21st Annual International Conference On Comparative Cognition

Sponsored by the Comparative Cognition Society

March 26th to March 29th, 2014

Radisson Hotel

Melbourne Beach, Florida

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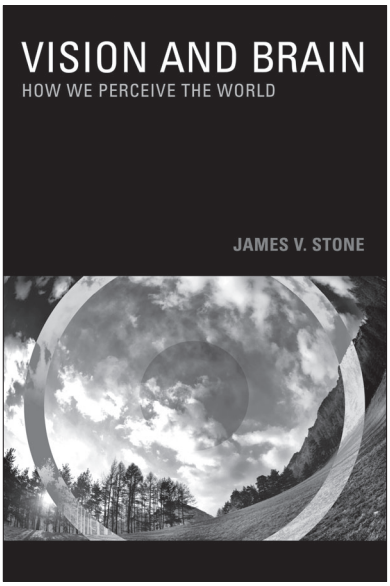

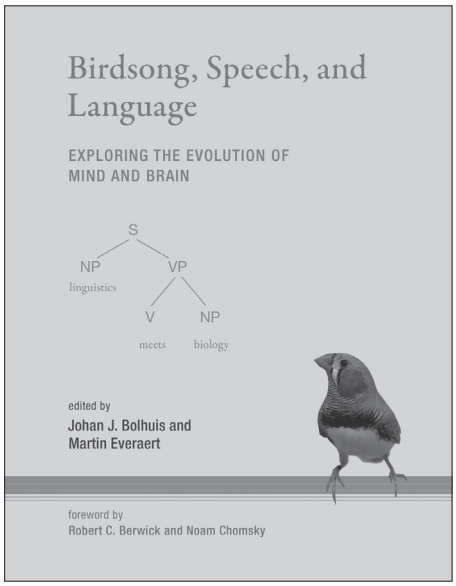

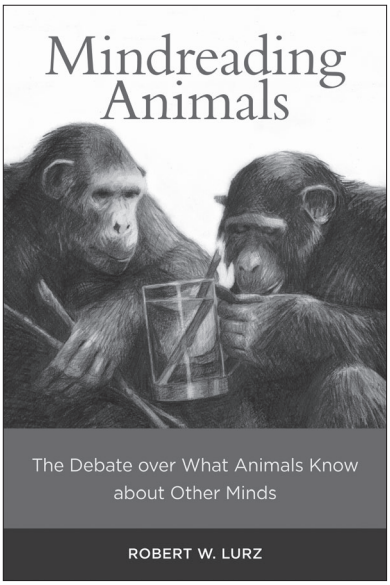

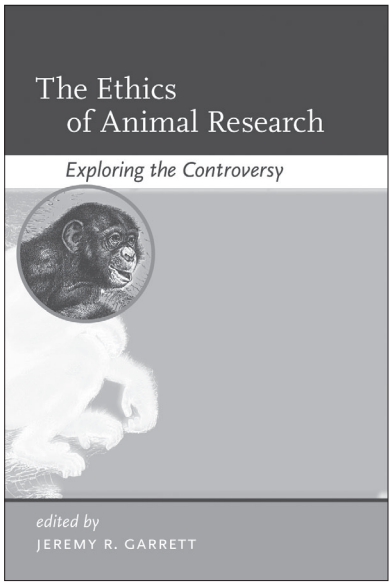

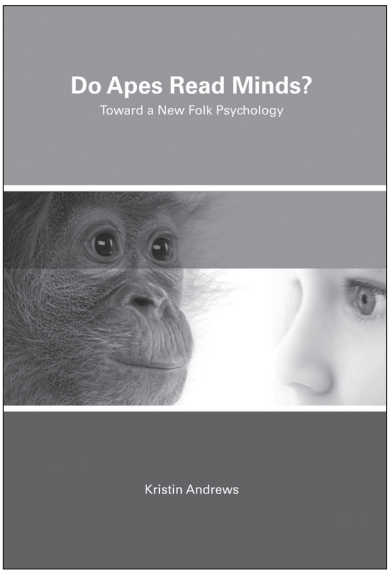

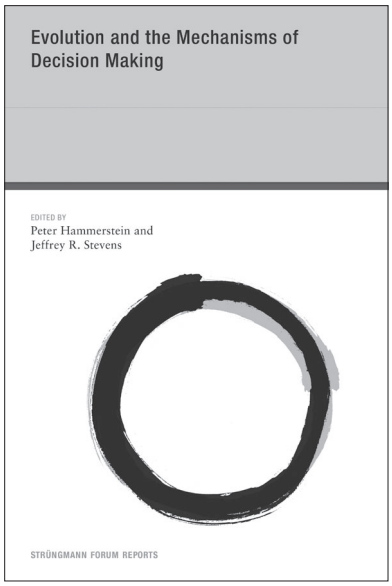

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PROGRAM NOTE: Five minute talks are designated by a Talk Number with a grey background. They are five minutes in duration followed by two minutes for discussion. Ten minute talks are designated by a Talk Number with a white background. They are ten minutes in duration followed by four minutes for discussion. Posters with a black boarder are in competition for the Best Graduate Student Poster award.

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Wednesday Afternoon

3:30 PM Welcome Reception and Check-In

7:00 PM Opening Remarks (Jeff Katz)

7:05 PM Tool-Use and Problem Solving (Chair: Jeff Katz)

1

7:05 PM **Grey squirrels show efficient problem solving requires flexible change of tactics**

Pizza Ka Yee Chow, Lisa Leaver, & Stephen Lea (University of Exeter UK)

Persistence has been found to be crucial to problem solving success. However, time costs are greater when an individual persistently employs ineffective tactics. Therefore, there is an underlying need to be flexible as well as persistent in order to maximise the gain (solving the problem) and/or minimise the loss (time spent on solving the problem). This is especially the case for caching animals such as grey squirrels (*Sciurus carolinensis*) that respond to conspecifics as competitors. We investigated the role of persistence and flexibility in tactics used to tackle a problem through giving five grey squirrels a problem solving task in laboratory. The task required squirrels to pull or push levers to obtain out-of-reach but visible hazelnuts. We found that persistence, measured as the number of attempts to solve the task, is not sufficient to predict problem solving success. Instead, the number of changes between tactics employed is the key to solve problem efficiently. These results further implied that being flexible to change might bring adaptive significance for caching animals as flexibility allows them to change their food protection tactics readily when they encounter different social challenges.

2

7:12 PM **A sea otter's use of a novel tool**

Pepper Hanna, Erin Frick (University of Southern Mississippi), Nicole Hardy (Audubon Aquarium of the Americas), & Stan Kuczaj (University of Southern Mississippi)

Wild sea otters use tools to open shells, but little is known concerning the flexibility of this ability. The present study used a tool choice paradigm in which an otter was presented with two identical tools. For each trial, only one tool was positioned such that pulling it allowed the otter to obtain food. Pulling the other hook resulted in the correct hook being moved out of reach, necessitating that the otter select the correct tool as its first choice. The otter performed at chance levels (40% correct). However, we suspect that her poor performance reflected her interest in playing with the apparatus. During early trials, she was more likely to choose correctly and obtain the food. But she became increasingly interested in breaking the apparatus in order to play with its parts. During one trial, she left and then returned with a plastic tire that she used to hit the wall separating her and the tools. It appeared that she was using the tire as a tool in an attempt to “break down” the barrier that was preventing her from reaching the objects, although it is possible that she was simply hitting the wall out of frustration.

3

7:19 PM **When do dolphins cooperate?**

Kelley Winship (University of Southern Mississippi), Holli Eskelinen (Dolphins Plus), & Stan Kuczaj (University of Southern Mississippi)

Wild dolphins appear to cooperate on some occasions while foraging and playing. In addition, male dolphins may cooperate to both obtain mating opportunities and deny these opportunities for other males. However, it is difficult to determine the origins and nature of these cooperative efforts. Moreover, it has proven difficult to demonstrate cooperative behavior in problem solving situations with captive dolphins. We provided three different groups of captive dolphins the opportunity to cooperate in order to open a container filled with fish, gelatin, and ice. The animals were not trained to cooperate, although some of the dolphins were trained to open the container in a context in which it was possible for only a single dolphin to open it. However, the two males that engaged in the most cooperative behavior had no prior training or experience with the techniques needed to open the apparatus. Our results demonstrate that captive dolphins can cooperate to solve an artificial problem, but also suggest that individual differences (including personality characteristics) and social relationships play important roles in cooperative behavior (or the lack of the same).

7:26 PM *Break*

7:31 PM Perception (Chair: Roger Thompson)

4

7:31 PM **Spatial frequency reliance in the lateral and frontal visual fields in pigeons (*Columba livia*)**

Matthew S. Murphy, & Robert G. Cook (Tufts University)

Pigeons predominantly rely on local cues when processing visual scenes and images, and we have shown that they predominantly rely on high spatial frequencies in item-specific memory tasks with pictorial stimuli. Pigeons have two distinct visual pathways for the frontal and lateral visual fields, which are preferentially used for different tasks. Here, we tested spatial frequency reliance within these two pathways, and results will be discussed from a cognitive and ecological perspective.

5

7:38 PM **Zöllner illusion in rhesus monkeys (*Macaca mulatta*)**

Christian Agrillo (University of Padova, Italy), Audrey E. Parrish, & Michael J. Beran (Georgia State University , USA)

The study of visual perception represents one of the research areas that have made substantial progress in comparative psychology during the last decade. In humans, the Zöllner illusion occurs when two parallel lines appear to be convergent when oblique crosshatching lines are superimposed. Two studies suggest that birds see this illusion in the opposite direction from humans. To date, it is unclear whether these results reflect a peculiarity of birds' visual system or instead reflect a wider phenomenon shared among non-human species. Here we trained six rhesus monkeys to select the narrower of two gaps at the end of two convergent lines. Three different conditions were presented: Control (no crosshatches), Perpendicular (crosshatches not inducing the illusion in humans) and Zöllner (crosshatches inducing the illusion to humans). Once monkeys reached the learning criterion with easy discriminations (from 15 to 12° degrees of convergence), they received harder trials (11-1°), including parallel lines (0°). The results showed that monkeys perceived the Zöllner illusion in the same direction of humans. Comparison of these data to the data from bird studies suggests the existence of different orientation-tuned mechanisms between monkeys and birds.

6

7:52 PM **Sensory processes, psychophysics, and manatee conservation**

Gordon B. Bauer (New College of Florida), Roger L. Reep (University of Florida College of Veterinary Medicine), Joseph C. Gaspard III (Mote Marine Laboratory), & David A. Mann (Loggerhead Instruments)

The primary food source of endangered Florida manatees (*Trichechus manatus latirostris*), light-dependent vegetation, concentrates them in shallow water areas where they are vulnerable to human-related dangers such as boats, water control structures, and fisheries gear. For example, thirty-one percent of all manatee deaths in the period from 1976-2000 were attributable to human-related causes. The Florida Manatee Recovery Plan recognized the possibility that casualties caused by human activities can be reduced through an understanding of how manatees sense their environment and in some cases fail to sense it. To address the Recovery Plan sensory objectives, we have investigated vision, audition, and mechanoreception in a controlled laboratory environment, as well as neurophysiologically, to discover features sensible to manatees. Manatees are tactile/auditory specialists with limited visual acuity, a pattern consistent with the frequently turbid underwater environment of these herbivores. To test the hypothesis that watercraft-related manatee deaths and injuries appear to be critically related to auditory limitations, we conducted psychophysical investigations of manatee frequency thresholds, critical ratios, temporal processing rates, and sound localization. These studies indicate that manatees should be able to hear and localize boats in many parts of their habitat, a conclusion important for managing watercraft.

7

8:06 PM **Pigeons are less sensitive to differences in speed of motion than to differences in size**

Olga F. Lazareva (Drake University)

Recent reports suggest that pigeons are highly sensitive to speed of motion (Cook, Beale, Koban, 2011; Herbranson, Fremouw, & Shimp, 2002). In contrast, we found that pigeons required more extensive training to learn motion discrimination than size discrimination (Lazareva, Young, & Wasserman, in press). However, our results were based on a comparison of two experiments conducted in different laboratories, complicating the interpretation of the data. Here, we trained pigeons to perform size discrimination or speed discrimination in a two-alternative simultaneous discrimination task using within-subject design. All birds acquired size discrimination much faster than speed discrimination, confirming our prior report. We further explored pigeons' sensitivity to differences in speed and size by training them to discriminate two end-point stimuli (e.g., a 30-px circle and a 90-px circle) in a two-alternative forced-choice task and then presenting a wide range of testing stimuli located between the training end-point stimuli. The results again indicated weaker control by the differences in speed in comparison to size. Comparative data using human subjects will be presented.

8:20 PM

No evidence for distinct visual short-term memory systems in pigeons

John Magnotti (UT Medical School at Houston), & Jeffrey Katz (Auburn University)

8

Visual short-term memory (VSTM) is critical to the daily functioning of most animals. Early studies of visual change detection suggested that human VSTM is comprised of two subsystems: a brief (less than 50ms) and volatile (susceptible to masking) iconic system with high capacity and a longer lasting, more durable, working memory system with sharp limitations on storage. Comparative VSTM work has focused on the working memory system, being careful to avoid any influence of the iconic system, although the existence of separate VSTM systems in nonhuman species is not firmly established. We adapted a yes/no change detection procedure used previously to demonstrate iconic memory effects in humans. We tested pigeon memory across a range of probe delays (0ms, 100ms, and 1000ms), display sizes (1, 2, and 3), and with/without a mask. If pigeons employ iconic memory, there should be no effect of display size at the 0ms probe delay and the mask should severely disrupt performance at higher display sizes. In contrast, pigeon VSTM was durable (no effect of masking) and showed typical delay-dependent memory performance rather than a sharp decrease from 0ms to 100ms. These results provide negative evidence for the existence of separate memory systems in pigeons.

