. A significant effect of walking type was found, but no effect of attentional state. Attentional state was found to be a significant factor in the 2014 study. Results are discussed both in terms of what they say about squirrel avoidance behavior and in terms of the project being a good way to introduce students to research methods and data collection in animal behavior and cognition.

Orangutan health and behavior: Implications for nutrition in captivity

Rachel Hamilla (Kent State University)

P21

Zoo-housing of great apes is beneficial to conservation efforts, and captivity provides valuable research opportunities. However, captive life is inherently different than wild, as specifically seen in dietary content and general behavior. The present study aims to explore this by examining the effects of diet on the health and behavior of captive Bornean orangutans. High-starch/low-fiber commercial biscuits largely supplements the diet of zoo-housed orangutans, creating a wide discrepancy between the fiber content of captive and wild diets. This discrepancy may play a role in the weight problems and cardiovascular/respiratory issues common of captive apes. Subsequently, these health issues may be linked to behavioral abnormalities. This study will implement a diet change to eliminate the biscuit and increase fiber content. Data collection will include: blood samples to monitor physiological markers of potential health problems, observations recorded using an ethogram to monitor undesirable behaviors and overall time spend active, and weigh-ins throughout the course of study to ensure all subjects maintain a healthy weight. This study hopes to find that the diet manipulation and increased opportunities to forage will lead to decreased undesirable behaviors, increased time spent active, and a lower risk of disease.

Dissociation of Explicit and Implicit Memory in Rhesus Monkeys (*Macaca mulatta*)

Thomas C. Hassett (Emory University), Benjamin M. Basile (National Institute of Mental Health), & Robert R. Hampton (Emory University)

P22

Human memory taxonomies distinguish between explicit and implicit memory systems in part by the degree to which these systems are accessible to memory monitoring. The degree to which nonhuman memory systems also differ in accessibility to memory monitoring is understudied. We compared the accessibility of long-term habit and short-term working memory to monitoring in rhesus monkeys. We parametrically instilled weak, medium, and strong habits by biasing the presentation of specific stimuli within 144 image quads in a matching-to-sample paradigm. In addition, we parametrically modulated the usefulness of working memory by varying the duration of the retention interval. As intended, monkeys were more accurate on trials where habit was strong, and less accurate on non-habit trials where the delay interval was long. Critically, memory monitoring robustly tracked changes in accuracy due to retention interval, but only weakly tracked changes in accuracy due to habit. These results imply a dissociation between implicit and explicit memory in nonhuman primates, and thus that this aspect of the human memory taxonomy is phylogenetically conserved among Old World primates.

Persistence in an unsolvable task is associated with working dog performance

Lily Strassberg, Lucia Lazarowski, Sarah Krichbaum, Paul Waggoner, & Jeffrey S. Katz (Auburn University)

P23

Dogs' tendency to look at humans when faced with an unsolvable task has been interpreted as a socio-cognitive and communicative mechanism in domestic dogs. Alternatively, perseverating on the unsolvable task instead of looking to humans for help has been suggested as a measure of persistence and resistance to extinction (Hall 2017). We tested 40 detection dogs-in-training ranging from 3 to 10 months old on an unsolvable task (toy inside a locked transparent container) in the presence of a human experimenter and measured persistence (time spent interacting with the apparatus) and human-directed social behavior (gazing at and interacting with the human). We found that persistence increased with age while human-directed behaviors decreased. Additionally, individual level of persistence was correlated with several measures of dogs' training evaluations indicative of desirable detection dog performance. Our results suggest that training, in particular for roles in which dogs work more independently from humans, may increase persistence on the unsolvable task. Further, our findings indicate the utility of the unsolvable task in measuring persistence in dogs, which may be used to develop more objective definitions of traditionally subjective working dog behavioral characteristics as well as for identifying and selecting appropriate dogs for working roles.

Walden - a new way to make behavioral research at the laboratory

Alejandro Rodrigo, Laurent Avila-Chauvet, José-Natividad Moreno, & Yancarlo Ojeda (Centro de Estudios e Investigaciones en Comportamiento - Universidad de Guadalajara)

P24

There are many limitations in the third world countries to develop valuable behavioral research. Among them, the high costs of purchasing laboratory equipment and the lack of resources to support science restrict the improvements in this field. Due to this issue, many researchers have developed their own equipment to resemble traditional apparatus such

as the Skinner box. Unfortunately, there are many experimental questions that cannot be answered with this device. Many studies that include the record of locomotion patterns, such as foraging behavior or spatial behavior are outside the scope. Besides monetary restrictions, other factors can interfere with the evolution of behavioral research. Between them, the absence of companies developing innovative equipment -at a low cost- to study the mechanisms behind the animal behavior and also the lack of flexibility within the equipment to adjust to specific necessities of behavioral researchers. . A possible solution to this matter is "Walden". "Walden" is a low-cost customizable modular equipment which allows behavioral researchers not only to replicate the traditional tasks used in behavioral research (e.g. Skinner box, Open field, and mazes) but also to create ingenious solutions by assembling the modules into a more personal and suitable equipment to answer their own questions.

The development and implementation of a simple free-operant maze navigation apparatus

E. Carlos Ramirez, & W. David Stahlman (University of Mary Washington)

P25

Traditionally, the collection of spatial navigation data in animal learning preparations has typically been some combination of arduous, inefficient, inflexible, and costly. Standard appetitive preparations involve conducting trials in a serial fashion, necessitating a great deal of handling on the part of experimenters. Such preparations are also by necessity limited in the types of reinforcement schedules that may be employed (typically FR-1 and extinction). We outline an inexpensive and simple apparatus that allows for the implementation of a much wider array of conditions, including a variety of reinforcement schedules and controlled variation of the delivery of multiple reinforcers within a single session. This apparatus can be installed in a variety of maze types, is highly modifiable, and dramatically reduces the need for handling individual animals, as iterative opportunities for reinforcement are automatically presented depending on the animal's performance. We present cumulative performance records on several schedules of reinforcement and highlight possibilities for future research.

