26ᵗʰ Annual International Conference on Comparative Cognition

Sponsored by the
Comparative Cognition Society
April 10ᵗʰ to 13ᵗʰ, 2019
Radisson Hotel
Melbourne Beach, Florida

President	Steve Fountain
Conference Organizers	Kent Bodily, Lauren Guillette
Secretary	Ken Leising
Treasurer	Mike Brown
Program Committee	Lauren Guillette (Chair), Kent Bodily, Jonathon Crystal, Jeffrey Katz, Suzanne MacDonald, W. David Stahlman
Team CO3	Jessica Sharp (Chair), Katherine Dyer, Vincent Edwards, Claire Jackman, Jeremy Jasmer, Tanya Shoot, Robby Southern, Caroline Strang
Awards Committee	David Brodbeck (Chair), Bob Cook, Marisa Hoeschele, Olga Lazareva, Reggie Gazes, Chris Sturdy
Member-at-Large	Noam Miller
Past Presidents	Olga Lazareva , Debbie Kelly, Mike Brown, Bob Cook, Jonathon Crystal, Jeffrey Katz, Suzanne MacDonald, Marcia Spetch, Ed Wasserman, Ron Weisman, Tom Zentall

CO3 - 2019 Program Summary		
	Time	**Page**
Wednesday		
Welcome Reception and Check-In	3:30	5
Opening Remarks (Steve Fountain)	7:00	5
Canine Cognition I	7:05	5
Canine Cognition II	8:20	6
Discrimination Learning	9:09	7
Communication I	9:35	7
Meta-cognition and Comparative Psychology	10:10	10
Thursday		
Ron Weisman Outstanding Student Presentation Competition: Paper	12:00	10
Social Learning	12:35	12
Attention	1:03	12
Symposium I - Meaning of Memory Systems in Comparative Cognition	1:22	13
Symposium II - New Trends in Fish Cognition	3:35	15
Communication II	4:40	16
Memory and Geometry	5:15	18
Poster Session I	8:30 - 11:00	28
Friday		
CO3 Mentor Program: Meet the Experts	10:30 AM	18
Cognitive Processes I	12:00	19
Symposium III - Arthropods Negotiating Space	1:26	20
In Honour of the Contributions of Stephen Lea I	3:00	21
In Honour of the Contributions of Stephen Lea II	4:05	22
Master Lecture - Stephen Lea	6:05	23
Banquet	7:30	23
Saturday		
Business Meeting of the Comparative Cognition Society	12:00	24
Group Photo Shoot	1:10	24
Symposium IV - Cephalopod Cognition: Foundations and Prospects	1:30	24
Problem Solving and Welfare	2:30	25
Associative Processes	3:14	25
Cognitive Processes	4:08	27
Closing Remarks (Steve Fountain)	5:06	27
Poster Session II	8:30 - 11:00	36

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. Twenty minute talked are designated by a box around the talk number and are followed by five minutes for discussion. Symposium talks are 15 minutes, including discussion.

3:30 PM Welcome Reception and Check-In

7:00 PM Opening Remarks (Steve Fountain)

7:05 PM Canine Cognition I (Chair: Reggie Gazes)

7:05 PM **Social learning as a function of demonstrator species in domestic dogs (*Canis lupus familiaris*)**
Heidi Lyn (University of South Alabama), & Beatrice Chenkin (University of Southern Mississippi)

1

Social learning is a relatively rare capability among animal species as most learning is individual in nature. However, social learning can increase survival and reproduction by short-circuiting the necessary trial-and-error learning otherwise required. Domestic dogs are social animals and have also been bred to cooperate extensively with humans. Competing hypotheses have suggested that dogs are sensitive to human communicative cues due to either genetic pre-disposition to cooperation or to extensive social interaction with humans. What has been less studied are the processes for social learning in dogs and whether dogs are more sensitive to information from conspecifics or humans. We tested 60 shelter dogs on the classic social-learning two-action paradigm, twenty dogs had no model, twenty had a canine model, and twenty had a human model. In general, the novice dogs were unsuccessful at opening the apparatus, but zero dogs without a model even approached the correct mechanism. In contrast, five dogs with human models approached the correct mechanism, and one with a canine model activated the correct mechanism multiple times (although still unsuccessfully). Our results suggest that domesticated dogs utilize local enhancement as their main social learning process and that they may be more sensitive to human demonstrators.

7:19 PM **Estimating the Heritability of Cognitive Traits Across Dog Breeds**
Gitanjali E. Gnanadesikan, Evan L. MacLean (University of Arizona), & Brian Hare (Duke University)

2

Dog breeds have historically been bred for specific behaviors, and anecdotally certain breeds have distinct behavioral and cognitive traits. However, attempts to systematically assess behavior and cognition across breeds have found minimal differences. These studies generally use pairwise comparisons among a few common breeds, a method that may be stymied by intra-breed variation and small sample sizes. Another approach is thus to examine phenotypic heritability: to what extent genetic relatedness among breeds explains the observed trait variation. We therefore combine Dognition—a large citizen science cognitive and behavioral data set—and breed-averaged genetic data from published sources to estimate the heritability of traits with linear mixed models. The resulting dataset includes 11 cognitive and behavioral tasks for 1,654 adult dogs across 49 breeds. A factor analysis reveals a considerably heritable social factor ($h2 = 0.39$), a minimally heritable cunning factor ($h2 = 0.03$), an intermediately heritable memory factor ($h2 = 0.13$), and a fourth factor ($h2 = 0.19$) that includes physical and inferential reasoning. Since heritability is necessary for natural selection, this indicates that social traits are potentially highly selectable, as well as consistently variable among breeds.

7:26 PM **Rapid assessment of short-term spatial memory in pet dogs using adaptive staircase procedures**
Joshua Van Bourg, Rachel Gilchrist, & Clive Wynne (Arizona State University)

3

The development of clinical tests for canine Cognitive Dysfunction Syndrome has been hindered by the speed with which task-specific behavior must be trained and shaped in a single-session. To address this obstacle, we applied two novel adaptive testing procedures to a simple visual displacement paradigm in order to rapidly assess the duration of short-term spatial memory in forty pet dogs within a one-hour session. Using an up-down staircase method, we titrated the maximum delay length (MDL) after which each dog accurately recalled the location of treats hidden behind one of two identical boxes. In a second experiment, we retested dogs but adjusted the magnitude of delay increase or decrease based on performance. In both experiments, age was significantly correlated with MDLs and the proportion of correct choices in 0s-delay maintenance trials, 45s- and 60s-delay trials, and all trials combined. Thus, these tests may be sensitive to age-related changes in rule retention, resistance to interference, and spatial memory. Age did not predict side bias magnitude or training rate, indicating that perseverative behavior and rule learning did not confound performance. We conclude that adaptive testing procedures may facilitate rapid cognitive assessments for aging pet dogs.

4

7:33 PM **Domestic dog understanding of physical containment, covering, and occlusion events.**
Julia Espinosa, & Daphna Buchsbaum (University of Toronto)
Intuitive physical concepts help us navigate the physical world. One such concept is object containment and has been studied extensively in infants and nonhuman primates. Evidence indicates finding objects hidden inside of containers is more difficult than finding covered or occluded objects, perhaps due to the prerequisite understanding that containers are hollow. Dogs frequently encounter containers in their daily lives, and canine cognition studies commonly require subjects to locate hidden treats. However, no research has examined whether the way in which an object is hidden (via containment, covering, or occlusion) impacts dogs' searching success. We hypothesize that dogs, like primates, may find it harder to make inferences about containment vs other hiding events. To address this hypothesis, dogs (N=90) participated in a search task with 2 possible locations, only 1 of which concealed a treat. They watched one of three different methods of treat hiding: i) placing inside cups, ii) placing behind cups, and iii) placing under cups. Though data collection is ongoing, preliminary analysis suggests that dogs are above chance in choosing the baited location over the non-baited location across conditions, and they are more likely to find the treat when it is covered than when occluded or contained.

5

7:40 PM **Olfactory working memory in dogs: matching-to-sample under various interference manipulations**
Ka Ho (Gordon) Lo, & William A. Roberts (Western University)
Dogs in the field often use their olfactory working memory for crucial tasks that save human lives, such as detecting explosives, criminals, and various cancers. Yet, there are gaps in our knowledge of dogs' olfactory working memory. Our goal was to fill this gap by investigating how well dogs can match an odour sample under various forms of proactive and retroactive interferences. An olfactory match-to-sample task was designed, which involved presenting a dog with a sample odour, and then multiple target odours, one of which contained the odour that matched the sample. Dogs were rewarded if they initially chose the box that contained the matching odour, but non-rewarded if they chose a box that contained a non-matching odour. Once dogs reached the success criterion, they were tested on variations of this task to investigate proactive and retroactive interference by varying the retention interval and introducing distractor odours before and after the target sample odour. Results from these tests shed light on how different conditions that mimic potential field scenarios can impact dogs' olfactory working memory.

6

7:47 PM **Lending a Helping Paw: Variables in Canine Empathy**
Julia Manor (Ripon College)
Dogs are used in a variety of human settings, such as emotional support animals, for their perceived empathetic ability, however little research has been done to test their empathetic responses in controlled settings. Recent research in my lab has examined the behavioral and physiological responses of dogs to crying and humming by their owner and by a stranger. Additionally, we have examined dogs responses to other dogs in distress. Results indicate that dogs may have empathetic tendencies in some situations, but that it requires good emotional regulation to display this empathy.

7

8:01 PM **Early emerging cognition in 9-week-old puppies**
Emily Bray, Gitanjali Gnanadesikan, Daniel Horschel, & Evan MacLean (University of Arizona)
While past research has largely focused on profiling the temperament of young puppies by measuring their behavioral responses to novel or startling situations, much less is known about the early cognitive abilities of dogs. To address this deficit, we tested 168 puppies (97 females and 71 males) when they were approximately 2 months old (mean age = 9.20 weeks) across a wide range of cognitive tasks. Our sample consisted of Labrador x Golden crosses, Labrador Retrievers, and Golden Retrievers from 65 different litters at Canine Companions for Independence, an organization that breeds, trains, and places assistance dogs for people with disabilities. Puppies participated in a cognitive battery that consisted of 16 different tasks measuring abilities such as memory, impulse control, problem-solving skills, interpretation of social cues, and discrimination of sensory information. Additionally, 147 adult dogs from the same population were also tested, allowing for a comparison between the two age groups. Results indicated that by 9 weeks of age, most puppies are already performing at above chance levels on the cognitive tasks, although in most cases not as proficiently as the adults.

8:15 PM *Break*

8:20 PM Canine Cognition II (Chair: Julia Manor)

8

8:20 PM **The effects of physical luminance on colour discrimination in dogs: A cautionary tale**
Sarah-Elizabeth Byosiere (La Trobe University/Hunter College), Philippe A Chouinard, Tiffani J Howell, & Pauleen C Bennett (La Trobe University)

While dogs are assumed to be colour-blind due to their retinal composition, various assessments have demonstrated that dogs can distinguish between red and green. The present investigation evaluated dogs' ability to differentiate between colour contrasts (red and green, blue and yellow, and white and black), at different physical luminance levels, and intensities. Seven dogs were trained on a simultaneous size discrimination task in which two circles were presented on a monitor. The colours of the circles were varied such that dogs would choose one stimulus if they could discriminate between two colours and a different stimulus if they could not. In Experiment 1, all seven dogs were equally proficient at discriminating between red and green, yellow and blue, and black and white stimuli when presented at their maximum RGB values (in which colour and/or physical luminance cues were present). Experiments 2 to 4, utilized an identical paradigm in which physical luminance was equal but varied in intensity. In these isoluminant conditions, colour discrimination performance varied across intensities. These findings demonstrate physical luminance and intensity can affect colour discrimination in dogs and must be considered in cognitive paradigms that utilize on-screen presented stimuli.

8:27 PM **Awake fMRI of dogs reveals mechanisms for processing 2D representations of 3D objects**
Ashley Prichard, Raveena Chhibber, Kate Athanassiades, Veronica Chiu, Jon King, & Gregory S. Berns (Emory University)
Though most dog studies use visual stimuli, few have examined whether pictures serve as visual representations for the concrete. There is one example of dogs abstracting pictures or miniatures to familiar objects, and some evidence suggests that dogs successfully translate pictures of faces to familiar humans. However the neural mechanisms for how dogs abstract stimuli remain relatively unknown. Using awake fMRI of domestic dogs, we measured neurobiological responses to two dimensional (2D) and three dimensional (3D) versions of objects. Half of the dogs were trained on 2D stimuli and half on 3D stimuli. Prior to scanning, one stimulus of the trained pair was associated with food (CS+) and the other with nothing (CS-). During scanning, both 2D and 3D stimuli were presented. Similar to human studies, activation in the canine brain to 2D and 3D stimuli occurred in the dorsal parietal cortex and in a region similar to the human lateral occipital cortex (p<.05). Here we demonstrate the application of fMRI to examine the neurological mechanisms for dogs' abstraction of perceptual stimuli to concrete objects. While behavioral evidence for abstraction is mixed, our approach illustrates the potential for more complex perceptual capacities in dogs.

8:34 PM **Cognitive flexibility in cats and dogs**
Amy Desjardins, & Sylvain Fiset (Université de Moncton in Edmundston)
The objective of the current study was to investigate whether domestic dogs and domestic cats differ in regards to their cognitive flexibility for locating a spatial position. The task of the animal was to find a piece of food hidden inside one of two containers that were two meters apart. In Experiment 1 (30 cats and 30 dogs), we used an A-Not-B task in which the food was visibly hidden eight times inside container A and for the next four trials, it was hidden four times inside container B. In Experiment 2 (20 cats and 20 dogs), for 12 consecutive trials, the target location alternatively changed from A to B on every trial. Our results suggest that dogs are cognitively more flexible than cats when unexpected changes take place in the environment.

8:41 PM **Examining social evaluation in domestic dogs**
Zachary Silver (Yale University), Ellen Furlong (Illinois Wesleyan University), & Laurie Santos (Yale University)
Social evaluation refers to the tendency to favor individuals who behave prosocially compared to those who behave antisocially. Efforts to determine whether domestic dogs can effectively perform third party social evaluations have produced mixed results, with methodological differences potentially explaining the contradictory results seen across various experiments. Our study sought to determine whether testing two distinct samples of dogs on a social evaluation task using an identical method would yield consistent results. We tested dogs from the Kentuckiana Dog Show and community pet dogs located near New Haven, CT on a social evaluation task using identical methodology. Dogs watched an experimenter reach for a clipboard positioned just outside his grasp. Additional experimenters either handed the clipboard to him (prosocial) or pulled it away from him (antisocial). After repeated exposure to these actors, each actor offered the dog a treat. We recorded which actor dogs initially approached. Our results indicate contrasting patterns of behavior across our two samples. Kentuckiana Dog Show dogs initially approached the prosocial actor significantly more often than the antisocial actor, while New Haven community dogs didn't display a significant preference for either actor. Given the identical methodology, we interpret our contrasting results as a possible population difference.

8:48 PM **Heritability of Cognitive Traits in a Pedigreed Dog Population**
Evan MacLean, Emily Bray, Gitanjali Gnanadesikan, & Daniel Horschler (University of Arizona)
Heritability is an important criterion for evolution by natural or artificial selection, yet we know relatively little about heritability of cognitive traits in nonhuman animals. We conducted a cognitive test battery with 9-week old puppies (N = 168), and young adults (N = 147) from a pedigreed dog population. The battery included tests probing diverse aspects of dog cognition, including memory processes, perceptual discriminations, inhibitory control, and skills for social

communication and physical problem solving. Using linear mixed models, we assessed heritability of these traits in both puppies and young adults. The vast majority of traits exhibited significant heritability, and genetic factors accounted for more than 40% of variance on several measures including gesture following, working memory, and inhibitory control. These findings suggest that genetic factors make substantial contributions to individual differences in dog cognition, and inform hypotheses regarding phenotypic changes during domestication and breed diversification.

13

9:02 PM

Physical cognition in dogs of land and sea: *Canis familiaris* and *Zalophus californianus*
Maria Zapetis (University of Southern Mississippi / National Marine Mammal Foundation), Megan Broadway (University of Louisiana Monroe), Jason Mulsow (National Marine Mammal Foundation), & Heidi Lyn (University of South Alabama)
Domesticated dogs (*Canis familiaris*) and California sea lions (*Zalophus californianus*) both belong to the Caniformia suborder, within the order Carnivora. Although pinnipeds separated from other caniforms 50 million years ago, they maintain many of the same behavioral phenotypes as their terrestrial counterparts. However, the ecological demands of life in the ocean may have altered sea lions' method of information processing. Comparing performance on similar tasks can be useful in understanding the effect of evolution on psychological traits; however, a cognitive comparison between sea lions and dogs has not yet been reported. Using the same cognitive tasks, we compared data previously obtained for domesticated dogs [Broadway et al. (2017) Behavioral Processes] to trained California sea lions housed at the U. S. Navy Marine Mammal Program. The physical cognition assessment addressed both species abilities to solve spatial memory, displacement, rotation, and transposition tasks. Initial results showed that sea lions were less successful at the tasks than dogs, but that is likely due to novelty effects and the small number of sea lions tested (n=4). Additional data will be reported regarding the sea lions' capacity for learning these tasks over time, as well as the potential impact of the neurotoxin domoic acid.

9:09 PM Discrimination Learning (Chair: Julia Manor)

14

9:09 PM

Development of a Visual Discrimination Procedure for Archer Fish
Michael Brown (Villanova University), Alexander Brown (Lafayette College), Adam Davila, Bridget Austin, Kelly Gabriel, & Loren Paz-Gonzalez (Villanova University)
A procedure and testing system for the study of visual discrimination performance in archer fish will be described. Results from a same-different concept learning task failed to provide evidence of discrimination. Subsequent experiments exploring conditions that reveal and facilitate discrimination performance in fish will be described.

15

9:16 PM

Goldfish (*Carassius auratus*) discriminate between 2D color representations of familiar 3D objects rotated in the picture and depth planes
Caroline DeLong, Evan Morrison, Jessica Wegman, Trisha Rachfal (Rochester Institute of Technology), & Kenneth Tyler Wilcox (University of Notre Dame)
The ability to visually recognize objects despite differences in orientation would be advantageous for fish because they often view objects from many aspect angles. In a series of studies, we trained fish to discriminate between two objects at 0 degrees, then tested them with the same objects at novel aspect angles. Our previous research showed that goldfish performed very well across all angles when inspecting 3D full-color stimuli (M = 93%), but were unable to discriminate between objects at all aspect angles with black and white simple or complex 2D stimuli (M = 66%). In the current study, we presented six goldfish with 2D color photos of familiar 3D stimuli (plastic turtles and frogs) rotated in the picture and depth planes. They were tested with the same aspect angles presented in the prior study with 3D stimuli (0, 90, 180, 270 degrees). The current results show that performance was above chance at all aspect angles (M = 83%), with the lowest accuracy for depth plane rotations about the x-axis. The performance of fish in these object constancy tasks appears to be influenced by the dimensions of the stimuli, the presence of color cues, and prior exposure to the objects.

9:30 PM *Break*

9:35 PM Communication I (Chair: Marisa Hoeschele)

16

9:35 PM

Referential communication in black-capped chickadee (*Poecile atricapillus*) mobbing calls
Jenna V. Congdon (University of Alberta), Allison H. Hahn (St. Norbert College), Kimberley A. Campbell, Erin N. Scully, Shannon K. Mischler, Carolina Montenegro, William D. Service, & Christopher B. Sturdy (University of Alberta)
Referential communication has been defined as the exchange of information giving reference to something, and is commonly observed in humans and other primates (Seyfarth & Cheney, 1990); however, there is little evidence to support the use of referential alarm calls in songbirds. However, immediate early gene expression in black-capped chickadee auditory brain areas is similar across vocalizations of the same threat level (Avey et al., 2011), suggesting

that chickadees perceive predator vocalizations and conspecific mobbing calls of the same threat level as similar. In the current study, we trained birds in an operant go/no-go discrimination task in which chickadees were to respond ('go') to high-threat predator calls and withhold responding ('no-go') to low-threat predator calls. Following this training, birds were tested with untrained conspecific mobbing calls (i.e., high- or low-threat). We predicted that birds would show transfer of training; for example, birds trained to respond to high-threat predator calls would respond to untrained high-threat mobbing calls, suggesting that chickadees perceive classes of predator and mobbing calls as similar. We found that although birds were mostly re-learning rather than transferring their training, there appears to be differences depending on the vocalizations being discriminated.

17

9:42 PM **A model for referential communication learning**
Shereen Chang (University of Pennsylvania)
Researchers sometimes train animals to communicate referentially using words or other symbols. Animals learn with varying degrees of success. What makes an animal more likely to learn such forms of communication? In this presentation, I look to the research programs of Irene Pepperberg and Nicolas Giret. The Pepperberg and Giret labs trained grey parrots to communicate using words. While parrots in the Pepperberg lab successfully learned to use many words referentially, parrots in the Giret labs did not learn as many words. I analyse the methods and conditions under which both sets of subjects were trained in the Pepperberg and Giret labs. From this analysis, I propose a model for learning referential communication: the MUSE model. I investigate the likelihood that the MUSE model applies more generally to other species beyond grey parrots. After discussing cases of corroborating evidence in other species, I look at cases of interspecies "eavesdropping" behaviour in wild animals and suggest avenues for further research that could productively illuminate the scope of the MUSE model.

18

9:49 PM **Behavioural responses to female song playback in black-capped chickadees (*Poecile atricapillus*)**
Carolina Montenegro, William D. Service, Kimberley A. Campbell, Erin N. Scully, Shannon K. Mischler, Jenna V. Congdon, Christopher B. Sturdy (Department of Psychologya, Neuroscience and Mental Health Institute, & University of Alberta) (University of Alberta)
In Oscine songbird species, songs are used in territorial defense and mate attraction. Recent studies suggest that female song may serve similar functions to male song. The function of female black-capped chickadee (*Poecile atricapillus*) fee-bee song is unknown, however, male and female fee-bee songs differ perceptually and acoustically. Therefore, we hypothesized that female fee-bee songs have a distinct function from male song. We conducted a behavioural playback study in which male and female chickadees were presented with playbacks of female-produced songs. The same female-produced fee-bee songs were played to both male and female black-capped chickadees with the following behavioural responses evaluated from video recordings: (a) phonotaxis (i.e., movement towards sound); (b) general movement (i.e., beak wipes, feather ruffles, perching, and flight); and (c) vocalizations (i.e., fee-bee songs, chick-a-dee calls, gargle calls, and tseet calls). We found that in response to female fee-bee songs, female chickadees produced more fee-bee songs compared to males. Females remained in the center of the chambers whereas males visited the outer perches more often, and females spent more time closer to the speaker than males. This suggests that female-produced fee-bee song is directed at other females with regards to territoriality.

19

9:56 PM **Looking beyond silence as a way to segment animal vocalizations: A comparison with humans**
Marisa Hoeschele (Austrian Academy of Sciences), & Dan C Mann (University of Vienna)
Studying the communication systems of non-human animals is difficult because we're missing knowledge about both meaning (top-down approach) and fundamental units (bottom-up approach). Most efforts to study the units comprising non-human animal vocalizations have focused on elements of sound separated by silence. This has been very successful in some species, where elements separated by silence are easily identifiable because of their stereotyped nature. However, in some species, these elements seem to never repeat. This has parallels to humans who often produce multi-word utterances without any intervening silences, and many of these utterances never repeat. Instead of silence, rapid changes in the signal structure indicate that a unit type has changed (e.g., transition from "p" to "o"). Here we show that breaking up an acoustic signal based on rapid transitions may be useful in identifying basic units in vocal communication in another species: the budgerigar. This discovery has led us to observe other structural parallels to human vocalizations as well. These findings suggest that budgerigars may be an ideal model species for human language, because we can begin to tease apart what aspects of human language are cultural phenomena and what aspects are the result of widely-shared sound production biases.

20

10:03 PM **The Influence of Personality Traits on Pectoral Fin Contact Exchanges in Bottlenose Dolphins (*Tursiops truncatus*)**
Riley Macgregor (The University of Southern Mississippi), Kathleen Dudzinski (Dolphin Communication Project), Kelsey Moreno (Tel Aviv University), & Teri Bolton (Roatan Institute for Marine Sciences)
Pectoral fin contact exchanges between bottlenose dolphins help build and maintain social relationships between individuals (Dudzinski & Ribic, 2017). Previous research has shown that bottlenose dolphins have distinct personalities

that are consistent across time and context (e.g., Highfill & Kuczaj, 2007; Kuczaj, Highfill, & Byerly, 2012), and it has been suggested that personality may influence tactile behavior exchanges. The aim of the present study was to determine if personality traits influenced how dolphins initiate contact as a rubber or rubbee during pectoral fin contact exchanges. Instances of pectoral fin contacts were selected from previously recorded underwater video observations of a social group residing in human care and the dolphins' personalities were assessed using a Five-Factor Model questionnaire. Results suggested dolphins who were rated high in Agreeableness and initiating pectoral fin contact as a rubbee were more likely to initiate contact to their face over their mid-body and posterior-body. Also, dolphins who were rated low in Neuroticism were more likely to initiate contact to their face compared to dolphins who were rated high in Neuroticism. This study demonstrates an initial look at how personality influences the initiation of pectoral fin contact exchanges in bottlenose dolphins.

10:10 PM Meta-cognition and Comparative Psychology (Chair: Marisa Hoeschele)

10:10 PM Joint Intentionality in Chimpanzees and Bonobos

Dennis Papadopoulos (York University)

I offer a joint intentional interpretation of chimpanzee dominance hierarchies and bonobo territory sharing practices. This philosophical work relies on a very general understanding of normativity required for joint intentionality in both humans and non-human animals. I suggest that great apes can intentionally socially coordinate behavior in appropriate ways. This requires that great apes are appropriately individuated to render coordinated social activity optional. It further requires, they can intentionally take up cooperative activities that rely on predicting others. These predictions do not depend on the attribution of beliefs but can be explained through other heuristics as part of a naïve normativity. Together these open the theoretical possibility of using heuristics to intentionally coordinate activities—joint intentionality. On this account of joint intentionality, I suggest that dominance hierarchies in chimpanzees are the product of a joint intention of all group members to take some particular chimp to be the alpha. This does not require tracking each members relation and calculating dominance, but rather conforming to a social norm of deference. Bonobo territory sharing provides a more obviously normative case because the act of "joining in" with a new temporary, toleration of others is a norm that appears to be optional.