8:34 PM

Comparative studies on motion perception in pigeons and humans with a visual search paradigm

Noriyuki Nakamura, & Masako Jitsumori (Chiba University)

9

Two visual search studies compared motion perception between pigeons and humans. The first study tested subjects to search for a single static icon among identical icons that made small random movements in the same direction (coherent motion) or in different directions (incoherent motion). The human results showed that search slope was near zero (parallel search) with coherently moving distractors while reaction times increased as a function of display size (serial search) with incoherently moving distractors. Conversely, the pigeon results showed that reaction times increased as a function of display size regardless of the distractors' motion, with the search slope shallower for incoherently than coherently moving distractors. The second study examined whether pigeons demonstrated a search asymmetry between expansion and contraction targets, using a rotating logarithmic spiral pattern that induces illusory expansion and contraction in humans without changes in the pattern's physical size. Search for a single expanding spiral among contracting ones was easier (reaction times were shorter) than search for a single contracting spiral among expanding ones in pigeons and humans. These results suggest that both pigeons and humans have developed their perceptual ability to detect objects' motion, but there are some species differences in perceptual systems underlying motion perception.

Thursday Afternoon

12:00 PM Graduate Award Competition (Chair: Chris Sturdy)

10

12:00 PM **In-air and underwater hearing in a long-tailed duck**

Sara C. Therrien, Sally E. Yannuzzi (University of Maryland), & Alicia M. Wells-Berlin (USGS Patuxent Wildlife Research Center)

Hearing tests on a long-tailed duck (*Clangula hyemalis*) suggest sensitive underwater hearing. The long-tailed duck has been recorded diving to depths greater than 100 m, making it the deepest diving species of duck. However, underwater hearing has not previously been measured in any species of bird. Psychoacoustics and the auditory brainstem response were used to measure hearing in this species in the air and underwater. All tests reveal a peak sensitivity from 2000-3000 Hz, with a steep high-frequency roll off above 4000 Hz, and a more gradual low-frequency roll off below 1000 Hz. The in-air auditory brainstem response thresholds were higher than the in-air psychoacoustic thresholds by up to 30 dB, but were still a good approximation of the U-shaped audiogram. Underwater psychoacoustic tests show sensitive hearing, which may suggest that diving birds could be susceptible to impacts from anthropogenic noise sources in aquatic environments.

11

12:07 PM **Perception of male and female song by black-capped chickadees**

Allison H. Hahn, & Christopher B. Sturdy (University of Alberta)

Black-capped chickadees are songbirds that produce a tonal two-note *fee-bee* song. Similar to many temperate species, male song has been well studied, while female song has not. Previously, we reported that females produce song with a greater frequency decrease in the *fee* note, but with similar amplitude to male song. Here we trained birds on a go/no-go operant discrimination task to respond to either male or female songs. Following acquisition training, birds were presented with manipulated songs that contained either two male-produced notes, two female-produced notes, or one note produced by each sex. Birds responded significantly more to manipulated stimuli that contained two S+ associated notes compared to two S- associated notes (e.g., male *fee* and *bee* notes for birds in Male Song S+ group). When presented with stimuli that contained one note produced by each sex (e.g., female *fee* and male *bee*), male birds responded more to S+ associated *fee* notes, while female birds responded more to S+ associated *bee* notes, suggesting that males and females may attend to different acoustic cues within the song, with males attending preferentially to the start and females to the end of the song.

12

12:14 PM **Birds are different from humans in global form perception mechanisms**

Muhammad A. Qadri, & Robert G. Cook (Tufts University)

Visual perception requires organisms to group information across space to derive coherent, global shape information. Using Glass patterns, previous research has shown that humans are more sensitive to circular than linear dot-generated, global forms, but contrastingly, pigeons are equally sensitive across these different global organizations. Whether this divergence is the result of class differences between birds and primates or unique to pigeons has not been investigated. Five starlings (*Sturnus vulgaris*) were tested in a choice task discriminating circular and linear, dotted, global form stimuli from random alternatives. Starlings were presented with two dot-pattern stimuli and made a choice by sitting on computer-sensitive perches. Results indicated that starlings perform equally effectively across these global forms, similar to pigeons. This outcome suggests that birds as a class have functionally different visual grouping mechanisms than those found in humans.

13

12:21 PM **Most dogs prefer food to petting, but context, familiarity, and schedule of reinforcement matter**

Erica N. Feuerbacher (University of Florida), & Clive D. L. Wynne (Arizona State University)

Despite dogs' long-standing relationship with humans, little is known about their preference for different human interactions. We assessed dogs' preference in a concurrent choice for food or petting as measured by their time allocation to each alternative. We thinned the schedule of food reinforcement across five 5-min sessions, from continuous down to extinction. We assessed five groups of dogs that varied in the familiarity of the context and the familiarity of the person providing petting. We tested shelter dogs, owned dogs with strangers in a familiar context, owned dogs with strangers in an unfamiliar context, owned dogs with their owner providing petting in a familiar context, and owned dogs with their owner providing petting in an unfamiliar context. Most, but not all dogs showed preference for food when food was available on a continuous schedule. As the food schedule thinned, most dogs showed a sensitivity to the thinning food schedule. As dogs allocated less time to the food alternative, they varied between and within groups as to whether they then allocated more time to the petting alternative. We found schedule effects, population differences (shelter vs. owned), context effects, and familiarity effects on choice.

12:28 PM Spatial Cognition (Chair: Olga Lazareva)

12:28 PM **Navigation experience and cognitive maps**

Jennifer E. Sutton, Melanie Buset, & Mikayla Keller (Brescia University College)

14 Humans' spatial abilities appear to be malleable and can be improved through targeted spatial training in the laboratory (Uttal et al., 2013). Less is known about how experience outside the laboratory affects spatial cognition, however. In the current study, the association between pilot training and the ability to form a survey representation, or cognitive map, of a novel non-flight environment was investigated. Undergraduates who were engaged in pilot training and matched controls freely explored a virtual town from a ground-based perspective and then performed a direction estimation task using their memory for the layout of locations in the town. Participants also completed the paper-and-pencil Object Perspective Test (OPT; Hegarty & Waller, 2004) and rated their spatial abilities. Pilots were significantly more accurate than controls on the direction estimation task but the two groups did not differ on the OPT. The two groups visited the locations in the town at a similar rate, indicating that controls' relatively lower accuracy was not due to incomplete exploration of the town. Pilots' superior performance is likely due to better online cognitive processing during exploration, suggesting the spatial updating they engage in during flight navigation may transfer to a non-aviation context.

12:42 PM **Rats average entire vectors when navigating toward a hidden goal: A test of the vector sum model in rodents.**

Brett Gibson, & Felicia McGowan (University of New Hampshire)

15 Cheng and colleagues (Cheng, 1988, 1989, 1990; Cheng & Sherry, 1992; Spetch, Cheng & Mondloch, 1992) have shown that birds use vector information from landmarks to return to hidden goal locations. Cheng (1994) subsequently showed that pigeons average the distance and directional components of landmark-to-goal vectors separately, rather than as a single entity (distance-averaging model). Cheng reasoned that other animals might also average the distance and directional components of landmark-to-goal vectors separately, in part, given commonalities in the neural architecture of visual systems. We used procedures developed by Cheng (1994) to examine how rats utilize landmark-to-goal vectors. In contrast to the results with pigeons, we found evidence indicating that rats average whole vectors rather than their separate scalars (vector-averaging). The ways that pigeons and rats use vectors may be related to evolved differences in the visual systems between these two species.

12:49 PM **Effect of landmark distance and stability on reward relocation**

David J. Pritchard (University of St Andrews), T. Andrew Hurly (University of Lethbridge), & Susan D. Healy (University of St Andrews)

16 Much of what is known about how vertebrates use landmarks is based on laboratory experiments. To investigate landmark use by wild vertebrates, we trained wild male rufous hummingbirds to feed from a flower placed in a constant spatial relationship with two artificial landmarks. In the first experiment, the landmarks and flower were 25cm, 50cm or 1m apart and were always moved 3-4m after each visit by the bird. In the second experiment, the landmarks and flower were always 25cm apart and we moved them either 1m or 25cm between trials. In tests, for which we removed the flower, the hummingbirds searched closer to the apparent flower location when the landmarks had been closer to the flower during training. However, while the distance that the birds searched from the landmarks and flower location was unaffected by the distance that the landmarks moved between trials, the birds directed their searching more towards the flower location, relative to the landmarks, when the landmarks and flower were more stable in the environment. We conclude that the hummingbirds likely used the spatial relationship between the landmarks and other nearby features in the environment to orient themselves relative to the landmarks.

12:56 PM *Break*

1:01 PM Cognitive Processes I (Chair: Lauren Guillette)

1:01 PM **Rats' serial reaction time performance as a function of inter-stimulus-interval consistency: automatic vs. deliberative responding**

Kaitlyn Iannicello, Ema Sisic, & Jerome Cohen (University of Windsor)

17 Rats learned to 'nose' poke three successively lit keys that occurred in a fixed sequence. We investigated whether rats would be more likely to acquire a more automatic than deliberative sequence of nose poke movements when inter-stimulus-intervals remained constant than varied (independent groups). To answer this question we interspersed occasional sequence violation probes to determine if such probes would disrupt signal responding more (greater increase in serial reaction times and nose poke errors) in the constant than in the varied inter-stimulus-intervals group. We also examined the effect of different violation probes on response disruption to determine the type of sequence 'rule' rats in each group might have acquired.

1:08 PM

18

Associative and relational processes during transposition in pinyon jays (*Gymnorhinus cyanocephalus*)

Bryce A. Kennedy, & Alan C. Kamil (University of Nebraska-Lincoln)

We used operant transposition to study the cognitive mechanisms of relative size discrimination in pinyon jays. The jays were trained in a multiple-pair transposition task to discriminate stimuli by relative size and were tested for relational learning on a variety of novel stimulus pairs. Results indicated that choice was influenced by a combination of relative and absolute stimulus features, which we assessed by measuring deviations from predictions of an S-R associative model of transposition. Subjects trained to peck the larger stimulus (Large treatment) relied more on absolute stimulus features than did subjects trained to peck the smaller (Small treatment). We fit a linear ballistic accumulator model to response time data for each bird and mapped psychophysical variables from the stimulus configuration onto model parameters: Sensory information accumulation rate increased with associative strength disparity in the Large treatment, and with stimulus area disparity in the Small treatment. This suggests that the basis for decision, whether associative strength or relative size, directly influences sensory information processing as modeled by the linear ballistic accumulator.

1:15 PM

19

Cross-taxon comparison between the ecological and cognitive approaches to cognition: Performance of capuchin monkeys (*Cebus apella*), rhesus macaques (*Macaca mulatta*) and children (*Homo sapiens*) in different versions of the Ephemeral-Permanent Paradigm

Laurent Pretot, Sarah Brosnan, Rebecca Williamson (Georgia State University), & Redouan Bshary (University of Neuchatel)

In a follow-up study of the original Ephemeral-Permanent Paradigm in fish and primates using a plate task (Salwiczek et al., 2012), we added a social component, which might help the monkeys to perceive the task as more naturally relevant, because cooperation in the wild typically involves intraspecific interactions between conspecifics. The results of this investigation did not support our hypothesis. In a second experiment, using capuchins and macaques, we designed a computerized version of the same task that allowed us: 1) to compare the performance of two primate species which strongly differ in their level of cooperative behavior, 2) to limit the impact of the human experimenter and inadvertent variations in procedure, and 3) to introduce a series of procedural modifications to explore which aspects of the original task created the difficulty for the monkeys. Overall, capuchins learned the task more effectively using this computerized procedure than in manual tests. Interestingly, we found differences in performance, choice pattern and variability between the two species. Finally, a parallel investigation showed that children performed better in the social task than in the original plate task. Taken together, the results of our research allowed us to hypothesize several major factors influencing subject's performance.

1:22 PM

20

Use of trial and error to solve a novel confinement problem by jumping spiders

Fiona Cross, & Robert Jackson (University of Canterbury)

Jumping spiders (family Salticidae) have unique, complex eyes and a capacity for spatial vision exceeding that for any other animals of similar size. Some salticids from a subfamily, Spartaeinae, are known to express an active preference for other spiders as prey ('araneophagy'). After invading another spider's web, some araneophagic spartaeines gain dynamic fine control of the resident spider using web-based signals derived by trial and error. Our hypothesis is that proficiency at trial-and-error signal derivation predisposes spartaeines to solve a novel confinement problem. Test spiders began on an island in a tray of water, with an atoll surrounding the island. From the island, the spider could choose between two potential escape tactics (leap or swim), one of which was set at random to fail and the other was set to achieve partial success. We tested species from genera known to adopt trial-and-error signal derivation (*Brettus*, *Cyrba* and *Portia*) and genera that are not (*Cocalus* and *Paracyrba*). All *Brettus*, *Cyrba* and *Portia* species solved the confinement problem by repeating correct choices and switching tactics after making incorrect choices. However, as predicted by our hypothesis, there was no evidence that *Cocalus* or *Paracyrba* used trial-and-error to solve the confinement problem.

1:36 PM

21

Bottlenose dolphins perceive projected stimuli

Heidi E. Harley (New College of Florida), Wendi Fellner (Disney's The Seas), Diana Ward (New College of Florida), M. Andy Stamper, Lisa L. Green, & Leslie Larsen (Disney's The Seas)

Although we have learned a great deal about the cognitive processes of avian and terrestrial species via their interactions with computers and computer-generated visual stimuli, most cognitive work with dolphins has required object-based methodologies. In this study, we tested two dolphins with a 3-alternative matching task using lighted images projected onto an acrylic window in their pool. The dolphins performed well across two groups of five 18-trial sessions in two conditions: object-to-image (M=98%) and image-to-object (M=90%). Now we are using this system to test a dolphin's ability to match projected stimuli based on their direction of movement (horizontal, vertical, circular), a skill they may employ for prey capture.

1:50 PM **Sea lions use mirrors to detect objects**

Heather Hill (St. Mary's University), Krista Webber, Alicia Kemery, Brett Posey (Houston Zoo Inc), & Stan Kuczaj (University of Southern Mississippi)

22

California sea lions (*Zalophus californianus*) are capable of forming complex mental concepts, but do not recognize themselves in mirrors. Many non-human species that do not recognize themselves in mirrors but can use mirror reflections to locate and retrieve objects. Three sea lions housed at a facility in Houston, TX were tested on their ability to find an object using a mirror. The results of the initial detection task using a 3-location mirror apparatus suggested that 2 of the sea lions located a single object in one of the three locations statistically above chance when the mirrors were added to the task for the first time. After additional exposure to the mirrors in the apparatus 1 sea lion successfully achieved 100% accuracy in object detection. This animal was also 100% correct on a transfer task in which she detected an object in a novel location. The results suggested that sea lions have the capability to use mirrors to locate an object reflected below with minimal exposure to a mirror, but likely need additional experience with mirrors to use them consistently.