Personality and problem solving in zebra finches

Lisa Barrett (University of Wyoming Program in Ecology and University of Wyoming Department of Zoology Physiology), Jessica Marsh (University of Wyoming Department of Zoology Physiology), & Sarah Benson-Amram (University of Wyoming Program in Ecology and University of Wyoming Department of Zoology Physiology)

P26

Individual differences in how animals respond to their physical and social environments represent a new and exciting area of research within the field of behavioral ecology. Animal personality, defined as individual behavioral responses that are stable over time or context, is pervasive across the animal kingdom and has substantial fitness effects. Personality may also interact with other traits, such as cognition, to impact how animals respond to and solve novel problems. For example, bolder individuals may solve a novel task more quickly than shyer individuals. Previous studies have shown an effect of both personality and cognition on mate choice and reproductive success. Zebra finches are a model species for studies of personality, cognition, and mate choice, yet we lack an understanding about how personality and cognition interact in this species. We present preliminary results of birds' performances on personality and problem-solving assessments. We investigate whether there is evidence of repeatable individual differences in personality assessments, examine sex differences in personality and cognitive abilities, and identify which personality traits influence performance on problem-solving tasks. We conclude by describing future research, which will investigate performance of dissimilar and similar personality pair-bonds of zebra finches on cognitive tasks requiring coordination of pair members.

Working memory in Tiger Salamanders' (*Ambystoma tigrinum*)

Shannon M. A. Kundey, Alexander Sexton, Aleyna Fitz, Anne Lessard, Roberto Millar, & Danielle Ali (Hood College)

P27

We explored tiger salamanders' (Ambystoma tigrinum) ability to retain information in working memory over various durations. In a first phase, salamanders were trained that one of four possible compartments would lead to reward (return to the home cage) on each trial. The rewarded compartment, which varied pseudorandomly between trials, was indicated by a symbol as salamanders watched from a holding area with a window that was centered across from the four compartments. During the first phase, the symbol remained visible during choice. All salamanders learned to approach the compartment marked by the symbol. During a second phase, salamanders again watched from a holding area as a symbol indicated the rewarded compartment. In the second phase, the symbol was only present for 10 s. Following the symbol's disappearance, salamanders were released from the holding compartment after increasing delays to evaluate their working memory. As the delays increased, salamanders were less likely to locate the rewarded compartment correctly. The maximum delay tolerated varied across individuals.

Changes in a dolphin's echolocation clicks across object sets in a matching task

Heidi E. Harley (New College of Florida Disney's Epcot's The Seas), Whitlow W. L. Au (University of Hawaii), John Atkins (Ocean Instruments New Zealand), Henri Volpilier (Ecole Polytechnique Palaiseau), & Wendi Fellner (Disney's Epcot's The Seas)

P28

Dolphins use echolocation clicks to investigate objects. Previous studies have suggested they rarely change their click structure across objects, but some data suggest that they do. Here we recorded clicks of an echolocating dolphin as he performed a 3-alternative matching-to-sample task across a variety of object sets. The dolphin used his mouth to carry a bite-plate apparatus with a dowel extending from the bite plate to support a hydrophone. The detected signals were digitized and stored on a modified SoundTrap recording device attached to the dowel. We calculated four attributes of the clicks: peak frequency, center frequency, RMS bandwidth, and RMS duration. All attributes changed significantly across object sets.

Defining creativity and confirming understanding of the concept in dolphins

Deirdre Yeater (Sacred Heart University), Heather Hill (St. Mary's University), Kathleen Dudzinski (Dolphin Communication Project), Teri Bolton (Roatan Institute for Marine Sciences), & Holli Eskelinen (Dolphins Plus)

P29

Many facilities demonstrate dolphin cognitive abilities by training animals to "execute a unique and/or distinct behavior." Testing the degree of creativity of dolphins has required the establishment of a concept-oriented cue, the "innovate" SD. The subtle intricacies of training the innovate SD have not been studied systematically across facilities. Moreover, there are differing criteria for what is considered novel behavior in the research examining it to date. Our goal is to establish a training and research protocol for using the innovate SD to assess the creative abilities in non-human species. We compared training methodologies used with dolphins for the innovate behavior. Our review, and discussions with trainers, indicated that a number of potential pitfalls occur when training this cognitive task (e.g., avoiding shaping a chained behavioral response). There were also issues with dolphin(s) understanding that resulted in superstitious behavior and frustration. Knowledge gained from this review will allow a clear definition of the criteria accepted as novel behavior as well as to better understand creativity, as measured by human-influenced constructs: fluency, flexibility, originality, and elaboration. This application of human-based measures will facilitate cross-species comparisons.

North American River Otters (*Lontra canadensis*) use Shape and Color to Discriminate Between 2D Objects

Evan Morrison, Caroline M. DeLong (Rochester Institute of Technology), Catina Wright (Seneca Park Zoo), Kathryn Gardner, Henry Rachfal, Meredith Gamble (Rochester Institute of Technology), K. Tyler Wilcox (University of Notre Dame), David Frye, Hannah Thorner, Irene Fobe, & Jennifer Dami (Rochester Institute of Technology)

P30

We explored the ability of two North American river otters (Lontra canadensis) to visually discriminate between 2D objects. This project is part of an ongoing study at the Seneca Park Zoo (Rochester, NY). The goal of the current experiment is to determine whether otters trained to discriminate between objects varying in both shape and color can use either feature alone, and to determine which feature may be more salient for otters. Otters were trained in a two-alternative forced choice task to discriminate between a red circle and a blue triangle to a criterion of 75% correct. Test sessions contained probe trials (always reinforced) containing novel shapes, colors, or shape-color combinations. Heather chose the probe stimulus with the same shape as her training stimulus 82% of the time, and the same color as her probe stimulus 71% of the time. Sailor chose the probe stimulus with the same shape as his training stimulus 67% of the time, and the same color as his probe stimulus 69% of the time. These results suggest that otters can use either color or shape to discriminate among objects. This research can be used to support future conservation efforts for this species.