10:17 PM The Invisible Field of Comparative Psychology

Megan Broadway (University of Louisiana Monroe), Jennie Christopher, & Tabatha Lewis (University of South Alabama)

Is comparative psychology dying or is it just invisible? Some people feel that the field of comparative psychology is fading (ex. Abramson, 2015, 2018; Krachun, 2015; Vonk, Hoffmaster, Johnson-Ulrich and Oriani, 2015) while others think it is thriving under different names (ex. Brodbeck and Brodbeck, 2015; Osvath and Persson, 2015; Kuhlmeier and Olmstead, 2016). But has anything really changed? The public still doesn't know the field exists and undergraduates can't readily find us. Are we as scientists the problem? Is our unconscious tendency to avoid using the term "comparative psychology" or referring to ourselves as "comparative psychologists" (McMillan and Sturdy, 2015) contributing to the dearth of public knowledge about this field of study? In this talk, we will present the results of a brief questionnaire to gauge public perception and results from CO3 members regarding their own experiences relating to these issues. We will rehash some history, review a few of the major issues facing comparative psychology, use a few of your own words against you, and maybe find a new way of looking at the problem while offering a few extremely painful solutions.

Thursday Afternoon

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

12:00 PM Asian elephants use water as a tool to reach a floating reward

Lisa P. Barrett, & Sarah Benson-Amram (Program in Ecology and Department of Zoology Physiology at the University of Wyoming)

One of the greatest challenges in comparative cognition is to design tasks that accurately assess cognitive abilities across taxa with differing morphologies and behaviors. The floating object task tests insightful problem solving via water tool

use in animals, but so far it has only been tested in primates. Elephants are considered to exhibit complex cognitive abilities, and they possess a unique trunk appendage well-suited for tests of tool use. We presented the floating object task to 12 zoo-housed Asian elephants to determine if they demonstrate innovative problem solving. One elephant solved the task on its own and another was trained on the task. Thus, it appears that elephants are capable of using water as a tool and that they might exhibit insightful problem solving. We then extended the traditional use of the task by inquiring whether elephants solve via social learning. We did not find evidence of imitation on the task, but at one institution, elephants that observed a conspecific solve the task exhibited increased interest in the task compared to controls. Our results bolster support for elephants' convergent cognitive evolution with primates, but we discuss why the floating object task may not be appropriate for testing in diverse species.

24

12:07 PM

Human Auditory Discrimination of Bottlenose Dolphin Signature Whistles Masked by Noise: Investigating Perceptual Strategies for Anthropogenic Noise Pollution

Evan Morrison, & Caroline DeLong (Rochester Institute of Technology)

Anthropogenic masking noise in the world's oceans is known to impede many species ability to perceive acoustic signals, but little research has addressed how this noise pollution affects the detection of bioacoustic signals used for communication. Bottlenose dolphins use signature whistles which contain identification information. Past studies have shown that human participants can be used as models for dolphin hearing, but most previous research investigated echolocation. In Experiment 1, human participants were tested on their ability to discriminate among signature whistles from three dolphins. Participants' performance was nearly errorless (M = 98.8%). In Experiment 2, participants identified signature whistles masked by five different samples of boat noise, with different signal to noise ratios. Preliminary results suggest that participants perform worse in lower ratios of signal to noise, that some signature whistles are easier to identify in the presence of noise, and that some noises have more detrimental impacts on whistle recognition. The presence of boat noise may cause participants to use more auditory cues in order to identify whistles, although participants always relied most heavily on frequency contour and duration. This study may provide insight into the impacts of different types of boat noise on dolphin whistle perception.

25

12:14 PM

The Chambered Nautilus changes its tentacle behavior in response to conspecific scent

Naomi Lewandowski (The Graduate Center and Brooklyn College - City University of New York), Chelsea Quaies, Ling Yang, Wajeh Syed, Chaya Fastow, Mahwish Ashfaq, & Jennifer Basil (Brooklyn College - City University of New York)

Little is known about social or reproductive behavior in the solitary, heavily olfactory *Nautilus pompilius*. As they may use odor to find and choose mates in the wild, I hypothesized that Nautilus respond differently to female, male, and individual olfactory cues. Past experiments demonstrate sex differences in choice of conspecific scent. Here I test if there are differences in Nautilus arousal to conspecific scent, as indicated by their tentacle extension. Each nautilus was presented paired conspecific scents in a Y maze, and allowed to choose one of the maze arms. I also ran control trials with sea water and no odor. As nautiluses swam upstream within the arm of the Y-Maze we scored their tentacle extension at three points in the maze. Males and females extended their tentacles in a similar pattern at the three points when tracking either same or opposite sex odor. Though the patterns were similar, there a significant difference in the amount of extension among the three points along the Y-maze. Further, in the absence of odor, the level of tentacle extension was markedly different compared to scented trials.

26

12:21 PM

Do non-human primates really represent others' ignorance? A test of the awareness relations hypothesis

Daniel Horschler (University of Arizona), Laurie Santos (Yale University), & Evan MacLean (University of Arizona)

Whether, and to what extent, animals understand the mental states of others is a longstanding question in comparative cognition. Researchers have proposed that non-human primates form 'awareness relations' to link objectively true information to other minds, as opposed to human-like representational relations tracking ignorance or belief states. We present the first explicit test of this hypothesis by examining when monkeys' understanding of others' knowledge falters. Monkeys watched an agent observe food being hidden in one of two boxes. While the agent's view was occluded, either the food moved out of its box and back into it, or the box containing the food opened and immediately closed. Monkeys looked significantly longer when the agent reached to the incorrect compared to the correct location after the box's movement, but not after the food's movement, suggesting that monkeys did not expect the agent to know the food's location when it moved while the agent could not see it, but did expect the agent to know the food's location when only the box moved. Our findings support the hypothesis that monkeys reason about others' knowledge using 'awareness relations' which are disrupted by arbitrary manipulation of a target object while an agent cannot see it.

27

12:28 PM

The Importance of Social Group Composition for the Development of Socio-Sexual Behavior in Beluga Whales (*Delphinapterus leucas*) Under Human Care

Malin K. Lilley (The University of Southern Mississippi and Texas AM University- San Antonio), & Heather M. Hill (St. Mary's University)

Adult male belugas have been observed frequently engaging in same-sex socio-sexual behavior; however, the development of this behavior in young animals has not yet been explored. It was hypothesized that if these behaviors are socially learned, the presence of an adult male in a social group would increase the prevalence of socio-sexual behavior. The present study explored how socio-sexual behavior developed in beluga whales under human care by recording the behavior of 5 belugas between years 4 and 10 of their lives and coding socio-sexual behavior. Significant predictors of socio-sexual behavior included the subject sex, subject age, and presence of young male conspecifics, but not the presence of environmental enrichment. No support was found for the hypothesis regarding the influence of an adult male in the social group, however this does not negate the necessity of an adult male serving as a role model sporadically and further research is necessary. Understanding how social group composition influences the development of beluga socio-sexual behavior may contribute to their reproductive success under human care and in the wild. Additionally, because socio-sexual behavior composes a relatively large portion of belugas' activity budgets, it is likely crucial for social bonding and well-being in belugas.

12:35 PM

Social Learning (Chair: Jo Madden)

28

12:35 PM

Monkeys learn causal sequences from their own experience, but may not benefit from seeing a human demonstrator

Elisa Felsche, Christoph Voelter, Amanda Seed (University of St. Andrews), & Daphna Buchsbaum (Presenting Author) (University of Toronto)

While humans often faithfully imitate all of a demonstrator's actions independent of their effectiveness, other primates tend to copy more faithfully if the demonstrated actions are causally plausible. We investigated the tendency of capuchin monkeys (*Sapajus sp*) and 3- to 5-year-old children to carry out a two-action sequence on a transparent reward-dispensing machine, when either both actions or only the second action were mechanically necessary for reward obtainment. We also explored whether the intentionality of the human demonstrator influenced the imitation rate and compared performance to a baseline group that did not receive any demonstration. Monkeys performed the full sequence more often when it was necessary to obtain the reward, showing that acquiring a novel two-action sequence lies within their capability. As expected for the monkeys, there was no consistent influence of the demonstrator's intentionality. Surprisingly, unlike in previous work, monkeys also did not benefit from seeing a demonstration, but did improve in efficiency of reward obtainment over multiple attempts. In contrast, human children learned from seeing a human demonstrator, though their imitation performance also did not differ between demonstrator intentionalities, suggesting that overimitation in children may in part result from the causal opacity of the demonstrations.

29

12:49 PM

Testing models of collective decision-making in fish

Noam Miller, & Kevin Kadak (Wilfrid Laurier University)

Animals that live in groups have two potential sources of information for making decisions: personal information based on their own past experiences, and social information derived from the choices they observe others making. In the absence of personal information, models of (optimal) collective choice suggest that social information can be used to guide behavior in different ways: animals may either take into account the sequence of choices they observe or only the total number of choices made. For example, a single individual contradicting the majority early in the sequence is less informative than one contradicting later in the sequence. Different models of social information coding therefore make differing predictions about choice. We trained groups of zebrafish to consistently choose one of two arms in a Y-maze. We then released 4 of these fish in a specific order in the maze and, after they had made their choices, released a maze-naïve test fish behind them. This allowed us to manipulate the sequence of social information the test fish observed. We compare the choices made by the test fish to the predictions of two leading models, and show that fish appear to have relatively sophisticated rules for using social information.

30

1:03 PM Attention (Chair: Jo Madden)

1:03 PM **Cuing attentional shifts during a visual search of hierarchical stimuli by pigeons**
Suzanne L. Gray, Muhammad A. J. Qadri, & Robert G. Cook (Tufts University)

The ability to respond flexibly to changing external cues is suggestive of higher-order processes. We investigated if pigeons could shift their attention appropriately given an external cue during successive search and selection in a complex visual array of compound stimuli. We trained four pigeons to search among 16 hierarchically-organized stimuli in which four target letters were presented both in local and global configurations in every display. During initial training, pecking the two positive letters in either the global or local configuration would lead to reinforcement. A color cue was then added to the display that changed the reinforcement contingencies such that when green was present only local positive letters were reinforced and when red was present only global positive letters were reinforced (a neural gray cue was also tested some trials). Changing the color cue mid-trial showed that pigeons rapidly shifted responding to the appropriate level of configurations (local to global; global to local). These results suggest that pigeons are capable of attentional flexibility reminiscent of executive function.

31

1:10 PM **Temporal dynamics in pigeon pecking behavior**
Muhammad A. Qadri, & Robert G. Cook (Tufts University)
Most research using pigeons to investigate cognitively interesting concepts, such as visual perception, categorization, and recognition, use changes in the number of pecks elicited to particular stimuli to argue that the pigeons observe different features. When using dynamic stimuli, the timing of pecks becomes increasingly important, but the temporal features that underlie pecking behavior during go/no-go paradigms remains under-examined. We evaluate several datasets across different stimulus domains using similar go/no-go task structures to examine the temporal structure of pigeon discriminative behavior. In addition to a simple visual task to evaluate computational models of pecking behavior, we consider whether there are identifiable bouts of pecking that better express pigeons' discrimination behavior.

1:17 PM *Break*

1:22 PM Symposium I - Meaning of Memory Systems in Comparative Cognition (Chair: Rob Hampton)

32

1:22 PM **Dissociation of memory systems and what I wish we knew about the evolution of memory**
Robert Hampton (Emory University)
Sherry and Schacter (1985) taught us that natural selection will drive memory to express in systems with distinct or incompatible modes of operation. Recognition of these systems provides a framework for the study of both qualitative and quantitative variation among species, and creates a powerful connection between comparative cognition and neurobiology. We identify systems when we dissociate them, finding that some types of memory respond more strongly to a set of variables than do others. I will present work from our laboratory, and others, that reveal dissociations in memory systems that are based in the manipulation of both cognitive and neurobiological variables. The rest of this symposium will consist of presentations spanning a range of approaches to the study of the operation of memory systems across species. These studies advance our understanding of the organization of memory and the role memory plays in adaptation, and provide context for the changes in memory we see in development and disease.

33

1:36 PM **Double dissociation of familiarity and working memory in rhesus monkeys (*Macaca mulatta*)**
Ryan J. Brady, & Robert R. Hampton (Emory University)
Monkeys have been found to actively rehearse memoranda when tested with repeating stimuli, but not with trial-unique stimuli. This difference may exist because monkeys have difficulty processing trial-unique stimuli in a way that permits active maintenance in working memory. Alternatively, monkeys may have maintained trial-unique images in working memory in past studies, but the relative familiarity of to-be-remembered stimuli compared to never before seen distractors in classic recognition memory paradigms may be such a strong determinant of recognition performance that evidence of working memory was obscured. We contrasted these two hypotheses with a procedure that attenuated the utility of familiarity as a mnemonic signal permitting a more sensitive assessment of working memory. The familiarity attenuation caused a large decrease in accuracy with trial-unique but not with repeating stimuli. Conversely, concurrent cognitive load during the memory interval resulted in a large decrease in accuracy with repeating stimuli but not trial-unique stimuli. When we combined the familiarity attenuation procedure with concurrent cognitive load, we observed clear evidence of working memory with trial-unique stimuli. These results constitute a double dissociation of familiarity and working memory in rhesus monkeys, and show working memory for trial-unique stimuli in monkeys.

34 1:43 PM **Process dissociation of memory systems in a caching and a non-caching bird species**
Emily Kathryn Brown (Emory University), Caroline G. Strang (Western University), David F. Sherry (Emory University), & Robert R. Hampton (Western University)

In the winter, reliable access to food is a matter of life or death. Some species manage this risk by storing food in uniquely-located caches, which they then remember. A bird that caches food in unique, varied locations must constantly and flexibly update its memory of where to find food. In contrast, a bird that consistently finds food in patches with a distinct appearance may rely on a less flexible habit of repeatedly returning to a patch with that appearance. These foraging strategies share properties with distinct types of memory: one-trial memory is rapid-forming, rapid-updating, and flexible, whereas habit is slow-forming, slow-updating, and inflexible. Process Dissociation Paradigm (PDP), a technique used to measure independent contributions of one-trial and habit memory, can inform our understanding of the degree to which species rely on a particular memory system. We used a computerized PDP to evaluate whether food caching has led food-caching birds to rely relatively more on one-trial memory compared to non-caching birds. Neither chickadees nor juncos showed any evidence in probe trials of having acquired habits despite control trials that demonstrated that they had sufficient opportunity to do so. We will discuss potential explanations for birds' unexpected reliance on one-trial memory.

1:57 PM

35

One-trial and habit memory in Black-capped Chickadees (*Poecile atricapillus*) and Dark-eyed Juncos (*Junco hyemalis*)
Caroline G. Strang (Western University), Emily K. Brown (Emory University), David F. Sherry (Western University), & Robert R. Hampton (Emory University)
Black-capped Chickadees and Dark-eyed Juncos are both under selective pressure to keep track of long-term reliable food sources. Chickadees are under additional ecological pressure to re-locate previously-stored food. We tested both species on touchscreen experiments that assessed two types of memory we expect to serve these components of foraging behaviour: habit memory and one-trial memory. In Experiment 1, habit memory was established with discrimination trials in which photographic backgrounds were paired with configurally-unique spatial arrays, in which one location was always rewarded. In probe trials stimuli were presented as spatial matching to sample trials. Both species preferentially used habit memory on incongruent trials (i.e. when one-trial and habit memory were in conflict) despite high accuracy on independent assessments of one-trial memory. We hypothesized that backgrounds controlled which memory system birds used. In Experiment 2, habits were trained using both discrimination and DMTS trials to reduce the salience of backgrounds in the control of which memory system birds used. This change in procedure increased use of one-trial memory with a corresponding decrease in use of habits on incongruent trials. We will discuss how species ecology and context influence chickadee and junco reliance on different types of memory.

2:11 PM

36

Dissociable Learning Processes in Categorization
J. David Smith (Georgia State University)
The controversy over multiple category-learning systems is reminiscent of the controversy over multiple memory systems. Researchers continue to seek paradigms to dissociate explicit categorization processes (featuring category rules held in consciousness) from implicit categorization processes (featuring learned stimulus-response associations that lie outside declarative cognition). I will describe this theoretical differentiation. I will illustrate why this distinction is relevant to cross-species research. I will describe an empirical dissociation that we arranged in this area using the technique of deferred-rearranged reinforcement. Participants learned matched category tasks that had either a one-dimensional, rule-based solution or a multidimensional, information-integration solution. They received feedback either immediately or after each block of trials, with the blocked feedback organized such that positive outcomes were grouped and negative outcomes were grouped. Deferred reinforcement qualitatively eliminated implicit, information-integration category learning. It left intact explicit, rule-based category learning. Moreover, participants facing deferred reinforcement turned by default and information-processing necessity to explicit, rule-based strategies no matter whether this approach suited their task. It is theoretically important that dissociative techniques of this kind can essentially "unplug" associative learning, so that animals have to process tasks explicitly and declaratively instead—if they can!

2:25 PM

37

Lagged Reinforcement: A Dissociative Methodology for Fostering Animals' Explicit Cognition
Brooke N. Jackson, Barbara A. Church, & J. David Smith (Georgia State University)
Prominent theories of categorization (e.g. Ashby et al., 1999) suggest that humans excel at learning rules because of their ability to create verbal hypotheses. However comparative research has shown that non-human primates perform similarly to humans in rule-based category-learning tasks (e.g. Smith, et al., 2010; 2012; 2015). It is unclear whether this rule-learning is the same as that seen in humans or if it is supported by associative learning processes that map specific stimuli to responses (Zakrzewski et al., 2018). The current study examines whether rhesus macaques can learn simple category rules when these associative-learning processes are not possible. To do this, we examined monkeys' abilities to learn category rules with lagged feedback. Lagged feedback rewards or punishes the animal not for the stimulus-response pairing they just performed, but for the pairing one trial back from the current trial. This breaks the time-locked stimulus-response-reinforcement chain needed for associative learning. Results show that the monkeys are able to learn category rules with lagged feedback suggesting that, like humans (Smith et al., 2018), they are able to learn rules using processes other than those of associative learning.

2:32 PM

38

Effects of social housing on cognitive decline due to aging: reference and working memory
Victoria L. Templer, Taylor B. Wise, & Victoria R. Heimer-McGinn (Providence College)
Longitudinal human studies suggest that as we age, sociality provides protective benefits against cognitive decline. Thus far rodent studies have failed to examine the independent effects of social housing while controlling for physical enrichment in all groups. Here rats were socially housed (SH) or nonsocial housed (NSH) throughout their lifespan and tested in the radial arm maze to measure working (WM) and reference (RM) memory longitudinally at three ages. In old age exclusively, SH rats made significantly less WM errors than NSH rats, while RM errors did not differ between groups at any age. Anxiety, as assessed behaviorally and physiologically, could not account for the observed differences in WM. These data provide the first evidence that social enrichment alone can prevent age-related WM deficits in spite of the effects of practice seen in longitudinal designs.

2:46 PM

39

Cognitive effects of social housing: dissociating acquisition of task-set and spatial memory
Taylor B. Wise (Brown University), Victoria R. Heimer-McGinn (Roger Williams University), & Victoria L. Templer (Providence College)
The aim of this study was to determine the learning and memory impacts of social vs. individual housing in rats in a longitudinal model. In adolescence, rats were divided into two separate housing conditions, social (SH) and nonsocial housing (NSH). Spatial navigation, long-term memory, and cognitive flexibility were assessed in several iterations of the Barnes Maze across three timepoints (early adulthood, middle-age, and old age). Results showed that in early adulthood, SH rats exhibited faster acquisition, but did not perform better than NSH rats during long-term memory probes. This suggests that social housing may affect early learning, but not long-term memory. Interestingly, when given new tasks in middle-age, SH rats outperformed NSH rats, mirroring results from their first exposure to the initial task in early adulthood. Results also show that SH rats were faster at acquiring changes to the task-set in a reversal task, suggesting enhanced cognitive flexibility. Findings that SH rats were faster to acquire novel tasks but remembered correct locations equally to NSH rats suggests that social housing provides a differential benefit to cognition. In sum, this study provides evidence for a dissociation between acquisition of task-set and long-term memory by means of social enrichment.

2:53 PM

40

Dissociating episodic memory from memory trace strength in rats
Danielle E. Panoz-Brown, & Jonathon D. Crystal (Indiana University)
Episodic memories in people have been characterized as the vivid replay of multiple unique events in sequential order. Most animal models of episodic memory have documented episodic memory of a single event. However, a fundamental feature of episodic memory in people is that it involves multiple events, and notably, episodic memory impairments in human diseases are not limited to a single event. Critically, it is not known whether animals remember many unique events or the order in which those events occurred using episodic memory. To this end, we developed animal models of episodic memory for multiple events in context and the replay of episodic memories. In each approach, we dissociate episodic memory from non-episodic memory. Here we show that rats remember a stream of multiple episodes (Panoz-Brown et al., (2016) Current Biology), and the order that they occurred by engaging hippocampal-dependent episodic memory replay (Panoz-Brown et al., (2018) Current Biology). Our findings suggest that the ability to represent a stream of numerous episodic memories is quite old in the evolutionary timescale and supports the view that rats may be used to model fundamental aspects of human cognition.

3:05 PM *Snack Break*

3:35 PM Symposium II - New trends in fish cognition (Chair: Maria Elena Miletto Petrazzini)

3:35 PM

41

World in motion: Movement discrimination in grey bamboo sharks (*Chiloscyllium griseum*) and Malawi Cichlids (*Pseudotropheus sp.*)
Vera Schluessel (Institute of Zoology)
Generally, we assess learning and memory functions in elasmobranchs in comparison to teleosts, both on a behavioral and neuronal level. Topics of interest include object categorization, illusory contours, spatial orientation, serial learning and numerical abilities. Here, cichlids and sharks were shown to successfully discriminate between a range of stationary and moving objects. Their ability to recognize unique movement patterns and to discriminate between videos of moving organisms was tested in two alternative forced-choice experiments. Following successful discrimination training, both species underwent transfer testing, where they performed under altered conditions, i.e. training stimuli were shown (a) from a different perspective (front or sideways), (b) enlarged or downsized, or (c) in form of point displays. While cichlids mastered all tasks, sharks only performed well when stimulus size was changed but failed to recognize stimuli

shown from a new perspective or as a point display. This indicates that cichlids have the ability to recognize a familiar organism under new conditions, e.g. based on its movement alone, which may be helpful in recognizing approaching predators early on. Results suggest that the two species place different emphasis on movement discrimination, possibly in relation to their respective ecologies and lifestyles.

3:49 PM

42

Visual illusions as a tool to investigate how fish see the world
Christian Agrillo (Department of General Psychology), & Maria Santacà (University of Padova (Italy))
Visual illusions are more than simple tricks. Visual illusions are commonly investigated to understand perceptual mechanisms underlying human visual perception. In addition, they have become a useful tool to compare visual perception among vertebrates. To date, most of the literature investigated mammals and birds. However, in the last decade researchers started to focus their attention also to more distantly related species, such as fish. The use of training procedures, as well as the observation of spontaneous behaviour in the presence of biologically-relevant stimuli, showed that fish have a human-like perception of different visual illusions, such as Ebbinghaus illusion, brightness illusion and the rotating snake illusion. In other cases, fish are poorly sensitive to illusory patterns (e.g., solitaire illusion). Lastly, they may exhibit also a reversed perception of visual illusions (e.g., Delboeuf illusion). On the whole, the heterogeneous pattern of data in this field suggests the existence of inter-specific differences in the perceptual mechanisms underlying visual illusions in fish.

4:03 PM

43

What can fish tell us about non-symbolic numerical abilities?
Maria Elena Miletto Petrazzini (School of Biological and Chemical Sciences)
Studies over the past few decades have shown that numerical abilities are not unique to humans but are rather widespread among animals. Fish are distantly related to primates and are therefore an ideal group for testing whether vertebrates' numerical systems have a common origin. Interest in fish numerical abilities has exploded in recent years. Fish possess features that make them unique for the study of numerical cognition and have now become a valuable model to address this issue. For instance, in mammals and birds it is difficult to use the same paradigms to compare young and adult individuals and to design experiments that disentangle the contribution of maturation, experience and genes. In some species, offspring are independent at birth and display a full behavioral repertoire thus giving the possibility to test fish very early in life to investigate the ontogeny of numerical abilities. Methodological approaches commonly used with mammals and birds have also been adopted in fish studies. Results have shown that fish possess sophisticated numerical abilities partially comparable to those reported in higher vertebrates raising the question as to whether numerical abilities are more ancient than previously thought and have been inherited from a common ancestor.

4:17 PM

44

Using zebrafish forward genetic behavioural analysis to identify genes and pathways affecting aspects of executive function
Alistair J. Brock (School of Biological and Chemical Sciences Queen Mary University of London), Judit García-González (Queen Mary University of London), Matthew O. Parker (University of Portsmouth), Ari Sudwarts (Queen Mary University of London), Muy-Teck Teh (Barts and The London School of Medicine and Dentistry), Elisabeth M. Busch-Nentwich (Wellcome Trust Sanger Institute), Adrian R. Martineau (Barts and The London School of Medicine and Dentistry), Jaakko Kaprio, Teemu Palviainen (University of Helsinki), Valerie Kuan (University College London), Robert T. Walton (Barts and The London School of Medicine and Dentistry), & Caroline H. Brennan (Queen Mary University of London.)
Although there is clear evidence of genetic contributions to a range of human behavioural disorders such as addiction, it has proved difficult to identify causal alleles and pathways from studies in humans. Mutagenesis in model species generates strong phenotypes not present in wildtype populations and thus can be used to predict biological mechanisms underlying conserved behavioural phenotypes. We describe the application of this approach to two fields of study: addiction biology and ageing research. We identified mutations in the zebrafish Slit3 gene associated with increased nicotine preference. Slit3 mutant fish show altered behavioural sensitivity to dopaminergic antagonists and up-regulation of DrD2a mRNA but neuronal pathfinding was unaffected. Analysis of the SLIT3 locus in humans identified 2 genetic markers that predict level of cigarette consumption and likelihood of cessation. We identified 4 lines showing differences in basic learning rates and/or attention. Three lines showed significant gene and age interactions for either attention or reaction time parameters. For one line the disrupted locus has previously been associated with Familial Alzheimer's disease in humans. Our findings suggest a role for SLIT3 signaling in dopaminergic pathways affecting nicotine dependence and demonstrate the translational relevance of the zebrafish model in exploring complex human behaviors.