2:04 PM **Substitutional reality system for macaque monkeys**

Yasuo Nagasaka, Tomonori Notoya, & Naotaka Fujii (Laboratory for Adaptive Intelligence; RIKEN BSI; Japan)

23

In the laboratory experiments, multiple trials under identical conditions are required, however, it has been difficult to repeatedly present the identical social interaction in live. In the present study, we applied the SR system (Suzuki et al. 2012) for macaques (mSR), an immersive interface in which a monkey was either presented with a live or a pre-recorded environment and hardly recognized which environment the monkey was experiencing. The mSR system consisted of a head-mounted display (HMD) fitted with a video camera at the front center of the HMD (mSR-headset), and a control PC. It had two presentation modes, 1) live-scene mode: the monkey viewed a live scene streamed from the camera, and 2) recorded-scene mode: the monkey viewed scenes that were pre-recorded by the camera. During the evaluation of mSR, the monkey wore the headset and performed a food-grabbing task under the live-scene mode. All three monkeys performed the task successfully after the adaptation of visual-motor-tactile coupling in the system. Furthermore, under the recorded-scene mode all monkeys chased and tried to get the food. These observations suggesting that the monkeys experienced the virtual world with a feeling of being at a live event in the mSR system.

2:18 PM **A call for analysis in comparative cognition**

Clive D. L. Wynne (Arizona State University)

24

Much research in comparative cognition is a search for "cognitive instincts." Cognitive instincts are complex behaviors construed as relatively invariant phenotypical characters. Investigators report complex behaviors as if they were traits not amenable to further analysis. I shall review examples in diverse species and argue that cognitive behaviors are highly contingent on environmental context: they should not be reported like the number of pistils on a flower. Comparative Cognition should act like other sciences: it should not be content to make discoveries – it should analyze what it finds into more basic processes. Doing so may risk losing attention from the broader media (though I have reasons to doubt this), but it will lead to a deeper science. I am not arguing for a return to an old-time behaviorism: the analysis I am calling for can be of many different kinds, including appeals to intervening state variables or physiological factors. I am just calling for some kind of further analysis beyond the existence proof of animals acting cleverer than previously thought.

2:32 PM *Snack Break*

3:12 PM Social Learning (Chair: Marisa Hoeschele)

3:12 PM **Follow the leader IV: Flexibility of individual and social learning**

Teagan A. Bisbing, Marie Saxon, Jennie Ruff, & Michael F. Brown (Villanova University)

25

Over the past few years, we've presented data showing rats' use of individual and social learning strategies in an open field foraging task. The current study assesses rats' abilities to alternate between these two strategies as a function of the availability and reliability of personal and social information in the task. Rats were trained to consistently find bait in distinct patterns of spatial locations, such that their spatial choices came to be highly controlled by these patterns. The rats were then randomly assigned to search the arena with a different rat partner from trial to trial. During these trials, one rat's assigned locations were baited, while the other's locations remained empty. Results showed that when a rat's assigned locations were not baited, he tended to choose locations in his partner's baited set, suggesting that, in the absence of personal information, rats' behaviors are influenced by social information. These data suggest that individuals are flexible in their use of learning strategies and are able to alternate between individual and social learning strategies depending on the costs and benefits of each in the local environment.

3:19 PM

Can Clark's nutcrackers flexibly adapt caching behaviours in a cooperative context?

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

26

Many corvids cache food to survive periods when resources are scarce. These caches are often stolen by other individuals. In an effort to ensure the safety of caches, corvids use cache protection strategies such as suppressing caching in the presence of others or re-caching compromised caches to new locations after an observer has left. These cache protection abilities have been shown to be flexible in competitive contexts. The study to be discussed, however, presented Clark's nutcrackers with a cooperative caching task to examine whether caching behaviours could be flexibly adapted to this context. To do so, a bird's caches were reciprocally exchanged with the caches of a partner bird over repeated trials. Thus, if the birds recognize the cooperative nature of the task they should show an increase in caching, whereas if caching behaviours are domain-specific and viewed as a competitive activity, then a decrease in caching should be observed. The results suggest a mix of strategies were used; however, little evidence was found that the birds cooperated in a reciprocal fashion.

3:26 PM

Sex differences in copying behaviour

Lauren M. Guillette, & Susan D. Healy (University of St. Andrews)

27

As a social species it might be expected that zebra finches would copy food choices of more experienced conspecifics. Copying has previously been tested by presenting observers with two demonstrators that differ in some way (e.g., sex, leg-band colour), each feeding on a different colour food. However, using this paradigm, it remains unclear whether the observer is copying the choice of one individual or avoiding the choice of the other. Therefore we presented the observer bird with only one demonstrator eating from only one of two coloured food hoppers. We tested both same-sex and opposite-sex dyads and found evidence of copying in only one experimental group: females observing males. Next we tested an independent group of birds for hopper preference in the absence of demonstration and found no systematic preferences. Lastly, we tested whether observers relied more on location cues or on stimulus cues (i.e., hopper colour) to guide their behaviour. Here we found that female observers tended to use colour cues more than location cues provided by male demonstrators. This sex specificity of social learning may be associated with females more usually paying attention to male cues in a mate-choice context.

3:40 PM

The advantages of search images in collective foraging

Noam Miller, & Iain Couzin (Princeton University)

28

Animals hunting for cryptic prey may use search images which enhance their capture of a specific prey type, leading them to bias their intake in favor of more common types. Search images are assumed to be an attentional priming effect. We present an agent-based model that reproduces the main features of search images. We show how, for animals that forage in groups, using search images may increase the success rate of all group members. By focusing on the most common prey type, foragers lower the local density of that type, increasing the probability that nearby individuals will form a search image for a different prey morph. This mechanism might act to decrease direct competition between nearby group members and increase the group's ability to exploit all available prey. This advantage may partially account for the inability of most species to hold more than a single search image at one time.

3:54 PM

Dissociation of social affiliation and social memory in social influence on spatial choice

Marie Saxon, Andrew Stokesbury, Chase Phillips, & Michael Brown (Villanova University)

29

Recent experiments from our lab show that rats' choices in a spatial search task are influenced by choices of conspecifics. There are two types of rats in the current study, models who possess specific information of where food is located and subjects who do not. Previous research from our laboratory has found that subjects are influenced by social cues (choices of models) when making choices in the maze. It is of interest whether subjects use memory during this task or rely on social affiliation. In the current study, models and subjects were tested together in two types of trials, simultaneous-release or delayed-release. Subjects are held in an observation cage while the model makes its first two choices in the maze during the delayed-release condition trials. Subject and models are released into the maze simultaneously for the other half of trials. If subjects visit the first location the model visited after they are released from the observation cage, than this would suggest subjects are using memory during this task. However, if subjects do not visit the first location the model visited while it was in the observation cage than this suggests that social affiliation is controlling behavior in this task.

4:01 PM

Experimental study of skills transmission in wild large-billed crows (*Corvus macrorhynchos*)

Tanya Obozova, Anna Smirnova, & Zoya Zorina (Lomonosov Moscow State University)

30

In this work we studied how new skills are transmitted between large-billed crows living wild on Shikotan Island. In order to find out whether crow youngsters are able to learn new skills from their parents, three parents (males) from different families were trained to get a bait opening a red box of four boxes differing in color (it took 8 and 10 trials). It took 2 and 3 trials for their female partners to learn the skill. Each day (during one month) the youngsters flied with their trained parents and could see what the parents were doing to obtain food. The parents opened the red box and used the obtained food to feed their youngsters. When youngsters were 91 - 92 days old they started to open boxes and obtained food without assistance from their parents. The other adult crows were around and could observe how the trained crows obtained food as well. In contrast, none of them tried to open boxes. On the basis of this study, we drew a conclusion that the special skills are transferred through the family only, i.e. from a trained crow's male to its female partner and then to their youngsters.

4:08 PM **Learning to play. What belugas do.**

Dominique Ramirez, Heather Hill, & Abby Arroyos (St. Mary's University)

31

Previous research with cetaceans in their natural habitat and captivity has suggested that several types of learning influence the development and type of play. Independent learning involves discovering the properties of stimuli individually through trial and error. Teaching involves instruction and guidance by a knowledgeable mentor as a naïve learner performs a behavior. Observational learning includes a range of mechanisms, such as incentive motivation, stimulus and local enhancement, social facilitation, and imitation. We examined the frequency and function of play behavior for five beluga calves and five beluga adults located in Texas. Although adults did not participate directly in calf play, the adults did watch (Stimulus Enhancement) the calves in their play bouts and were observed performing behaviors similar to what they observed with the calves. This trend occurred most often with mother-calf pairs. It seems that beluga calves may learn much of their play behavior independently or by attending the actions of the other animals. Belugas had the tendency to pay attention to their companion's actions and then independently perform behaviors similar to what their models had presented. Ultimately, calves seem to learn the most from their mothers, if their mothers were present, or from other calves.

4:15 PM *Break*

4:20 PM Canine Cognition (Chair: Stan Kuczaj)

4:20 PM **The effects of prior Pavlovian conditioning to an odor on resistance to disruption of an odor discrimination task in dogs**

Nathaniel J. Hall (University of Florida), & Clive D.L. Wynne (Arizona State University)

32

The present study explores the effects of Pavlovian conditioning an odor as a CS on resistance to disruption in an odor-discrimination task. Dogs were trained on two different odor discriminations (odor A vs B and odor C vs D). After reaching a stable performance on both discriminations, half of the dogs received appetitive Pavlovian conditioning to either odor A or odor C for five days. The remaining dogs received an explicit un-pairing procedure to either odor A or C with food. All dogs' accuracy on both odor discriminations was measured during three disruption phases. For the first disruptor, dogs were fed immediately prior to the session. For the second disruptor, food was buried in all of the discrimination bins. The last disruptor was extinction. Performance on the conditioned or un-paired odor discrimination was compared to the performance for the unexposed odor discrimination suggesting a potential effect of the Pavlovian contingency.

4:27 PM **Interval timing in the domestic dog**

Krista Macpherson, & William A. Roberts (Western University)

33

Interval timing is an important skill that allows animals to approximate how much time has elapsed since a given event. Little, however, is known about interval timing in domestic dogs. In an initial experiment, a peak procedure was used with 5 dogs trained on 30 second fixed intervals. When 1 minute probe trials were introduced, the dogs' rate of responding rose to a peak around 30 seconds, despite the fact that they had not been rewarded. These findings are consistent with previous studies using rats and pigeons. In a second experiment with 4 dogs, a bi-section task was used in which dogs had to learn to approach one feeder when given an 8 second signal, and another when given a 2 second signal. The signal had both visual (white light) and auditory (a tone) properties. The visual and auditory properties were eventually dissociated in order to determine which had more influence over the dogs' behavior. Results and implications of this study will be discussed.

4:34PM **Is interspecific attention a discriminative stimulus for social reinforcement during social play in domestic dogs?**

Lindsay R. Mehrkam (University of Florida), & Clive D.L. Wynne (Arizona State University)

34

A scientific understanding of play behavior is hindered by a lack both of experimental evidence and an obvious function. The proximal causes of play behavior in nonhuman animals is especially elusive. Domestic dogs have been widely cited as a model species for the study of social play (i.e., play between conspecifics). Previous research has reported that social play in dogs occurs at higher levels in the presence of familiar caretakers. However, no previous studies have yet identified the nature of the relationship between the availability of interspecific attention and increased levels of social play. The aim of the present experiment was to determine whether interspecific (via owner) attention functions as a discriminative stimulus for social reinforcement for pairs of dogs engaging in social play. We present both individual and aggregate results of 12 pairs of domestic dogs who underwent alternating discriminative stimulus (attention available) and extinction stimulus (S-delta, or no attention available) conditions. The results from this study will contribute to an enhanced understanding about the role of owner attention as a proximal factor influencing social play in domestic dogs, as well as the role interspecific social stimuli as a proximal cause of in species-typical behaviors in other species.

4:41PM **35**

Canine Self-Control: Ego Bolstering without an Ego?

Kristina Pattison & Thomas Zentall (University of Kentucky)

Past research indicates that dogs and humans may share some common self-control processes. The strength model of self-control suggests that like training a muscle, systematic practice enhances self-control. Dogs were tested for self-control strength using a design analogous to the two-task paradigm commonly used in humans. Extended practice with an unrelated task increased dogs' self-control strength. Dogs were later tested after several weeks without self-control practice. Although the dogs showed no decrease in their task accuracy, higher levels of self-control depletion were observed in the second self-control task, suggesting that as with humans, some of the gains from self-control practice were lost over time.

4:48 PM **36**

Evaluating attachment styles in domestic dogs

Monique A. R. Udell (Oregon State University)

Pet dogs are often thought to form strong bonds with their human owners that continue into adulthood. Especially in the Western world, dogs are often treated like children and appear to develop a level of dependence on their owners as a result. A growing body of research has established that, on average, dogs appear to seek out proximity to their owners in attachment tests. However little is known about individual patterns of attachment behavior in dogs. In this talk I will provide data on the individual responses of pet dogs towards their returning owners, who have reentered an unfamiliar room after a short absence. The emergence of patterns, or attachment styles, within this data will be presented. This approach may provide a new way of investigating attachment behavior in dogs, accounting for different relationship styles that could have predictive value in applied settings. Parallels to human-attachment styles will be considered, however differences and dog specific considerations will also be discussed.

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

See Poster Abstracts Starting on Page 23

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

Friday Morning

10:30 AM CO3 Mentoring Program I: Meet the Experts (Chair: Ken Leising)

Have you ever wanted to ask questions to 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 mentor from an academic or other (e.g., zoo) setting will be seated at each of tables. Students are allowed (and 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 pertinent academic information will be displayed at the entrance to the Manatee room. This session will end at 11:30 promptly.

Friday Afternoon

12:00 PM Concept Learning (Chair: Robert Hampton)

12:00 PM

Pigeons perceive actors engaging in behavior

Robert Cook, & Muhammad A. Qadri (Tufts University)

37

Pigeons have recently been shown to discriminate and categorize simple quadruped and complex human actions. The mechanisms behind this action categorization are still unknown, however. To help determine if they are discriminating the actions of "animate" organisms, eight pigeons were tested in a go/no-go task with video displays consisting of two adjacent digital actors, one engaging in a complex human action (the acting actor) and the other standing in a static, neutral pose (neutral actor). Four of the pigeons were trained to discriminate based on the identity of the acting actor and its actions and four were trained to discriminate based on the identity of the neutral actor and the actions of the acting actor. The condition where the actions and conditional actors were coincident was learned to a higher level. These data suggest pigeons may perceive dynamic actions as being performed by "actors".