Poster Session II - Saturday Evening

Fiddler Crabs (*Uca pugilator*) Learn Locations of Conspecifics in an Opaque Circular Maze

Frank W. Grasso Ezra Isaacs (BCR Lab)

P31

Fiddler crabs live in colonies containing individual burrows. They depart their burrows to forage and find mates and they return with great accuracy. We tested the spatial abilities of 48 male fiddler crabs to assess the generality of their spatial memory. The crabs were placed in an opaque circular maze with a target location opposite the start location where a size-matched male fiddler crab was tethered. The target location was divided to require the crabs to choose a direction when placed in the maze. The experiment, with 15 10-minute training followed by 5 test trials, was designed to evaluate the crabs' use of allocentic (visual) and egocentric (path-integration) cues. ANOVA did not detect the effects anticipated by our experimental design. However, in the test phase the crabs showed a strong preference for the side with their conspecific $t(15)=19.40$ $p<0.001$, Cohen's d 10.36. The attraction for conspecifics is not surprising in this gregarious species. However, the discovery that conspecifics could lead to a learned location preference is new. Non-homing place-preference-learning in fiddler crabs, could inform our understanding of the evolution of spatial memory because crustaceans are phylogenetically basal to eusocial, homing arthropods (e.g., ants and bees).

Rewarding and attentional effects of conspecific infant in chimpanzees

Yuri Kawaguchi, & Masaki Tomonaga (Kyoto University)

P32

There are many human studies about cognitive mechanism underlying infant care, but very few in nonhuman animals. We aimed to investigate chimpanzee's preference (Study 1) and attentional bias (Study 2) for infants. Study 1 examined the reward value of conspecific infant in chimpanzees. We adopted a simple discrimination task. There were two types of trials: food reward trial and sensory reinforcement trial. In the latter, the video clip of chimpanzee infant was played back after a correct choice and adult one after an incorrect choice. The results show that participants learned the discrimination of food-reward pair but not video-reward pair. However, most participants, especially elders looked at infant longer than adult. This may be because infant stimuli attract attention, but they are not more rewarding compared with adult ones. In order to investigate attentional aspect of infant stimuli further, we conducted "gap-overlap task", in which infant face, adult face or control stimulus was presented as distractor before the target. If the distractor holds attention stronger, the response time was expected to be longer. However, the response time was not different among distracter types.

Selective Attention and Peck Tracking in Pigeons' Category Learning

Deja Knight, Leyre Castro, & Edward Wasserman (University of Iowa)

P33

In prior categorization experiments, pigeons have been shown to track stimulus features that are relevant for category discrimination (Castro & Wasserman, 2014, 2016). Those experiments utilized complex, multi-colored stimuli, with four features per category exemplar. In the present experiment, we simplified our experimental paradigm by using simple-patterned, black-and-white stimuli, and category exemplars with just two features: one relevant and one irrelevant for the category discrimination. We examined categorization accuracy and whether pigeons pecked at the relevant or irrelevant category features. Overall, we saw a positive correlation between categorization accuracy and the percentage of pecks at the relevant category feature. Furthermore, when the pigeons pecked at the relevant category feature, their categorization accuracy was higher than when they pecked at the irrelevant category feature. These findings indicate that pigeons were indeed tracking the relevant category features. This task with simple, black-and-white stimuli is a promising paradigm for animals with poorer eyesight such as rats. Experiments that are now underway with rats will allow us to conduct neurobiological manipulations to examine the underlying brain regions involved in selective attention during category learning.

Ratting on illegal trade: Using African giant pouched rats (*Cricetomys ansorgei*) to detect contraband wildlife products.

Kate Webb, Dian Kuipers (APOPO), Kelly Marnewick (Endangered Wildlife Trust), Cynthia D. Fast, & Christophe Cox (APOPO)

P34

APOPO is a non-profit humanitarian organization that trains African giant pouched rats (Cricetomys ansorgei) to save lives by detecting landmines and tuberculosis. In addition to conducting research aimed at optimizing these operations, APOPO's Research and Development division explores new ways for the rats to save lives. In collaboration with Endangered Wildlife Trust of South Africa, we investigated the potential for rats to combat illegally smuggled wildlife. As proof-of-principle, we trained rats to detect the odor of pangolins (the most widely trafficked endangered mammal in the world) and African hardwoods (slow growing trees that are targets of illegal logging). Rats were required to identify these targets from an array of items commonly used to mask the odor of wildlife products during shipping. Future steps of this project will explore how the rats are best suited to search for these contraband items, such as in shipping containers at busy international ports (where smuggling of wildlife contraband frequently occurs), or stationed at the perimeter of national parks. Due to their keen olfactory abilities, short training time, long lifespan, flexibility to work with multiple handlers, and mobility even within confined environments, rats may offer a practical, cost effective alternative for addressing wildlife smuggling.

Development of executive function and its relation to detector dog performance

Lucia Lazarowski, Sarah Krichbaum, Lily Strassberg, Paul Waggoner, & Jeffrey S. Katz (Auburn University)

P35

Executive function (EF) is important for maintaining attention, flexible responding, and behavioral inhibition. In humans, EF predicts life outcomes in various domains. The socio-cognitive abilities of dogs have been widely reported and compared to humans, but investigations of canine EF are lacking. Working dogs present an ideal opportunity for the study of EF and its prediction of future performance because many cognitive tasks have been adapted for canines and working dogs' training program outcomes can be easily tracked. Further, working dogs are a neglected population in the canine cognition literature that may provide important comparisons to pet dogs regarding effects of experience on cognitive abilities. We tested a group of detection dogs-in-training at 3, 6, and 10 months old (n=20 per group) on three tasks of EF measuring attention, behavioral flexibility, and inhibitory control. Group performance on each task was assessed for developmental effects and correlated with training evaluations/program outcome. EF measures showed improvements with age during development, and some aspects were associated with behavioral evaluations of detection dog performance. These results suggest that higher-order cognitive processes are involved in detection dog performance, which may be used to objectively define and identify working dog traits and improve working dog selection.