4:35 PM *Break*

4:35 PM Communication II (Chair: Jennifer Basil)

45

4:35 PM **Categorization of predators by wingspan and body length in black-capped chickadees**
Christopher B. Sturdy, Jenna V. Congdon (University of Alberta), Allison H. Hahn (St. Norbert College), Kimberley A. Campbell, Erin N. Scully, Daniel A. Yip, & Erin M. Bayne (University of Alberta)
Smaller owls and hawks are considered a higher threat to small songbirds, such as chickadees, compared to larger owls and hawks, due to the smaller predators' agility (Templeton et al., 2005). We conducted an operant go/no-go experiment investigating chickadees' categorization of predator threat. Vocalizations from 16 owls and hawks were obtained; we assigned each species to a category: (1) large, low threat, (2) mid-sized, and (3) small, high threat predators, according to wingspan and body size. Black-capped chickadees (*Poecile atricapillus*) were trained to respond ('go') to either low-threat predator vocalizations or high-threat predator vocalizations and not to respond to the other category (low- or high-threat). We confirmed that black-capped chickadees discriminate between high- and low-threat owls and hawks; following initial training, we examined how chickadees responded to mid-sized predators and found that short eared owl (*Asio flammeus*) vocalizations were responded to by the low-threat condition birds, whereas broad-winged hawk (*Buteo platypterus*) vocalizations were responded to by the high-threat condition birds, and intermediate responding occurred to the other species' vocalizations, suggesting that the perception of threat falls along a continuum rather than clearly defined categories. Our findings provide insight regarding the perception of predators according to wingspan and body size.

46

4:49 PM **Emotional communication transcends species: Human perception of rhesus macaque vocalizations**
Jay W. Schwartz, Mark Wilson, & Mar Sanchez (Emory University)
If aspects of emotional communication are shared across species, as Charles Darwin hypothesized, then we might expect listeners of one species to be sensitive to emotion conveyed by vocalizations of another species. To assess this, several studies have examined human perception of emotion from heterospecific vocalizations. Most have used sounds from domesticated species, making it difficult to know whether findings would extend to other taxa. In the present study, humans listened to rhesus macaque (*Macaca mulatta*) coos (a contact call) recorded during controlled behavior testing, and screams (an aid-recruitment call) recorded during natural agonistic interactions. Each coo was associated with either high or low cortisol increase during testing, and each scream was associated with either contact aggression (high intensity) or non-contact aggression (low intensity) experienced by the screamer. Human listeners inexperienced with monkeys were tasked with choosing which out of a pair of vocalizations represented greater emotional intensity. They achieved above-chance accuracy for both coos and screams, suggesting a sensitivity to the emotional significance of variation within these two call types. Participants did not significantly indicate screams as more emotionally intense than coos or vice versa. Overall these results support Darwin's hypotheses about evolutionary continuity in emotional communication.

47

4:56 PM **Do black-capped chickadees (*Poecile atricapillus*) discriminate between male- and female-produced chick-a-dee calls?**
Kimberley A. Campbell (Department of Psychology), Jenna V. Congdon, Erin N. Scully, Allison H. Hahn (University of Alberta; Department of Psychology), & Christopher B. Sturdy (St. Norbert College; and Department of Psychology)
Like many forest-dwelling songbird species, black-capped chickadees (*Poecile atricapillus*) often rely on auditory (rather than visual) signals for communication. Their chick-a-dee call serves a variety of functions, including warning of predators, flock mobilization, and individual identity. For other black-capped chickadee vocalizations (tseet calls and fee-bee songs), acoustic features differ between sexes, as do the chick-a-dee calls of Carolina chickadees (*P. carolinensis*). To evaluate acoustic features within chick-a-dee calls that black-capped chickadees may use for discriminating between male and female-produced calls, we conducted a series of operant go/no-go discrimination experiments. Black-capped chickadees were rewarded for responding to chick-a-dee calls produced by one sex, and not to calls produced by the other sex. Category learning was evaluated by examining responses to untrained male- and female-produced calls. Results indicated that subjects could learn to discriminate between male- and female-produced chick-a-dee calls, but did so via memorization and rather than treating them as perceptual categories. This could suggest that, in this instance, black-capped chickadees make use of individual identity, rather than forming broad categories (e.g., male vs. female) into which novel individuals can be sorted. These findings add to our understanding of the information contained within and structure of this complex vocalization.

48

5:03 PM **Female and male mice differ in rates of hearing loss for simple and complex acoustic signals in silence and noise.**
Anastasiya Kobrina, & Micheal Dent (University at Buffalo SUNY)
Mouse hearing has been extensively studied using a variety of behavioral and electrophysiological methodologies. Recent behavioral studies also used a longitudinal design to collect auditory sensitivity thresholds for pure tones and ultrasonic vocalizations (USVs) in mice across the lifespan. USVs are produced by mice during various quiet and noisy social interactions such as mating and territory disputes. Yet, no one has examined how age, sex, and listening environments affect the detection of acoustic signals. The current study used a cross-sectional longitudinal design to measure the detection of USVs and pure tones in mice in silent and noisy listening conditions. Mice were trained on a

go/no-go operant conditioning task with positive reinforcement to detect four USVs and two pure tones. Mice of all ages were able to detect USVs and pure tones in both listening environments across their lifespan. Detection thresholds were lower for USVs than pure tones across listening conditions. The rate of hearing loss for certain USV types differed between male and female mice. These results contribute to our understanding of the ways USVs may be used for acoustic communication in mice.

5:15 PM Memory and Geometry (Chair: Jennifer Basil)

5:15 PM **Do boundaries affect distance estimation in rats?**
Z. Kade Bell (Oakland University), Bradley R. Sturz (Georgia Southern University), & Martha Escobar (Oakland University)

Boundaries delimit most objects and environments, and are relevant for perception and distance estimation. Some of these boundaries are physical, but some are illusory. In a recent study with human subjects that used first-person perspective views of a rectangular room, Sturz and Bodily (2016) observed biases in estimations of distance to the back wall when the viewing point crossed an illusory boundary. This boundary was created by two corner projections (i.e., a "hallway" that connected the viewing point to the room). In the present study, rat subjects were placed inside a short or long hallway that led to an open arena where a reward was hidden at different distances from the starting point. During probe trials using the short or long hallways, distance estimation (location of search for the reward) was biased by the length of the starting hallway. Search patterns were analyzed to determine whether animals used distance from the boundary, back wall, or starting point, in order to guide their search. Preliminary data suggest that rats acquire rich information about the environment, and flexibly adapt to the most efficient strategy.

5:22 PM **Pigeons (*Columba livia*) learn two interleaved response sequences in a Serial Response Time task.**
Walter T Herbranson (Whitman College)

Many animals can learn complex response sequences via procedural memory. In a Serial Response Time task, cues appear in different locations according to a predictable sequence, and with experience, response times to predictable locations decrease relative to randomly cued locations. Pigeons learned to perform two interleaved response sequences. Each trial consisted of presentation of a cue in one of three locations, a peck to the cued location, reinforcement on a random 5% of trials, and a 500 ms response-stimulus interval. Cue locations were determined by two fixed sequences: One determined cue locations on even-numbered trials; the other determined cue locations on odd-numbered trials. Response times to locations cued by both sequences decreased with training. In a second condition, cues appeared in unpredictable locations and response times were slower. A third, hybrid condition presented cue locations according to one of the two sequences, alternating with random cue locations, and response times to the sequenced cues were faster than to the random cues. Together, results indicate that pigeons' ability to learn complex sequences of responses extends beyond short, stereotyped motor programs. The learning mechanism likely involves the conditional probabilities of specific key-to-key transitions.

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

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

Friday Morning – Manatee Room 10:30 AM

CO3 Mentoring Program: Meet the Experts (Chair: Noam Miller)

Have you ever wanted to ask questions of established researchers at CO3, but couldn't find the right time or place? In an effort to encourage undergraduate and graduate students to get to know established researchers in the field of comparative cognition, an informal meet and greet will be held in the Manatee room. One faculty mentor will be seated at each of tables. Students are encouraged to come and go from table to table to get to know different mentors. You are encouraged to ask questions about faculty life, funding challenges, research projects, and graduate/career opportunities. A poster identifying each mentor and relevant academic information will be displayed at the entrance to the Manatee room. This session will end promptly at 11:30

Friday Afternoon

12:00 PM

Cognitive Processes I (Chair: Lauren Guillette)

12:00 PM

51

The link between personality and cognition: A meta-analysis

Lauren M. Guillette (University of Alberta and University of St Andrews), & Liam R. Dougherty (University of Liverpool)

In the past decade, several conceptual papers have linked variation in animal personality to variation in cognition, and recent years have seen a flood of empirical studies testing this link. However, these results have not been synthesized in a quantitative way. Here, we systematically searched the literature and conducted a phylogenetically controlled meta-analysis of empirical papers that have tested the relationship between animal personality (exploration, boldness, activity, aggression, and sociability) and cognition (initial learning/reversal speed and number of correct choices/errors after standard training). We found evidence for a small but significant relationship between variation in personality and variation in learning across species in the absolute scale; however, the direction of this relationship is highly variable and when both positive and negative effect sizes are considered, the average effect size does not differ significantly from zero. These results, moreover, do not support current hypotheses suggesting that fast-explorers are fast-learners or that slow-explorers perform better on tests of reversal learning. In sum, while personality and learning are indeed related across a range of species, the direction of this relationship is highly variable. Thus further empirical work is needed to determine whether there are important moderators of this relationship.

12:14 PM

52

How should we interpret inconsistent relationships between cognitive performance and fitness measures?

Joah Madden, Mark Whiteside, Jayden van Horik, Ellis Langley, Christine Beardsworth, & Pip Laker (University of Exeter)

Exaggerated cognitive abilities presumably arise because they bring fitness benefits to individuals expressing them. For example, in species where one sex moves further, we expect the fitness of that sex will be more strongly correlated to spatial ability. Female pheasants disperse further than males so we predicted they would show stronger relationships between spatial ability and survival than males. We assayed the spatial memories of ~200 pheasant (*Phasianus colchicus*) chicks over three years. In 2015, as predicted, females dispersed further and those that had exhibited better spatial memory were more likely to survive, but this did not predict male survival. In contrast, in 2016 although females still dispersed further, the result was reversed: males with better spatial memory were more likely to survive, but this did not predict female survival. In 2017, we found no relationships in either sex. Our results can be interpreted in two ways. Either annually fluctuating selection pressures act on sex differences in spatial ability, necessitating long term studies of fitness outcomes to understand evolution of cognitive abilities. Alternatively, spurious relationships may be detected, even with reasonable sample sizes and clear a priori hypotheses, necessitating extensive replications before we can confirm how selection may act.

12:28 PM

53

Spatial skills do not solely predict an ability to make transitive inference

Olga Lazareva, Haley Dikkers, Nora Balboa, Courtney Kalender, Riddhi Soni, Laura Claydon, & Abigail Nordman (Drake University)

Transitive inference (TI) is a form of deductive reasoning which allows one to derive a relation between items. Spatial models suggest that TI is based on mental representation of spatial order among the training stimuli. We therefore hypothesized that the individual differences in TI performance may positively correlate with measures of spatial ability. In two experiments, the participants received a standard 6-item TI task, a postexperimental awareness questionnaire, three tests of spatial ability, a deductive reasoning test, or a general intelligence test. We found that scores on spatial skills test predicted training TI performance but not the accuracy to the testing pairs. In contrast, Raven's APM scores predicted the accuracy to the testing pairs but training performance. Our results suggest that the ability to learn the overlapping pairs of training stimuli may be associated with spatial ability, but making TI after learning training task requires behavioral flexibility.

12:42 PM

54

Threshold-based Egg Rejection Decisions in Hosts of Avian Brood Parasites

Mark E. Hauber (University of Illinois at Urbana-Champaign)

The rejection of foreign eggs from the nest is the behaviorally and phylogenetically most widespread adaptation by hosts to avian brood parasitism. Investigations of the mechanisms by which a host accomplishes the task of perceiving to recognize and deciding to reject the foreign egg from the nests have been a hotbed of debate and discovery for decades in the context of host-parasite cognitive arms races. There is a steadily building experimental body of work on diverse host species from 3 different continents to indicate that hosts have plastic discrimination thresholds between accepted and rejected eggs, such that the extent to which parasitic eggs must be mimetic of or different from a host's own egg appears to be both socio-ecological context dependent and shaped by earlier experiences through a learning

component. Overall, the cognitive architecture of egg rejection decisions is complex and how it is shaped the perceptual particularities of the coevolutionary history between hosts and their parasites remains to be discovered.

55

1:07PM **Nonhuman Animal Cognitive Gadgetry**
Brandon Tinklenberg (York University)
Many researchers interested in the psychological mechanisms responsible for uniquely human cultural evolution assume they must be domain-specific and genetically inherited. In contrast to those that posit these 'cognitive instincts', Heyes (2018) introduces the notion of a cognitive gadget, whereby cultural evolution selected for the very psychological mechanisms that generate and maintain it. Heyes claims humans are the only creatures with cognitive gadgetry, and this gadgetry explains the obvious social differences between us and other animals. While I think that the idea of a cognitive gadget is theoretically useful, I'm not certain it answers Heyes' ultimate question as to what makes humans unique. I contend that Heyes' sketch of the potential mechanisms responsible for cognitive gadgets, such as metacognition, have long been studied in nonhuman primates. I also suspect that similar selection pressures could drive the evolutionary development of primate social cognition. I therefore suggest that animal cognition researchers test for cognitive gadgets in nonhuman animals, by measuring whether intragroup social learning skills affect the gain of the transmission of social information.

56

1:14 PM **Nocturnally migrating songbirds and the Earth's magnetic field: What activates Cluster N?**
Madeleine I.R. Brodbeck (The University of Western Ontario), Verner P. Bingman (Bowling Green State University), Songyi Yuan, & Scott A. MacDougall-Shackleton (The University of Western Ontario)
Migratory birds use several cues to orient and navigate during migration, including Earth's magnetic field. Cluster N is a group of neurons in the forebrain of nocturnally migrating songbirds that responds to magnetic field input. Cluster N consistently expresses immediate-early genes only at night in nocturnal migrants. It remains unknown whether neuronal activity in Cluster N is the result of a circadian cycle or if it is correlated with nocturnal migratory restlessness. We housed 15 white-throated sparrows, a nocturnal migrant with frequent stopovers, in migratory condition in outdoor aviaries. Birds were sacrificed, and brains collected either during the day (n=4) or at night. In the night condition, some birds exhibited migratory restlessness (n=5) while others were inactive (n=6) at the time of sacrifice. We used immunohistochemistry to quantify ZENK expression in Cluster N in the right hemisphere. Birds in the nocturnal migratory restlessness condition had significantly greater numbers of cells expressing ZENK in Cluster N than birds that were in migratory condition but were inactive at night, and birds collected during the day ($F_{2,12} = 41.63$; $p>0.0001$). We conclude that Cluster N is facultatively activated and not by a circadian cycle of activity.

1:21 PM *Break*

1:26 PM Symposium III - Arthropods negotiating space (Chair: Ken Cheng)

57

1:26 PM **A spider-eating predator's capacity to decide when to take a detour**
Fiona Cross, & Robert Jackson (International Centre of Insect Physiology and Ecology (Kenya))
Exceptionally complex predatory strategies are characteristic of *Portia*, a genus of jumping spiders (*Salticidae*) that specialize at preying on other spiders. We have been interested in the capacity these small predators express for making plans, including plans that require choosing detour paths that take them to otherwise inaccessible prey. Previous research has demonstrated *Portia*'s remarkable proficiency at choosing between two indirect routes (i.e., detours) when only one leads to the prey. Less is known about *Portia*'s proficiency at making strategic decisions regarding whether to adopt a more or a less direct path to prey. However, when freedom of movement was restricted by water and when prey was only visible at the beginning of a trial, we found evidence that *Portia africana* decides ahead of time whether to take a more direct path to the prey when available and, when not available, to take a less direct path.

58

1:41 PM **Celestial Cue Use in the Socially Foraging Desert Harvester Ant,** *Veromessor pergandei*
Cody A Freas, Jenna Congdon (The University of Alberta), Nicola JR Plowes (Mesa Community College), & Marcia L Spetch (University of Alberta)
The desert harvester ant (*Veromessor pergandei*) employs both social and individual navigational strategies while foraging. Individuals leave the nest along a pheromone-based column before spreading out to forage individually in a fan. Foragers are known to use path integration (PI) while in this fan, accumulating a direction and distance estimate (vector), to return to the column head. It is unknown if these foragers' use of the PI system is in use throughout the foraging trip or begins after foragers leave the column. We show that foragers rely on PI both in the fan and column. After distant displacements, fan foragers oriented to the column head direction while foragers displaced from the column oriented and travelled in the nest direction, suggesting the accumulation of both a fan vector and a (global)

column vector. Interestingly, the pheromone cues of the column appear to mediate foragers' use of the column vector, as fan foragers exposed to only the pheromone cues of the column altered their paths to a combination of the fan and column vectors. Pheromones appear to act as a contextual cue triggering the retrieval of the column vector and its integration with the fan vector.

Sisyphus in the desert: what desert ants do when their usual route leads nowhere

1:56 PM *Antoine Wystrach, Sebastian Schwarz (Université Paul Sabatier), Paul Graham (University of Sussex), & Ken Cheng (Macquarie University Sydney)*

59

Ants are expert navigators. Although insect learning has been much studied, the learning processes in navigation have not received much attention. Here we investigate in desert ants (*Melophorus bagoti*) the effects of repeating a well-travelled route segment without success. Re-running a homeward route without entering the nest impacted subsequent trips. Over trips, ants showed more meandering from side to side and more scanning behavior, in which the ant stopped and turned, rotating to a range of directions. In repeatedly re-running their familiar route, ants eventually gave up heading in the nestward direction as defined by visual cues and turned to walk in the opposite direction. Further manipulations showed that the extent and rate of this path degradation depend on 1) the length of the vector accumulated in the direction opposite to the food-to-nest direction, 2) the specific visual experience of the repeated segment of the route that the ants were forced to re-run and 3) the visual panorama: paths are more degraded in an open panorama, compared with a visually cluttered scene. Ants modulate dynamically the weighting given to route memories, and results fit well with recent models of reinforcement learning of views for navigation in insects.

Laboratory Studies of Spatial Learning in Fiddler Crabs (*Uca pugilator*)

2:11 PM *Frank W. Grasso, Richard Troise, Ezra Isaacs, Ahuva Buchbinder, Jennifer Basil, & Stephen G. Volz (BCR Laboratory Brooklyn College CUNY Brooklyn NY 11210 and the LIBE Laboratory Brooklyn College CUNY Brooklyn NY 11210)*

60

Fiddler crabs return reliably to their home burrows after foraging trips. Thus they are an ideal model for studies of spatial navigation in a non-eusocial invertebrate. Path integration as a mechanism for navigation in arthropods, particularly eusocial insects, is ubiquitous and well-studied. Elegant field studies of spatial memory in Fiddler crabs suggest that fiddler crabs may navigate using additional spatial tactics along with path integration. We examined the ability of fiddler crabs to learn locations in spatial tasks that did not involve a home burrow, under controlled laboratory conditions. We tested their abilities to learn conditioned place-avoidance using visual cues, to solve a y-maze spatial choice task which placed visual and spatial cues into conflict, and to make spatial choices via access to a conspecific as the cue. We found no significant differences in conditioned place avoidance. However, in ay-maze, crabs used visual cues under certain conditions. We also found that conspecifics are a strong visual stimulus that can be used in spatial-learning tasks. Taken together these results indicate that visual cues influence fiddler-crab spatial-learning in a manner that extends beyond path integration and burrow homing.

2:26 PM *Snack Break*

3:00 PM In Honour of the Contributions of Stephen Lea I (Chair: Anna Wilkinson)

3:00 PM **The imitation game**
Ludwig Huber, & Kaja Salobir (Messerli Research Institute)

61

Humans imitate, but often in irrational manners, such as actions that are causally irrelevant, like first tapping the side of the jar with a feather and then unscrewing the lid in order to retrieve a desired object. This phenomenon, called 'over-imitation', has been claimed to be uniquely human. Indeed, great apes have been repeatedly found to ignore the irrelevant action and only copy the relevant, goal-directed one. But recent studies with dogs have challenged this view. About half of the tested pet dogs (22 of 45) copied both actions demonstrated by a human, the causally irrelevant and the causally relevant action. In humans, this peculiar form of imitation is strongly motivated by social factors, such as affiliation or conformity. Since the human demonstrator in this first study had been the affiliated caregiver of the subjects, we hypothesized that dogs would not participate in the imitation game if the human demonstrator were unknown. This was confirmed in a second study, in which only few dogs (out of 90) copied the causally irrelevant, non-functional action. We conclude that dogs, like human children, over-imitate in order to promote affiliation with the caregiver, challenging the human uniqueness in the over-imitation game.

3:15 PM **Discrimination of relative numerosity and assessment of the SNARC effect in mice**
Kazuhiro Goto, & Miku Kimura (Sagami Women's University)
The spatial-numerical association of response codes (SNARC) refers to a spatial organization of numerical information. When making numerical judgments, people typically respond faster to small numbers presented on the left and to large numbers presented on the right. Recent studies showed that the SNARC effect also occurs in several nonhuman animals such as chimpanzees, rhesus monkeys, and chicks. Some others reported a reliable SNARC effect, but its direction was reversed from that was typically observed in people. In the present study, we examined the SNARC effect in mice. We first trained them to discriminate eight dots from four dots in a simultaneous discrimination in a touchscreen chamber. Mice successfully learned the discrimination and it was transferred to novel quantities, suggesting that mice discriminate relative numerosity. We then examined the SNARC effect by presenting equal numbers of dots (2, 4, 8, or 16) side by side. If mice show the SNARC effect, leftward response bias should systematically decrease as the number of dots increase. Data will be presented at the meeting.

62

3:30 PM **Information as a resource.**
Alex Kacelnik, & Andrés Ojeda (University of Oxford)
Active learning and exploration can be seen as foraging for knowledge, specially when information serves to guide adaptive choices. As a consequence, the value of being informed is a ubiquitous issue in behavioural and cognitive research, in paradigms ranging from the Two-Armed Bandit, where agents pay a cost to transform uncertainty into risk, to protocols in which animals pay a cost in reward rate to reduce time under uncertainty. We will briefly review some relevant work and present new experiments. In the latter, rats choose between sources of reward that differ in post-choice (hence inconsequential) uncertainty about forthcoming outcomes. We manipulate differences in information about probability, amount, or delay to food. Overall, our results lead us to (temporarily) favour the view that information per-se does not act as a primary goal or reinforcer: general properties of associative learning with food as conditioned stimulus are sufficient to generate most of observed results. This emergent viewpoint is consistent with evidence accumulated in related themes such as risk sensitivity, temporal discounting, and classical foraging theory.

63

Lateralized eye use during information acquisition
3:45 PM *Anna Wilkinson (University of Lincoln), Anna Frohnwieser (University of Cambridge), John C. Murray (University of Hull), Ludwig Huber (Messerli Research Institute), Anna Kis (Hungarian Academy of Sciences), & Thomas W. Pike (University of Lincoln)*
Lateralized eye use, the predominant use of one eye over the other, is widespread among vertebrates. It is thought to increase brain efficiency and is thus considered adaptive. In many species, different types of information are processed by different eyes e.g. information about conspecifics is processed by the left eye and information about prey by the right eye. Thus, lateralized eye use provides a tool to investigate how animals process different sensory information and is therefore likely to be a good indicator of how a stimulus is perceived. To investigate eye use during information acquisition, we presented bearded dragons (*Pogona vitticeps*) with various stimuli containing different types of information and investigated the impact on behavior. We found little effect of visual information such as shape and color, however, lateralization was more pronounced when animals received information relevant for solving a task. This suggests that there are differences in information processing between the brain hemispheres during more complex information acquisition.

64

4:00 PM *Break*

4:05 PM In Honour of the Contributions of Stephen Lea II (Chair: Anna Wilkinson)

65 **4:05 PM** **Learning to hunt: Using an artificial paradigm to investigate what makes an efficient predator**
Catriona M. E. Ryan (University of Exeter)
Abstract Lure coursing is a sport originating in the USA, in which sighthounds (dogs which hunt by sight) chase an artificial lure around a zigzag course, designed to mimic that taken by a live prey animal. The dogs are scored on their speed, agility, endurance, enthusiasm for the chase and how closely they follow the line of the lure. Typically, the more inexperienced dogs tend to score better than the old hands – which may seem odd in the light of current thinking which suggests that such simulated hunting should serve to hone the dog's skills in the pursuit of live prey. However, analysis of the results from a number of meetings suggests that this anomaly may be due to the more experienced dogs scoring lower on the 'follow' scale, due to them cutting corners in order to stay on terms with the lure. The implications of these findings will be discussed.

66   4:20 PM   **Measuring response inhibition with a continuous inhibitory-control task**
Christina Meier (University of Manitoba), Stephen Lea, & Ian McLaren (University of Exeter)
Inhibitory control enables subjects to quickly react to unexpectedly changing external demands. In humans, this kind of behavioural flexibility is often used as an indicator of an individual's executive functions, and more and more research emerges investigating this link in non-human animals as well. However, the standard method of human studies - taking reaction time differences as a measurement of inhibitory-control processes - might be inadequate to assess such processes in animals, whose latencies are often determined more by motivational than by cognitive factors. Here, we explored alternative ways of measuring inhibitory processes and compared their value in assessing inhibitory-control capacities in animals. Pigeons completed a response-inhibition task that required them to adjust their movement in space in pursuit of a reward across changing target locations. Inhibition was measured in terms of overall latencies (for trials in which the target location did and did not change), movement trajectory (distance travelled towards the initially indicated location after a change occurred) and change reaction time (latency to correct the trajectory towards the changed location). Analyses show that the change reaction time was the most informative measure of inhibitory-control processes; the pigeons' overall latencies and trajectories provided only limited additional insight.