12:14 PM

Pigeons use both high and low spatial frequency information to make visual category discriminations, but do not show generalisation between them

Stephen E. G. Lea (University of Exeter UK), Victoire Poser-Richet (University of Exeter UK and Institut Polytechnique LaSalle Beauvais France), & Christina Meier (University of Exeter UK)

38

Pigeons were trained to discriminate multiple images of modified cat faces from multiple images of modified dog faces displayed on medium grey backgrounds on a touch-screen. The faces had been subjected to either low-pass or high-pass spatial frequency filtering, and the cat and dog face sets were matched for average overall brightness and balance between the three computer colour channels. Once the initial discrimination had been acquired, birds trained with low-pass stimuli were tested with high-pass filtered versions of their training stimuli, and vice versa. All birds were also tested with the original, unfiltered stimuli, and with novel exemplars of the categories that had been filtered in the same way as their training stimuli. No generalisation was observed between high- and low-pass filtered versions of the same stimuli, but some generalisation was observed to the unfiltered original stimuli, and to new exemplars of the categories subjected to the same filtering as the training stimuli. These results are as would be expected if pigeons are able to use both high and low frequency information, but are unable to reconstruct the high frequency information in an unfamiliar visual image from its low frequency information, or vice versa.

12:28 PM

Pigeons use a default strategy to learn a pseudoconcept

Thomas A. Daniel (Auburn University), Anthony A. Wright (The University of Texas Health Science Center at Houston), & Jeffrey S. Katz (Auburn University)

39

Katz & Wright (2006) demonstrated abstract same/different concept learning in pigeons. Using small training sets, pigeons transferred performance above chance but below baseline (i.e., partial concept learning), but with large training sets, pigeons transferred performance to novel items. The present study's aim was to determine how the set-size function would manifest if all exemplars had to be learned through memorization. Holding all other aspects of the Katz & Wright (2006) procedure constant, we created exemplars that must be learned with item-specific strategies by arbitrarily assigning responses as same or different. While pigeons were unable to solve the task via concept learning, all were able to solve the early training sets by memorizing exemplars. Some pigeons developed default strategies, granting them faster acquisition but failed transfer to novel items. The present study further demonstrates that our previous studies demonstrating full concept learning cannot be successfully completed using only item-specific strategies.

12:35 PM **Natural concept formation at three levels of abstraction in young children**

40

Stephanie E. Jett (University of Southern Mississippi), & Jennifer Vonk (Oakland University)

Young children (two- to five-year-olds) were tested using nonverbal, two-choice natural concept discrimination tasks at three levels of abstraction on a touch screen computer. The tasks were modified from those utilized in comparative work with orangutans (Vonk & MacDonald, 2004), a juvenile gorilla (Vonk & MacDonald, 2002), chimpanzees (Vonk, Jett, Mosteller, & Galvan, 2013), and black bears (Vonk, Jett, & Mosteller, 2012). The levels of abstraction were as follows: concrete - tigers versus lions, intermediate - cats versus dogs, and abstract - animals versus nonanimals. The children's performance provides some support for the "global-first" hypothesis in children and corroborates some of the findings with nonhuman animals in that the children's performance on the abstract concept discrimination was significantly more accurate than performance on both the intermediate and concrete level tasks.

12:42 PM **Conditional discrimination learning of same/different relationships among pictorial stimuli in rats**

41

Makiko Kamijo, & Tohru Taniuchi (Kanazawa University)

Three Long-Evans rats were trained in a conditional place discrimination task where sameness or differentness in a stimulus-set of four pictorial stimuli was used as a discriminative cue. Same-sets consisted of four identical pictures (AAAA, BBBB, CCCC, DDDD), while different-sets consisted of four different pictures (ABCD, CDBA and so on). Two LCD displays were attached on the sides of a discrimination box and presented as identical stimulus-sets. The discrimination box was divided into two compartments by a central partition with an opening and a guillotine door. Rats were trained to respond to same- and different-sets by staying either side of the box 60 s after the start of a trial. Two rats achieved the acquisition task with four different pictures (A, B, C, and D) and responded significantly better than chance to test-sets consisting of novel pictures (E, F, G, and H). One of these rats also learned to discriminate same- and different-sets consisting of two pictures from A, B, C, and D, and showed reliable transfer to novel stimuli (I, J, K, and L). These results show that rats can learn same/different discriminations on a somewhat abstract level.

12:49 PM *Break*

12:54 PM Choice (Chair: Stephen Lea)

12:54 PM **Impulsivity affects suboptimal gambling-like choice by pigeons**

42

Jennifer R. Laude, Joshua S. Beckmann, & Carter W. Daniels, Thomas R. Zentall (University of Kentucky)

Pigeons prefer a low-probability, high-payoff but suboptimal alternative over a reliable low-payoff optimal alternative (i.e., one that results in more food). This finding is analogous to suboptimal human monetary gambling because in both cases there appears to be an overemphasis of the occurrence of the winning event (a jackpot) and an underemphasis of losing events. In the present research we found that pigeons chose suboptimally to the degree that they were impulsive as indexed by the steeper slope of the hyperbolic delay-discounting function (i.e., the shorter the delay they would accept in a smaller-sooner/larger-later procedure). These correlational findings have implications for the mechanisms underlying suboptimal choice by humans (e.g., problem gamblers) and they suggest that high baseline levels of impulsivity can enhance acquisition of a gambling habit.

1:01 PM **Reanalysis of reinforcement history and successive-pair training: Expansion of the theory**

43

Carter W. Daniels (Arizona State University), Jennifer R. Laude, Thomas R. Zentall (University of Kentucky), & Federico Sanabria (Arizona State University)

Transitive inference (TI) tasks typically involve training a series of four premise pairs in which one item is reinforced [+] and the other is not [-], represented as A+B-, B+C-, C+D-, D+E-. TI is demonstrated by choices of B over D. We recently conducted two studies of TI by pigeons in which we used the successive-pair training procedure where pairs are trained one at a time in sequential order. Acquisition criterion for each pair was 90% correct choices for two consecutive sessions. When we assumed 90% performance on each training pair, training pair and test pair performance in Study 1 was well described by two mathematical models of TI (EK Model and Wynne Model). However, in both studies, memory tests (Study 1: after testing; Study 2: before testing) revealed that accuracy on premise pairs at the end of successive-pair training was lower than 90%. Thus, we re-simulated the data from Study 1 using levels of performance derived from the memory test. These simulations described training pair and test pair performance for only 4 of 7 pigeons. We suggest that mathematical models of TI be amended to take into account memory-related variables.

1:08 PM

Zebra finches learn the structural efficacy of nest material

Susan D. Healy (University of St Andrews), Ida Bailey, Kate Morgan, & Simone Meddle (University of Edinburgh)

44

It is generally assumed that birds' choice of structurally suitable materials for nest building is genetically predetermined. We tested that assumption by investigating whether experience affected male zebra finches' choice of nest material. After a short period of building with relatively flexible string, birds preferred to build with stiffer string while those that had experienced a stiffer string were indifferent to string type. After building a complete nest with either string type, however, all birds increased their preference for stiff string. The stiffer string appeared to be the more effective building material as birds required fewer pieces of stiffer than flexible string to build a roofed nest. Birds did not change their preferences as a result of their reproductive success and while material preference of first time builders did not reflect either the preference of their father or that of their siblings juvenile experience of either string type increased their preference for stiffer string. As through their own experience these birds learned which was the more structurally appropriate nest material, nest material preferences cannot be entirely genetic.

1:22 PM

Species generality and validity of keeper assessments of enrichment preferences across taxa

Nicole R. Dorey, Lindsay R. Mehrkam (University of Florida), Tarah Jacobs, & Shawntal Abram (Santa Fe College Teaching Zoo)

45

Environmental enrichment is widely used in the captive management of exotic animals, and has great importance for increasing the behavioral welfare of these populations. It may often be difficult, however, to identify potentially effective enrichment items that are also cost-effective and readily available. The aim of the present study was to assess the utility of preference assessments across six different species – each representing a different taxonomic group. In addition, we evaluated the agreement between zoo personnel predictions of animals' enrichment preferences and items selected via a preference assessment. Four out of six species (7 out of 11 individuals) exhibited clear, systematic preferences for a specific enrichment item. Results were generally consistent within species, with the exception of avian subjects that showed individual preferences for different enrichment items. Overall, zoo personnel, regardless of experience level, were significantly more accurate at predicting less preferred enrichment items than highly preferred enrichment items across species. Preference assessments may therefore be a useful, efficient husbandry strategy for identifying enrichment items that zoo animals would be likely to initially interact with.

1:36 PM

Midsession reversal in a go/no-go task with pigeons and chickadees

Neil McMillan, Marcia L. Spetch, & Christopher B. Sturdy (University of Alberta)

46

It has been shown previously that pigeons make surprising anticipatory and perseverative errors on tasks in which reward contingencies for different stimuli reverse midway through each session. We were interested in whether these errors result from directed reversals in choice behavior, or rather from an inability to inhibit responding near the reversal to stimuli which are proximally (but not currently) rewarded. Where previous midsession reversal procedures have almost exclusively been simultaneous discrimination tasks, we used a go/no-go procedure in which pigeons (*Columba livia*) viewed only one alternative (a red or green circle) on a particular trial, with the contingencies for responding to the red and green stimuli reversed midway through the session. We are also testing black-capped chickadees (*Poecile atricapillus*) on an analogous version of the procedure with naturalistic, acoustic stimuli, in the first extension of midsession reversal to a non-Columbid avian species. These experiments will be discussed in the broader context of the potential utility of midsession reversal for studying cognitive systems, including timing and category learning.

1:50 PM

The domain specificity of self-control

Jeffrey R. Stevens, Bryce A. Kennedy, Dina Morales, & Marianna Burks (University of Nebraska-Lincoln)

47

When choosing between a piece of cake now versus the possibility of a slimmer waistline in the future, many of us have difficulty with self-control. Food hoarding species, however, exhibit self-control every time they cache a piece of food for later. Though these species can sometimes wait months before retrieving their caches, it remains unclear whether these long-term preferences generalize outside of the caching domain. The central hypothesis for this project is that the ability to save for the future is a general tendency that cuts across different situations. We tested this hypothesis by using individual difference measures and experimental manipulations to evaluate the relationship between caching behavior and self-control. We predicted that caching more food will be associated with longer delays in waiting for larger food times. Preliminary results support this prediction that more consistent cachers wait longer in operant delay-choice tasks.

2:04 PM

Risk sensitivity to food amount in the grey squirrel (*Sciurus carolinensis*)

Lisa A Leaver (University of Exeter)

48

Sensitivity to variance (risk sensitivity) in food amount has been investigated extensively in a broad range of species but very little has been done on animals that cache food for future use. Most animals are sensitive to variance in mean reward amount and delay to reward, generally preferring the risk averse option (non-variable) when there is variance in amount of food rewarded, whereas they tend to be risk prone when making choices about variance in delay to reward. We suggest that caching animals, *Sciurus carolinensis*, may show adaptive specialisations in risk sensitivity to reward amount depending on whether the food reward is eaten or cached. We predict that when rewarded with food that will be consumed immediately, squirrels will be risk averse, like most other animals, but when rewarded with food that can be cached, the same animals will be indifferent or risk prone. We report results from a series of experiments on risk sensitivity to variance in reward amount in grey squirrels in a laboratory setting and discuss them in terms of mechanism (associative learning) and function (adaptive specialisations for food caching).

2:11 PM *Break*

2:16 PM Cognitive Processes II (Chair: Jonathon Crystal)

2:16 PM **Pay attention to diet: An obesogenic, refined low-fat diet increases choice and omission errors but not impulsivity errors compared to an unrefined low-fat diet in rats performing a vigilance task**

Aaron P. Blaisdell, Yan Lam Matthew Lau, Ekatherina Telminova, Boyang Fan, Hwee Cheei Lim, Dennis Garlick, & Cynthia D. Fast (UCLA)

49 Diet-induced obesity from the overconsumption of highly refined "junk food" is associated with cognitive impairment. We investigated the causal relationship between diet-induced obesity and attention in the rat. One group of rats ate an obesogenic, refined low-fat diet (REF) while another group of rats ate an unrefined low-fat control diet (CON). Rats were trained on a two-lever vigilance task. Magazine entry initiated the trial with the insertion of two levers, followed by a 1-s presentation of a light above one of the levers. Food was delivered for a single press of the lever below the light within 6 s of light onset. Across trials, the light occurred at either 0 s, 3 s, or 6 s after the levers were made available. While overall accuracy did not differ between the two groups, REF rats made more choice errors and omission errors. CON rats, however, made more impulsivity errors at the 6-s delay. These results suggest that diet-induced obesity causes decrements in attention, specifically an increase in inattention. The surprisingly higher rate of impulsivity errors shown by CON rats at long delays suggests a higher degree of task engagement leading to an "itchy trigger finger."

2:30 PM **Using genetic algorithms to test hierarchical attention in pigeons and people**

Daniel I. Brooks (Brown University), Muhammad A. Qadri, & Robert G. Cook (Tufts University)

50 Because most objects consist of local elements organized into a global form, a key question in comparative perception has centered on the organizational level at which objects are processed. To investigate this issue, past researchers have tested hierarchically structured displays, such as the nested letter-identification task (Cavoto & Cook, 2001; Navon, 1977); when presented with such stimuli, pigeons primarily focus on the particulate elements whereas humans initially perceive the global configuration of the parts. Using a genetic algorithm which expanded the open-ended range of tested stimuli, we tracked attention to global and local features in nested compound displays ("T" vs "+") in a two alternative simultaneous choice task. For both levels, critical features (e.g., the angle and placement of the crossing bar) and non-critical features (e.g., the brightness and height of the stimulus) were genetically varied. Displays evolved by reproducing correctly-selected stimuli until the resulting populations of selected displays and associated gene values were stable. We then tested conflict stimuli in which attention to global or local features could be directly compared. Although pigeons were strongly controlled by the local features, we observed evolution along feature dimensions that suggested some role for global processing.