Episodic-like memory in dogs: solving what-where-when tasks

Ka Ho Lo, & William A. Roberts (Western University)

P36

Episodic memory is a unique, personal memory that contains what happened, where it happened, and when it happened. Although initially thought to be unique to humans, more recent research has revealed episodic-like memory (ELM) in non-human animals using ¬¬what-where-when (WWW) memory paradigms. Although WWW memory has been shown in some animals, it has not yet been reported in dogs. Dogs are highly domesticated and may have acquired human-like traits throughout evolutionary time, making them interesting candidates for studying ELM. Taking advantage of dogs' innate heightened olfactory acuity, we developed a WWW task that involved memory for odours as one component of a WWW memory. In a series of experiments that involved temporally and spatially unique odour presentations, we asked if dogs could remember the odours (what), their locations (where), and their sequence of presentation (when). Preliminary results show that dogs successfully learned the WWW memory task. This study provides evidence for ELM in dogs, shows how dogs encode WWW memory, and demonstrates how flexible dogs' WWW memory is. Our findings show the usefulness of utilizing olfactory cues when studying ELM in dogs, a procedure which may be extended to other areas of dog cognition research.

Comparative decision making of rats amid varying methodologies

P37

Mary-Kate Moore, Kelly Marden, Thea Smith, Daniel Crafton, Kimberly Prescott, & Rebecca Rayburn-Reeves (Armstrong State University)

The current studies examined decision-making strategies in rats across two distinct methodologies which differed with respect to work effort. In Experiment 1, rats were given reinforcement for completing a choice task involving pushing a wheel down one of two runways presented at the onset of each trial. The wheels were placed at differing intervals along the runways, requiring choice of pushing a wheel a short or long distance. As the weight of the wheels increased, the rats showed a preference for less work, choosing the path with the wheel set further form the starting point and indicating an effect of choosing optimally. In Experiment 2, rats were tested in operant chambers for a choice between two fixed-interval (FI-seconds) schedules, whereby the rats chose between the completion of a short followed by a long ratio schedule (FI 5 to FI 15) or the inverse (FI 15, FI 5). Results showed differences in choice based on varying methodological approaches adding to the growing knowledge of decision-making processes in rats.

Serial Pattern Learning in a Touchscreen Serial Multiple Choice (SMC) Task for Rats: Hierarchical versus Interleaved Patterns

Megan E. Miller-Cahill, Jessica L. Sharp, & Stephen B. Fountain (Kent State University)

P38

Rats can learn complex serial patterns of responses in a circular spatial array in an octagonal operant chamber (e.g., Fountain et al., 1995a, b), and pigeons can learn similar patterns in a much smaller circular array of spots on a touchscreen (Garlick, Fountain, & Blaisdell, 2017). We investigated whether rats could learn hierarchical and interleaved patterns in an analog of the pigeon touchscreen task. Male rats were trained for 1200 trials per day to nosepoke a circular array of 8 or 9 spots for brain-stimulation reward. One group of rats nosepoked a hierarchical pattern with a violation element, 123-234-345-456-567-678-781-818, where digits indicate the clockwise position of spots in an 8-spot circular array. Another group nosepoked an "interleaved" pattern, 010203-020304-030405-040506-050607-060708-070801-080108, where rats made a forced-choice response to a "0" spot centered in the circular array between each pair of elements of the hierarchical pattern. The interleaved group learned slower than the hierarchical group. This result replicated work showing that chunking from nonadjacent serial positions increases pattern learning difficulty. The results also suggest why touchscreen procedures involving food or water reward that require animals to leave an array for reinforcement produce significantly slower learning than procedures that do not.

Sweet Tooth: The Role of Glucose and Saccharin on Self Control

Maggie Oimoen, Micaela Rivera, & Julia E. Meyers-Manor (Ripon College)

P39

Ego depletion of self-control and the role of glucose in reversing it have been a hotly debated topic in human research (e.g., Lange & Eggert, 2014). There is however evidence in dogs that animals can show ego-depletion and that the depletion can be reversed by glucose (Miller et al., 2010). We created a model of ego depletion in rats using a mild stressor to reduce self-control. Furthermore, we were able to reverse that self-control depletion by administering glucose but not by administering saccharin or water. Rats could provide an excellent model for testing mechanisms of ego-depletion.

Using a novel motor task to assess sub-lethal effects of imidacloprid exposure on complex motor learning in bumblebees (*Bombus impatiens*)

Jordan Phelps, Caroline Strang, & David Sherry (Western University)

P40

It has been shown that bumblebees exposed to neonicotinoid pesticides collect less pollen on foraging trips than unexposed bees, but the reason for this is unclear. Bees often must learn complex motor patterns to extract pollen from flowers. The ability to learn, remember, and execute motor patterns is therefore crucial for successful pollen foraging. Few studies have investigated whether neonicotinoids affect learning of complex motor patterns in bumblebees. We investigated this question using a novel motor task to model flower handling. Bumblebees (Bombus impatiens) exposed to imidacloprid at 0, 2.6 or 10 ppb were trained to enter a plastic tube leading to a sucrose reward. A plastic, petal-shaped barrier was inserted in the tube in front of each bee. Bees had to learn to turn upside down and lift the barrier to access sucrose. They were trained on 10 trials of this task for three successive days to assess short and long-term memory. Preliminary data show that bees exposed at 10 ppb take longer than bees exposed at 0 or 2.6 ppb to learn the correct motor strategy, and that they do not reach the same level of efficiency. These results may help explain why exposed foragers collect less pollen.