67   4:35 PM   **Distribution of attention to perfect predictors, imperfect predictors, and irrelevant stimuli in pigeon category learning**
Edward Wasserman & Leyre Castro (University of Iowa)
Selective attention to the relevant features of complex visual stimuli helps organisms optimize performance in categorization tasks. We explored possible differences in attention being paid to perfect predictors, imperfect predictors, and irrelevant stimuli in pigeon category learning. Experiment 1 deployed peck tracking technology during category learning and stimulus generalization testing. Experiment 2 deployed computational modeling during stimulus generalization testing. Experiment 1 revealed weak attention being paid to irrelevant stimuli; attention to imperfect predictors was substantial despite strongest attention being paid to perfect predictors. Experiment 2 also found that attention was substantial to imperfect predictors despite strongest attention being paid to perfect predictors. Thus, pigeons readily appreciated the difference between relevant and irrelevant stimuli; however, they continued to attend to imperfect predictors even though perfect predictors provided all of the information necessary for the birds to attain optimal categorization accuracy. These results challenge prevailing accounts of attention in category learning.

68   4:50 PM   **Laterality and learning in wild grey squirrels (*Sciurus carolinensis*): a trade-off?**
Lisa Leaver, Matilda Yeo, Christopher Miller, & Tim Fawcett (University of Exeter)
Cerebral laterality, via hemispheric specialisation, has been evidenced across the animal kingdom and linked to cognitive performance in a number of species. The bulk of evidence suggests cognitive processing is more efficient in brains with high hemispheric specialisation, and this efficiency may be the key fitness benefit driving the evolution of laterality. There are, however, two lines of evidence showing costs associated with lateralisation. The first is the persistence of individual variation in strength of lateralisation. The second consists of a handful of studies showing that strength of lateralisation is related to negative fitness outcomes e.g. suboptimal decision-making and lower foraging efficiency. The mix of costs and benefits associated with laterality is indicative of a trade-off faced by animals in their natural environments. We tested wild squirrels in the field to explore the nature of this trade-off by measuring behavioural bias as an assay of cerebral lateralisation and learning speed as an assay of cognitive efficiency. We carried out a motor-based laterality test using a reaching paradigm and measured learning speed on a problem-solving task. We will report the relationship between performance on these two tasks in individual squirrels and discuss the possible trade-offs faced by highly lateralized animals.

   4:00 PM *Break*

   6:00 PM Introduction - Anna Wilkinson

   6:05 PM Master Lecture - - Stephen Lea

   7:30 PM Banquet

12:00 PM Business Meeting of the Comparative Cognition Society

1:10 PM ☺ Group Photo Shoot ☺

1:30 PM Symposium IV - Cephalopod Cognition: Foundations and Prospects (Chair: Frank Grasso)

1:30 PM **Do octopuses have a mind and if so, what is in it?**
Jennifer Mather (University of Lethbridge)
To look at an animal so different from us, we must use general definitions and explore where they take us, so 'mind' is here seen as a central entity of an animal that can be defined as "thinking, feeling, perceiving and reasoning". Octopuses' excellent vision is constrained, as they have lateral eyes and monocular vision, perceive plane of polarization of light but not wavelength (colour) and likely seldom use visual self-monitoring. Their excellent skin patterning system appear to be open loop, and the movement output system is controlled at several levels. These generally solitary animals are dominated by proactive exploration, fear and problem-solving flexibility. They have a multi-step predator avoidance strategy and several actions that function for proactive information gathering, indicating a central controller that gathers, stores and then uses information.

69

1:45 PM **Living Fossil Memories**
J. Basil, M. Ashfaq, N. Lewandowski, & G.J. Barord (City University of NY. Graduate Center and Brooklyn College)
Nautilus makes migrations along coral reefs to forage – spatial memory may be advantageous. We have demonstrated spatial learning in nautilus showing that animals rely both on proximate and distant visual cues to orient. In a Spatial Paradigm we examined 1) the role route information plays in solving spatial problems and 2) how simultaneously learned information is processed into memory. Animals learned to orient toward an escape from a maze cued by a beacon. We also trained nautiluses with no beacon to determine if route memory alone was sufficient. If animals are tested with the component stimuli (beacon, route) of a compound (e.g., beacon& route) on their own, 1) they should perform less well than with the stimuli in combination. An alternative would be 2) that the two sources of information are stored and accessed separately, as demonstrated in vertebrates (e.g. rats). We determined that nautiluses can use route information alone to learn and remember the location of the escape from the maze. We also found that nautiluses remember the escape location better when they were not trained with the compound beacon/route stimulus, indicating that the memory streams are shared and compete for memory space.

70

2:00 PM **Just how smart is a cephalopod? A hierarchical approach for quantifying complex intelligence.**
Alexandra K. Schnell, Piero Amodio, Markus Boeckle, & Nicola S. Clayton (University of Cambridge)
Cephalopods are renowned for their extraordinary behaviours, leading to claims of complex intelligence. They have the most centralized and largest nervous systems of all invertebrates. Despite being endowed with a sophisticated nervous system, the prospect that complex cognition emerged in cephalopods challenges the provenance of intelligence. Specifically, because the selection pressures that are purported to drive the evolution of intelligence in large-brain vertebrates may not apply to cephalopods. Many cephalopods live in simple social environments and do not show sophisticated social recognition abilities, suggesting that unlike most large-brained vertebrates, they have not faced strong social pressures. Different pressures are also likely to have played a role in the evolution of cephalopod cognition, such as increased predation pressure due to the loss of their external shell. Given the divergence between these large-brained molluscs and vertebrates, fundamental insights into cognitive evolution can be gained by investigating cephalopod intelligence. However, present knowledge of cephalopod cognition is largely based on anecdotal observations, meaning many claims remain unsupported by quantitative data. Whether many of their sophisticated behaviours are underpinned by complex cognition or by simpler mechanisms remains to be tested. Here, I outline a hierarchical approach for quantifying intelligence in cephalopods in a comparative context.

71

2:15 PM **Polarization vision in cephalopods- what is it good for?**
Nadav Shashar: Roger T. Hanlon: Anne-Sophie Darmaillacq (Eilat Campus)

72

Polarization sensitivity (PS), or sensitivity to the e-vector orientation of linearly polarized light, in cephalopods was reported in the 1960' and the anatomical basis for this sensitivity has been known ever since. Anatomic examinations suggest that PS is wide spread among coleoid cephalopods; however the function of this ability is far from being clear and has recently been challenged. Here we will examine the evidence available for using PS in different behavioral tasks and explore the physical constraints to performing these tasks.

2:30 PM Problem-solving and Welfare (Chair: Lisa Leaver)

2:30 PM **The effects of offering cognitive testing on the welfare of a group of zoo-housed Japanese macaques (*Macaca fuscata*)**

Sarah L. Jacobson (The Graduate Center of the City University of New York), Anne C. Kwiatt, Stephen R. Ross (Lester E. Fisher Center for the Study and Conservation of Apes Lincoln Park Zoo), & Katherine A. Cronin (Animal Welfare Science Program Lincoln Park Zoo)

73

Cognitive testing programs are being implemented more frequently in zoo settings due to the benefits these programs can provide for the animals, researchers and visitors. However, the impact that cognitive studies have on the welfare of primates in a social group is debated. Although cognitive testing can be mentally enriching, the provision of monopolizable apparatuses and food rewards to a social group can elicit competition and potentially contribute to negative welfare. We investigated how the behavior of a group of 12 Japanese macaques changed when they were given access to touchscreen devices. We assessed rates of affiliation, anxiety-related behaviors, general activity, and aggression over 15 months, comparing times when cognitive testing was available and when it was not. Rates of affiliation, anxiety-related behaviors, and general activity were not significantly different between conditions. Rates of contact and non-contact aggression were significantly higher during cognitive testing (p<0.05 for both). We used social network analysis to visualize the patterns of directed aggression and found that juveniles were receiving the most aggression. However, because the overall rates of aggression were low, we do not think these results should broadly discourage the implementation of cognitive testing programs and should instead inform how programs are executed

2:37 PM **Socialization, Age, and Problem-solving in Domestic Cats (*Felis catus*)**

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

74

An animal's socialization towards humans may enhance their problem-solving ability. Domestic cats (*Felis catus*) are capable of leading both solitary and social lives with and without humans. We examined the relationship between socialization towards humans, age, and problem-solving ability in domestic cats sheltered at the McKamey Animal Center in Chattanooga, TN. Socialization towards humans was measured with the Feline Behavior Assessment, used by McKamey, which is based on the ASPCA's Feline Spectrum Assessment. Problem-solving was assessed with a food acquisition puzzle box that required the cat to pull a tab to release a food reward from a clear enclosed upper chamber to an open lower one. Twenty-four out of eighty-six cats solved the problem-solving task during a 10-min session. There were significant effects of the cats' socialization on their problem-solving abilities and latency to solve; more socialized cats were more likely to problem-solve with lower latencies. We also found a significant effect of age on problem solving, younger adult cats were more likely to solve the problem than older adults. These results add to our knowledge of domestic cat cognition and other species by providing evidence that socialization towards humans and age can affect problem-solving capability.

2:44 PM *Snack Break*

3:14 PM Associative Processes (Chair: Olga Lazareva)

3:14 PM **Integrating Information About Reward Identity and Time**

Andrew Delamater (Brooklyn College - CUNY), Eric Garr (Graduate Center of CUNY), & Norman Tu (Brooklyn College - CUNY)

75

Pavlovian and instrumental peak timing tasks were used to study rats' learning of reward identity and timing. Two different 60s-stimuli signaled qualitatively different rewards after 20s. Subsequently, only one of the reward types was devalued through selective taste aversion learning. In a final test, both stimuli were tested under extinction. Responding in the presence of both stimuli was temporally organized and peaked just prior to the actual reward time. However, responding was reduced to the stimulus signaling the devalued outcome. Thus, the task provides evidence for learning about both the outcome's identity ("what" it is) and time ("when" it occurs). In different experiments we observed that (1) pre-training basolateral amygdala lesions disrupted the reward devaluation effect without strongly impacting

temporal control, (2) neural suppression of dorsal striatum (using inhibitory DREADDs) exerted similar effects, but (3) reward devaluation affected temporal averaging in a related task in which two stimuli signaling different intervals were paired with different reward types and then combined in an averaging test. The data support the view that learning about reward identity and time involves separate systems, but such information interacts in their control of behavior.

76

3:28 PM **Select- and Reject-control in Learning Rich Associative Networks**
Victor Navarro, & Edward Wasserman (The University of Iowa)
When queried to choose one of two options, an organism's response is determined by associations that support selecting one option and/or rejecting another option. We used rich associative networks to assess select-control and reject-control in the pigeon. Birds were first trained to learn two associative networks, each containing 8 object photographs (samples) and 8 colored tokens (options). On each trial, a sample determined the reinforcement contingencies for choosing one of the two options. One group of pigeons learned two S+/M- networks, in which each sample had a single correct choice and multiple incorrect choices. The second group learned two M+/S- networks, in which each sample had multiple correct choices and a single incorrect choice. After pigeons attained a learning criterion, we assessed select-control and reject-control by presenting pigeons with probe trials in which either the correct option or the incorrect option was replaced with an option from the other network. These tests disclosed that pigeons trained with S+/M- networks largely based their choices on select-control and to a lesser degree, on reject-control. By contrast, pigeons trained with M+/S- networks based their choices entirely on reject-control. The implications of this asymmetry for contemporary learning theories are discussed.

77

3:35 PM **Emotion Labeling with Visual Stimuli: The Effects of Physiological Responses on Conditioning**
Cheyenne Elliott, Lauren Cleland, Mackenzie Jordan, Karen Borowski, Kenneth Leising (Texas Christian University), & David Stahlman (University of Mary Washington)
Emotion labeling occurs when one learns to discriminate interoceptive sensations caused by external events. Often, emotion labeling is facilitated by language, such as labeling an increase in heart rate in the presence of a grizzly bear as "fear". However, for nonverbal animals, the evidence for something like emotion labeling is limited. By using visual labels, one can investigate the extent to which nonhuman animals can discriminate and report their internal states. The current study aims to establish a procedure to study emotion labeling in humans and pigeons. Humans and pigeons were trained with discriminative stimuli that would be followed on separate trials by the delivery or absence of money (for humans) or food (for pigeons), and then to select the visual label associated with the preceding event (one label for delivery and another label for absence). Across several experiments, human participants failed to learn the task, and responded at chance levels. When certain conditions were altered, we successfully observed a labeling effect. After encountering similar difficulties, pigeons also learned the task. Cross-species comparisons will be discussed.

78

3:42 PM **The relationship between latent inhibition, spontaneous eyeblink rates, and creativity**
W. David Stahlman, Brighton Payne, & Hilary E. Stebbins (University of Mary Washington)
Creativity has been linked to 1) an ineffectiveness of stimulus pre-exposure at reducing subsequent conditioned responding (i.e., as in latent inhibition) and 2) relatively high striatal dopamine levels. The literature connecting these variables is still quite sparse, particularly in non-clinical populations. We report here an experiment in which neurotypical college students completed a spontaneous eyeblink task (a behavioral correlate of striatal dopamine levels); the Epstein (2008) creative competencies inventory (a measure of creative behavior); and a latent inhibition task. We predicted, among other things, that those with a higher blink rate would show reduced latent inhibition compared to those with a lower blink rate. We obtained a strong latent inhibition effect, which replicates prior findings (e.g., Carson, Peterson, & Higgins, 2003). We report the degree to which inter-individual variation in this effect was predicted by spontaneous eyeblink rates and creative competence.

79

3:49 PM **ACQUISITION of Associative Memory is Driven by TOTAL PREDICTIVE Error-Reduction: No!, No!, and No!**
Ralph R Miller, & Cody W Polack (State University of New York at Binghamton)
Three dogmas in one sentence. A series of phenomena will be reviewed that indicate: (a) Error between outcome expectation and occurrence modulates subsequent retrieval of associative memories as much or more than it contributes to acquisition of new memories; (b) Reduction in Local (as opposed to Total) error between outcome and expectation suffices to account for negatively accelerated acquisition curves, and cue competition is due largely to retrieval failure as opposed to acquisition failure; and (c) the 'errors' that modulate acquisition and retrieval need not be Predictive (i.e., forward). Phenomena reviewed will include the testing effect, Rescorla's compound testing experiments demonstrating unequal changes in cues conditioned in compound, recovery from cue competition, and backward conditioning. Collectively, these phenomena support discarding the dogmas that 'ACQUISITION of associative memory is driven by TOTAL PREDICTIVE Error-Reduction,' and replacing them, less dogmatically, with 'Local discrepancy drives formation of associative memories, and total discrepancy modulates subsequent retrieval of associative memories.'

4:03 PM *Break*

4:08 PM Cognitive Processes (Chair: Olga Lazareva)

80

4:08 PM **Flexible spatial representation of magnitude in humans, apes, and birds**
Reggie Paxton Gazes (Bucknell University)

Neurological and behavioral evidence suggest that magnitude may be represented spatially in humans. For example, English speaking humans respond faster to one side of space when processing small quantities and to the other side of space when processing large quantities, known as the Spatial-Numerical Association of Response Codes (SNARC) effect. This effect is reversed for people who read and count from right-to-left, suggesting an important role for cultural training in the formation of this representation. However, a recent study found similar left-to-right spatial-magnitude congruity in 3-day-old chicks, suggesting a strong biological basis for the spatial representation of magnitude. I will review the results from a set of our recent studies designed to determine the extent to which spatial representations of magnitude are based on brain organization, working memory, and cultural experience. Three sets of studies examined the existence and individual variability in the association between space and magnitude in apes, humans, and birds. Together, results suggest that the spatial representation of magnitude is phylogenetically ancient, not inflexibly based in brain lateralization, and that the orientation of these representations is flexibly influenced by a number of factors including cultural experience and task instructions.

81

4:33 PM **Cognition in the Paridae**
Anders Brodin (Department of Biology)

Parids (tits, titmice and chickadees) are small birds with relatively large brains. Many species in this family are year-round residents in regions with harsh winter conditions. Hence, there is strong selection for adaptations that will increase survival during this critical period. There is a clear dichotomy in the wintering strategies in the family that results in differing cognitive specializations. Most species, like the American chickadees and the Eurasian willow and marsh tits, are large scale food hoarders that stock their year-round territories with cached food in the autumn. These species are memory specialists, but can be quite stereotypic and neophobic in other respects. The Eurasian great and blue tits have a completely different winter strategy. They do not store food but roam around large areas in winter. They are very innovative and explorative and especially the great tits is a quick learner when it comes to how association with humans can produce food. I discuss the cognitive abilities of great, willow and marsh tits, with results both from lab and field studies.

4:47PM Closing Remarks (Steve Fountain)

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

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

Posters

Poster Session I - Thursday Evening

Exploring Metacognitive Movements in Orangutans

Erin E. Stromberg (Smithsonian's National Zoo), Michael J. Beran (Georgia State University), & Audrey E. Parrish (The Citadel)

P1 Metacognition is the ability to reflect on one's own mental states and control responding to situations of uncertainty by seeking out more information or confirming the accuracy of responses prior to external feedback. In a recent study, we assessed metacognition in chimpanzees using a movement-based paradigm. Chimpanzees completed a delayed matching-to-sample task, followed by movements towards a distant reward location. Chimpanzees were more likely to move to the reward location prior to external feedback on correctly completed trials compared to incorrectly completed trials. In the current study, we extended this research to orangutans also working on a computerized matching-to-sample task. Orangutans showed varying degrees of success on this task, sometimes responding with early movements to a reward location more often on correct versus incorrect trials. But, they were not as proficient as were the chimpanzees. Research is ongoing with additional orangutans. Importantly, this research is conducted on public display in Think Tank at Smithsonian's National Zoo in Washington, DC, as a critical component to educating the public about great ape cognition and comparative cognitive science.

Use of Features and Geometry by Tiger Salamanders (*Ambystoma tigrinum*)

Shannon M. A. Kundey, & Mitchell Phillips (Hood College)

P2 Salamanders must avoid predation and desiccation, making efficient navigation vital. We explored tiger salamanders' (Ambystoma tigrinum) ability to learn to use features and geometry to move about within their environment. First, salamanders learned to move to distinct columns placed in each corner of a rectangular box. Each was placed alone in the box's center, and the experimenter rewarded the salamander if it moved to the correct column. If incorrect, it repeated the trial until it moved to the correct location. To succeed in this task, salamanders could have used geometric information (The box is rectangular.), feature information (Each corner contained a distinctive column.), or both. After navigating to the correct cue location on three consecutive days, two tests were conducted in counterbalanced order. In one test, the columns' placements in the corners were jumbled. In this test trial, salamanders followed the column they were previously rewarded for navigating towards even though it was now in a novel location, suggesting that feature information is important. In the other test, all columns were removed, leaving only geometric information available. In these trials, salamanders did not make systematic responses. Thus, in this experiment, salamanders appeared to use feature information preferentially.

Neurotoxic lesions to rats' posterior parietal cortex lead to social recognition deficits

Taylor B. Wise (Brown University), Judith N. Dayaw, Katrina I. Dayaw, & Victoria L. Templer (Providence College)

P3 Recent literature points to a potential link between the evolution of complex social behavior and the posterior parietal cortex (PPC) in primates including humans (Parkinson & Wheatley, 2013). Thus far, this theory has been overlooked in other highly social animals that may have also evolved due to social selective pressures. We investigated the role of the PPC in social function using neurotoxic lesioning proceeded by the 3-Chamber Sociability and Social Novelty test in rats. Our results show that all rats preferred social interaction in the Sociability phase of the task. Interestingly, when given the choice between a familiar and novel conspecific in the Social Novelty phase, only sham subjects preferred novelty whereas lesioned subjects interacted equally with the two conspecifics. As a follow-up, subjects explored a highly familiar cagemate and stranger conspecific, increasing novelty difference. Results supported those of the initial task. Further, when given the equivalent Object Recognition Task, all rats preferred the novel object to the familiar. This suggests that PPC function is required for recognition memory specific to social contexts. These results are the first to link the PPC to social function in non-primates and could be applied to rodent labs examining neural mechanisms of social cognition.

The role of the posterior parietal cortex in memory for temporal order

Annie Dankert, Robert Vera, Taylor B. Wise, Victoria R. Heimer-McGinn, & Victoria L. Templer (Providence College)

P4 The purpose of this study was to investigate the role of the posterior parietal cortex (PPC) in memory for temporal order in rats. Following neurotoxic lesions to the PPC, rats explored two identical objects (A1, A2) in Sample 1 and, following a three hour inter-stimulus interval, explored two novel, but again identical objects (B1, B2) in Sample 2. Finally, following a five-minute delay, rats were presented with one object from each sample (A3, B3). Due to rats' natural preference for novelty, if the PPC is involved in temporal order tasks, it is expected that the lesioned rats would spend equal amounts of time exploring both objects at test because there is a deficit in their memory for object order, while sham rats would spend more time exploring the A3 (vs. B3) during test 1 because it is the least familiar. Several measures were collected, including a discrimination ratio, total exploration time, and bout frequency, all of which showed no significant group differences. However, controls but not lesioned

rats explored the temporally novel object significantly longer than the familiar. Overall, evidence supports the conclusion that PPC does not play a central role in the memory of events in relation to time.

Same/Different Abstract Concept Learning in Archerfish
Adam Davila, Joanna Keane, & Michael Brown (Villanova University)

P5 Abstract concept learning involves learning to respond to the relationship between stimuli, completely separated from the perceptual properties of the stimuli. While this ability has been found in a variety of nonhuman animals, evidence in nonmammalian, aquatic species has been scarce. Archerfish (*Toxotes spp.*) are known for their unique ability to hunt aerial prey by spitting streams of water and downing them. Recently, archerfish have been used in a range of behavioral studies. In a series of experiments, Newport, Wallis, and Siebeck (2015; see also Newport, Wallis, Reshitnyk & Siebeck, 2013), found little abstract concept learning capability in archerfish, generally, and no evidence of same/different concept learning specifically. This experiment served as a follow up, focusing on expanding the number of training stimuli used, which has been shown to be a factor in eliciting same/different discrimination in a variety of species (Wright & Katz, 2006). Archerfish were presented with a simultaneous same/different discrimination task. Performance in this task was measured in terms of learning the task and transferring this discrimination to novel stimuli. Over trials, the set-size of exemplars was expanded. Subjects never improved performance above chance, indicating a failure to acquire the abstract concept.

Perception of Variation in Song Motifs by Birds and Humans
Adam R. Fishbein, Nora H. Prior, William J. Idsardi, Gregory F. Ball, & Robert J. Dooling (University of Maryland College Park)

P6 Perceptual comparisons between animals and humans are arguably the most intriguing in the area of vocal communication signals. Humans and vocal learning birds both produce vocal signals consisting of acoustically complex syllables arranged in species-typical sequences. In one widely studied species of songbird, the zebra finch, males learn to produce a song motif consisting of a fixed syllable sequence that is repeated several times in a song bout. These motif renditions sound very similar to the casual human listener, but variation among them can be detected with the use of song analysis techniques. Here, we used psychoacoustic methods to test how well zebra finches discriminate different renditions of natural song motifs and song syllables. We show that zebra finches are very sensitive to this subtle natural variation in song. This stands in contrast to past work showing that zebra finches, tested under similar conditions, are remarkably insensitive to variation in the sequential order of song syllables. These results suggest that zebra finches may be preferentially extracting information about the spectro-temporal content of individual syllables rather than sequential structure, which is generally opposite to the importance of sequential patterns in human language.

Training-set expansion and novel-environment tests of human reorientation.
Alex Bern, Steven Nichols, & Kent D. Bodily (Georgia Southern University)

P7 Previous research has shown several species are able to utilize elements of global geometry within enclosed spaces to reorient and make navigational choices. Medial-axis and Principle-axis are two global accounts which have previously been proposed as potential explanations of observed choice behavior in spatial navigation decision tasks. In the current study, humans were exposed to a series of virtual enclosures in which they were either reinforced to make choices consistent with medial-axis navigation or principle-axis navigation. Participants were subsequently introduced to novel environments with no feedback provided upon decision making. A set size expansion method was employed to introduce novel enclosures one at a time, and then the enclosure was added into the subsequent training sets. Participants were exposed to 6 enclosure in total. Choices in testing enclosures were analyzed against chance levels.

Habituation and Appetitive Conditioning in Cockroaches (*Gromphadorhina portentosa* and *Eublaberus posticus*)
Ann Taylor Adams, & Christopher A Varnon (Converse College)

P8 This poster describes several experiments aimed at establishing cockroaches as inexpensive alternatives to rodents for teaching and research in comparative psychology. In experiment one, we studied habituation of the disturbance hiss in response to touch in hissing cockroaches (*Gromphadorhina portentosa*). We found that males were more vocal, that cockroaches hissed more when heated, and that habituation rate was consistent across sex and temperature. In experiments two and three, we investigated habituation of startle in response to light in orange head cockroaches (*Eublaberus posticus*). We found that the startle habituates rapidly at short intertrial intervals (ITIs), and that longer ITIs of at least 30 minutes are needed to produce gradual habituation. We also found that sensitization and habituation occur simultaneously when subjects are not given time to acclimate to the apparatus. These findings are predicted by Thompson and Spencer's principles of habituation and dual process theory. In a final experiment, we investigated appetitive conditioning in juvenile *E. posticus* cockroaches by adapting a method for wild bees. We found that cockroaches outperformed bees during conditioning trials and showed a learned preference for stimuli associated with food during testing trials. Taken together, these findings support a growing movement in cockroach psychology research.