2:44 PM **Brainy birds have complex neural machinery**

Can Kabadayi, Mathias Osvath, Per Petersson, & Lina Petersson (Lund University)

51 Bird species vary in terms of cognitive skills. The skills of corvids have been suggested to be at level with the cognitively advanced great apes. We wanted to identify whether corvid brains have noticeably different neural features from other birds. In mammals, certain brain structures, like the prefrontal cortex, the hippocampus, and associative areas are thought to mediate complex cognitive feats. These structures are proportionally enlarged or have higher cell density in cognitively sophisticated species. We studied whether analogous brain structures are enlarged or have higher cell density in corvids compared to other bird species. Our approach was based on relative measures of gross morphological differences between species in combination with quantitative cell density estimates for certain key brain regions (mesopallium, nidopallium, the hippocampus, parahippocampal region, basal ganglia). We compared rook brains with those of ducks and chicken. Ducks and chicken are currently not regarded as particularly cognitively flexible, and the last common ancestor of rooks and ducks, and chicken, lived around 100 million years ago. This would provide a clear comparison. The initial data indicate differences in both cell density and proportional size in several areas; which suggest similar neurobiological principles for advanced cognition in both birds and mammals.

2:51 PM **Visible displacement in the bottlenose dolphin (*Tursiops truncatus*) and California sea lion (*Zalophus californianus*)**

Rebecca Singer (Georgetown College), & Elizabeth Henderson (National Marine Mammal Foundation)

52 Object permanence, the ability to understand that objects exist even when they disappear from view, has been extensively studied in humans and many terrestrial mammals. However, little research has been conducted on object permanence in marine mammals. Jaakola, Guarino, Rodriguez, Erb, & Trone (2010) demonstrated that bottlenose dolphins were capable of passing visible displacement tests of object permanence but not the more complex, invisible displacement test. It has been hypothesized that dolphins may fail invisible displacement tests because their ability to echolocate may preclude the need to develop complex object permanence ability (Mitchell, 2010). The current experiment tested visible displacement in a species that does echolocate (bottlenose dolphin) and a species that does not echolocate (California sea lion). Subjects were initially trained a "find it" cue in which they found a fully visible object. On test trials, subjects had to indicate in which of three boxes an object had been hidden. Both dolphins and sea lions performed significantly above chance. This study provides convergent evidence of visible displacement ability in bottlenose dolphins and the first evidence to date of visible displacement in sea lions.

2:58 PM **Lateralization of dominance-related immediate early gene expression**

Christopher B. Sturdy, Allison H. Hahn, Marisa Hoeschele, Lauren M. Guillette, Daniel Lee, John Hoang, Neil McMillan (University of Alberta), & Ken A. Otter (University of Northern British Columbia)

53 Two auditory areas within the songbird brain, the caudomedial mesopallium (CMM) and caudomedial nidopallium (NCM), show increased immediate early gene (IEG) expression following presentation of conspecific vocalizations compared to tones or silence. IEG expression can also vary depending on the information contained within the vocalizations, regardless of whether the vocalization is produced by a conspecific or heterospecific. Black-capped chickadees are a songbird that produces a relatively simple two-note song. Previously, we reported that information regarding a male's dominance rank is contained within the acoustic features of its song, and females respond differentially to playback of dominant and subordinate songs. Here we presented dominant male songs, subordinate male songs, or reversed dominant male songs to females and examined IEG expression in CMM and NCM. We found more expression in the left hemisphere of birds that listened to dominant songs compared to birds that listened to subordinate songs, while hearing reversed song lead to an intermediate amount of expression; however, there were no differences between the playback groups for the right hemisphere. These results may indicate that the perception of higher auditory information, such as dominance status or quality, is lateralized in the songbird brain.

3:12 PM **Dynamic interactions of cognitive monitoring and cognitive control in monkeys**

Robert R. Hampton (Emory University)

54 A potential function of metacognitive monitoring is to provide dynamic feedback on the status of ongoing cognitive processes to optimize cognitive control of those processes. Most of the work investigating metacognition in nonhumans has focused on the monitoring side of this interaction while minimizing the role that feedback based cognitive control might have on cognition. For example, metacognitive monitoring has been inferred when monkeys exert cognitive control in minimal ways, such as by avoiding tests or seeking information when ignorant. I will describe experiments from our lab in which we have begun to test whether metacognitive monitoring and control might interact in more dynamic ways in the contexts of working memory and discrimination.

3:26 PM *Snack Break*

4:15 PM In Honor of Tom Zentall (Chair: Mike Brown)

4:15 PM **Personal information and social information in spatial choice**

Michael Brown, Teagan Bisbing, & Marie Saxon (Villanova University)

55 In several experiments, we have tested pairs of rats in a spatial choice task in which one rat has learned to find food in particular places but the other rat does not have the same information about the likely location of food. When the choices of the informed rat provide unique information about the location of food, the uninformed rat is influenced by them and, as a result, chooses more efficiently. Control by these social cues is limited, however, when other sources of spatial information are available. In this talk, ideas about the ways in which social cues complete with other kinds of spatial cues will be explored and experiments testing those ideas will be reviewed or reported. In addition, the relation between social influences on choice and the imitative learning described by Zentall and others will be considered.

4:30 PM **Paradoxical preferences for low reward probability in Zentall's protocol: How adaptive mechanisms can have costly consequences.**

Alex Kacelnik, Tiago Monteiro, & Marco Vasconcelos (Oxford University)

56 Everything else being equal, animals prefer high to low probabilities of reward, but when things are not exactly equal, these expectations are often violated, and animals display paradoxical preferences. Such cases are important in revealing the mechanisms controlling preferences and choices. We study the behavior of starlings in an experimental protocol developed for pigeons by Tom Zentall and collaborators, in which subjects prefer an option with lower reward probability but earlier availability of outcome information, thus systematically losing the majority of available rewards but spending less time uncertain. We consider mechanistic interpretations such as uncertainty aversion, local contrast and Pavlovian conditioning, incorporate new experimental controls, and propose a functional interpretation by contrasting sequential decisions in the wild with simultaneous choices in the laboratory.

4:45 PM **Why is time so powerful?**
Kimberly Kirkpatrick, & Andrew Marshall (Kansas State University)

57 Anticipatory timing plays a critical role in many aspects of human and non-human animal behavior. For example, anticipatory timing has been consistently observed in the range of milliseconds to hours, and demonstrates a powerful influence on the organization of behavior. Anticipatory timing is acquired early in associative learning and appears to guide association formation in important ways. In many learning situations, timing often dominates when temporal cues are available along with other stimulus dimensions. Such control by the passage of time has even been observed when other cues provide more accurate information. This is particularly intriguing given that both human and non-human animals are not particularly adept at timing. Indeed, timing processes are riddled with error and are subject to deviations due to environmental conditions such as ambient temperature and the presence of arousing stimuli, as well as being susceptible to pharmacological manipulations. The dominance of temporal cues in governing anticipatory behavior suggests that time may be inherently more salient than other stimulus dimensions. Evidence from both behavioral and neuro-scientific studies is brought to bear in understanding the powerful nature of time as a stimulus dimension.

5:00 PM **The interaction of working and reference memory in pigeons**
William A. Roberts, Caroline Strang, & Krista Macpherson (Western University Canada)

58 People often experience interference between working and reference memory. Thus, a person forced to park his car in a spot different from the normal one may later forget parking in the most recent location (working memory) and return to the habitual parking spot (reference memory). We report an analog of this confusion between working and reference memory in pigeons. After being trained to perform symbolic delayed matching-to-sample (working memory), pigeons learned a simultaneous visual discrimination between the comparison stimuli in the delayed matching-to-sample task (reference memory). Working memory was tested on sessions that alternated with reference memory training and showed a progressive warping of working memory that was most marked at long retention intervals.

5:15 PM **Transitive and anti-transitive emergent relations in pigeons' successive matching**
Peter J. Urcuioli, & Melissa J. Swisher (Purdue University)

59 Pigeons concurrently trained on AB and BC arbitrary successive matching along with BB identity matching subsequently demonstrate AC transitivity on non-reinforced probe trials. In contrast, pigeons concurrently trained on AB and BC successive matching along with BB oddity subsequently demonstrate anti-transitive AC relations akin to previously reported anti-symmetry effects (e.g., Urcuioli, 2008, Experiment 4). Training only AB and BC arbitrary matching baseline relations does not yield emergent differential AC responding in most pigeons. These results can be derived from, and provide additional validation for, Urcuioli's (2008) theory of pigeons' stimulus-class formation.

5:30 PM **Multiple necessary cue discrimination learning by pigeons**
Ed Wasserman, & Yuejia Teng (University of Iowa)

60 We deployed the Multiple Necessary Cue (MNC) discrimination learning task to see if pigeons can simultaneously attend to four different dimensions of complex visual stimuli. Specifically, we trained eight pigeons (*Columba livia*) on a two-alternative forced-choice discrimination to peck only 1 of 16 compound stimuli created from all possible combinations of two stimuli from four separable visual dimensions: shape (circle/square), size (large/small), line orientation (horizontal/vertical), and brightness (dark/light). Half of the pigeons had CLHD (circle, large, horizontal, dark) as the positive stimulus (S+), whereas the other half had SSVL (square, small, vertical, light) as the S+. Our pigeons: (1) very effectively learned the MNC discrimination involving four dimensions of the visual discriminative stimuli, (2) evidenced clear, but slightly unequal control by those four dimensions, and (3) responded with increasing choice accuracy the more dimensional discrepancies existed between the presented S+ and the presented S-. Although these findings were in general accord with the original Rescorla-Wagner model, adding configural cues to the model materially enhanced the ability of the model to account for the present case of MNC discrimination learning.

5:45 PM *Break*

5:55 PM Introduction - Mike Brown

6:00 PM Master Lecture – When Animals Misbehave
61 Tom Zentall (University of Kentucky)

7:30 PM Banquet

Saturday Afternoon

12:00 PM Business Meeting of the Comparative Cognition Society

1:10 PM Group Photo Shoot - SMILE!! ☺

1:30 PM Memory (Chair: Monique Udell)

1:30 PM **Where are the tools? Memory for distant past events in great apes**

Gema Martin-Ordas (Center on Autobiographical Memory Research)

62 Autobiographical memory is the kind of memory that allows one to remember personal past events. It can happen spontaneously through associative cuing or strategically through goal-directed retrieval. Comparative research has mainly focused on whether animals remember what-where-when something happened (i.e. episodic-like memory). Using a new experimental paradigm we show that chimpanzees and orangutans recalled a tool-finding event that happened four times 3 years earlier and a tool-finding unique event that happened once 2 weeks earlier. Subjects were able to distinguish these events from other tool-finding events. Like in human autobiographical remembering, a cued, associative retrieval process triggered apes' memories. Our results strongly suggests that apes' memories are much more human-like than previously believed.

1:44 PM **Reduced adult neurogenesis impairs spatial learning in black-capped chickadees**

David F. Sherry (University of Western Ontario), Zachary J. Hall (University of St. Andrews), & Shauna Delaney (University of Western Ontario)

63 The function of hippocampal neurogenesis in birds is not well-understood. Seasonal elevation in hippocampal neurogenesis in black-capped chickadees corresponds only roughly to the seasonal occurrence of food storing. Birds prevented from caching and retrieving food in captivity, however, have less hippocampal neuronal recruitment than control birds. Adults of migratory subspecies of songbirds can have higher levels of hippocampal neurogenesis than adults of non-migratory subspecies. While these findings are consistent with the idea that hippocampal neurogenesis makes a positive contribution to hippocampus-dependent memory in birds, the results are also correlational. We reduced hippocampal neurogenesis in black-capped chickadees for a 6-day period with the anti-mitotic agent methylazoxymethanol (MAM) and observed no reduction in the accuracy of spatial memory immediately following treatment. We found, instead, a reduction in memory accuracy 20 days following treatment with MAM. The timed pulse of reduced neurogenesis both impaired spatial learning and did so after a lag corresponding to the time required for new neurons to migrate into the hippocampus from the subventricular zone where they originate. This result confirms that new adult-generated hippocampal neurons play a central role in the acquisition of new spatial information in birds.

1:58 PM **The effect of hibernation on spatial memory retention in an amphibian (*Salamandra salamandra*)**

Anna Wilkinson (University of Lincoln), Anne Hloch, Julia Mueller-Paul (University of Vienna), & Ludwig Huber (Messerli Institute)

64 Hibernation is an adaptive strategy which enables animals to survive harsh winter conditions. However, the impact that this has on cognitive functions is poorly understood. It is known that hibernation causes reduced synaptic activity and is therefore likely to have an adverse impact on memories formed prior to hibernation. Recent research with mammals is inconclusive. The aim of this study was to examine whether an amphibian, the fire salamander (*Salamandra salamandra*), was able to learn a maze-task and whether this information was retained after a period of hibernation. Twelve fire salamanders were trained to make a simple spatial discrimination using a T-maze. All subjects learned the initial task. Upon reaching criterion half of the subjects were hibernated for 100 days while the other half served as controls and were maintained under normal conditions. A post-hibernation memory retention test revealed that subjects from both conditions retained the learned response. This finding contrasts with much of the mammalian research and suggests that the processes underlying memory retention, and/or those involved in hibernation, may differ between mammals and amphibians.

2:12 PM

65

Does delay to reinforcement affect performance in a matching-to-sample task as it does when the delay is between sample and comparison?

Thomas R. Zentall, J. Case, & Jennifer R. Laude (University of Kentucky)

Working memory in pigeons has been assessed by training pigeons on matching to sample without a delay between samples and comparison stimuli and testing them with delays. However, some of the decrement in accuracy may result from the reduction in attention to the sample due to the delay between sample response and reinforcement. Furthermore, the novelty of the delays may result in additional disruption of matching accuracy. To reduce the effect of delay novelty on delayed matching we trained pigeons with delays from the start. And to assess the effect of sample-reinforcement delay, independently of sample-comparison delay, we compared delay between sample and comparison stimuli with delay following the comparison response. In addition, research has suggested that lighting the delay results in reduced matching accuracy but once again, illumination has been a novel event. In a 2 x 2 design we trained pigeons on delayed matching with delays from the start and manipulated the location of the delay and whether the delay was filled or unfilled with illumination. Filling the delay generally facilitated delayed matching, as well as delayed reinforcement and although delayed matching accuracy decreased with increasing sample-comparison delay, it did not decrease with increasing sample-reinforcement delay.