Effects of Visitor Density on Habitat Use in Zoo-housed Pigs

Audrey Robeson, Molly McGuire, Zoe Johnson-Ulrich, & Jennifer Vonk (Oakland University)

P41

Past research has shown that increased zoo visitor density is associated with increased rates of aggression and abnormal behaviors and decreased affiliative behaviors in various captive species (e.g., domestic pigs, chimpanzees, and gorillas). Previous research conducted with captive pigs has been restricted to a petting zoo setting. The current study examined whether pigs housed in a typical zoo setting avoid human areas and alter their use of enrichment as a function of visitor density. Five pigs of three different species housed at the Detroit Zoo were observed during the months of September to November in 2016. Number of visitors present per minute of observation and pigs' proximity to visitors, exact location were coded on video. We predicted that pigs would spend less time along the fence near the visitor area with larger numbers of visitors. It is also possible that visitors have positive impacts on pigs such that they spend more time closer to the visitor area when visitors are present.

Can humans use local landmarks in a virtual environment?

Alejandro Rodrigo, Jonathan Buriticá, & Laurent Avila-Chauvet (Centro de Estudios e Investigaciones en Comportamiento - Universidad de Guadalajara)

P42 It is well known that mammals can use landmarks present in their environment to locate sites of biological relevance, such as reinforcement areas. Especially, in humans, it has been observed that the proximity and the prominence of the landmark in relation to a target area, define the strategy used to situate themselves in space. There is little-known information that highlights if humans are guided by a single landmark or by multiple. The aim of this research was to establish whether humans follow one or multiple cues presented in a virtual environment. Six groups of 10 participants (±3) were formed. Each group was trained to locate one of three reinforced areas (A, B, C), which maintained a close relationship with a particular landmark. The landmarks were arranged in a hexagonal arrangement just as in Pritchard, et al. (2016). In the test phase, the landmarks were expanded and the participants were evaluated to locate the reinforced area between to the proximity or the total arrangement of visual cues. The results show that the groups trained in the reinforced area "A" follow the landmarks as a "whole", unlike the groups "B" or "C" which follow a more local arrangement.

Representations of Serial Patterns in Human Subjects: Violations of Lower and Higher Order Rules.

Liuruimin (Amy) Xiang, Chelsea Robbins, Morgan Lami, Kaitlin VanRyswyk, Sriharshini Chitluri, & James D. Rowan. (Wesleyan College)

P43 Restle (1970) was one of the first to define a notation to describe serial-patterns. This notation, presumably, describes the actual cognitive representation of the pattern. He assumed that all new elements are compared to the first element. Rules that link these individual elements together are 1st order, rules that link chunks of 1st order elements are 2nd order, rules that link chunks together are 3rd order, etc... Restle assumed that if there was a 3rd order rules, where the pattern on both sides was the same overall but reversed mirror rule), the subject would be sensitive of this and the lower order rules could be "hierarchically nested" to reduced memory load. This experiment compares acquisition of a perfectly nested pattern, to ones (3 additional patterns) that have violations to both the 1st and 3rd order rules. If subjects are nesting the pattern, violations in the second half should impair learning in the first half. The 1st halves (non-violation) of all patterns were learned equally well, bringing into question the assumption that subjects actually use 3rd order rules or simply look at patterns as sequential chunks of information expressed by 1st and 2nd order rules.

Cognitive judgment bias determines vulnerability of rats to chronic stress and antidepressant treatment

Rafal Rygula, Michal Rychlik, & Robert Drozd (Institute of Pharmacology Polish Academy of Sciences)

P44 Pessimistically biased judgment has been associated with the etiology and recurrence of depressive disorder in humans. In the present studies we investigated how biased judgments, measured as stable and enduring behavioural traits, could determine vulnerability of laboratory rats to chronic stress and antidepressant treatments. For this, initially, in a series of ambiguous-cue interpretation tests, we identified animals displaying 'pessimistic' and 'optimistic' traits. Subsequently, we tested, in naïve, chronically stressed, and antidepressant treated individuals, how these traits interacted with cognitive flexibility, sensitivity to feedback, and motivation to avoid stressful situation. We report significant differences between 'optimistic' and 'pessimistic' rats in vulnerability to chronic stress and sensitivity to antidepressant treatments. The results of our studies are discussed in terms of neurobiological mechanisms of the observed effects and their possible implications for establishing novel cognitive biomarkers of affective disorders. Supported by the National Science Centre (UMO-2014/13/B/NZ4/00214)

Spaced Training Speeds Serial Pattern Acquisition in Female but not Male Rats

Jessica L. Sharp, Megan E. Miller-Cahill, & Stephen B. Fountain (Kent State University)

P45 In human learning tasks, distributing training over multiple sessions often improves acquisition compared to massing training in fewer sessions. To examine possible spacing effects in rats, male and female rats were trained to nosepoke the serial pattern, 123-234-345-456-567-678-781-818, where digits represent clockwise positions of successive correct receptacles in a circular array and dashes indicate pauses that served as "phrasing cues." The pattern consisted of three element types: chunk-boundary elements, within-chunk elements, and the terminal violation element "8" that was inconsistent with pattern structure. Rats trained to criterion on the violation element, the hardest element to learn. Rats were assigned to one of three conditions: either spaced training on 5 patterns/day, spaced training on 5 patterns twice daily (5x2 patterns/day), or massed training on 10 patterns/day. Female rats learned to anticipate the violation element of the pattern fastest on 5 patterns/day spaced training, significantly slower on 5x2 patterns/day spaced training, and significantly slower still when trained on 10 patterns/day massed training. Male rats learned the pattern faster than females, but male rats learning rates were not affected by the spacing of training. These results demonstrated spacing effects in female rats like those observed in humans.