Nosing Around: Olfactory Enrichment in Heritage Breed Pigs in a Nonindustrial Farm Setting
Anna Litchfield, Jessica Eleazer, Hannah Buggs, Daniana Worster, Mary Ross Murphy, Nathan Popp, Stephanie E. Jett (Georgia College & State University)

P9 Enrichment is a popular tool used to improve the health and well-being of captive animals. Most of what we know about the benefits of enrichment have come from work done in laboratories, zoos, and sanctuaries/rescues. To date, less has been done for animals raised for meat production, specifically pigs. Previous work in industrial farm settings investigated preference for enrichment item type in breeding sows. Other work has used scent to condition piglets for easier and earlier weaning. As part of a larger, long-term enrichment program, the current project takes inspiration from those findings, as well as from work done with captive sea lions, using olfactory enrichment as a way to measure scent preference (savory versus sweet) in pigs raised for meat in a pasture farm setting. It was predicted that the pigs would show a preference for sweet scents over savory scents. Target behaviors were any scent directed behaviors (e.g. snout touching, body rubbing). Results will be discussed in terms of preference for scent as indicated by number of visits to the scented locations. Providing enrichment to meat animals is beneficial to the animals and the farmers as it has been shown to improve overall breeding success and meat quality.

Insightful Otters: Problem Solving via Tool Use in River Otters
Audrey E. Parrish, & Shona G. Sulzbach (The Citadel)

P10 Otters are highly inquisitive and social animals that demonstrate advanced cognitive processes in the wild, including tool use and social hunting. For example, sea otters utilize stones as anvils to crack open prey items in their natural habitats. Whether other otter species also use tools has been a topic of scientific debate, and has implications for the evolutionary trajectory of tool use. In the current study, we presented North American river otters (Lontra canadensis) with a classic tool-use task in which a highly-preferred food item is suspended out-of-reach. Animals must use a tool (box, etc.) to retrieve the food. This task has been used successfully with chimpanzees (Köhler, 1927) and elephants (Foerder et al., 2011), and provides an intuitive and motivating problem for animals to solve. Two otters successfully retrieved and used a tool to obtain out-of-reach food items, generalizing tool use to novel scenarios in subsequent experiments (e.g., new tools and new spatial layouts of the problem). These results present evidence of successful tool use by river otters, suggesting that previous designs may have presented difficult or non-intuitive tasks. Implications for understanding the physical intelligence of river otters and other non-tool using species are discussed.

Boundary Extension in Humans (*Homo sapiens*), Rhesus Monkeys (*Macaca mulatta*), and Capuchin Monkeys (*Cebus apella*)
Brielle T. James, & Michael J. Beran (Georgia State University)

P11 Humans have been shown to falsely remember seeing the details just beyond the edges of a pictured scene, a constructive memory error known as boundary extension. In the first comparative study of boundary extension, this phenomenon was assessed in humans (Homo sapiens), rhesus monkeys (*Macaca mulatta*), and capuchin monkeys (*Cebus apella*). Subjects completed a computerized, delayed matching-to-sample task with various picture stimuli of common scenes encountered by humans or monkeys. The target scene was shown alongside either a closer or wider-angle view of the same image with the objective being to choose which of the two simultaneously presented images exactly matched a previously shown sample image. The present study replicated boundary extension in human adults. However, neither monkey species demonstrated boundary extension when viewing human-unique or monkey-relevant scenes, even under conditions for which they should have been highly motivated to perform well. Unlike humans, monkeys may not have demonstrated boundary extension because they are local visual processors. This would have limited their view of the stimuli as scenes, allowing them to rely on direct visual input. This species discontinuity reflects the potentially human-unique qualities of boundary extension.

Do North American River Otters (*Lontra canadensis*) Have a Global or Local Processing Strategy?
Ryan Pluck (Rochester Institute of Technology), Catina Wright (Seneca Park Zoo), Evan Morrison, Jessica Wegman, Trisha Rachfal, Rhiannon Jimenez, & Caroline DeLong (Rochester Institute of Technology)

P12 Global processing is the visual perception of a whole image, whereas local processing is the perception of the individual parts of the image. Different species have different preferences for processing global or local stimuli. Past research has shown that humans, fish, and chimpanzees experienced global precedence, whereas pigeons, domestic chicks, and rhesus monkeys experienced local precedence. Two river otters at the Seneca Park Zoo were trained to discriminate between two hierarchical stimuli: a global triangle made of 12 local triangles and a global circle made of 12 local circles. Only one otter reached the training criterion of 75% correct. The otter who was tested was reinforced for selecting the circle during training. Test stimuli were a global triangle made of 12 local circles (local circle stimulus) and a global circle made of 12 local triangles (global circle stimulus). The otter did not show a clear preference for either the global circle or the local circle stimulus, but developed a pervasive side bias during testing. Both otters struggled to discriminate between the hierarchical stimuli in this study. These results suggest that we may need to modify the stimuli or methodology to investigate global vs. local processing in river otters.

Pair foraging degrades socially transmitted food preferences

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

P13 Following presentation of a novel food odour on the breath of a conspecific, a naïve rat will exhibit a preference for that food, a form of learning known as the social transmission of food preferences (STFP). When tested in isolation, STFP acquired preferences are robust, persisting for up to a month and overcoming prior aversions. However, rats and other rodents often forage in small groups, rather than alone. We allowed rats to pair forage and find that STFPs rapidly degrade during social foraging. Non-foraging rats exposed to the same foods in isolation did not show STFP degradation. We also examined whether consistent individual differences between rats affect STFP. Neither boldness nor sociability predicted initial STFP strength, but bolder rats' preferences degraded more following social foraging. Shy rats mostly ate at the same time as their partner, whereas bolder rats often ate alone. By tracking rats' interactions during social foraging, we show that they use complex rules to combine their own information and preferences with socially acquired information about foods in their environment. These results situate STFP within the behavioral ecology of foraging and suggest some of the behavioral mechanisms by which socially transmitted food preferences are maintained, modified, and lost.

Neophilic behavior in wild raccoons (*Procyon lotor*) and other woodland species

Christina M. Sluka, John K. Kruschke, Matthew V. Morrison (Indiana University), Colin Allen (University of Pittsburgh), & Jonathon D. Crystal (Indiana University)

P14 Throughout North America, raccoons are viewed as clever pests who invade our urban areas. Despite frequent interactions between humans and raccoons, there is little published research on cognition, memory, and learning in this species. We designed a study to determine if raccoons are more likely to interact with a novel object than other woodland species. A baited or unbaited puzzle box was presented in Indiana forests. Motion sensor cameras recorded activity. Video from the sites was used to code an animal's visit to the area and if they interacted with the box. A Bayesian hierarchical model showed that wild raccoons clearly interact at a higher rate with a novel object than other species. Across species, animals also interacted more with baited boxes than unbaited boxes. However, there was no strong evidence of a difference in interaction rates across seasons. This implies that seasonal pressures, such as lack of food resources, do not affect the frequency of interactions with the box. This study demonstrates that wild raccoons are more likely to interact with a novel object than other species regardless of season. This may indicate neophilic tendencies that could lead to a greater understanding of their flexible urban behaviors.

Toward a Robust Automated Image-Processing-Based Methodology for Tracking Octopuses in Video

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

P15 Octopuses pose challenges to automatic tracking due to their malleable morphology and their ability to change color and texture. We studied the image processing methods of background subtraction, intensity thresholding, and search-radius thresholding to quantify octopus position from video recordings of Octopus bimaculoides in the laboratory. Our analysis aimed to identify the method that minimized the mean square error relative to tracks of octopuses made by a trained human observer. Manipulations included mean versus median centroid estimation, and whether distance thresholds of approximately 1, 2, or 3 mean radii of the octopus' body, or full image field of view, were used. We performed a mixed-effects ANOVA including video (N = 4) as a factor, which indicated significant differences in the errors for both fixed factors and their interaction (p < 0.001 for all effects), but with a minuscule overall effect size (R^2 = 0.016), indicating that each method performed similarly. The mean position estimation error across all conditions ranged between 32% and 39% (SD = 2.6%) of the average octopus radius (~5 cm). Ongoing efforts are aimed at further reducing this error, to produce a robust, reliable tool for the analysis of exploratory behavior and spatial learning in octopuses.

A Mid-Session Reversal Task in Leopard Geckos (*Eublepharis macularius*)

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

P16 Reptiles represent an under-studied taxa of vertebrates in the field of comparative cognition, partially because they are not as mobile or easily-reinforced as mammals and birds. We wanted to study a complex discrimination reversal task as a comparison to birds and mammals. We tested leopard geckos in a mid-session reversal task, in which an operant color discrimination task using heat reinforcement was reversed at the temporal mid-point of a 40-minute session. Interpretation of results are limited due to low behavioral output and high inter-subject variability. Discussion of a follow-up classical conditioning variant will be discussed.

How do monkeys behave in probabilistic categorization tasks?

Will Whitham, & David A. Washburn (Georgia State University)

P17 Probabilistic categorization tasks involve using a weight of evidence conferred by visual cues to make a probabilistic judgment about category membership. In typically-developing, human populations, participants' performances follow a characteristic pattern in which responses are random in early trials (because there is no way to reason about the arbitrary relationship between cues and outcomes) but become more and more optimal with greater experience in the task. Because this optimality might be

achieved by any number of response patterns, analysis of weather prediction data are often paired with a 'strategy analysis', in which blocks of participant trials are fit to predefined strategies (e.g., attend only to the most predictive cues, optimally integrate information across cues). We tested rhesus macaques (*Macaca mulatta*) and tufted capuchin monkeys (*[Cebus] Sapajus apella*) on a computerized version of the weather prediction task at very high trial counts, and adapted a sophisticated form of strategy analysis from Meeter, Myers, Shohamy, Hopkins, and Gluck (2006) to describe how each animal's pattern of responding changed with greater and greater experience in the task environment. Data collection and analysis is complete, and follow-up experiments with rhesus, capuchins, preschool children, and adults are ongoing.

Investigating Conditioning as a Method to Decrease Veterinary Visit Anxiety in Canines
Danielle LaBonte, Nicole Dorey, Ph.D., & C.A.A.B. (University of Florida)

P18
During veterinary visits, 83% of dogs experience anxious or fearful behavior (Stanford, 1981). Operant conditioning training has been shown to reduce these behaviors with dogs that become anxious when separated from their owner or during thunderstorms. Dog trainers and veterinarians alike have suggested that operant conditioning would also help with dogs that are anxious during veterinary visits. The purpose of this study is to investigate whether counter-conditioning and desensitization decrease a dog's anxiety during veterinary visits. Twenty-seven dogs were included in this study that took place over a 6-month period. Dogs were split into two groups; a training group and a non-trained group. The training group received counter-conditioning and desensitization across a 6-month period and the non-training group did not receive training. Data was collected on heart rate, salivary cortisol levels, and anxious behaviors for all dogs at the start of the investigation and after six months. Data collection is currently in progress but preliminary data suggests a decrease in anxious behaviors across dogs in the training group. However, no matter the outcome of the results, veterinarians and trainers would have empirical data to support whether or not training will help alleviate anxious behavior for dogs visiting the veterinarian.

The Role of Laterality in Beluga and Bottlenose Dolphin Visual Discrimination
Deirdre Yeater (Sacred Heart University), Emma Halter (Northeastern University), & Heather Hill (St Mary's University)

P19
While the concept of lateralized behavior has been addressed in cetaceans, it is only recently that efforts have begun to explore its importance in cetacean cognition. In the current study, two consecutive presentations of stimuli were shown in front of a curtain using a violation of expectation procedure. Human and object stimuli were integrated within the same trial, and the familiarity level of each stimuli was varied. Using a violation-of-expectation paradigm within a free swim context, we investigated the representational capacity of 11 belugas (Delphinapterus leucas) and 11 dolphins (*Tursiops truncatus*) from two facilities. Belugas and dolphins did not show significant gaze duration variation between either humans and objects, or familiar/unfamiliar stimuli, contrary to previous findings. No laterality differences were observed for stimulus type; however, the belugas preferred to view all stimuli types with both eyes, while dolphins preferred monocular right eye use. Additionally, belugas displayed significantly shorter gaze duration as a group compared to dolphins. Overall, significant individual differences and the distraction of social interactions in subject groups, may have contributed to lack of gaze duration differences between specific stimuli.

Pigeons show no evidence for dimensional rule formation
Ellen O'Donoghue, & Edward Wasserman (University of Iowa)

P20
Humans and nonhuman primates (macaques, capuchins) learn explicit, rule-based categorization tasks (those with a verbalizable solution) more quickly than implicit, information-integration tasks (non-verbalizable tasks requiring dimensional integration). However, pigeons learn both tasks with the same speed, suggesting that they lack the capacity for explicit dimensionalization. Here, we further characterized the nature of pigeons' rule-based (RB) and information-integrative (II) learning. We replicated prior reports that pigeons learn RB and II tasks at the same speed. Later, we found similar stimulus generalization gradients for both groups drawing novel stimuli from equivalent regions of the same stimulus space. We next administered a between-session subtask switch: RB birds were switched to the opposite dimension, whereas II birds were switched to the opposite integrative diagonal. If RB birds were selectively attending to the relevant dimension, then they should exhibit negative transfer whereas II birds should not; however, there were no differences in learning speed or stimulus generalization. Finally, we administered a within-session subtask switch involving both dimensions (RB birds) or both integrative diagonals (II birds). Learning speeds were equivalent, with no cost of switching between subtasks. These results suggest that pigeons may attend to multiple stimulus dimensions (even when irrelevant) rather than forming dimensional rules.

The role of laterality handedness on performance during a tool-use task in Asian small-clawed otters (*Aonyx cinereus*)
Erin E. Frick (Georgia Southern University)

P21
Asian small-clawed otters demonstrate remarkable hand dexterity when gathering and consuming prey, and have been shown to utilize novel tools as a form of enrichment. Performance on a novel tool-use task varied greatly between male and female subjects, with several of the subjects showing s significant bias toward either the right or left side. Laterality, or handedness preferences may have impacted side biases observed in experimental trials. The aim of the current study was to determine if Asian small-clawed otters exhibit significant paw preferences in behaviors associated with completing a tool-use task. Video data of the otters completing the task was analyzed for specific paw interactions with the tool-use apparatus, and the percentage of correct completion of the task was documented for each otter. Overall, no significant paw preference was present. However, individual

differences in paw preference as well as differences in task performance were present. The results showed that paw preference (or lack thereof) did affect the tool-use task performance for some otters, and for others, the preference did not seem to have an effect. These results indicate that individual differences in laterality and handedness for paw-usage affect performance on a novel tool-use task in Asian small-clawed otters.

Exploring problem-solving and innovation in snow leopards (*Panthers onca*)
Victoria O'Connor, Sheila Chase (The City University of New York: Hunter College), Patrick Thomas (WCS: Vice President General Curator Bronx Zoo Associate Director), & Natalia Borrego (The American University of Cairo)

P22 Despite being vastly underrepresented in cognitive studies, the order Carnivora makes an excellent group for studies of social and physical intelligence hypotheses. Carnivores offer a socially diverse model that enables investigations of the social and evolutionary cognitive relationship. We tested these hypotheses through experimental comparisons in social and nonsocial carnivores: African lions, *Panthera leo*, and snow leopards, *Panthera uncia*. Specifically, individuals opened a custom multi-access puzzle box and produced new solutions after past solutions became accessible. In our preliminary findings, we have observed between and within species differences in multiple measures: number of successful solutions to the puzzle box, latency to success, number of trials to repeated success, time working on the box and exploration diversity.

Do pinnipeds exhibit a gravity bias?: Investigations in the California sea lion (*Zalophus californianus*)
Kristy Lindemann-Biolsi, Afia Azaah (St. Francis College/Center for the Study of Pinniped Ecology Cognition), Nicole Izzo-McDonald, & Candyce Paparo (Center for the Study of Pinniped Ecology Cognition/ Long Island Aquarium and Exhibition Center)

P23 Whether or not a gravity bias is demonstrated by a marine mammal has yet to be elucidated, while it has been demonstrated across a variety of non-human animals such as chimpanzees (*Pan troglodytes*; Tomonaga, Imura, Mizuno, & Tanaka, 2007), rhesus macaque monkeys (*Macaca mulatta*; Southgate & Gomez, 2006), and the domesticated dog (*Canis lupus familiaris*; Osthaus, Slater, & Lea, 2003). Pinnipeds are of particular interest as amphibious marine mammals since expectations for object trajectories due to gravity are contingent on the interaction between the medium (e.g., air vs. water) and object material (e.g., foam vs. metal). Researchers at the Center for the Study of Pinniped Ecology & Cognition (C-SPEC; www.sfc.edu/pinnied) have been investigating the opaque tubes task with a California sea lion. To date the sea lion subject, Bunker, has struggled with the basic training task. This performance challenge has been surprising due to the relative ease of other species to reach criteria to a testing stage in gravity bias studies. The researchers suggest methodological changes and discuss comparisons of the training phases across species tested.

Behavioral Ethograms of Pinnipeds in Human Care
Dareen Generoso, Amanda Neal, Kristy Lindemann-Biolsi (St. Francis College/ Center for the Study of Pinniped Ecology Cognition), Kevin L. Woo (SUNY Empire State College/ Center for the Study of Pinniped Ecology Cognition), & Candyce Paparo (Long Island Aquarium/Center for the Study of Pinniped Ecology Cognition)

P24 Detailed ethograms inform researchers and caretakers about potential modifications to species' behavior in human care. In many instances, ethograms serve as an important tool for understanding the baseline behavior of the target species. Consequently, the behavioral baseline allows us to compare changes to behavior as they relate to interactions with conspecifics or their environment. This study is an example of such a collaboration between the animal care team at the Long Island Aquarium and researchers at the Center for the Study of Pinniped Ecology & Cognition. In this study, we utilized web cams mounted within the perimeter of the habitats and conducted observations to generate behavioral ethograms of pinnipeds (harbor seals and California sea lions). The utilization of web cams for data collection will be discussed as well as preliminary data in reference to 1) a baseline activity budget, 2) usage of space within exhibits by animals, and 3) relationships between activity/exhibit usage with and without people present. This work will serve to inform captive management objectives as well as highlight positive interactions for animals that are housed in appropriate human care environments.

Increasing the Impact of Conservation Messages: The Value of Including Information About Animal Cognition
Lauren Highfill, Mark Davis (Eckerd College), & Radhika Makecha (University of Eastern Kentucky)

P25 Zoos hope to inspire their visitors to contribute to conservation efforts through learning about their animals. Signage is an important tool for disseminating relevant animal information that might increase interest in the species. Space is limited, so choosing the most impactful message is important. We were interested in whether messaging that focuses on animal cognition would have a bigger impact than more traditional types of messaging. Participants (N=480) were randomly assigned to read one of four paragraphs describing a "newly discovered" species called the Caora. The four paragraphs were identical in length, as well as information regarding the endangered status of the species. The paragraphs varied in their inclusion of specific information about: general life history, social behaviors, cognitive-emotional behaviors, or tool-use behaviors. After reading the paragraph, participants answered a series of questions to assess general attitudes towards the animal, as well as to indicate their level of interest in conservation-related behaviors for the species. Overall, those reading the cognitive-emotional message reported the most positive attitudes towards the Caora ($F(3, 476) = 13.638$, $p < .01$), as well as the greatest likelihood of engaging in conservation-related behaviors ($F(3, 476) = 5.02$, $p = .002$).

Training Awake Canine fMRI

Lily Strassberg, Adam Davila, Sarah Krichbaum, Gopikrishna Deshpande, Paul Waggoner, & Jeffrey Katz (Auburn University)

P26 Awake canine functional Magnetic Resonance Imaging (fMRI) is a new procedure that lacks well-established training methods. We investigated the efficacy of a new training method on the quality of awake, unrestrained canine fMRI data. Our aim was to design a procedure that produces high-quality functional and structural data at first exposure to the MRI environment in a cost-effective manner. The method segmented operant conditioning of the in-bore stationing behavior, a 5-minute prone down stay aligned in a chin rest, from appetitive classical conditioning of a positive response to the assorted 100+ decibel scan sequences. Using minimal and easily accessible training aids and trained to completion in a location away from the MRI suite, the new method utilized a transfer phase of mock MRI sessions conducted in five different locations before the final transfer test in the MRI environment. Motion, a proxy of data quality, during EPI Resting State scans, was compared between dogs trained with the new method (n=4) and the four best-performing dogs scanned in previous fMRI experiments at Auburn University. Although one dog failed transfer, the others showed an improvement in data quality compared to previously tested dogs.

Domestic dogs understanding of the accuracy of human social cues

Madeline Pelgrim, Julia Espinosa (University of Toronto), Emma Tecwyn (Birmingham City University), Sarah Marton (University of Toronto), Angie Johnston (Yale University), & Daphna Buchsbaum (University of Toronto)

P27 Domestic dogs excel at using human social-communicative gestures. Can dogs preferentially use information from an accurate versus an inaccurate informant to locate hidden food? In Experiment 1, dogs watched either an accurate or inaccurate informant hide a treat and point at one of two opaque containers. Dogs were more likely to follow the accurate informant's point (M=11.63/12, SE=0.20) than the inaccurate informant's point (M=4.06/12, SE=0.69), t(18)=5.16, p<.001, and located the treat more often than expected by chance for both accurate, t(15)=27.91, p<.001, and inaccurate t(15)=2.82, p=0.013 informants, though they made more errors with the inaccurate informant. In Experiment 2, dogs first interacted individually with both an accurate and an inaccurate informant (history phase). As in Experiment 1 they were more likely to follow the accurate informant's point. In the test phase dogs did not witness hiding of the treat and saw both informants simultaneously point at different locations. Dogs chose between the informants at chance-level (M=6.68/12, SE=0.48), t(15)=1.53, p=0.17. Experiment 3 (ongoing) reduces the non-social task demands of Experiment 2 to see if this improves dogs' ability to use accuracy information.

Memory effects in Rats based on Novel Object Task after change in Enrichment

Maggie Oimoen, Katherine King, Laurissa Johnson, Kristine Kovack-Lesh, & Julia Meyers-Manor (Ripon College)

P28 Short-term exposure to environmental enrichment improves memory functions in task like the Morris Water Maze and the novel object recognition task (Lima et al., 2014; Cortese et al., 2018). Whether these effects are sustained following removal from environmental enrichment or whether continual enrichment is necessary is still unclear. We examined the effects of removal from environmental enrichment on memory. Long Evans rats were reared in enriched environments until the start of the experiment. They were then split up among the two conditions: maintaining enrichment and removal of enrichment. Enriched environments contained toys and boxes as well as more conspecifics, while unenriched environments were standard cages with only food bowls and one other conspecific. All rats were given a pretest on the novel object recognition task. The rats were then placed into their respective condition for four weeks and then retested on the novel object task. There was a marginally significant difference found between enrichment conditions and a trend indicating that rats maintained in enriched environments increased their memory for the novel object while rats removed to unenriched housing decreased their recognition. Maintenance in enriched environments appears to be necessary to sustain the positive memory effects of enrichment.

Instructed matching strategies: Learning symbols to guide decision making

Maisy Bowden, Brooke Jackson (Georgia State University), Carmen Shaw (Emory University), Barbara Church (Language Research Center), & J. David Smith (Georgia State University)

P29 One foundation of human cognition is the ability to symbolically represent objects, constructs, and ideas. Humans have language for this purpose. Symbols, like words, can be used to instruct behavior, summarize performance rules, and declare task strategies. Comparative research has shown that non-human primates can learn rules (Smith et al., 2010; 2012) though they lack language. However, it is difficult to know the degree to which they understand these rules. To give monkeys abstract representations for their rules, we are developing a method for teaching symbols for matching strategies (e.g., match by color or match by shape). In a series of learning tasks that progressively increase in complexity and difficulty, we teach monkeys to match by color when one icon is presented and by shape with another. The monkeys can take instruction from these icon symbols: they can selectively attend to stimuli based on the dimension (color or shape) indicated by the icon, even in complex environments in which both matches are possible. This provides evidence that monkeys can learn symbols and use them to instruct their perception and decision making.

P30 **Left-Cradling Bias in Chimpanzees**
Maria Botero (Sam Houston State University), & Suzanne MacDonald (York University)
Several studies have shown the role played by lateralization in mother-infant interaction in apes (for a review see Hopkins, 2004). It has been hypothesized that a left-side cradling bias optimizes maternal monitoring by directing sensory information to the mother's right hemisphere, which has an advantage for social processing. Some researchers have found a left-side cradling lateralization in chimpanzees and gorillas in captivity, but other have not replicated these findings. In our current study we investigated whether there is a left-cradling bias in mother and infant chimpanzees in the wild, to compare with the results of previous studies that focused on captive apes. We focused on seven mother- infant chimpanzee pairs (*Pan troglodytes schweinfurthii*) from the Kasekela community in Gombe National Park, Tanzania. We recorded the side bias of the infant and the active arm/hand cradling biases of the mother. Our results showed pronounced left-side bias in seven mother-infant pairs across a range of behavioural contexts, including travel, aggression, rest, feeding, grooming-mother, grooming-infant and retrieving infant. These results support the hypothesis of the evolution of left-cradling bias in mother-infant interaction across great apes and human primate species, across diverse behavioral contexts in different mother-infant pairs.

P31 **Effects of Perceived Audiences on Discrimination Learning in Pigeons (*Columbia Livia*)**
Peyton M. Mueller, & Matthew S. Murphy (Coastal Carolina University)
This study aims to observe differences in the rates of learning a simple discrimination task in pigeons when presented with a video of a pigeon, a puppet, or no video. The audience effect has long been a topic of dispute among social psychologists, namely in why differential performance outcomes arise as a result of exposure to an audience or observer. There have been some studies on the social facilitation effect on nonhuman animals, most measured in terms of increased or decreased feeding habits; however, there are relatively few studies that attempt to measure the effect of an observer on a learning task, and fewer still that use perceived (i.e., nonphysical) audiences or observers. As such, the current study attempts to see what effects, if any, may arise as a result of the type of video presented on a discrimination task. Results and implications will be discussed.

P32 **Odor Span Task in Purpose-Bred Detection Dogs**
Sarah Krichbaum, Bart Rogers, Emma Cox, Lily Strassberg, Paul Waggoner, & Jeffrey Katz (Auburn University)
Dog odor detection relies on the ability to remember many odors when introduced to a complex environment; therefore, proficient working memory is a necessity. Developing an Odor Span Task (OST) as a model of working memory in detection dogs is important to understanding the predictive value of working memory on detection dog success. The OST has been argued to measure working memory capacity, therefore we chose this task to assess its across species reliability and examine how working memory is operationalized in this context. In Experiment 1, six purpose-bred detection dogs were trained on a dog-adapted OST with 24 odors. The OST is a non-match-to-sample task in which the dog is presented with both a novel (S+) and a previously encountered (S-) odor on each trial. A response to the novel odor is always reinforced. In Experiment 2, the dogs were tested on the OST with an increasing number of odors within a session in order to study working memory capacity for odors. The dogs displayed accurate performance (80% correct or higher) for up to 72 odors. These results provide insight on how detection dogs store odor information across short time periods.