2:19 PM

66

Working memory: Testing modality-specific memory in a successive match-to-sample go/no-go task with humans

Trevor Swanson, J. Taylor, & Kenneth J. Leising (Texas Christian University)

Working memory is theorized to consist of parallel subsystems, including those for visuospatial (object and location) and auditory information. To this end, we developed a successive match-to-sample go/no-go procedure utilizing modality-specific stimuli to test the independence of each subsystem. Human participants were shown stimuli on a touchscreen-equipped monitor and asked to determine whether an initial stimulus matched a subsequent 'target' stimulus in the dimension specified by stimulus type: colorless snowflake images had to match in pattern, but not screen location, colorful kaleidoscope images had to match in location, but not pattern, and sounds had to match in frequency, but not source location. Participants were trained and tested in a single session. During training, the sample and target were divided by a 4-second delay. In the test phase, separate trials with each stimulus type (snowflake, kaleidoscope, tone) included a 'distracter' stimulus from one of the three stimulus types inserted in the delay; auditory distracters caused the greatest deficits in remembering sound frequency, and snowflake distracters caused the greatest deficits in remembering patterns. Due to the adaptability of this apparatus, future applications may include variations aimed at making successful cross-species comparisons of working memory.

2:26 PM

67

Practicing memory retrieval improves long-term retention in rats

Jonathon D. Crystal, J. Aaron Ketzenberger, & Wesley T. Alford (Indiana University)

The view that the human mind is a repository of stored items dates at least to Aristotle and Plato and continues to dominate investigations of human memory. This view fits with our intuitions that we study information as the optimal method to store information in memory and that retrieval of information functions only to assess what information was previously stored. Yet modern research on human memory suggests that retrieving information during a test facilitates later memory of that information. Here we show that practicing memory retrieval improves long-term retention in rats. Rats' retention was evaluated using a standard 2-phase radial maze procedure. We tested the hypothesis that placement in the central hub prompted memory retrieval and improved subsequent memory performance by comparing performance in the test phase after receiving an extra hub placement or no-placement treatments. Placement in the hub after studying improved long-term retention. The benefits of practicing memory retrieval is apparently quite old in the evolutionary timescale.

2:33 PM

68

A new theory of visual short-term memory supported by monkeys and humans

Deepna Devkar, Anthony A. Wright (University of Texas Medical School), & Wei Ji Ma (New York University)

Despite decades of theorizing that visual short-term memory (VSTM) is a fixed capacity —for example 4±1 items (humans)—recent evidence from our (and other) laboratories has shown that VSTM in monkeys and humans is a noisy, continuous resource distributed across many if not all items in the visual field. This new theory of memory was tested against the fixed-capacity theory in a change detection task, where set size and magnitude of change were manipulated along a continuously variable dimension of change (degree of line tilt). Behavioral performance across these manipulations generated psychometric functions that allowed discrimination among VSTM models and theories including fixed-capacity, continuous-resource, and other hybrids. These findings have profound implications for how the brain processes stimuli including encoding, retrieval, and recollection.

2:47 PM **Neurobiology of associative and non-associative learning in social insects: A pharmacological study**

Kaylynn Coates (Westminster College), Hunter McClevish, & Katherine Robertson (PA)

69

Social insects have well-developed olfactory learning and memory capabilities for nest-mate recognition and pheromone communication. They also are good subjects for olfactory conditioning, making them good models for studying the neurobiology of learning and memory. Previous studies that paired conditioned odors with food rewards implicated cholinergic and GABAergic systems in olfactory learning in various insects. However, many of those studies failed to adequately exclude the requirement for acetylcholine or GABA in olfaction or motivation to feed. Nor did they distinguish between memory retrieval and memory formation or associative and non-associative learning. Here, we demonstrate that in ants, muscarinic acetylcholine-receptor antagonists disrupt memory retrieval of learned, conditioned odors and nest-mate recognition but not memory formation, habituation, olfaction or motivation to feed. We also show that GABAA-receptor regulators modify olfaction making it difficult to elucidate their role, if any, in olfactory learning, and finally, that GABA and acetylcholine are expressed in regions of the brain consistent with these roles. Our results suggest that learning and memory in insects is more complex than previously thought; they support a role for muscarinic receptors in long-term memory retrieval but indicate a requirement for further research into the mechanisms that underlie memory formation.

3:01 PM **Pavement ants, *Tetramorium sp. E*, learn to avoid predatory antlions' pit traps**

Karen L. Hollis, Kelsey McNew, Alexandra Bemis, Talisa Sosa, Felicia Harrsch (Mount Holyoke College), & Elise Nowbahari (Université Paris 13)

70

Pavement ants, *Tetramorium sp. E*, often inhabit the same sandy soils as a common predator, pit-digging larval antlions (*Myrmeleontidae spp.).* Previous research in our laboratory has shown that pavement ants are able to rescue captured nestmates from antlions' pit traps, thus sabotaging antlions' attempts to capture them. Recent work suggests that pavement ants possess yet another antipredator strategy, namely the ability to learn to avoid antlion pits following a successful escape from a pit trap. In Phase I, an ant was confined to a bowl containing an antlion pit and, if it fell into the pit and successfully escaped, it was tested for its ability to avoid a pit in Phase II. Seven different experimental conditions, including the presence or absence of an actual antlion in the pit during either or both phases, and the opportunity to confront the same or a different pit, allowed us to test various explanations of how ants might avoid antlions. Results suggest that ants are able to form a generalizable memory of pit characteristics and that the ability to avoid pits does not depend on cues that the ant, itself, leaves behind in the pit or cues emanating from an antlion's presence.

3:15 PM *Snack Break*

3:55 PM Associative Processes (Chair: Ken Leising)

3:55 PM **Adaptive benefits of conditioning to find food in snails (*Helix aspersa*)**

Beatriz Alvarez, & Ignacio Loy (Universidad de Oviedo)

71

Learning to anticipate the access of a biologically relevant event should promote benefits in terms of biological function. In fact it has been clearly demonstrated that classical conditioning increases the biological function of some behaviors (e.g., reproductive efficacy, Hollis, 1989, 1997). In snails it is not clear whether appetitive classical conditioning procedures result in an increase of the biological function in terms of food finding (Ungless, 2001). However, other studies have shown that just experiencing a given source of food is enough to find it (Teyke, 1995). The experiment presented showed that, when carrot is used as a US, both training to find it and experience with it results in faster food finding. However when potato is employed, only training snails to find it, but not mere experience with it, results in an improvement in food finding. The results are discussed in terms of substance's detectability, and their importance for pests controlling is also considered (Baker, 2012).

4:02 PM **Mutually competing associations during blocking: Why more is not always better**

Duncan Amegbletor, & Francisco Arcediano (Auburn University)

72

The blocking effect (Kamin, 1968) showed that responding to a stimulus was diminished (blocked) if it was presented in compound with a previously trained stimulus. Recent work with non-human animals, which examined the ability of the blocked stimulus to attenuate responding to the blocking stimulus (Arcediano et al., 2004), indicated that in some circumstances blocking is a reciprocal effect. That is, even though the blocking stimulus attenuated responding to the blocked stimulus, the blocked stimulus in turn reduced responding to the blocking one. We sought to examine this reciprocal blocking effect in human learning. Both the blocking and the blocked stimuli were found to mutually compete with each other. Of key interest is the observation that the blocking stimulus loses behavioral control because of its additional training with the blocked stimulus. This finding is not only at odds with the assumptions of traditional and modern associative learning models, but also with recent models of causal learning based on inferential reasoning.

73 4:09 PM

Negative patterning is sufficient but not necessary for rats to behave sensitively to ambiguously absent events

Cynthia D. Fast, M. Melissa Flesher, Esther W. Yang, Michael S. Fanselow, & Aaron P. Blaisdell (UCLA)

Fast & Blaisdell (2011) reported that rats discriminate the ambiguous absence from the explicit absence of a light after learning a negative patterning discrimination (A+/B+/AB-). In the present experiment, we questioned the necessity of Negative Patterning to promote sensitivity to stimulus ambiguity using a Pavlovian conditioned inhibition procedure (A+/AX-). Following conditioned inhibition training, rats received probe trials with excitatory CS A-alone while Inhibitory CS X was either covered (ambiguously absent) or uncovered (explicitly absent). Subjects responded to A less when X was covered than when it was uncovered. This suggests that the representation of X retrieved by the presentation of A was more effective at inhibiting the conditioned response when X's physical status was rendered ambiguous by the cover. Furthermore, the retrieved representation of X appeared to protect A from extinction during the probe test trials. Collectively, the results offer insight into associative mechanisms that mediate the sophisticated ability to inferentially reason in ambiguous situations.

74 4:16 PM

The cost of associating tasks

Christina Meier, Stephen E. G. Lea, & Ian P. L. McLaren (University of Exeter)

Humans and pigeons engaged in a task-switching paradigm involving grating patterns that varied in spatial frequency and orientation. On each trial, one of four colour cues signalled which of two discriminations had to be made between the patterns. Human performance was worse on trials when participants had to switch between tasks rather than continuing with the same task, even for people who could not subsequently verbalise the rules underlying the two tasks. Pigeons, however, showed no sign of such "switch costs". The pigeons' behaviour was best matched by Pearce's configural model of Pavlovian conditioning. This suggests that, in the case of pigeons, the combined representation of cue, stimulus and the correct response location became associated with the outcome, so that each cue-stimulus-location combination was represented as a unit in the associative network. This had the effect of minimising switch costs, though the influence of one trial on the next was still detectable if the stimulus was the same in successive trials. Contingency-governed human behaviour, on the other hand, was better described by an instrumental conditioning model, in which the two cues that signalled the same task became associatively equivalent, increasing the magnitude of the switch costs in humans.

75 4:23 PM

Training history and ambiguity alter conditional spatial discriminations

Chad Ruprecht, Arielle Elliott, Joshua Wolf, & Kenneth Leising (Texas Christian University)

Aristotle pondered the concept of an association, contending that objects close together in space tend to be associated together. We wondered if spatial relations were also encoded within conditional links, such as the link between an occasion setter and its target. We trained undergraduates to solve feature-positive spatial discriminations (e.g., XA+, A) during a spatial search task. The spatial location of the hidden goal, in relation to the landmark, was conditional on the occasion setter paired with it. Transfer tests pitted pre-trained occasion setters with landmarks differing from training, to asses the control the occasion setter had on (i) the magnitude, and (ii) the spatial accuracy (i.e., direction) of responding. Exp. 1 revealed that the training history of the landmark affected the magnitude of responding at test but not spatial accuracy; these results differed markedly from pigeon subjects. Exp. 2 revealed that the occasion setter itself may exert control over spatial accuracy, if the landmark is rendered spatially ambiguous during feature-positive training. The results are discussed within the backdrop of current configural/hierarchical accounts of conditional responding; we argue tracking spatial behavior will further qualify what kind of information is encoded within conditional relationships.

76 4:30 PM

Modulation of variability in path choice by reward expectation in rats

Kelly A. Griffith, & W. David Stahlman (University of Mary Washington)

The relationship between behavioral variability and reward expectation has been examined in recent years (Gharib, Derby, & Roberts 2001; Stahlman & Blaisdell, 2011b). The evidence indicates that this relationship is predictive: When an animal has a low expectation of reinforcement for a particular behavioral set, they will engage in high levels of variability in their actions. We conducted a study to further investigate this relationship using a novel measure of behavioral variability. Rats were trained to run through a column maze, with many possible reinforced pathways, to receive either their maintenance diet or a highly palatable reinforcer. We hypothesized that animals trained with their maintenance diet would demonstrate more variation in the pathways taken to the goal location than those animals trained with a highly preferred reward. As predicted, rats that received chow showed greater variability in pathway choice and made more errors than rats that received cereal. These results corroborate the relationship between reward expectation and behavioral variability in a new behavioral measure.

4:37 PM **The search for a motion superiority effect in feature-positive conditional discriminations**

Josh Wolf, Chad Ruprecht, Joe Leyva, Katarina Royder, & Kenneth Leising (Texas Christian University)

77

The survival pressures of the animal kingdom have led to the development of highly effective senses utilized during hunting and predator evasion. In the domain of visual perception, motion cues are critical for the success of both predator and prey. The superiority of motion over static cues during predictive learning has been found within basic Pavlovian and instrumental conditioning paradigms. To evaluate the superiority of motion cues in conditional relations, we trained rats on a feature-positive discrimination. During feature-positive training animals must learn to respond to a target (e.g., A) in the presence of a feature (XA+) but not in its absence (A-). Two groups of rats were tested with a visual feature stimulus and an auditory target stimulus. The visual stimulus was vertical black and white grating displayed for 5-15 s on the upper half of an iPad screen followed by 15-s of the auditory stimulus. The visual stimulus appeared to move left-to-right for Group Dynamic, and remained motionless in Group Static. After considerable training, we did not find a motion superiority effect. The results, including data from tests for transfer to other targets, will be discussed.

4:44 PM *Break*

4:49 PM Discrimination Learning (Chair: Stephen Fountain)

4:49 PM **Learning variable sequences of responses based on an artificial grammar**

Walter Herbranson (Whitman College)

78

Implicit memory is a broad category, and as such has spawned a wide variety of experimental procedures. Some of these procedures typically involve repetition of a relatively small stimulus set (such as serial response learning) whereas others feature large, tremendously variable stimulus sets (such as artificial grammar learning). It has been suggested that the potential to accommodate variability is a fundamental feature of implicit memory. If so, then serial response learning tasks ought to produce learning, even if additional variability is introduced. To test this possibility, pigeons learned a serial response task in which target locations were determined by a synthetic grammar. Targets appeared sequentially on three response keys determined by the rules of the grammar, and pecks to targets were intermittently reinforced. Average response times became gradually faster, and slowed immediately when the sequence was changed to a random (non-grammatical) one. Furthermore, response times to specific transitions within the grammar became faster when the associated probabilities were increased. These results are consistent with both chunk-strength accounts of artificial grammar learning and local predictability accounts of serial response time learning.