Individual differences in sociability in Eastern garter snakes

Morgan Skinner, & Noam Miller (Wilfrid Laurier University)

P46 Social cognition in reptiles is poorly understood. Snakes prefer to aggregate with individuals from different litters and with individuals that have different diets. In addition, it is possible that snakes may avoid individuals with whom they have previously fought over food. Controlling for all these factors, we placed groups of juvenile Eastern garter snakes (each consisting of one litter) in an enclosure that had four hides. Snakes were shuffled twice a day, their hides were replaced, and the areas around the hides were cleaned. To shuffle the snakes, we either returned them randomly to the center of the enclosure, or placed them in particular hides based on four different pre-determined release patterns. During all 12 hours of light, the snakes' positions were recorded every 5 seconds, for 8 days. We find that some individuals are

consistently more likely to aggregate than others, and that patterns of aggregation are rarely stable. Aggregation in a captive environment is common in Garter Snakes but the reasons for aggregating, and drivers of individual differences in inclination to aggregate, are unknown. In our lab, juvenile Eastern Garter Snakes appear to have distinct patterns of sociability, even in the absence of variation in diet or relatedness.

P47 **The effect of a 5-HT antragonist on navigation of a successive T-maze under aversive environmental conditions in pill bugs (*Armadillidium vulgare*)**

Greg Genuardi, Kristina Haskins, Taylor Wiseman, & W. David Stahlman (University of Mary Washington)

Pill bugs (Armadillidium vulgare) engage in spontaneous turn alternation in a successive T-maze. This behavior is considered to be an adaptive response to adverse environmental conditions. Research indicates that, under certain circumstances, the administration of a serotonin antagonist can reduce sensitization and speeds the rate of habituation to noxious stimulation. We examined the impact of the administration of methysergide, a nonselective 5-HT antagonist, on pillbugs' performance in a successive T-maze under both light (i.e., aversive) and dark conditions. We hypothesized that animals given an antagonist would respond less quickly and engage in less spontaneous alternation than control animals, particularly under aversive conditions. Though we found little evidence for these hypotheses, we did find that pill bugs engaged in more abortive turns (i.e., backtracks) in dark conditions. We discuss these results in the context of past literature and make suggestions for future research.

P48 **Differential Space-Use Between Wild-Caught and Laboratory-Reared Octopus bimaculoides**

Ian Strieter (The Graduate Center Brooklyn College), & Frank Grasso (CUNY)

Octopus is well known for its highly derived neural and sensory systems, rapid learning capabilities, and remarkable behavioral flexibility. Most, if not all, previous research into the behavioral and cognitive characteristics of octopuses has been conducted using wild caught animals of uncertain age and unknown life histories. The present study is one of few explorations of behavior in O. bimaculoides which were raised from the egg under laboratory conditions, and thus have known life histories. Animal locations within identical individual housing units were recorded daily (for 20-74 days). A measure of information entropy was calculated for each animal (lower values reflecting greater fidelity to particular locations) on the observed proportions of time spent per location. A statistically significant difference was identified ($t(4.41)=-3.56$, $p=0.02$; Cohen's $d=2.15$; 95% CI[-0.257, -0.037]) between the two groups, with the laboratory-raised animals (N=12) displaying greater entropy than wild (N=4). An entropy pattern across time, possibly reflecting habituation, common to both wild and laboratory-raised animals was identified ($R2=0.14$, $F(4, 152)=6.27$, $p<0.001$). Although potential confounds were present in this dataset, we believe these results underscore the previously underappreciated importance of early experience for studies of spatial learning and cognition in Octopus.

P49 **How Early Life Immune Challenges Affect Behaviors of Adult Zebra Finches**

Ahmet Kerim Uysal (University of South Florida), Nathan Burkett-Cadena (University of Florida), Lynn Martin, & Toru Shimizu (University of South Florida)

Early-life immune challenges (ELIC) are known to have long-term effects on adult brain and behavior. Avian ELIC studies are epidemiologically important since adult birds are primary hosts of many mosquito-borne viruses. In this study, Polyinosinic: polycytidylic acid (Poly I:C, a virus mimicking agent) was administered in nestling zebra finches. When birds became sexually mature, their general activity (i.e., hopping, feeding behavior) in their housing cages and defensive behaviors to mosquitos were analyzed to compare with control birds. Following behavioral measurements, brains were collected for anatomical and histochemical analyses. Results showed that Poly I:C had effects on general activity and mosquito defense behaviors of female birds, but not males. Poly I:C injected females hopped less often, but fed more compared to control females. Injected females also showed more defensive behavior (hopping) to mosquitos while control birds did not show such differences. The nucleus taeniae of the amygdala of Poly I:C injected males was smaller in size, yet had more immediate-early gene positive neurons, suggesting that these neurons were more active than control group. These results suggest that infected birds became less active and more defensive to mosquitos and that these changes might be related to the smaller, but active amygdala.

P50 **Partially occluded action discrimination in pigeons.**

Amy Vasquez, Suzanne L. Gray, Muhammad A.J. Qadri, & Robert G. Cook (Tufts University)

Identifying predators stalking behind obstacles or partly hidden courting mates can be critical for an animal's survival. However, previous studies on amodal completion have shown pigeons use local features to identify partially occluded objects. To assess what features are necessary for partially occluded action discrimination to occur, we trained six pigeons in a go/no-go task to discriminate the actions of digital animal models walking or running behind a series of columns so that the actor was never fully visible at any given moment. The discrimination transferred to novel stimuli. Reducing the size of the gap between the series of occluders proportionally decreased the accuracy of the pigeons' discrimination. These results suggest that the pigeons were able to categorize occluded walking from running actions, and that they need little momentary information in order to discriminate between these partially occluded actions. This setup will allow us to understand how these segments are integrated into a whole action.