P33 **Evidence That Urban Anthropogenic Noise Impacts Vocal Communication Monk Parakeet (*Myiopsitta Monochus*) Populations In Brooklyn, Ny, And Barcelona, Spain**
Tatyana Desire-Brisard (BioMimetic and Cognitive Robotics Lab), & Frank W Grasso (Department of Psychology Brooklyn College)
Anthropogenic noise impacts breeding success in many avian species, and cognitive coping strategies offer a means to reduce effects of this ecological stressor. We hypothesized that Monk Parakeets would alter call structure in response to anthropogenic noise because they are age-independent vocal learners. We analyzed two communication signals used by Monk Parakeets for social communication: chatter calls made by groups and contact calls made by individuals. We collected 23 audio-video recordings of parrots at their nests in Brooklyn and Barcelona from which we extracted 17 chatter calls and 56 contact calls. We used Raven software (Cornell Ornithological Laboratory) to compute average call amplitude, peak call frequency, peak-frequency-contour-max-slope and several other measures for each call. We measured anthropogenic noise level for the period immediately before each call. We found increases in peak call frequency [t(73) = 17.40 p < 0.01] and slope [t(73) = 9.41 p < 0.01] with increased anthropogenic noise levels in both calls but no significant changes in call amplitude. We conclude that Monk Parakeets possess the ability to adjust their call characteristics in response to ambient noise. This strategy might be energetically less costly, and cognitively more sophisticated than amplitude increase exhibited by many other bird species.

P34 **Behavioral Measurements of Hearing Before and After Noise Exposure in Laboratory Mice**
Kali Burke (University at Buffalo SUNY Department of Psychology), Laurel A. Screven (Johns Hopkins University School of Medicine Department of Otolaryngology – Head and Neck Surgery), Anastasiya Kobrina (University at Buffalo SUNY Department of Psychology), Katrina M. Schrode (Johns Hopkins University School of Medicine Department of Otolaryngology – Head and Neck Surgery), Hannah Thorner, William A. Smith-Peters, Faiza Hafeez, Payton E. Charlton (University at Buffalo SUNY Department of Psychology), Amanda M. Lauer (Johns Hopkins University School of Medicine Department of Otolaryngology – Head and Neck Surgery), & Micheal L. Dent (University at Buffalo SUNY Department of Psychology)

Typically, measurements of auditory function are conducted using physiological methods in anesthetized animals. Behavioral methodologies obtain thresholds that are 5-30 dB lower than physiologically obtained thresholds across the hearing range of the animal, and are generally thought to be more accurate for determining the acoustic world of the animal. Here, we behaviorally measured hearing in laboratory mice following acoustic trauma. The acoustic trauma was a noise exposure of 8-16 kHz narrowband noise at 100 dB SPL for 2 hours. The behavioral task was operant conditioning with positive reinforcement. This task involved shaping a mouse's behavior to poke into an infrared beam-lined poke hole when they heard a stimulus. Across trials, the intensity of that stimulus varied randomly. Using the psychophysical Method of Constant Stimuli, where tones that are easily detectable and tones that are harder to perceive are presented in a random order throughout a session, we were able to obtain thresholds for stimuli of several frequencies, before and following the acoustic trauma. Our results showed that hearing thresholds shifted temporarily for both pure tone and ultrasonic vocalization stimuli; however, post-exposure thresholds varied across mouse sex and age.

Quantity Discrimination and Reinforcement Efficacy in Domestic Dogs
Xenabeth A. Lazaro, Nicole R. Dorey, Ph.D., & C.A.A.B. (University of Florida)

P75
Use of food in animal training is commonly utilized with a number of different species. Although there are many methods used to train animals, this research focused on the jackpot technique. We defined jackpotting as a reward that is larger than the normal reinforcer and unexpected by the subject (Videan et al., 2005). The efficacy of using high quality food reinforcers in jackpot training has been explored with rhesus macaques (Martin, Franklin, Perlman, & Bloomsmith, 2018). However, no study has evaluated the efficacy of food quantity. This study aimed to assess the reinforcing efficacy of differing quantities of food for domestic dogs by comparing responses when receiving 1, 3, and 7 pieces of kibble. Results suggest that dogs are capable of discriminating between small and large ratios of food. This study also found a statistically significant difference in responses between 1 and 7 pieces of food, but none between 1 and 3 pieces or 3 and 7 pieces of food during a progressive-ratio task, suggesting that jackpotting has the potential to be an effective reinforcer if the amount of food given as a jackpot is at least at a 1:7 ratio. These results have applied implications for animal trainers.

Poster Session II - Saturday Evening

Temporal modulation transfer functions (TMTF) in CBA/CaJ mice (*Mus musculus*)
Huaizhen Cai, Faiza Hafeez, & Micheal L Dent (SUNY at Buffalo)

P35
CBA/CaJ mice were trained in a Go/No-go operant conditioning procedure and the psychophysical method of constant stimuli to measure amplitude modulation thresholds as a function of modulation frequency. Gaussian white noise was used as a carrier, and was sinusoidally modulated at 9 modulation frequencies ranging from 5 to 1280 Hz. All sounds were delivered at 53 dB SPL, and the duration of the modulated Go stimuli was 800 ms. Each modulation frequency condition was measured in a separate session. Multiple modulation depths were presented in each session in the eight mouse subjects. The mean response latency and percent discrimination for each modulation depth at each modulation frequency were measured. The resulting temporal modulation transfer function (TMTF) in mice displays a low pass characteristic, with a cut-off frequency around 640 Hz. For each modulation frequency condition, response latency generally increased with decreasing modulation depth. The shape of the mouse TMTF generally follows that of other rodents and mammals. These data add baseline behavioral data to normal-hearing mice, which have been widely used as a model to investigate hearing function in other mammals.

Sex differences and scopolamine effects in rat serial pattern learning and retention
Claire C. Jackman, Katherine H. Dyer, Jessica L. Sharp, & Stephen B. Fountain (Kent State University)

P36
Muscarinic cholinergic antagonists impair some aspects of serial pattern acquisition and retention in male rats (e.g., Chenoweth & Fountain, 2015). The current study examined sex differences in rats' response to the muscarinic cholinergic antagonist scopolamine (SCOP) in serial pattern learning. Male and female rats received intraperitoneal injections of either saline or SCOP before daily training in an octagonal operant chamber to nose-poke a serial pattern, 123-234-345-456-567-678-781-818, where digits represent correct responses in the circular spatial array. Saline-treated males and females learned chunk-boundary elements (the first chunk element) and within-chunk elements equally quickly, and SCOP impaired learning for both elements for both sexes. Sex differences were observed in violation element (terminal element) acquisition: control females learned it to a high level of performance whereas SCOP females' violation acquisition was severely impaired. Control males learned it slowly, and SCOP males never differed from controls. It is possible SCOP had no effect on males' acquisition of the violation element because neither saline nor SCOP males learned to anticipate the violation element before the SCOP challenge. Future work should determine if SCOP challenges affect males similarly to females after males are trained to a high criterion on the violation element.

Procrastination in the pigeon: Conditioned reinforcement may contribute to human procrastination
Ines Elena Martin, Thomas R. Zentall, Jacob P. Case, & Danielle M. Andrews (University of Kentucky)

P37
Procrastination is the tendency to put off the completion of a task. Although people are typically known to procrastinate, research suggests that they sometimes "pre-crastinate" by initiating a task sooner than they need to (Rosenbaum et al. 2014). In the present experiment, we used a procedure with pigeons that was similar to procedures used by Rosenbaum et al. Pigeons had a choice

between two sequences. Choice of the "procrastination" chain resulted in color A, which 15-s later would change to color B and 5-s later resulted in reinforcement. Choice of the "precrastination" chain resulted in color C, which 5-s later would change to color D and 15-s later resulted in reinforcement. Both chains led to reinforcement after 20 s. Results indicated that the pigeons procrastinated; preferring the 15-5 chain over the 5-15 chain. The results are consistent with Fantino's (1969) delay reduction theory, which posits that stimuli that signal a reduction in the delay to reinforcement, such as the 5-s stimulus that occurred immediately prior to reinforcement, serve as conditioned reinforcers and should be preferred. To support this theory, the pigeons pecked most at the 5-s stimulus that led immediately to reinforcement, indicating it had become a strong conditioned reinforcer.

Testing the Animate Monitoring Hypothesis in Macaques and Humans
Jennifer M. Johnson, & David A. Washburn (Georgia State University)

P38 Understanding what stimuli are naturally salient is important not only for future research designs, but also for understanding underlying cognitive mechanisms that influence memory and attention across species. Previous research has shown that humans show preferential processing of animate over inanimate stimuli. Specifically, humans remember animate stimuli better than inanimate stimuli, and animate stimuli capture attention more quickly than inanimate stimuli (Nairne, Thompson, & Paneirada, 2007; New, Cosmides, & Tooby, 2007). One hypothesis is that this occurs due to evolutionary adapted mechanisms: our ancestors needed to monitor living things more closely because those things are most important to survival. However, few researchers have looked into the whether this adaptation theory holds true for nonhuman animals. For this study, we tested humans and macaques using an antisaccade picture-based task to look at differences in attention to animate and inanimate stimuli.

Interference Differentially Impairs Retention in Serial Pattern Learning
Jessica L. Sharp, Katherine H. Dyer, Claire C. Jackman, & Stephen B. Fountain (Kent State University)

P39 Current research in serial pattern learning suggests parallel processing in acquisition and retention of structured serial patterns. Previously, our lab has demonstrated that structured elements and elements that violate structure are learned concurrently through different mechanisms. While data suggest that the presence of a violation element does not interfere with acquisition of structured elements, little work has been done to evaluate how violation elements affect retention of structured elements. In order to assess the effects of interference on retention, rats were trained to criterion on one of two serial patterns: a pattern that contained two types of structured elements (chunk-boundary and within-chunk elements) or a pattern that contained the same structure with an added violation element. Rats were then tested for retention of both of the structured elements in separate experiments. Replicating previous research, the presence of a violation element did not interfere with acquisition of the structured elements. However, in retention tests the presence of the violation element impaired retention of chunk-boundary elements without affecting retention of within-chunk elements. This study demonstrated that acquisition of structured elements is resistant to interference by a violation element, but retention for different types of elements can be differentially susceptible to interference.

A Preliminary Investigation of Categorization and Visual Object Constancy in North American River Otters (*Lontra canadensis*)
Jessica Wegman (Rochester Institute of Technology), Catina Wright (Seneca Park Zoo), Evan Morrison, Trisha Rachfal, Rhiannon Jimenez, & Caroline DeLong (Rochester Institute of Technology)

P40 Little is known about visual perception and cognition in North American river otters. An adult male otter, Sailor, that was successfully trained to discriminate between a 2D solid blue triangle and red circle in a previous study participated in the current study. During the training phase, he learned to discriminate between 2D black outlines of the same triangle and circle on a white background (M = 86%). In this preliminary test, he was presented with two types of test sessions. To test Sailor's ability to categorize novel stimuli, we presented him with triangles and circles that were modified in shape (e.g., taller or wider than the training stimuli). Sailor selected the triangular stimulus on 69% of the trials. To test Sailor's ability to recognize objects at multiple aspect angles, we presented him with his training triangle rotated at 90, 180, or 270 degrees (paired with the training circle). Sailor continued to correctly choose the triangle on 83% of the trials. More tests are planned to continue to investigate how river otters perceive and categorize objects. This research can be used to support future conservation efforts and to design better enrichment opportunities for river otters in zoos.

Will Terminating Training Trials After the First Response Produce an Effect of Stimulus-Response Compatibility During a Spatial Occasion Setting Procedure With Humans and Pigeons?
Joshua Wolf (Carroll University), Cheyenne Elliot, & Kenneth Leising (Texas Christian University)

P41 Previous research investigating the effects of stimulus-response compatibility on the rate of learning and transfer of stimulus control during a spatial occasion setting procedure with humans and pigeons has been unable to demonstrate a difference in the rate of learning the occasion setting discrimination. It is possible that the occasion setting procedure utilized in the previous experiments, that allows participants to make responses until the goal location is found, may have masked any potential differences in the rate of learning the occasion setting discrimination predicted by the stimulus-response compatibility (i.e., the location of the goal relative to the point of visual stimulus presentation) for different trial types. The current procedure has removed the correction procedure and terminates the trial after the first response is produced, even if the response is not correct. If the level of compatibility between the required response and direction of stimulation leads to incorrect responses it is

hypothesized that participants should take longer to acquire the discrimination. This study will compare the performance of humans on the previous and current procedure as well as pigeons if they are able to acquire the discrimination and reach testing.

Conserv(ED): Zoo Education in a Modern Society
Joy Vincent, & Lauren Highfill (Eckerd College)

P42 The main role of the modern zoo is to support conservation through education. In recent years, there has been a push to study the effectiveness of the design and implementation of different educational programs. This study aimed to investigate four tactics of education prominently employed at zoos: signage, docents, trainer talks, and the demonstration of cognitive research sessions. Participants watched one of five videos intended to mimicational mechanism and then completed a series of questions designed to test the overall impact of the interpretation. The results indicated that, while none of the conditions had lasting effects overall, the signage condition had the greatest impact on short-term retention rates. The individuals who watched a research session and chose to visit an informational website, however, demonstrated greater long-term retention of the information than those in the other conditions. In addition to providing a framework for future investigation into the benefits of conducting research at zoos, this study also has implications for the allocation of zoo resources.

Beware of Strangers: Dogs' Empathetic Responses to Strange Humans and Strange Dogs
Mica Rivera, Katie King, Melissa Micale, & Julia Manor (Ripon College)

P43 While dogs have long been known to show empathetic responses in the form of emotional contagion, only recently have dogs been tested in more complex forms of prosocial actions as a form of empathy. In one study, dogs responded to the cries of their owner more rapidly than to their owner's humming, but this was dependent on the level of stress in the dog (Sandford et al., 2018). We followed up this experiment by testing the responses of dogs to a recording of a distressed or snoring puppy using a "trapped-other" paradigm. Dogs did not respond by opening a door for the crying puppy, but did show some physiological signs of stress. Given that dogs responded to their owner's distress, we wanted to see what role unfamiliarity may have played in the conspecific study. We are currently examining dogs' responses to a crying and humming human stranger. We hope to see whether empathetic prosocial behaviors extend beyond familiar individuals.

Effective Motivation of Discoid Cockroaches (*Blaberus discoidalis*)
Kara Watts, Isadora Salatiel, & Darby Proctor (Florida Institute of Technology)

P45 Active learning significantly improves student success compared to lecturing. Traditionally, university psychology labs have used animal models such as rats and pigeons to promote active learning. These labs are costly to maintain and carry ethical concerns. We are exploring the efficacy of discoid cockroaches as an alternative model species by testing their ability to be motivated to complete tasks. We evaluated eleven adult male cockroaches using five motivators: sucrose-free diet, sucrose-rich treat, water, sucrose solution, and shelter. Each cockroach was presented with two motivators for ten-minute sessions. Our results suggest that with motivators cockroaches were more likely to participate than not; $t(10) = 3.71$, $p = 0.004$, 95% CI [0.18, 0.76]. Further comparison found no significant differences in the effectiveness of each motivator, $F(2, 20) = 2.08$, $p > 0.05$, partial $\eta2 = 0.173$. The comparison between sucrose solution and sucrose treats was approaching significance with a large effect size, $t(10) = -1.82$, $p = .09$, $d = 0.7$. This suggests that an increased sample size may show significant results. We found that on average, the cockroaches completed five trials in 10 minutes. These results indicate that discoid cockroaches can be used as animal models in classroom settings.

Differential Acquisition of Incrementing Matching- and Non-Matching to Sample Tasks in Rats
Thomas J. Wagner, Nicole R. Westrick, Genevieve C. Guidone, Jonathan D. Shaw, Kelly A. Lowe, Bobbie F. Wolff, Connor Hebert, Angel M. Bennett, Ashley Campbell, Chandler Hicks, Kate Bruce, & Mark Galizio (University of North Carolina Wilmington)

P46 In the rodent odor span task (OST) responses to odors are reinforced the first time they are presented in a session, but not when presented again in the same session. This task is an incrementing non-matching to sample task; each odor serves both as sample and as reinforced comparison stimulus on first presentation. Rats rapidly learn to respond only to session-novel stimuli in this task, but the extent to which acquisition is based on novelty preference is unknown. We created a free operant version of the OST and compared acquisition under both incrementing non-matching- and matching-to-sample variations. Twelve rats (six matching, six non-matching) were trained to nose-poke to either session-familiar (Matching Group) or session-novel (Non-Matching Group) odor stimuli on an FI 5-s schedule of food reinforcement. Rats in the Non-Matching Group mastered the task much faster and were performing with better accuracy at the end of training. Discriminated performances were obtained in most of the Matching Group rats, but several failed to respond above chance. Preference for novelty may explain the more rapid acquisition of incremental non-matching, but data from the Matching Group show that the task can be learned even when it requires responding to familiar stimuli.

Variables Affecting Performance on the Rodent Odor Span Task

MacKenzie Wantje, Nicole Westrick, Genny Guidone, Kelly Lowe, Angel Bennett, Elyssia Calvillo, Nick Blackburn, Kathryn Farias, Dominick Giordano, Mark Galizio, & Kate Bruce (University of North Carolina Wilmington)

P47 The Rodent Odor Span Task (OST) is used as a model of both working and episodic memory. In this task, rats learn to select the session-novel scent on each trial; the task is in effect an incrementing non-match to samples procedure. Rats perform at high accuracy even as the number of odors to remember increases during the session. We investigated variables that may impact performance. Rats were trained daily on the OST (24 trials/session) with three odors on each trial-one session-novel and two randomly selected from odors presented earlier in the session. After rats consistently performed the task accurately, we manipulated the comparison odors used in the second half of the session; one was an odor presented early in the session and the other had been recently presented. More errors were made by selection of the less recent odor comparison, suggesting that "time since smelled" may be more important than is often recognized in the OST. Further, insertion of a short delay in the middle of the session resulted in a short-lived decrement in performance, again underscoring the contribution of relative familiarity for stimulus control. The findings are considered in the context of both working and episodic remembering.

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)

P48 Environmental enrichment is typically used in zoos, laboratories, and refuges to reduce negative behaviors (e.g. stereotypy) and increase positive behaviors. 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.

Serial Pattern Acquisition and Effects of Central Cholinergic Challenge in a Touchscreen Task for Rats

Katherine H. Dyer, Claire C. Jackman, Jessica L. Sharp, & Stephen B. Fountain (Kent State University)

P49 Research shows rats can learn complex serial patterns in a circular array in an octagonal operant chamber (Fountain & Rowan, 1995) and pigeons can do so in a circular touchscreen array (Garlick, Fountain, & Blaisdell, 2017). The current study assessed whether male rats could learn patterns in a touchscreen array. The pattern was 123-234-345-456-567-678-781-818, where digits indicate array positions and dashes indicate phrasing cues. The pattern included three element types: chunk-boundary, within-chunk, and violation elements. One group had 3-s phrasing cues and one group made a center-key phrasing response. Rats experienced 50 patterns/day and received brain stimulation reward for correct responses. Groups learned at the same rate overall. As in previous studies, within-chunk elements were learned first. However, unlike earlier studies, the violation element was learned before chunk-boundary elements in both groups. After 35 sessions, a scopolamine challenge was conducted. The scopolamine challenge increased errors for all three element types, a finding different from previous octagonal chamber research that found within-chunk elements were unaffected by scopolamine. The different learning rates are consistent with claims that elements are learned via independent mechanisms. Manipulating elements across paradigms could identify whether the same underlying mechanisms are responsible for element learning across procedures.

Human choice corresponds to reinforcer probability in a concurrent-chains procedure

Erin Baum, Jeremy Jasmer, Vincent Edwards, Darren Miles, Austin Smith, Robert Southern, Jessica Stagner, & Kent D. Bodily (Georgia Southern University)

P50 Stagner & Zentall (2010) found that pigeons chose an alternative that was reinforced on only 20% of trials over an alternative that was reinforced on 50% of trials, if the 20% reinforced alternative was followed by stimuli which predicted reinforcement. To test the extent to which human participants would behave similarly, Molet et al. (2012) modified the method to a narrative form (defending planets from space invaders) and found that human participants describing themselves as gamblers behaved less optimally than those that did not. The current study tested human participants in the concurrent-chains procedure. Participants were randomly assigned to a realistic narrative (serving at a restaurant) or an abstract (shapes and colors) version of the task. Regardless of condition, human participants did not allocate responses suboptimally. Results are compared to those obtained with pigeons and to predictions derived from the Matching Law.

A Comparative Test of Analogical Reasoning

Kevin Leonard, Parisa Sepehri, Breanna Cheri, & Debbie M. Kelly (University of Manitoba)

P51 Analogical reasoning, or second-order relational processing, involves the ability to compare relations to relations. Although spontaneous analogical reasoning abilities of non-human animals have been examined using relational matching-to-sample tasks

(RMTS), these tasks typically do not examine which stimulus properties are controlling choice behaviour. During our modified version of the RMTS task, human participants were presented with an exemplar pair of stimuli that were either the same or different according to a single dimension (shape or colour), alongside a probe stimulus and several choice stimuli. Participants were required to select the single choice stimulus, from a number of distractors, which maintained the same relationship to the probe as existed between the two exemplars. The process was then repeated for the other stimulus dimension. Participants subsequently received transfer tests during which the stimuli could now vary along a third, novel dimension (pattern). Importantly, incorrect choice stimuli were constructed such that they could be correct along one or two dimensions, but only one stimulus was correct according to all three. Our design is intended for comparative investigations examining learning of relational rules of same and different, and how stimulus complexity influences the ability to reason by analogy.

Do Domestic Dogs (*Canis familiaris*) Perceive the Solitaire Illusion?
Krista Macpherson, & William A. Roberts (Western University)

P52

The study of optical illusions in non-human animals is a useful approach to the understanding of comparative differences in perception. The Solitaire illusion is one such example, where the arrangement of stimuli influences the quantity perception of a set. Tied to Gestalt principles, this illusion occurs when one large cluster of items appears to contain more elements than the same number of non-clustered items. To date this illusion has been demonstrated in humans, non-human primates, and guppies (*Poecilia reticulata*). Domestic Dogs (*Canis familiaris*) have been shown to be sensitive to number, however findings regarding their sensitivity to perceptual illusions has been mixed. Dogs were trained to select an array containing the larger quantity of either blue or yellow elements presented on a black display. After reaching the learning criterion, dogs were presented with novel arrays of items, including probe trials with solitaire arrangements. Results and implications for the understanding of perceptual ability in domestic dogs will be discussed.

The Assessment of Cognitive Bias in Two Species of Nonhuman Primates Using a Computerized Task
Kristin French, & Michael Beran (Georgia State University)

P53

Cognitive bias refers to the influence of affective state on the interpretation of ambiguous stimuli and has been used to assess emotional state in nonhuman animals. Many species exhibit a tendency to classify ambiguous stimuli as resembling a previously trained negative response when in a negative affective state and to classify ambiguous stimuli as positive when in a positive affective state. Studies with nonhuman primates are fewer in comparison to other species but offer an important perspective on cognitive bias. The current study will assess cognitive bias in two species of nonhuman primates, brown-tufted capuchins and rhesus macaques, using a computerized psychophysical task and a novel manipulation to affect that involves giving moneys a drink that looks identical but tastes either sweet or sour. In addition, the study will include training on several positive and negative training cues to assess how affective state may influence responses to previously learned stimuli along with an ambiguous probe. It is hypothesized that monkeys who receive the sour flavor will be more likely to classify the ambiguous probe using the pre-trained negative response, while monkeys who receive the sweet flavor will be more likely to classify the ambiguous probe as positive.

Did I launch that?; A new methodology for examining self-agency nonverbally
Markie N. Adamczyk, Brooke N. Jackson, Carmen N. Shaw, Barbara A. Church, & J. David Smith (Georgia State University)

P54

A sense of self-agency is a crucial aspect of metacognitive awareness (e.g. Metcalfe & Green, 2007). Self-agency in nonhuman species is an important issue but remains under researched because of methodological limitations (e.g. Couchman, 2012). The present study was designed as a new measure of self-agency that does not require verbal instructions or declarations. Therefore, it can be implemented with nonverbal populations. Participants learn by trial and error two event categories differentiated by whether or not their own movement controls a rocket launch. In human participants, those who were able to discover their self-agency shared a distinct error pattern and reached very high accuracy levels. On the other hand, those who did not use self-agency to categorize performed poorly and did not show the same error pattern. We tested rhesus macaques in this task to see if any would show performance and error patterns similar to humans who categorized based on a sense of self-agency. Results show that rhesus monkeys can show similar response profiles and levels of accuracy to those seen in humans who use self-agency. It strongly suggests that rhesus macaques may have the ability to discover their own self-agency.

Sex differences in spatial memory following early moderate prenatal exposure to alcohol: A pilot study
Jacob Dowell, Zebulon Bell, Eriel Datuin, & Martha Escobar (Oakland University)

P55

Alcohol use during pregnancy can lead to physical, developmental, and learning disabilities. Approximately 40,000 live births/year are in the Fetal Alcohol Spectrum Disorders (FASD) spectrum, expressing deficits that range from very mild to severe. The early postnatal period in the rat (Postnatal days 1-9) is often used as a model for rapid cortical development that takes place during the third trimester of a human pregnancy, and has been the focus of most research on the cognitive effects of prenatal alcohol exposure. In the present study, we focused on the effects of alcohol exposure during the rat gestational period (Days 1-21 of gestation), which would model the first two trimesters of development in a human pregnancy (initial structure formation). The rationale for this is that even women who do not have alcohol-consumption problems may consume alcohol before they learn they are pregnant. Dams consumed moderate levels of alcohol (5 mg/kg/day, or the equivalent to 3 drinks), and their pups were tested in a Y maze at age 40 days. Alcohol-exposed female pups exhibited more deficits than their control or male counterparts,

suggesting that early prenatal exposure to alcohol may have differential effects in male and female brain organization during gestation.