5:03 PM **Lexical stress in humans and budgerigars**

Marisa Hoeschele, & W. Tecumseh Fitch (University of Vienna)

79

Language is a defining feature of the human species. Through comparative work, researchers can tease apart what aspects of language are uniquely human, and what aspects can be found in other species. To date, phonology has received less attention than syntax in nonhuman animals, despite it being a fundamental sub-system structuring language. One important aspect of phonology is lexical stress: the apparent "strength" of some syllables relative to others. The ability to perceive lexical stress is important because it can help a listener segment speech and distinguish the meaning of words and sentences. We used a go/nogo operant paradigm to train human participants and budgerigars (*Melopsittacus undulatus*) to distinguish trochaic (stress-initial) from iambic (stress-final) two-syllable nonsense words. Once participants learned the task, we presented novel words and also words that had certain cues removed (e.g., pitch, duration, loudness, or vowel quality) to determine which cues were most important in stress perception. While human participants generally learned the task within 1 session and made errors closely reflecting previous knowledge about stress perception in the humans, the budgerigars had considerable difficulties with this seemingly simple stress discrimination task. The results from the two species will be compared and discussed.

5:10 PM **Personality differences in a jar opening task for giant Pacific octopuses.**

Robert Gormley, & Preston Foerder (University of Tennessee Chattanooga)

80

Research into octopuses has shown that they are highly visual, are capable of problem solving tasks, and have varied personalities. Past research has shown octopuses capable of opening closed jars for food reward. The giant Pacific octopuses (*Enteroctopus dofleini*) at the Tennessee Aquarium are regularly fed using closed jars as behavioral enrichment. We conducted a visual discrimination test on the aquarium's three octopuses in which they were presented with two clear jars simultaneously, one containing a food item (shrimp). We hypothesized that the octopuses would be capable of visually choosing and opening the food jar. Interestingly, only one octopus showed evidence of this capability. The other two octopuses showed different individual strategies for making their choice. While we observed some evidence for visual discrimination in this species, our findings provide further support for personality differences in octopuses.

5:17 PM **The effect of response modality on mid-session reversal tasks in dogs, pigeons, and rats**

Aaron P. Smith, Kristina F. Pattison, Jennifer R. Laude, & Thomas R. Zentall (University of Kentucky)

81

Multiple reversal learning has been used to assess the flexibility of a species' learning ability. In the limit, animals may be able to learn to use the feedback from the last simultaneous discrimination trial as the basis for their response on the next trial (win-stay/lose-shift). In the midsession reversal procedure, a simultaneous discrimination (S1+S2-) is reversed midway through each session (S2+S1-). Previous research found that pigeons appear to time when the reversal will occur (i.e., they begin to choose S2 in anticipation of the reversal and they perseverate by continuing to choose S1 following the reversal), whereas rats appear to learn to use local reinforcement history as the basis for reversing (i.e., they approximate win-stay/lose shift performance). In the present research we find that dogs, using a touch screen version of the task, perform similarly to pigeons and we test the hypothesis that the nature of the response (lever pressing by rats, key pecking by pigeons and nose pressing by dogs) may be responsible for the species differences by comparing lever pressing and nose pressing by rats to key pecking by pigeons and nose pressing by dogs.

5:24 PM **Motion improves numerical discrimination in the guppy (*Poecilia reticulata*)**

Maria Elena Miletto Petrazzini, Christian Agrillo, & Angelo Bisazza (University of Padova)

82

Although several studies have shown that non-human animals exhibit numerical abilities in different contexts, little is known about their ability to enumerate moving stimuli. To date, the influence of items in motion has been mainly investigated in mammals. Here we studied the effect of items in motion on numerical acuity of fish. To this aim, guppies were initially trained to discriminate two numerical contrasts having the same easy ratio (0.50): 2vs.4 (small numbers) and 6vs.12 (large numbers). Half of the fish were presented with moving items; the other half were shown the same stimuli without motion. Fish were then subjected to probe trials in the presence of a more difficult ratio (0.75: 3vs.4 and 9vs.12). Under both static and moving conditions, fish significantly discriminated 6 versus 12, but not 9 versus 12 items. As regards small numbers, both groups learned to discriminate a 0.50 ratio, but only fish tested with moving stimuli also discriminated 3vs.4 items. Our results showed that items in motion differently affect the performance of small (≤4) and large (≥4) quantity discrimination, a dissociation that is suggestive of the existence in fish of separate cognitive systems for small and large numbers.

5:31 PM Closing Remarks (Debbie Kelly)

8:30 PM Poster Session II (8:30 - 11:00)
See Poster Abstracts Starting on Page 30

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

Posters

Poster Session I - Thursday Evening

P1

The discrimination of pure tone sweeps by mice

Laurel A. Screven, David P. Holfoth, Katrina L. Toal, & Micheal L. Dent (University at Buffalo SUNY)

Mice are able to vocalize in ultrasonic frequency ranges, with many of their vocalizations in the 60-80 kHz range. CBA/CaJ mice often produce ultrasonic upsweeping and downsweeping vocalizations (sweeps) within their vocal repertoire. Determining the ability of mice to discriminate between artificially created upsweep and downsweep tonal stimuli will expand the current knowledge about acoustic communication in mice. Mice were trained and tested using operant conditioning procedures and positive reinforcement to discriminate between upsweeping and downsweeping stimuli. The stimuli varied in frequency range, duration, and direction of the sweep. The animals were required to respond when they heard a change in the repeating background, indicating that they could discriminate background from target. The mice did significantly worse discriminating between background and target upsweeps and downsweeps when the stimuli occupied the same bandwidths, even when the stimuli also differed in duration. However, when the sweeps occupied different frequency ranges, discrimination performance improved. These results collected using artificial stimuli created to mimic natural USVs indicate that the bandwidth of vocalizations may be much more important for communication than the frequency contours of the vocalizations. This work was supported by NIH DC012302.

P2

The perception of intensity and frequency differences in CBA/CaJ mice

Katrina L. Toal, Kelly E. Radziwon, & Micheal L. Dent (University at Buffalo-SUNY)

The ability to distinguish between sounds of differing intensities and frequencies is a fundamental auditory process, yet it has not been explored in CBA/CaJ mice. Using behavioral approaches, previous researchers have examined the frequency and intensity discrimination abilities of the NMRI mouse, feral house mice, and other strains of mice with known hearing impairments. The present experiments examine the basic hearing abilities of the normal-hearing CBA/CaJ mouse using operant conditioning procedures. Nine CBA/CaJ mice were trained and tested using operant conditioning methods to obtain IDLs (six subjects), and FDLs (three subjects). For both measures, the Method of Constant Stimuli and a threshold d' of 1.5 were used. IDLs and FDLs were obtained for 12, 16, 24, and 42 kHz tones. FDLs were obtained at 10 dB SL and 30 dB SL whereas the background for the IDL task was only 10 dB SL. At higher frequencies, the calculated FDLs increased. Furthermore, the thresholds were higher when sounds were presented at 30 dB SL compared to 10 dB SL. Interestingly, IDLs were similar across all frequencies. In the FDL experiment, the mice had a mean just-noticeable-difference (JND) of 3.5% Weber fraction across all four frequencies and sound levels.

P3

Developmental stress affects auditory learning in female, but not male, European starlings (*Sturnus vulgaris*)

Tara Farrell, Amanda Morgan, & Scott MacDougall-Shackleton (Western University)

In songbirds, early-life environments are instrumental in shaping song development. As it is typically the male of the species that sings, most studies to date have been male-focused. However, song has evolved through signaler-receiver networks and the effect stress has on the ability to receive auditory signals is equally important, especially for females who use song as an indicator of mate quality. We subjected juvenile European starlings (Sturnus vulgaris) to either an ad libitum or unpredictable food-supply treatment from 35-115 days of age. In adulthood, we assessed learning in both auditory and visual dimensions. In an operant conditioning task, we found that females reared in control conditions acquired two auditory discriminations (absolute and relative frequency tasks) faster than females raised in our stressful conditions. There was no difference between treatment groups for males. However, there was a significant effect of treatment group on the number of errors committed per trial on a colour association task; food-restricted birds committed more errors than controls. Our results suggest the auditory system may be more robust to developmental stress in males than females. In conclusion, developmental stressors have sex-specific effects on cognition that could be the result of different selection pressures on each sex.

P4

Can dogs learn an auditory same/different concept?

Andrea M. Thompkins, Adam M. Goodman, & Jeffrey S. Katz (Auburn University)

Canine cognition is a growing area of research, however the domestic dog's ability to utilize a same/different abstract concept has yet to be explored. Six domestic dogs (*Canis familiaris*) are being trained on a same/different task using auditory stimuli, including human, animal, environment, and effects sounds. A novel apparatus was designed and constructed to allow nose poke responses to be recorded during automated sessions. Training sessions are administered daily and consist of 24 trials (12 same, 12 different). Some dogs have demonstrated the ability to learn the auditory same/different discrimination. The results will add to both the canine cognition and abstract-concept literature by providing a comparative perspective on canine abstract-concept learning.

P5

Spontaneous quantity judgments in domestic dogs

Christine Dumbleton, Ann Marie Arnold, & Lauren Highfill (Eckerd College)

Recent studies have demonstrated that domestic dogs, like chimpanzees and monkeys, are able to detect quantitative differences between sets of visible stimuli. The current study examined the spontaneous performance of 25 domestic dogs on a quantity judgment task that required the viewing of food items presented one-by-one into an opaque container. Some dogs performed very well in the task, while others performed at near-chance levels. Overall, the findings were consistent with past studies in which subjects found numerically close comparisons (e.g., 2 vs. 5) more difficult than numerically distant comparisons (e.g., 1 vs. 5).

Domestic dogs (*Canis Familaris*) social cognition of communicative gestures

Page Holland, & Dr. Lauren Highfill (Eckerd College)

P6

Past research has indicated that dogs are able to follow communicative gestures to locate food in one of two separately placed cups (Hare & Tomasello, 1999). The current study tested whether a dogs' ability to read certain human communicative gestures would be useful in a puzzle-task. Thirty domestic dogs of different breeds and ages were shown three different communicative gestures indicating the location of a hidden treat in a treat puzzle game, which had four identical and closely spaced hiding chambers. The three gestures used were tapping (human informant tapped her finger on the correct chamber); gaze and point (human informant pointed and gazed approximately 5 inches from the correct chamber), and marker (human informant placed a small sponge on top of the correct chamber). Consistent with past research, the subjects were able to use the tapping (binomial test, $p < 0.01$) and point and gaze gestures (binomial test, $p < 0.05$), but were unable to use the marker as a communicative cue. Control trials indicated that the dogs were not being inadvertently cued or relying on their sense of smell. The current study provides additional support for the domestic dogs' ability to use communicative gestures from humans.

Domestic dogs' (*Canis familiaris*) choices in reference to agreement among human informants on location of food

Shannon M. A. Kundey (Hood College), Weston Dennen, Catherine Dennen, Blair Starnes, Kathleen Ford, Justin Deslise, & Andres De Los Reyes (University of Maryland at College Park)

P7

In interactions, informants sometimes offer conflicting information or information varying in accuracy. Research suggests that young children do not trust all informants uniformly and show selectivity in solicitation of claims and in supporting claims. We explored if domestic dogs (*Canis familiaris*) are similarly sensitive to informant agreement. We conducted two experiments utilizing the human pointing gesture. An experimenter hid food in one of two clear containers while the dog was distracted. Next, a small group moved to indicate the food's location using stationary points positioned above the containers. In Experiment 1, two experimenters moved to stand behind the non-baited container, while a third experimenter moved to stand behind the baited container. Then, all directed one static point at the container in front of them. Experiment 2 resembled Experiment 1 with the exception that the single experimenter standing behind the baited container directed two static points at the container (one with each hand). Dogs chose the container indicated by the majority in Experiment 1 significantly more often than chance, but chose the container indicated by the minority in Experiment 2 significantly more often than chance. The number of points, not the number of people, appeared to influence dogs' choices more strongly.

The performance of domestic dogs with a history of minimal human interaction on human-guided object-choice tasks

Lucia Lazarowski, Samantha Traver, Melanie Foster, & David Dorman (North Carolina State University College of Veterinary Medicine)

P8

Several studies have shown that domestic dogs are highly successful in using human communicative gestures to locate food. Comparative studies have evaluated these abilities in pet dogs and other canids with varying rearing histories, but populations of domestic dogs with known histories of limited human interaction are under-represented. The current study used domestic dogs (n=16) that had been socialized to humans during critical periods of development, but resided in a kennel environment since birth. Dogs were tested on a human-guided object-choice task. We found that unlike pet dogs, kennel-reared dogs did not perform above chance on trials in which food location was signaled by a pointing cue. Our results indicate that ontogenetic experiences may influence a domestic dog's ability to use human gestures, and highlight the importance of testing a diversity of sub-populations of domestic dogs.

The affect of structurally similar odors on discrimination tasks in dogs

Adriana Collada, Nathaniel J. Hall (University of Florida), & Clive D.L. Wynne (Arizona State University)

P9

Although dogs have a keen sense of smell, few basic studies on canine olfaction have been conducted. One important cross-species phenomenon is the finding that odorant structural similarity of aliphatic carbon chains predicts perceptual similarity in rats, squirrel monkeys, honeybees and humans. Despite the widespread use of domestic dogs for odor-detection, no studies have investigated the effects of odorant structure of aliphatic alcohols on odor perception in canines. In this experiment, we used a two-choice discrimination paradigm in which two sniffing ports were presented and dogs were trained to respond to the sniffing port containing pentanol (S+). In each session, the non-target odorant differed from pentanol by either 1, 2, or 3 carbons (i.e. ethanol, propanol, butanol, hexanol, heptanol or octanol). Comparing percent correct across sessions, dogs performed better as a function of an increasing number of carbon atoms difference between pentanol (S+) and the non-target odorant. These results suggest that aliphatic alcohols have predictable perceptual similarity for dogs, which can aid future studies investigating generalization and discrimination of odorant stimuli in dogs.

Breed differences in the motivation to play

Chelsea Haitz, Lindsay Mehrkam, & Clive Wynne (University of Florida)

P10

Due to its lack of an obvious function, researchers have largely overlooked play behavior in nonhumans. Domestic dogs provide a convenient subject to study the motivations of play as they are regularly housed with and handled by humans. Previous research suggests that social play in dogs mimics underlying, species-typical predatory behaviors (Burghardt 2005; Bekoff 1995). Furthermore, it has been suggested that differences in these predatory behaviors exist between the motor patterns of breed-types (Coppinger et al 1987), however, no research has been conducted to draw similar conclusions between differences in the proximate mechanisms of social play as a result of selective breeding. The goal of the present study was to determine whether breed differences exist in the motivating operations to engage in social and solitary play in 60 domestic dogs of three different breed-types of working dog: livestock guarding dogs, herding dogs, and retrievers, as defined by Coppinger et al (Coppinger 2001). Pairs of dogs of the same breed-type were exposed to conditions that simulate various stimuli a dog would naturally encounter. We will present findings on breed differences in the tendency to engage in different types of play, as well as the stimuli that evoke social play.