P51 **Roach Lab: Using cockroaches to increase learning outcomes in undergraduate psychology**

Cassie Vergason, Marshall Jones, & Darby Proctor (Florida Institute of Technology)

Nonhuman animal models have been used for many years to teach learning and animal behavior. Research has consistently shown that these types of active learning experiences provide students with better learning outcomes. Frequently, this is done in the traditional rat or pigeon lab setting. However, many universities no longer support these traditional labs due to the expense of maintaining vertebrates as well as ethical concerns over the treatment and disposal of animals. To remedy this situation, we propose using a novel and inexpensive invertebrate animal that could illustrate many of the same classic principles of learning and behavior, the discoid cockroach (Blaberus discoidalis). Using cockroaches avoids many ethical issues as most people would not hesitate to step on them and there are few if any regulations governing the housing and use of this model. Here, we will present our initial findings about using this model in undergraduate psychology classes to illustrate principles such as classical and operant conditioning. We believe that roach labs could be a viable manner to bring back animal labs to universities, thus improving student learning outcomes. Additionally, these laboratory experiences may further our knowledge of the cognitive processes in a relatively understudied species. Keywords: cockroaches, learning

Broadening the life-saving repertoire of African giant pouched rats: Rapid re-training and maintenance of multiple odor discriminations

Kate Webb, Caterina Caneva Saccardo, Cynthia D. Fast, & Christophe Cox (APOPO)

P52

APOPO, a Belgian non-profit organization based in Tanzania, trains African giant pouched rats (Cricetomys ansorgei) for humanitarian purposes. Operationally, APOPO's rats detect buried landmines in post-conflict zones and Mycobacterium tuberculosis (TB) in resource-poor countries. Although the rats have a proven track record on these tasks, the potential humanitarian impact of each rat is limited by the training duration required and constraint to only one target odor. We sequentially trained rats to indicate the presence of five novel and unrelated odor targets while disregarding 12 non-target odors. The rats successfully mastered all five odor targets in significantly fewer sessions ($M = 102.63$, $SD = 10.47$) than APOPO's operational rats currently require to master a single odor target ($t(7) = 20.90$, $p < .001$). Importantly, all rats maintained strong detection of the five odor targets, despite the potential for interference caused by each new odor and the passage of time between initial training and test, suggesting that African giant pouched rats can be trained to identify at least five different odors simultaneously. In practice, this could allow operational rats to search for more than one target, such as multiple forms of explosives, thereby expanding the life-saving impact of each rat.

Sequential decision-making in pigeons (*Columba livia*): The secretary problem

Walter T. Herbranson (Whitman College)

P53

The secretary problem is a decision-making puzzle in which one attempts to select the best candidate from a finite pool of variable-quality options. An individual views one candidate at a time, and must either hire or reject each before seeing another. The mathematically optimal strategy involves viewing and rejecting a set number of candidates and then setting a selection threshold based on the quality of those viewed candidates. Seven pigeons learned an adaptation of the secretary problem in operant chambers. Birds saw sequences of colored stimuli with colors corresponding to different probabilities of reinforcement. They could select or reject each in turn by pecking either the stimulus or an alternate reject key. Results indicate that like humans, pigeons made selections too soon, and in doing so received a lower average probability of reinforcement than the optimal strategy. Subsequent conditions varied the size of the candidate pool. Larger pools led to more rejections per trial and a higher rate of reinforcement, though both remained suboptimal. Thus, while their performance was suboptimal, birds were sensitive to pool size. Furthermore, while pigeons failed to maximize, their suboptimal approach paralleled that of humans.

Surprise!! Not so much...investigative responses of dogs following (un)expected events

Kimberly Brubaker, Michele Chaky, Kaitlyn Willgohs, Krysta Mochi, Ryan Alaimo, & Lauren Highfill (Eckerd College)

P54

For the current study, dogs ($N = 38$) were either shown an event that violated expectations about object behavior or an event that was nearly identical but did not violate expectations. Specifically, in one event (the possible event), a toy was placed behind one of two opaque screens, then both screens were lifted and the object remained behind the screen it was originally placed. In the second event (the impossible event), a toy was placed behind one of two opaque screens, then both screens were lifted and the object "magically" appeared behind the other screen. After viewing the event, the toy used in the demonstration plus a novel distractor toy were presented to the subject. All trials were video-recorded and coded to examine which toy the subjects approached first, and which toy the subject investigated more. We hypothesized that dogs would demonstrate more information seeking behaviors with a toy if it violated expectations. Overall, there were no statistically significant differences between the two groups, but we believe more investigation is warranted.

Sociability and Problem-Solving in Domestic Cats (*Felis catus*)

Mary Howard, & Preston Foerder (The University of Tennessee at Chattanooga)

P55

Animal personality has been shown to be an important source of variation that may affect cognitive performance. According to the social intelligence hypothesis, which states that intelligence evolved due to complex social environments, sociability should result in higher cognitive abilities. Domestic cats are capable of leading both solitary and social lives. I conducted a study to examine the relationship between sociability and problem-solving ability in domestic cats. I hypothesize that more social cats will solve a food acquisition problem-solving task more often than less social cats. Eighty-five cats from the McKamey Animal Shelter in Chattanooga, TN were used for this study. Each

cat's sociability was assessed by McKamey employees using a modified Feline Spectrum Assessment developed by the ASPCA. The cats received a letter grade (A, B, C, D, F) based on the number of socialized behaviors they exhibit. A puzzle box was placed in their cage for 10-minute sessions and the cats were analyzed for problem-solving success, latency to approach, and duration of interaction. Behaviors are correlated with each cat's sociability score. These results will not only provide knowledge about cat's sociability and problem-solving but also be useful for cat adoption.