Transitive Inference in Pigeons May Result from Differential Inhibition to the Test Stimuli
Megan Halloran, Thomas R Zentall, Daniel Peng, & Luke Miles (University of Kentucky)

P56 The five-term transitive inference task used with animals involves training on four premise pairs: A+B-, B+C-, C+D-, D+E-. A transitive inference effect is found when animals presented with B versus D prefer B because B is better than C and C is better than D. We propose a non-inferential hypothesis to account for the transitive inference effect. We suggest that the animals generally have had less experience with B- in the A+B- discrimination than with D- in the C+D- discrimination. To test this hypothesis, we encouraged pigeons in the Experimental Group to avoid B- in the A+B- discrimination by allowing the A+ stimulus to vary from trial to trial among four stimuli. In addition, half of the pigeons in each group had colors serve as their stimuli, while the remaining pigeons had highly discriminable flags of different countries. Regardless of stimulus type, the Experimental Group showed little preference for B over D, whereas the Control Group, which had a single stimulus as the A+, showed the typically reported preference for B over D. We conclude that it is not necessary to attribute the transitive inference effect to an inferential process.

Building a Rating Scale for Monkey Perceptual and Conceptual Classification Tasks
Molly Flessert, & Michael J. Beran (Georgia State University)

P57 Many tasks present animals with stimuli to be classified into dichotomous categories (e.g., larger/smaller, sparser/denser). However, fewer studies have trained animals to assign stimuli to a more continuous scale. We presented rhesus and capuchin monkeys with a computerized categorization task simulating a rating scale made up of "bins of classification." Monkeys were first trained with anchors of a scale (i.e., the stimuli that were the minimal or maximal exemplars on the scale), and then we introduced a full classification scale represented with 5 bins in which to place a possible 50 different types of stimuli (10 stimuli/bin). In the first task these stimuli were squares varying in size. Stimuli were presented to the monkey, two at a time, to give some context on each trial. Monkeys were cued as to which of the stimuli to categorize and used a joystick to move stimuli into a bin, and they were successful in categorizing these varying shapes into the correct bins. Further, incorrect responses were most often placed in a bin next to the correct bin. We will describe this methodology and describe generalization tests designed to determine whether this classification scheme shows properties of a true, domain-general ratings scale.

Individual differences in sociability and boldness in Eastern Garter Snakes
Morgan Skinner, & Noam Miller (Wilfrid Laurier University)

P58 There is little research on individual differences, sometimes called 'personality', in snakes. We measured sociability and boldness of juvenile garter snakes in both an individual and a group environment. To individually test sociability, we measured a snake's attraction to a social shelter (scented with conspecific skin lipids), compared to a control shelter. To measure boldness, we examined the time to emerge from a shelter and the time spent exploring an arena. We then examined the consistency of these behaviors when the snakes were moved into a group environment, by placing groups of ten snakes in a square enclosure that had four hides. We recorded positions of all the snakes every 5 seconds for 8 days. We constructed social networks of the snakes' interactions and examined the effects of individual differences in sociability and boldness on their aggregation tendencies. We found that social preferences within the group context were consistent across days and between the individual and group scenarios. Additionally, we found significant changes in boldness across contexts. Not only is this the first study to demonstrate individual differences in sociability in snakes, it is also the first study to examine the effects of snake 'personality' in a group context.

A Novel Method to Study Learning in Wild and Captive Bumble Bees: The Defensive Leg-lift Response (DLR)
Noelle Vallely, Claudia Coffin, & Christopher A Varnon (Converse College)

P59 Recent research uses bumble bees as indoor alternatives to the well-established honey bee model of invertebrate psychology. While bumble bees are comparatively hardy, indoor colonies have limitations. Captive conditions, such as artificial lighting, may impact navigation ability. Across one month, we found 2-5 bees became lost daily, never returning to the hive. "Lost bees" then aggregated and colonized new areas. Another issue is that appetitive tasks require specialized foragers, and captivity may inhibit forager production. Subjects collected from indoor hives may primarily be nurse bees and ill-suited for research. In our investigations, we found that wild bees were larger than captive bees and performed better in two appetitive tasks. These findings suggest that wild bees were foragers while captive bees were nurses. As a solution, we developed a novel method to study learning suitable for both forager and nurse specializations. In this method, the defensive leg-lift response (DLR) to a visual stimulus habituates across several trials. Both wild and captive bees show habituation learning, with captive bees showing more overall behavior. The DLR method thus provides a useful option when captive bees respond poorly and can investigate a range of topics including long-term memory and the effects of pesticides.

Conditional temporal discrimination in pigeons

P60 *Danielle Beckley, Kelsey M. Pogatetz (Drake University), Verner P. Bingman (Bowling Green State University), Martin J. Acerbo (Iowa State University), & Olga F. Lazareva (Drake University)*

We have developed a behavioral task in which pigeons have to discriminate the order of appearance of two pictorial stimuli in a delayed, three-alternative matching-to-sample task. During a trial, a first stimulus is shown (ST1) and a bird is required to peck a fixed number of times (FR). After a short delay, a second stimulus (ST2) is shown requiring the same FR response. Finally, the bird is presented with a choice display containing the ST1, the ST2, and a distractor stimulus that had not been shown previously. The correct choice is determined by the color of the background. For example, if the background is blue, then the choice of the ST1 is reinforced, but if it is green, then the choice of the ST2 is reinforced (or vice versa for counterbalancing). A choice to the distractor is never reinforced. All birds quickly acquired the task and showed a strong recency effect, i.e., higher accuracy to the ST2 than to the ST1. Preliminary results of delay testing will be presented.

Selective attention in stepwise discrimination of compound visual stimuli by pigeons.
Olga V. Vyazovska (V.N. Karazin Kharkiv National University), Victor M. Navarro, & Edward A. Wasserman (The University of Iowa)

P61
We trained 8 pigeons (*Columba livia*) on a stagewise go/no-go visual discrimination task of increasing complexity, to document the dynamics of selective attention. We constructed negative compound stimuli (S-s) on the basis of their overall similarity to a positive compound stimulus (S) along 4 binary-valued dimensions: shape (circle/square), size (large/small), line orientation (horizontal/vertical), and brightness (dark/light). Starting with 1 S and 1 S- that differed in all 4 dimensional values, in 3 later steps, we progressively added S-s sharing 1, 2, and finally 3 dimensional values with the S. Although in the first step the pigeons could have attended to any of the 4 dimensions (separately or together) to solve the discrimination, all of the pigeons attended to only 1 dimension. Furthermore, the pigeons attended to just 1 additional dimension in each of the 3 succeeding steps. Notably, all pigeons discriminated the 4 dimensions in the same order: first brightness, then line orientation, then size, and finally shape. This ordering corresponds with the overall discriminability of the dimensional values for these dimensions observed in prior studies. Pigeons clearly optimized their attentional behavior, selectively and efficiently processing only 1 additional dimension in each stage of discrimination learning.

Investigation of risk-taking behavior in capuchin monkeys (*Cebus [Sapajus] apella*) using a modified balloon analogue risk task
Olivia B. Tomeo, Michael J. Beran, & Sarah F. Brosnan (Georgia State University)

P62
Risk-taking behavior is often defined as behavior with uncertain outcomes, some of which could be harmful to oneself or others. However, risky decision-making presumably evolved due to its advantageousness, and a comparative approach will help us better understand the evolutionary history of risky decision-making and its underlying mechanisms. However, there is no consistent method of assessing risk across species. The Balloon Analogue Risk Task (BART) is a standardized task used to assess risk-taking behavior in humans. We created a modified computerized version of the BART so that it can be used for standardized assessment of risk-taking behavior in both human and nonhuman primates. We tested the validity of the modified BART in capuchin monkeys (*Cebus [Sapajus] apella*). These monkeys showed a similar pattern in performance on the modified BART to humans who completed the original BART. The modified version will also be tested in human adults to compare performance on the two versions of BART. Future directions will investigate the role of cortisol on the relationship between testosterone and risk-taking behavior in nonhuman primates using the results from the modified BART as the risk score.

The Effects of Anthropogenic Noise on Attention in *Tursiops truncatus*
Paige Stevens, & Jason Bruck (Oklahoma State University)

P63
Marine mammals are subject to increasing amounts of noise stimuli due to human activity. The extent of sound pollution on mental health and cognitive function, relative to other anthropogenic affects, is poorly understood. The objective of the study was to test attention to anthropogenic noise stimuli in bottlenose dolphins under human-care. In order to ascertain attention dolphins at two different facilities, one inland and one coastal, were recorded and observed during playback trials. Acoustics and visual behaviors were measured to assess attention levels and possible desensitization of the subjects. Further analysis will compare frequency and duration of each behavior between the two facilities.

Can rhesus monkeys learn to use symbols to label faces, tasks and foods?
Paola Soares (Federal Rural University of Amazonia), Theodore Evans (Georgia Institute of Technology), Will Whitham, Michael Beran, & David Washburn (Georgia State University)

P64
Previous research has demonstrated the ability of chimpanzees to use symbols, both meaningfully and functionally (Rumbaugh, 1977). Although no rhesus monkey has ever been trained to use communicative symbols in this fashion, these primates have shown an understanding of the values represented by Arabic numerals (e.g., Harris et al., 2010), and the ability to label the color of images using color-name symbols (Klein et al., 2012). This present work summarizes the status and plans for teaching rhesus monkeys additional symbols, as well as assessing whether these symbols serve representational and communicative functions for the animals. In Experiment 1, monkeys matched pictures of human faces to symbols. Generalization was tested with novel images of the same people, which the monkeys labeled accurately. In Experiment 2, we extended a previous finding that monkeys will select from a menu of task icons to gain access for a short time to corresponding tasks. For Experiment 3 we plan to test whether such monkeys can learn symbols relating to food items. This study is ongoing, but data collection and analysis will be complete by the meeting.

Differing levels of anthropogenic noise affects discrimination of conspecific fee-bee songs by black-capped chickadees (*Poecile atricapillus*)

Shannon K. Mischler, Kimberley A. Campbell, Jenna V. Congdon, Carolina Montenegro, Erin N. Scully, William D. Service (University of Alberta), Allison H. Hahn (St. Norbert College), Dan J. Mennill (University of Windsor), Ken A. Otter (University of Northern British Columbia), & Christopher B. Sturdy (University of Alberta)

P65

Black-capped chickadees (*Poecile atricapillus*) produce several vocalizations, including the fee-bee song which is used in mate attraction and territory defence. Fee-bee songs contain information about dominance hierarchy and, importantly for the current study, native geographic location. Previously, our lab demonstrated that black-capped chickadees can discriminate fee-bee songs produced by conspecific individuals from different regions of North America. Anthropogenic noise, though, can mask acoustic signals and compromise discrimination of fine details in songs. For this study we aimed to investigate whether black-capped chickadees' ability to discriminate between geographically-distinct fee-bee songs (Ontario vs. British Columbia) would be impacted by differing levels of anthropogenic noise using a go/no-go operant discrimination task. Once the birds acquired the discrimination, we played different levels of anthropogenic noise (low: 35-40 dB; high: 70-75 dB) with test stimuli to examine how anthropogenic noise would affect discrimination performance. Transfer test results revealed that discrimination performance declined as levels of anthropogenic noise increased. These results highlight the potential impacts of ever-growing human noise on wildlife, in particular the impact on perception of auditory signals.

Spontaneous Numerical Ability in Horses

Tammy McKenzie & Taylor King (Brandon University)

P66

Discrimination based on quantity has been suggested to have survival value, such as being able to determine between foraging areas with larger and smaller quantities of food, to detect differences in relation to the number of predators or competitors present between locations or situation, etc. (Perdue, Talbot, Stone, & Beran, 2012). The ability to discriminate based on number is one form of quantity discrimination (Henselek, Fischer, & Schloegl, 2012).Only two studies have examined the ability of horses to spontaneously discriminate between stimuli based on number of items and they reported conflicting results (Henselek, Fischer, & Schloegl, 2012; Uller & Lewis, 2009) The current research examined spontaneous numerical discrimination abilities in horses. Horses' numerical discrimination ability was tested using a 2-choice paradigm. Each horse had to select between two quantities of artificial apples (volume was controlled for half the trials but not the other half) for one of the following quantity comparisons: 1 vs 2, 2 vs 3, 2 vs 4, 4 vs 6, and 8 vs 16. One hundred horses were used in the study, with ten different horses experiencing each quantity comparison. Horses did not consistently choose the larger quantity for any of the quantity comparisons.

Understanding avian incubation with a computer algorithm

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

P67

Birds vary nest structure and incubation behaviour to regulate nest temperature for successful offspring. I used a modeling approach to test the hypothesis that incubation behaviour is affected not only by ambient temperature but also by previous incubation experience. I examined an extensive data set of nest temperatures and behaviour collected on zebra finch (*Taeniopygia guttata*) pairs that incubated at either 30°C or 14°C. Temperature loggers recorded in-nest temperature. Zebra finch pairs built nests and incubated in one of the two temperature conditions, then stayed in the same temperature condition, or switched conditions for a second round of nest building and incubation. Incubation behaviour was video recorded. I used a Hidden Markov Model (HMM) to infer incubation behaviour from a subset of the {behaviour, temperature} data. Different video records were used to test HMM predictions. Results show that the current temperature, previous temperature condition and previous reproductive success significantly affect incubation duration. This research explores a new use of modeling in animal behaviour and develops practical techniques for inferring behaviour from data loggers that can be applied in the field and in the lab.

Effects of Delay Type on Human Choice in a Concurrent-Chains Procedure

Baum, E., Edwards, V. M., Jasmer, J. A., Miles, D. L. T., Smith, A. L., Southern, R. A., Stagner, J. P., Bodily, & K. D. (Georgia Southern University)

P68

Stagner & Zentall (2010) found that pigeons chose an alternative that was reinforced on only 20% of trials over an alternative that was reinforced on 50% of trials, if the 20% reinforced alternative was followed by stimuli which predicted reinforcement. We adapted this concurrent-chains procedure for use by human participants to assess the generality of the effect across species. Building on previous research in our lab, the current study introduced a delay between the initial and terminal links (e.g., Spetch et al, 1990, McDevitt et al, 1997) in which stimuli were presented during the delay varied across groups. Choice allocation was analyzed and compared to chance and matching-law predictions.

Sensory-specific satiety, exercise, and the variability of maze navigation in rats

Wilber Galindo, Zafrullah Malik, Samantha Tiedeman, Emily Webberson, & W. David Stahlman (University of Mary Washington)

P69

Research has indicated that variability in operant behavior is a function of, among other things, the palatability of the reinforcer. We report a single experiment in which we examined the effects of pre-feeding and wheel-running on locomotor behavioral

variability. Using a repeated measures design, we 1) prefed all animals either sugar or grain, and 2) had them either remain sedentary or run in stationary wheels, prior to our observing their behavior in navigating a Dashiell maze, which was reinforced with sugar pellets. We observed that rats that did not run in the wheel expressed significantly more variability in paths taken than those that did not. We also report that, as expected, sugar pre-feeding appeared to increase subsequent variability of sugar-reinforced behavior. We discuss these results in a larger context of novel action and make suggestions for future research.

Performance of rhesus monkeys (*Macaca mulatta*) in a source memory for context paradigm
Wenying Zhu(2 (1. Department of Psychology), 3), Ryan J. Brady(1, 3), Robert R. Hampton(1, & 3) (Emory University 2.
Emory College of Arts and Sciences 3. Yerkes National Primate Research Center)

P70 Source memory is critical to human recollection, as it allows for the identification of the contexts of previously encountered events. In rhesus monkeys, little is known about the underlying memory mechanisms of discrimination between events associated with different contexts. We investigated memory processes supporting such discriminations in monkeys. At the beginning of each test session, forty images were shown to the monkeys in context 1. Images were then presented one at a time in context 2, each immediately followed by a recognition test, showing one image from context 1, one image from context 2, and two novel images. Selection of context 1 images was rewarded. With training, monkeys shifted from selecting context 2 images at test, to selecting context 1 images. This result demonstrates the ability to discriminate images encountered in different contexts in rhesus monkeys, akin to source memory. In experiments 2 and 3, additional cognitive load and longer delay intervals were added between context 2 and recognition tests to disrupt memory. Longer time intervals impacted monkeys' performance more than cognitive load, suggesting that the less cognitively-demanding familiarity process may play a larger role than working in this context recognition paradigm.

Operant Conditioning changes ZENK expression to Heterospecific Stimuli in Zebra Finches
Leslie Phillmore, Will Brien, Nafisah Ali, Tovah Kashetsky (Dalhousie University), & Christine Tsang (Huron University College)

P71 In songbirds, the immediate-early gene ZENK is expressed after playback of acoustic stimuli in brain regions important for song perception: caudomedial nidopallium (NCM) and caudomedial mesopallium (CMM). The type of stimuli can affect amount of upregulation of ZENK: birdsong induces more than pure tones (Mello et al 1992), sometimes conspecific song induces more than heterospecific song (Phillmore et al 2003, but see Avey et al 2014), complex stimuli induce more than less complex (Gentner et al 2001). However, why different stimuli induce different amounts of ZENK in NCM and CMM is not entirely clear. In this study we asked whether stimuli that should not induce ZENK expression, human vocalizations, could induce ZENK expression though association. Birds were trained on an operant conditioning paradigm to discriminate between human infant-directed song and speech. After conditioning, birds were presented with playback of the infant directed song and tissue processed via immunohistochemistry to label ZENK+ cells. Birds that had been trained with the stimuli in an operant paradigm had increased expression compared to birds not trained with the stimuli, indicating that associations formed in training can change how songbird auditory perceptual regions react to previously neutral, heterospecific vocalizations.

Greater Effort Results in Better Choice Accuracy in the Midsession Reversal Task by Pigeons
Thomas Zentall, & Dalton House (University of Kentucky)

P72 The midsession (MSR) task requires the participant to engage in a simultaneous discrimination between 2 stimuli (S1 and S2). For the first 40 trials of each session, S1 is correct. For the remaining 40 trials, S2 is correct. Optimal accuracy can be achieved by the adoption of a win-stay/lose shift strategy: Choose S1 until it stops being correct, then choose S2. In a typical MSR task, one peck is required to either stimulus. Even after considerable training on the MSR task, pigeons choose S2 before the reversal (making anticipatory errors) and continue to choose S1 (making perseverative errors) after the reversal.We hypothesized that interference between choice of S1 and S2 is responsible for many of the errors. We tested this hypothesis, by increasing the response requirement to S2 from 1 to 10 pecks This change virtually eliminated anticipatory errors while not introducing a greater number of perseverative errors. Thus, paradoxically, increasing the effort to obtain reinforcement when selecting S2 improved accuracy on the midsession reversal. By increasing the effort to select S2, the pigeons were encouraged to use the absence of reinforcement for incorrect choice of S1 as the basis for choice of S2.

Effects of Decreased Reinforcement on Pigeons Performance on Midsession Reversal Task
Daniel Peng, Danielle M. Andrews, & Thomas R. Zentall (University Of Kentucky)

P73 The midsession reversal task involves a simultaneous discrimination between 2 stimuli (S1 and S2) in which, choice of S1 is reinforced in the first half of each session, followed by choice of S2 in the second half of the session. With this task, even after considerable sessions of training, subjects continue to make anticipatory errors prior to the reversal and perseverative errors following the reversal. In the present research, we tested the hypothesis that reversal accuracy would improve by devaluing correct choice of S2. Correct choice of S1 was reinforced 100% of the time, whereas correct choice of S2 was reinforced only 20% of the time. The effect of this manipulation was to reduce anticipatory errors but not increase perseverative errors. We believe that, discrimination reversal errors were reduced by encouraging the pigeons to avoid using the feedback from choice of S2, and to rely solely on feedback from choice of S1. The results have implications for attentional theories of reversal learning, as well as reducing the pigeons' tendency to time the occurrence of the reversal.

Do human screams permit individual recognition?

Jonathan Engelberg, Jay Schwartz, & Harold Gouzoules (Emory University)

P74 The recognition of individuals through vocalizations is a highly adaptive ability in the social behavior of many species, including humans. Numerous studies have suggested that nonhuman primates recognize individuals from their screams, but the extent to which screams enable individual recognition in humans remains unclear. Using a same-different vocalizer discrimination task, we investigated participants' ability to correctly identify whether pairs of screams were produced by the same person or two different people, a critical prerequisite to individual recognition. Despite prior theory-based contentions that screams are not acoustically well-suited to conveying identity cues, listeners discriminated individuals at above-chance levels by their screams, including both acoustically modified and unmodified exemplars. We found that vocalizer gender as well as a factor associated with participants' experience with screams explained some variation in participant performance. We additionally conducted a post hoc investigation of selected acoustic features (namely, biphonations and harmonic regime), and found that they did not play a statistically significant role in listeners' perceptions. Our findings are consistent with evidence from nonhuman primates, suggesting that both human and nonhuman screams convey cues to caller identity, thus supporting the thesis of evolutionary continuity in at least some aspects of scream function across primate species.

Index

Last Name	First Name	Presentations	Affiliation	E-mail
Acerbo	Martin	P60	Iowa State University	
Adamczyk	Markie	P54	Georgia State University	madamczyk1@student.gsu.edu
Adams	Ann	P8	Converse College	atabbott001@converse.edu
Agrillo	Christian	42	University of Padova (Italy)	
Allen	Colin	P14	University of Pittsburgh	
Ali	Nafisah	P71	Dalhousie University	
Amodio	Piero	71	University of Cambridge	
Andrews	Danielle	P37, P73	University Of Kentucky	
Andrews	Kristin		York University	andrewsk@yorku.ca
Antoun	Angelle		Tufts University	angelle.antoun@tufts.edu
Ashfaq	Mahwish	25, 70	Brooklyn College – CUNY, City University of New York	
Athanassiades	Kate	9	Emory University	
Austin	Bridget	14	Villanova University	
Azaah	Afia	P23	St. Francis College/Center for the Study of Pinniped Ecology & Cognition	
Balboa	Nora	53	Drake University	
Ball	Gregory	P6	University of Maryland College Park	
Barord	G.J.	70	City University of NY. Graduate Center and Brooklyn College-CUNY	
Barrett	Lisa	23	University of Wyoming	lisapbarrett.lpb@gmail.com
Basil	Jennifer	25, 60, 70	CUNY Brooklyn College	ptolemeia@gmail.com
Bauer	Gordon		New College of Florida	bauer@ncf.edu
Baum	Erin	P50, P68	Georgia Southern University	
Bayne	Erin	45	University of Alberta	
Beardsworth	Christine	52	University of Exeter	
Beckley	Danielle	P60	Drake University	
Belio	Michelle		Hunter College	michelledogtrainingnyc@gmail.com
Bell	Zebulon	49, P55	Oakland University	zkbell@oakland.edu
Bennett	Angel	P46, P47	University of North Carolina Wilmington	
Bennett	Pauleen	8	La Trobe University	
Benson-Amram	Sarah	23	University of Wyoming	
Beran	Michael	P1, P11, P53, P57, P62, P64	Georgia State University	
Bern	Alex	P7	Georgia Southern University	ab13879@georgiasouthern.edu
Berns	Gregory	9	Emory University	
Bidel	Flavie	73	Silberman Institute of Life Sciences Hebrew University (Israel)	
Bingman	Verner	56, P60	Bowling Green State University	
Biolsi	Kristy	P23, P24	C-SPEC; St. Francis College	kbiolsi@sfc.edu
Blackburn	Nick	P47	University of North Carolina Wilmington	

Bleckmann	Horst		University of Bonn	Bleckmann@uni-bonn.de
Bodily	Kent	P7, P50, P68	Georgia Southern University	
Boeckle	Markus	71	University of Cambridge	
Bolton	Teri	20	Roatan Institute for Marine Sciences	
Bond	Sara		Georgia Southern University	sb09114@georgiasouthern.edu
Bonsack	Brooke		University of South Florida	Bbonsack@mail.usf.edu
Borchardt	Amanda		RA	dis445566@gmail.com
Borowski	Karen	77	Texas Christian University	
Borrego	Natalia	P22	The American University of Cairo	
Botero	Maria	P30	Sam Houston State University	
Bowden	Maisy	P29	Georgia State University	mbowden4@student.gsu.edu
Brady	Ryan	33, P70	Emory University; Yerkes National Primate Research Center	
Brand	Stephanie		Florida Institute of Technology	stephaniewathen@gmail.com
Bray	Emily	7, 12	University of Arizona	
Brennan	Caroline	44	Queen Mary University of London.	
Brien	Will	P71	Dalhousie University	
Broadway	Megan	13, 22	University of Louisiana at Monroe	megan.s.broadway@gmail.com
Brock	Alistair	44	Queen Mary University of London	
Brodbeck	Dave		Algoma University	dave.brodbeck@algomau.ca
Brodbeck	Madeleine	56	University of Western Ontario	mbrodbec@uwo.ca
Brodin	Anders	81	Lund University	anders.brodin@biol.lu.se
Brosnan	Sarah	P62	Georgia State University	
Brown	Alexander	14	Lafayette College	
Brown	Emily	34, 35	Emory University	emily.brown@emory.edu
Brown	Michael	14, P5	Villanova University	michael.brown@villanova.edu
Brubaker	Kimberly Brubaker		Student	kabrubak@eckerd.edu
Bruce	Kate	P46, P47	University of North Carolina Wilmington	bruce@uncw.edu
Bruck	Jason	P63	Oklahoma State University	
Buchbinder	Ahuva	60	BCR Laboratory Brooklyn College CUNY and the LIBE Laboratory Brooklyn College CUNY	
Buchsbaum	Daphna	4, 28, P27	University of Toronto	
Buggs	Hannah	P9	Georgia College	hannah.buggs@bobcats.gcsu.edu
Burke	Kali	P34	University at Buffalo, SUNY	kaliburk@buffalo.edu
Busch-Nentwich	Elisabeth	44	Wellcome Trust Sanger Institute	
Butcher	Greg	P25	Thiel College	
Byosiere	Sarah-Elizabeth	8	La Trobe University/Hunter College	
Cai	Huaizhen	P35	SUNY at Buffalo	huaizhen@buffalo.edu
Calvillo	Elyssia	P47	University of North Carolina Wilmington	
Campbell	Ashley	P46	University of North Carolina Wilmington	