Red River Hog (*Potamocherus porcus*) Performance on a Spatial Memory Task

Joy Vincent (Eckerd College), Diana Szoke, Ashey Gaia, Mike Burns, Madison Underwood, Alison Head (Lowry Park Zoo), & Lauren Highfill (Eckerd College)

P56

The current study tested the basic spatial memory ability of red river hogs (Potamocherus porcus). The subject was taught to associate log sections with food, and then six log sections were placed around the enclosure, three with a reward and three without a reward. The rewards were always placed at the same locations over the course of the trials. Time required to find all three rewards, along with the number of errors incurred before successfully finding the three rewards, was recorded. Results indicate that the subject met the criteria for the initial protocol. This study examined spatial memory in one individual, but is the first ever cognitive study with this species. This study examined spatial memory in one individual, but is the first ever cognitive study with this species. Plans for future studies will be discussed.

Double Alternation Learning in C3H Mice: Transfer from Non-Correction to Correction.

Deidre Inabnett, Dy-Onna Stith, Kayla Isom, Asia Cooks, Elizabeth Wells, Holly Boettger-Tong, & James D. Rowan (Wesleyan College)

P57

This experiment examines the effects of non-correction pre-training of a double alternation (DA) pattern on the subsequent learning of the pattern with correction. Kundey and Rowan (2008) demonstrated that rats were able to learn DA patterns but only if each incorrect response required the rat to then generate a correct response before advancing to the next trial. CH3 mice, in this experiment, were first trained for 21 days on a DA pattern without correction and then were transferred to a DA pattern with correction for 10 days. A second group of mice were only trained for 10 days using the correction procedure. The no correction pre-training group showed no significant learning of the pattern in the Training Phase and were still at 50% errors overall on Day 21. When transferred to the DA with correction (10 days), the mice showed improved performance and learned faster than the group without a pre-training phase. This indicates that, even though performance in Phase 1 was never above chance, the mice in this group possibly learned something about the DA structure in pre-training.

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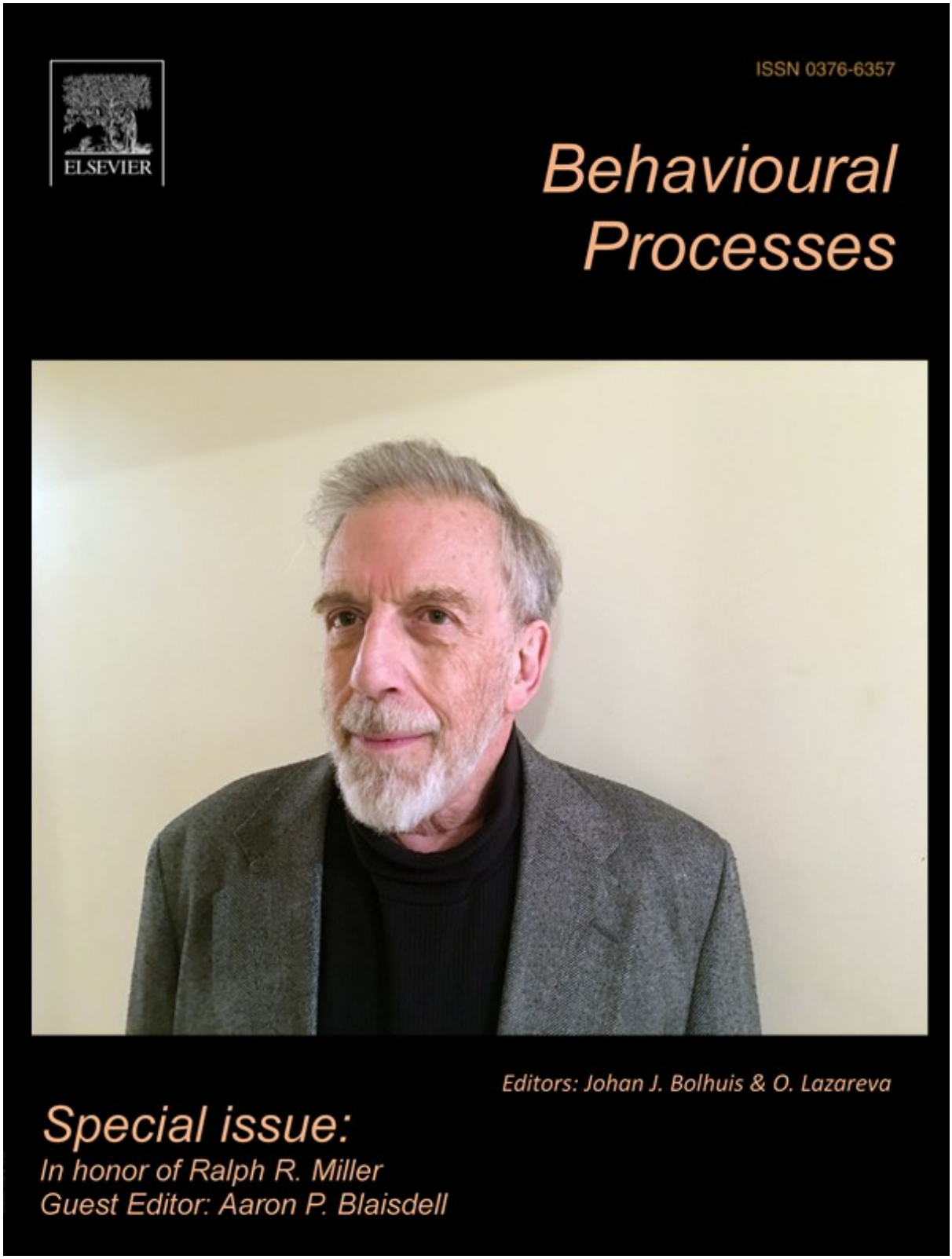
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