Campbell	Kimberley	16, 18, 45, 47, P65	University of Alberta	ki6@ualberta.ca
Case	Jacob	P37	University of Kentucky	
Castro	Leyre	67	University of Iowa	
Chang	Shereen	17	University of Pennsylvania	
Chapman	Kate	P48	University of Arkansas	kmc025@uark.edu
Charlton	Payton	P34	University at Buffalo, SUNY	paytonch@buffalo.edu
Chase	Sheila	P22	The City University of New York: Hunter College	
Cheng	Ken	59	Macquarie University Sydney	ken.cheng@mq.edu.au
Chenkin	Beatrice	1	University of Southern Mississippi	
Cheri	Breanna	P51	University of Manitoba	
Chhibber	Raveena	9	Emory University	
Chiu	Veronica	9	Emory University	
Chouinard	Philippe	8	La Trobe University	
Christopher	Jennie	22	University of South Alabama	
Church	Barbara	37, P29, P54	Georgia State University	
Claydon	Laura	53	Drake University	
Clayton	Nicola	71	University of Cambridge	
Cleland	Lauren	77	Texas Christian University	
Coffin	Claudia	P59	Converse College	cacoffin001@converse.edu
Congdon	Jenna	16, 18, 45, 47, 58, P65	University of Alberta	jcongdon@ualberta.ca
Cook	Robert	30, 31	Tufts University	
Cox	Emma	P32	Auburn University	
Cronin	Katherine	73	Animal Welfare Science Program Lincoln Park Zoo	
Cross	Fiona	57	University of Canterbury, New Zealand	fiona.r.cross@gmail.com
Crystal	Jonathon	40, P14	Indiana University	
Daley	Mark	P67	Western University London Ontario Canada	
Damphousse	Chelsey	P13	Wilfrid Laurier	damp7000@mylaurier.ca
Dankert	Annie	P4	Providence College	
Darmaillacq	Anne-Sophie	72	Eilat Campus	
Datuin	Eriel	P55	Oakland University	
Davila	Adam	14, P5, P26	Auburn University	aad0043@tigermail.auburn.edu
Davis	Mark	P25	Eckerd College	
Dayaw	Judith	P3	Providence College	
Dayaw	Katrina	P3	Providence College	
DeLong	Caroline	15, 24, P12, P40	Rochester Institute of Technology	cmdgsh@rit.edu
Deimeke	Moriah		New College of Florida	moriah.deimeke13@ncf.edu
Delamater	Andrew	75	Brooklyn College - CUNY	andrewd@brooklyn.cuny.edu
Dent	Michael	48, P34, P35	University at Buffalo SUNY	
Deshpande	Gopikrishna	P26	Auburn University	
Desire-Brisard	Tatyana	P34	BioMimetic and Cognitive Robotics Lab	

Desjardins	Amy	10	Université de Moncton in Edmundston	
Dikkers	Haley	53	Drake University	
Dooling	Robert	P6	University of Maryland College Park	
Dorey	Nicole	P18, P35	University of Florida	
Dougherty	Liam	51	University of Liverpool	
Dowell	Jacob	P55	Oakland University	jrdowell@oakland.edu
Dudzinski	Kathleen	20	Dolphin Communication Project	
Dyer	Katherine	P36, P39, P49	Kent State University	
Edwards	Sophie	P67	University of St. Andrews (Scotland UK)	
Edwards	Vincent	P50, P68	Georgia Southern University	ve00770@georgiasouthern.edu
Eilam	David		Professor of Zoology	eilam@tauex.tau.ac.il
Eleazer	Jessica	P9	Georgia College & State University	jessica.eleazer@bobcats.gcsu.edu
Elliot	Cheyenne	77, P41	Texas Christian University	
Engelberg	Jonathan	P74	Emory University	jonathan.engelberg@emory.edu
Escobar	Martha	49, P55	Oakland University	marthaescobar@oakland.edu
Espinosa	Julia	4, P27	University of Toronto	j.espinosa@mail.utoronto.ca
Evans	Theodore	P64	Georgia Institute of Technology	
Farias	Kathryn	P47	University of North Carolina Wilmington	
Fastow	Chaya	25	Brooklyn College - City University of New York	
Fawcett	Tim	68	University of Exeter	
Fellner	Wendi		The Seas, Disney	wendi.fellner@disney.com
Felsche	Elisa	28	University of St. Andrews	
Fiori	Summer		Hunter College	summer.fiori34@myhunter.cuny.edu
Fiset	Sylvain	10	Université de Moncton in Edmundston	
Fishbein	Adam	P6	University of Maryland College Park	
Flessert	Molly	P57	Georgia State University	mollyflessert@gmail.com
Foerder	Preston	74	The University of Tennessee at Chattanooga	preston-foerder@utc.edu
Fountain	Stephen	P36, P39, P49	Kent State University	
Franzone	Roberto		Student Hunter College	robertofranzone@gmail.com
Freas	Cody	58	University of Alberta	freascody@gmail.com
French	Kristin	P53	Georgia State University	
Frick	Erin	P21	Georgia Southern University	efrick@georgiasouthern.edu
Friedrich	Viktoria		Eckerd College	vcfriedr@eckerd.edu
Frohnwieser	Anna	64	University of Cambridge	
Furlong	Ellen	11	Illinois Wesleyan University	
Gabriel	Kelly	14	Villanova University	
Galindo	Wilber	P69	University of Mary Washington	
Galizio	Mark	P46, P47	University of North Carolina Wilmington	

García-González	Judit	44	Queen Mary University of London	
Garr	Eric	75	Graduate Center of CUNY	
Gazes	Reggie	80	Bucknell University	reggie.gazes@bucknell.edu
Generoso	Dareen	P24	St. Francis College/ Center for the Study of Pinniped Ecology & Cognition	
Gilchrist	Rachel	3	Arizona State University	
Giordano	Dominick	P47	University of North Carolina Wilmington	
Gladysz	Gage	P25	Thiel College	
Gnanadesikan	Gitanjali	2, 7, 12	University of Arizona	gitag@email.arizona.edu
Goto	Kazuhiro	62	Sagami Women's University	kazuhiro.goto@gmail.com
Gouzoules	Harold	P74	Emory University	
Graham	Paul	59	University of Sussex	
Grasso	Frank	60, P15, P33	BCR Laboratory Brooklyn College CUNY and the LIBE Laboratory Brooklyn College CUNY	
Gray	Suzanne	30	Tufts University	suzanne.gray@tufts.edu
Guidone	Genevieve	P46, P47	University of North Carolina Wilmington	
Guillette	Lauren	51	University of Alberta	guillett@ualberta.ca
Hafeez	Faiza	P34, P35	SUNY University at Buffalo	faizahaf@buffalo.edu
Hahn	Allison	16, 45, 47, P65	St. Norbert College	
Halloran	Megan	P56	University of Kentucky	
Halter	Emma	P19	Northeastern University	
Hampton	Robert	32, 33, 34, 35, P70	Emory University	robert.hampton@emory.edu
Hanlon	Roger	72	Eliat Campus	
Hare	Brian	2	Duke University	
Hauber	Mark	54	University of Illinois, Urbana-Champaign	mhauber@illinois.edu
Healy	Susan	P67	University of St. Andrews (Scotland UK)	
Hebert	Connor	P46	University of North Carolina Wilmington	
Hecht	Erin		Duke Lemur Center	erin.hecht@duke.edu
Heimer-McGinn	Victoria	38, 39, P4	Providence College	
Herbranson	Walter	50	Whitman College	herbrawt@whitman.edu
Hicks	Chandler	P46	University of North Carolina Wilmington	
Highfill	Lauren	P25, P42	Eckerd College	highfile@eckerd.edu
Hill	Heather	27, P19	St. Mary's University	
Hochner	Benny	73	Silberman Institute of Life Sciences Hebrew University (Israel)	
Hoeschele	Marisa	19	Austrian Academy of Sciences	marisa.hoeschele@oeaw.ac.at
Holiman	Chase	P48	University of Arkansas	
Horschler	Daniel	7, 12, 26	University of Arizona	daniel.horschler@gmail.com

House	Dalton	P72	University of Kentucky	
Howard	Mary	74	The University of Tennessee at Chattanooga	
Howell	Tiffani	8	La Trobe University	
Huber	Ludwig	61, 64	Messerli Research Institute	
Hultsch	Henrike		Free University Berlin, Dept. Animal Behaviour	hultsch@zedat.fu-berlin.de
Idsardi	William	P6	University of Maryland College Park	
Isaacs	Ezra	60	BCR Laboratory Brooklyn College CUNY Brooklyn and the LIBE Laboratory Brooklyn College CUNY	
Izzo-McDonald	Nicole	P23	Center for the Study of Pinniped Ecology & Cognition/ Long Island Aquarium and Exhibition Center	
Jackman	Claire	P36, P39, P49	Kent State University	
Jackson	Brooke	37, P29, P54	Georgia State University	bjackson55@student.gsu.edu
Jackson	Robert	57	International Centre of Insect Physiology and Ecology (Kenya)	
Jacobson	Sarah	73	The Graduate Center of the City University of New York	
James	Brielle	P11	Georgia State University	
Jasmer	Jeremy	P50, P68	Georgia Southern University	
Jellison	Jenny		Waynesburg University	jjelliso@waynesburg.edu
Jett	Stephanie	P9	Georgia College & State University	stephanie.jett@gcsu.edu
Jimenez	Rhiannon	P12, P40	Rochester Institute of Technology	
Johnson	Jennifer	P38	Georgia State University	
Johnson	Laurissa	P28	Ripon College	
Johnston	Angie	P27	Yale University	angie.johnston@yale.edu
Jordan	Mackenzie	77	Texas Christian University	
Kacelnik	Alex	63	Oxford University	alex.kacelnik@zoo.ox.ac.uk
Kadak	Kevin	29	Wilfrid Laurier University	
Kalender	Courtney	53	Drake University	
Kaprio	Jaakko	44	University of Helsinki	
Kashetsky	Tovah	P71	Dalhousie University	
Katz	Jeffrey	P26, P32	Auburn University	
Keane	Joanna	P5	Villanova University	
Keeley	Shannon		Hunter College	shannon.keeley01@myhunter.cuny.edu
Kelly	Debbie	P51	University of Manitoba	
Kimura	Miku	62	Sagami Women's University	
King	Jon	9	Emory University	
King	Katherine	P28, P43	Ripon College	
King	Taylor	P66	Brandon University	
Kis	Anna	64	Hungarian Academy of Sciences	
Kobrina	Anastasiya	48, P34	University at Buffalo, SUNY	akobrina@buffalo.edu
Kovack-Lesh	Kristine	P28	Ripon College	
Krichbaum	Sarah	P26, P32	Auburn University	szk0138@auburn.edu

Kruschke	John	P14	Indiana University	
Kuan	Valerie	44	University College London	
Kundey	Shannon	P2	Hood College	kundey@hood.edu
Kwiatt	Anne	73	Lester E. Fisher Center for the Study and Conservation of Apes Lincoln Park Zoo	
LaBonte	Danielle	P18	University of Florida	
Laker	Pip	52	University of Exeter	
Langley	Ellis	52	University of Exeter	
Lauer	Amanda	P34	Johns Hopkins University School of Medicine	
Lazareva	Olga	53, P60	Drake University	olga.lazareva@drake.edu
Lazaro	Xenabeth	P35	University of Florida	
Lazarowski	Lucia		Auburn University	lzl0017@auburn.edu
Lea	Stephen	66	University of Exeter	s.e.g.lea@exeter.ac.uk
Leaver	Lisa	68	University of Exeter	l.a.leaver@exeter.ac.uk
Leising	Kenneth	77, P41	Texas Christian University	
Leonard	Kevin	P51	University of Manitoba	umleona4@myumanitoba.ca
Lewandowski	Naomi	25, 70	The Graduate Center and Brooklyn College - City University of New York	naomilewski@gmail.com
Lewis	Tabatha	22	University of South Alabama	
Lilley	Malin	27	The University of Southern Mississippi and Texas A&M University	
Lindemann-Biolsi	Kristy	P23, P24	St. Francis College/Center for the Study of Pinniped Ecology & Cognition	
Litchfield	Anna	P9	Georgia College & State University	anna.litchfield@bobcats.gcsu.edu
Lo	Ka Ho (Gordon)	5	Western University	klo228@uwo.ca
Lowe	Kelly	P46, P47	University of North Carolina Wilmington	
Lyn	Heidi	1, 13	University of South Alabama	heidilynphd@aol.com
MacDonald	Suzanne	P30	York University	suzmac@yorku.ca
MacDougall-Shackleton	Scott	56	The University of Western Ontario	
MacLean	Evan	2, 7, 12, 26	University of Arizona	
Macgregor	Riley	20	The University of Southern Mississippi	
Mackey	Angela		Kentucky Wesleyan College	angmack@gmail.com
Macpherson	Krista	P52	Western University	kmacphe3@uwo.ca
Madden	Joah	52	University of Exeter	
Makecha	Radhika	P25	University of Eastern Kentucky	
Malik	Zafrullah	P69	University of Mary Washington	
Mann	Dan	19	University of Vienna	
Manor	Julia	6, P43	Ripon College	
Marrone	Diano	P13	Wilfrid Laurier University	
Martin	Ines	P37	University of Kentucky	

Martin	R. Jeff	P67	Western University	
Martineau	Adrian	44	Barts and The London School of Medicine and Dentistry	
Marton	Sarah	P27	University of Toronto	
Mather	Jennifer	69	University of Lethbridge	
McKenzie	Tammy	P66	Brandon University	mckenziet@brandonu.ca
McLaren	Ian	66	University of Exeter	
Meier	Christina	66	University of Manitoba	meierchristina@aol.com
Mennill	Dan	P65	University of Windsor	
Meyers-Manor	Julia	P28	Ripon College	
Mia	Ana	73	Department of Neurobiology Silberman Institute of Life Sciences Hebrew University Jerusalem Israel	
Micale	Melissa	P43	Ripon College	
Miles	Darren	P50, P68	Georgia Southern University	
Miles	Luke	P56	University of Kentucky	
Miller	Lauren		Moody Gardens	miller.lauren.e@gmail.com
Miller	Christopher	68	University of Exeter	
Miller	Noam	29, P13, P58	Wilfrid Laurier University	nmiller@wlu.ca
Miller	Ralph	79	State University of New York at Binghamton	rmiller@binghamton.edu
Mischler	Shannon	16, 18, P65	University of Alberta	
Montero	Sasha		Hunter College	smontero@ucdavis.edu
Montenegro	Carolina	16, 18, P65	University of Alberta	cmontene@ualberta.ca
Moreno	Kelsey	20	Tel Aviv University	
Morrison	Evan	15, 24, P12, P40	Rochester Institute of Technology	e.morrison@mail.rit.edu
Morrison	Matthew	P14	Indiana University	
Mueller	Peyton	P31	Coastal Carolina University	
Mulsow	Jason	13	National Marine Mammal Foundation	
Murphy	Matthew	P16, P31	Coastal Carolina University	
Murphy	Mary	P9	Georgia College & State University	
Murray	John	64	University of Hull	
Navarro	Victor	76, P61	The University of Iowa	victor-navarro@uiowa.edu
Neal	Amanda	P24	St. Francis College/ Center for the Study of Pinniped Ecology & Cognition	
Nesher	Nir	73	Ruppin Academic Center School of Marine Sciences (Israel)	
Nichols	Steven	P7	Georgia Southern University	
Nordman	Abigail	53	Drake University	
O'Connor	Victoria	P22	CUNY: Hunter College	Victoria.Oconnor73@myhunter.cuny.edu
O'Donoghue	Ellen	P20	University of Iowa	
Oimoen	Maggie	P28	Ripon College	
Ojeda	Andrés	63	University of Oxford	
Otter	Ken	P65	University of Northern British Columbia	
Pagel	Regina		student	reginampagel@gmail.com

Palviainen	Teemu	44	University of Helsinki	
Panoz-Brown	Danielle	40	Indiana University	
Papadopoulos	Dennis	21	York University	d.v.papadopoulos@gmail.com
Paparo	Candyce	P23, P24	Center for the Study of Pinniped Ecology & Cognition/ Long Island Aquarium and Exhibition Center	
Parker	Matthew	44	University of Portsmouth	
Parker	Scott	P16	Coastal Carolina University	
Parrish	Audrey	P1, P10	The Citadel	audrey.parrish@citadel.edu
Payne	Brighton	78	University of Mary Washington	
Paz-Gonzalez	Loren	14	Villanova University	
Pelgrim	Madeline	P27	University of Toronto	madeline.pelgrim@mail.utoronto.ca
Peng	Daniel	P56, P73	University of Kentucky	Dnpe224@g.uky.edu
Petrazzini	Maria	43	Queen Mary University of London	
Phillips	Mitchell	P2	Hood College	
Phillmore	Leslie	P71	Dalhousie University	leslie.phillmore@dal.ca
Pickens	Laura		Thiel College	lpickens@thiel.edu
Pike	Thomas	64	University of Lincoln	
Plowes	Nicola	58	University of Alberta	
Pluck	Ryan	P12	Rochester Institute of Technology	Rxp3357@rit.edu
Pogatetz	Kelsey	P60	Drake University	
Poindexter	Jaleesa		Student	jbpoinde@eckerd.edu
Polack	Cody	79	State University of New York at Binghamton	
Popp	Nathan	P9	Georgia College & State University	
Prior	Nora	P6	University of Maryland College Park	
Proctor	Darby	P45	Florida Institute of Tchnology	Dproctor@fit.edu
Przystawik	Kristina	P22	ZooTampa at Lowry Park	kprzystawik@mail.usf.edu
Pytka	Lisa		University of Rochester	Lisa.Pytka@gmail.com
Puitiza	Amanda		Hunter College	amanda.puitiza@macaulay.cuny.edu
Pulido	Adrianna		school	ampulido@eckerd.edu
Pytka	Lisa		University of Rochester	Lisa.Pytka@gmail.com
Qadri	Muhammad	30, 31	Tufts University	
Quaies	Chelsea	25	Brooklyn College - City Unniversity of New York	
Rachfal	Trisha	15, P12, P40	Rochester Institute of Technology	
Riley	Rachael		National Park Service	rachaeljriley@gmail.com
Rivera	Mica	P43	Ripon College	
Roberts	William	5, P52	Western University	
Rodriguez	Amanda		Hunter College of the City University of New York	amanda.rodriguez49@myhunter.cuny.edu
Rogers	Bart	P32	Auburn University	
Ross	Stephen	73	Lester E. Fisher Center for the Study and Conservation of Apes Lincoln Park Zoo	
Ryan	Catriona	65	University of Exeter	lurchers@blueyonder.co.uk
Salatiel	Isadora	P45	Florida Institute of Technology	

Salobir	Kaja	61	Messerli Research Institute	
Sanchez	Mar	46	Emory University	
Santacà	Maria	42	University of Padova (Italy)	
Santos	Laurie	11, 26	Yale University	
Schluessel	Vera	41	University of Bonn	v.schluessel@uni-bonn.de
Schnell	Alexandra	71	University of Cambridge	alex.k.schnell@gmail.com
Schrode	Katrina	P34	Johns Hopkins University School of Medicine	
Schwartz	Jay	46, P74	Emory University	jwschwa@emory.edu
Schwarz	Sebastian	59	Université Paul Sabatier	
Screven	Laurel	P34	Johns Hopkins University School of Medicine	
Scully	Erin	16, 18, 45, 47, P65	University of Alberta	
Seed	Amanda	28	University of St. Andrews	
Sepehri	Parisa	P51	University of Manitoba	
Service	William	16, 18, P65	University of Alberta	
Sharp	Jessica	P36, P39, P49	Kent State University	
Shashar	Nadav	72	Eilat Campus	
Shaw	Carmen	P29, P54	Emory University	
Shaw	Jonathan	P46	University of North Carolina Wilmington	
Sherry	David	34, 35, P67	Western Univsersity	
Shomrat	Tal	73	Ruppin Academic Center School of Marine Sciences (Israel)	
Shoot	Tanya	P67	Western University	tshoot@uwo.ca
Showalter	Rebecca	P9	Georgia Military College	
Silver	Zachary	11	Yale University	zachary.silver@yale.edu
Skinner	Morgan	P58	Wilfrid Laurier University	skin4450@mylaurier.ca
Sluka	Christina	P14	Indiana University	cmsluka@gmail.com
Smith-Peters	William	P34	University at Buffalo SUNY	
Smith	Austin	P50, P68	Georgia Southern University	
Smith	J. David	36, 37, P29, P54	Georgia State University	jsmith395@gsu.edu
Soares	Paola	P64	Federal Rural University of Amazonia	pcsoares1988@gmail.com
Soni	Riddhi	53	Drake University	
Southern	Robert	P50, P68	Georgia Southern University	
Spetch	Marcia	58	University of Alberta	mspetch@ualberta.ca
Spiotta	Michael		CUNY Hunter College	MSpiotta3@gmail.com
Stack	Aaron		University of Central Florida	aaron.stack@knights.ucf.edu
Stagner	Jessica	P50, P68	Georgia Southern University	
Stahlman	W. David	77, 78, P69	University of Mary Washington	wdstahlm@umw.edu
Stebbins	Hilary	78	University of Mary Washington	
Stern-Mentch	Naama	73	Silberman Institute of Life Sciences Hebrew University (Israel)	
Stevens	Paige	P63	Oklahoma State University	paige.elise.stevens@okstate.edu
Strang	Caroline	34, 35	Western University	Cstrang@uwo.ca

Strassberg	Lily	P26, P32	Auburn University	lrs0041@auburn.edu
Strieter	Ian	P15	CUNY Graduate Center	istrieter@gradcenter.cuny.edu
Stromberg	Erin	P1	Smithsonian's National Zoo	
Sturdy	Christopher	16, 18, 45, 47, P65	University of Alberta	csturdy@ualberta.ca
Sturz	Bradley	49	Georgia Southern University	
Sudwarts	Ari	44	Queen Mary University of London	
Sulzbach	Shona	P10	The Citadel	
Syed	Wajeh	25	Brooklyn College - City University of New York	
Tecwyn	Emma	P27	Birmingham City University	
Teh	Muy-Teck	44	Barts and The London School of Medicine and Dentistry	
Templer	Victoria	38, 39, P3, P4	Providence College	vtempler@providence.edu
Thomas	Patrick	P22	WCS: Vice President & General Curator Bronx Zoo Associate Director	
Thorner	Hannah	P34	University at Buffalo	hlthorne@buffalo.edu
Tiedeman	Samantha	P69	University of Mary Washington	
Tinklenberg	Brandon	55	York University	
Tomeo	Olivia	P62	Georgia State University	
Troise	Richard	60	BCR Lab/Brooklyn College CUNY	rtroise89@gmail.com
Tsang	Christine	P71	Huron University College	
Tu	Norman	75	Brooklyn College - CUNY	
Vallely	Noelle	P59	Converse College	nvvallely001@converse.edu
Van Bourg	Joshua	3	Arizona State University	jvanbour@asu.edu
Van Horik	Jayden	52	University of Exeter	
Varnon	Christopher	P8, P59	Converse College	christopher.varnon@converse.edu
Vera	Robert	P4	Providence College	
Vincent	Joy	P42, P22	Eckerd College	jlvincen@eckerd.edu
Voelter	Christoph	28	University of St. Andrews	
Volz	Stephen	60	BCR Laboratory Brooklyn College CUNY and the LIBE Laboratory Brooklyn College CUNY	
Vyazovska	Olga	P61	V.N. Karazin Kharkiv National University	
Waggoner	Paul	P26, P32	Auburn University	
Wagner	Thomas	P46	University of North Carolina Wilmington	
Walton	Robert	44	Barts and The London School of Medicine and Dentistry	
Wantje	MacKenzie	P47	University of North Carolina Wilmington	maw2748@uncw.edu
Washburn	David	P17, P38, P64	Georgia State University	
Wasserman	Edward	67, 76, P20, P61	University of Iowa	ed-wasserman@uiowa.edu
Watts	Kara	P45	Florida Institute of Technology	kwatts2017@my.fit.edu
Webberson	Emily	P69	University of Mary Washington	
Wegman	Jessica	15, P12, P40	Rochester Institute of Technology	jjw5884@rit.edu

Westrick	Nicole	P46, P47	University of North Carolina Wilmington	
Whiteside	Mark	52	University of Exeter	
Whitham	Will	P17, P64	Georgia State University	
Wilcox	Kenneth	15	University of Notre Dame	
Wilkinson	Anna	64	University of Lincoln	awilkinson@lincoln.ac.uk
Willgohs	Kaitlyn	P22	Eckerd College	
Wilson	Mark	46	Emory University	
Wise	Taylor	38, 39, P3, P4	Brown University	taylor_wise@brown.edu
Witthuhn	Leah		Carroll University	lwitthuh@pio.carrollu.edu
Wolf	Joshua	P41	Carroll University	
Wolff	Bobbie	P46	University of North Carolina Wilmington	
Woo	Kevin	P24	SUNY Empire State College/ Center for the Study of Pinniped Ecology & Cognition	
Worster	Daniana	P9	Georgia College and State University	
Wright	Anthony		University of Texas Medical school at Houston	anthony.a.wright@uth.tmc.edu
Wright	Catina	P12, P40	Seneca Park Zoo	
Wynne	Clive	3	Arizona State University	
Wystrach	Antoine	59	Université Paul Sabatier	
Yang	Ling	25	Brooklyn College - City University of New York	
Yeater	Deirdre	P19	Sacred Heart University	
Yeo	Matilda	68	University of Exeter	
Yip	Daniel	45	University of Alberta	
Youker	Evan	P25	Thiel College	
Yuan	Songyi	56	The University of Western Ontario	
Zapetis	Maria	13	University of Southern Mississippi & National Marine Mammal Foundation	zapetism@gmail.com
Zentall	Thomas	P37, P56, P72, P73	University of Kentucky	
Zhu	Wenying	P70	Emory University	wenying.zhu@emory.edu

In Honor of the Research Contributions by Marcia L. Spetch

COMPARATIVE COGNITION & BEHAVIOR REVIEWS

Volume 14

Co-Editors: Anna Wilkinson & Marcia Spetch

http://comparative-cognition-and-behavior-reviews.org

Follow us on social media: Twitter at @CCBRjournal and also on Facebook