Evaluation of behavioral interventions to decrease unattractive behavior in shelter dogs

Alexandra Protopopova (University of Florida), & Clive D. L. Wynne (Arizona State University)

P11

Euthanasia in animal shelters is the number one preventable cause of death in pet dogs. Previous research has found that certain behaviors of dogs, both in and out of the kennel, influence the decisions of adopters. In a sequence of studies, we have evaluated common and novel behavioral interventions to increase attractive and decrease unattractive in-kennel behaviors of shelter dogs. In Experiment 1, we assessed additional exercise versus calm interaction as an abolishing operation (AO) for unattractive in-kennel behavior. In Experiment 2, we compared the efficacy of a Pavlovian versus an operant procedure to decrease unattractive behavior. In Experiment 3, we assessed the efficacy of a Pavlovian procedure on a whole shelter population level. Our results suggest that interventions that aim to function as an AO are not generally effective; however, we found that Pavlovian procedures are, surprisingly, an efficient and effective way to alter in-kennel behavior. Future research will focus on finding interventions to change out of kennel behavior, as well as assess the effects of both interventions on adoption rate. Our results will provide shelter staff and volunteers with an empirically validated training procedure to reduce undesirable behaviors of shelter dogs and, thus, decrease euthanasia rates.

Using conditional probability analysis to identify play signals in the domestic dog (*Canis lupus familiaris*)

Cassandra L. Vazquez, Lindsay R. Mehrkam (University of Florida), & Clive D.L. Wynne (Arizona State University)

P12

Dogs engage in specific behaviors – often termed "play signals" – to communicate intent to engage in social play with a conspecific (Bekoff 1974). It should follow that dogs also engage in behaviors to communicate their intent to aggress. Previous research has suggested that even experienced owners and trainers have difficulty distinguishing between play and aggression in dogs, suggesting widely varying conceptions of what constitutes appropriate and inappropriate play. The primary aim of this study was therefore to identify discrete behaviors that may be high-probability and low-probability play signals in dog-dog play. A total of 845 play bouts were obtained from 486 dogs at two local dog parks. The occurrence of each discrete behavior (e.g., play-type, tail position and direction, ear position, vocalization, play signals, head position, self-handicapping) within a 15-s interval preceding the end of the bout were subsequently coded from video. Play bow was among the behaviors with the highest probability of occurring prior to the end of a non-aggressive play bout, whereas "play face" – a widely-cited play signal - occurred at a relatively lower probability. These results will contribute to a greater understanding of behaviors that serve as visual communicative cues among conspecifics during social play.

Control of choice by human gestures in domestic dogs

Jennifer Ruff, & Michael F. Brown (Villanova University)

P13

Previous research with domestic dogs has shown them to be especially well controlled by human pointing gestures. However, previous research has not focused on examining the strength of this control, or been performed on populations of dogs who may prove less sensitive to human gestures due to relatively little socialization with humans. By separately training dogs at an inner city open-intake shelter to select the location of a reward based on either a simple visual cue or a social communication gesture (pointing by an unfamiliar human) and then pairing the two cues in a competition paradigm, we examined the relative control by simple visual cues vs. human social gestures and correlations between a dog's history (e.g., age, previous exposure to humans, training). Data collected showed that dogs in this study were controlled significantly more by human social cues regardless of their socialization history, and that there was no significant interaction between dog's history and the degree to which the two types of cue controlled their behavior during testing.

Effects of dog breed labeling on potential adopter perceptions & shelter length of stay

Lisa Gunter, & Clive D. L. Wynne (Arizona State University)

P14

Previous research has indicated that certain breeds of dogs, including pit bull-type dogs, stay longer in shelters than other breeds. Current dog breed identification practices in animal shelters are often based upon information supplied by the relinquishing owner or staff determination based on the dog's phenotype. However researchers have found discrepancies between breed identification as typically assessed by welfare agencies and the outcome of DNA analysis. Specifically, breed identification of pit bull- type dogs by shelter staff and veterinarians was inconsistent across individuals and an unreliable means of identification: many dogs labeled as pit bulls lack such DNA breed signatures. The present study examines dogs that were labeled as pit-bull-type breeds (American Pit Bull Terrier, Pit Bull Terrier, American Staffordshire, Staffordshire Bull Terrier or American Bulldog) and dogs that were phenotypically similar but were labeled differently at a limited admission animal shelter in Phoenix, Arizona. We compared the dogs' lengths of stay as well as potential adopters' perceptions of their approachability, intelligence, friendliness and adoptability when viewed in photographs. Data analysis from this study will be presented.

The efficacy of a timeout treatment for an aggressive dog: Observations of discrimination and generalization across three stimuli situations

Ginnie Hershbarger (Arizona State University), Wendy Williams (Central Washington University), & Clive Wynne (Arizona State University)

P15

Dog aggression is a dangerous problem as 4.7 million people are bitten each year (Gilchrist, Sacks, White, & Kresnow, 2008, Injury Prevention, 14: 296-301). Current strategies for treating aggression include flooding, positive punishment, and systematic desensitization. However, these interventions have limitations and may exacerbate the problem or be ineffective. Therefore, the efficacy of a novel timeout treatment for an aggressive dog was studied. One highly reactive female German shepherd dog was subjected to three independent situations in which three different people approached and placed in timeout contingent on aggressive behavior. Aggression was measured as latency to aggression onset, distance from the stimuli when the aggression began, and duration of the aggressive episode. Results demonstrated that aggression could eventually be reduced towards all three stimuli through application of a contingent timeout. Furthermore, although the stimuli were initially discriminated, once the subject learned the timeout contingency, spontaneous generalization occurred across all stimuli. Implications of timeout treatment for aggressive dogs, conclusions regarding visual stimulus generalization and discrimination in the dog, and directions for future research will be discussed.

P16

Can early malnutrition explain the spatial deficit in adult rats following perinatal exposure to cannabinoids?

Christopher B. Hartless, Stephen P. Casazza, Amanda G. Adams, Michael A. Curry, Micaela L. Davidow, & Pamela A. Jackson (Radford University)

The potential confound of malnutrition in rodent models of perinatal cannabinoid exposure on spatial cognition was investigated. Our preliminary data suggested that dams exposed to a cannabinoid agonist during the lactational period reduced their food consumption. As a result, offspring on average weighed less during the neonatal period as well as during the first 7 weeks of life. In the current study, maternal dams were randomly assigned to a drug condition (subcutaneous injections of CP55,940 from postnatal day 2 through 19), or one of two vehicle control conditions. One control condition received free access to food throughout, as did the drug group, but each yoked-control animal received the same amount of food as consumed by a matched drug subject. On postnatal day 80 the offspring were behaviorally assessed for differences in acquisition and spatial strategy on the T-maze task. Drug and yoked-control animals were more likely to use a response strategy to solve the discrimination whereas the control animals were more likely to use a spatial strategy. Our findings suggest the need to eliminate the effects of malnutrition due to cannabinoid exposure during development before attributing any impairment in cognitive functioning to the drug alone.

P17

What underlies prosocial behaviors? The role of dominance, harassment, reciprocity, and audiences in pinyon jay food sharing

Juan Duque, & Jeffrey Stevens (University of Nebraska-Lincoln)

Prosocial behaviors involve attending to and improving the welfare of others. In the case of sharing food, a recipient gains a benefit at the expense of another individual, the donor. While expected among kin and pair-bonded individuals, it is unclear under what circumstances this occurs in other cases. In pinyon jays, we have documented the voluntarily giving of monopolizable food using two adjacent cages in which one bird has access to food and another does not. Though some birds share, other never share, suggesting that individuals differ in their propensity to share food. Furthermore, specific pairings of birds lead to more sharing, indicating a dyad-specific effect. We previously tested three non-mutually exclusive hypotheses for circumstances eliciting sharing: sharing as a signal of dominance, sharing as harassment avoidance, and/or reciprocity. The current experiment tests a fourth possibility: sharing for reputational gains. Here we test whether sharing birds attend to the presence of an audience when deciding whether to share.

P18

Common conceptual structures in humans and monkeys

Sarah E. Koopman, Bradford Z. Mahon, & Jessica F. Cantlon (University of Rochester)

Given our common evolutionary history, semantic information might be organized similarly in monkeys and humans. However, the fact that the human semantic system has a unique interface with language could lead to corresponding differences in semantic knowledge structures between humans and monkeys. We compared the semantic structures of humans and monkeys by measuring semantic distance effects in their performance during judgments over exemplars from the category 'animals'. Deciding that two animals are different should be less efficient when they are semantically similar compared to when they are semantically distant. Using a word-picture agreement task in humans, we found a significant relationship between efficiency score (response time/accuracy) and Cree and McRae's human-based measure of semantic similarity between concepts (2003). Surprisingly, using a picture-picture match-to-sample task in monkeys, we found the same relationship between efficiency and human-based semantic similarity. Neither monkey nor human performance was explained by visual similarity. Cree and McRae's semantic similarity measure incorporates linguistic features that are inaccessible to non-humans, yet it still explained a significant portion of the variance in monkeys' efficiency scores. This indicates that the abstract conceptual knowledge captured by the semantic similarity measure has a strong non-linguistic component that both humans and monkeys represent.

P19

Contextual use of the sign 'BLACK' in a signing chimpanzee

Susan Ann Keenan, & Mary Lee Jensvold (Central Washington University)

Gardner and Gardner (1989) cross-fostered several chimpanzees to observe how they would develop and learn signs from American Sign Language. Tatu, one of these chimpanzees, has been observed signing BLACK in varied conversations throughout her life. It was often thought that she used BLACK to describe items she prefers. This study explored that hypothesis. Sign logs, an archival database, contain records of the chimpanzees' use of signs. We selected all instances of the use of BLACK between February 2001 to May 2005. Nine caregivers rated items on a list of topics as positive, negative, or neutral. Tatu signed BLACK in topics rated positively and rarely signed BLACK in topics rated neutral or negative.

P20

Comparing vocalizations and hearing thresholds in aquatic bird species

Sally E. Yannuzzi, Sara C. Therrien (University of Maryland), & Alicia M. Wells-Berlin (USGS Patuxent Wildlife Research Center)

The dominant frequencies in the vocalizations of aquatic bird species closely align with their frequency of best hearing. Hearing thresholds for eight species of aquatic birds were estimated using the auditory brainstem response, and were compared to a spectrographic analysis of vocalizations. The dominant frequency (the frequency with the greatest power) in their vocalizations typically corresponded well to each species' frequency of best hearing, with the exception of the common eider (*Somateria mollisima*). While the rest of the birds had dominant frequencies between 1-3 kHz, the common eider emitted vocalizations that were of a significantly lower frequency (0.44 kHz) than their frequency of best hearing (2.4 kHz). While reasons for this are unknown, we suspect that the duckling vocalization may align closer to the common eider's frequency of best hearing in order to aid duckling survivability.

Signature whistle production during bottlenose dolphin group integration

Megan Broadway, & Heidi Lyn (University of Southern Mississippi)

P21

Most of what we know about dolphin communication comes from studies involving signature whistles (SW) - distinctive calls that are unique for each individual. Looking at the context in which SW are used is likely the most pragmatic way of learning the specific function of these whistles. For this project, we will observe the behavior and vocalizations of dolphins that are being introduced for the first time in order to assess how the production of SW changes over the course of the introduction period. A single-case-design will be used to look at the SW production of each subject in order to determine if SW use is different across baseline and treatment conditions. Example whistle types and exchanges will be presented to delineate social interactions among dolphins. If SW and whistle matching are observed during the course of this study, this will aid in the development of context-dependent interpretations of these whistles. The study of SW may be the key to decoding vocal communication in dolphins. Research and conclusions developed in a controlled setting will allow us to relate these findings to wild dolphin groups in similar situations and will help us to interpret other vocalizations used in those contexts.

Conspecific responses to a distress call produced by a dolphin

Erin Frick, Brittany Jones, & Stan Kuczaj (University of Southern Mississippi)

P22

This study describes succorant epimeletic behavior in a group of Atlantic bottlenose dolphins (*Tursiops truncatus*) off the coast of Jeddah, Saudi Arabia in September, 2012. Epimeletic (or 'care-giving') behavior in cetaceans involves various forms of support provided to a distressed, injured, or dying animal (Caldwell & Caldwell, 1966). Analyses of underwater video augmented by acoustic recordings revealed an unwell, slim, and consistently sinking dolphin (SD). The SD constantly produced distress calls (Lilly, 1965) that were frequently paired with the emission of long bubble streams. She received a number of supporting behaviors from several other conspecifics. These helping behaviors included raft formations, lifts, and stimulating pushes that were predominantly directed at the upper body and head of the SD. This is the first documented underwater account of a wild bottlenose dolphin using a distress call to elicit this type of epimeletic care from multiple conspecifics.

Representation of magnitude in rhesus monkeys (*Macaca mulatta*)

Rachel F. L. Diamond (Emory University), Regina Paxton Gazes (Zoo Atlanta), & Robert R. Hampton (Emory University)

P23

Discrimination between ordinally organized items results in the symbolic distance effect such that accuracy improves and latency decreases as the number of items intervening between two test items increases. The symbolic distance effect has been observed when monkeys perform a variety of tasks including transitive inference, simultaneous chaining, and list memory, suggesting that mental representation of stimuli in these tests depends on an ordinal code. Most English speaking humans represent ordinal information spatially from left to right, and the direction of this spatial representation may be plastic and culturally influenced. To the extent that spatial organization of ordinal information is an ancestral primate trait, monkeys, despite lacking cultural tools such as number lines, should show similar evidence of spatial organization. Because the directionality of putative spatial representations could not be known a priori, we evaluated spatial organization of ordinal information in monkeys both before and after training designed to establish a right-left orientation of representational space.

Numerical discrimination in goldfish (*Carassius auratus*)

Ashlynn M. Keller, & Caroline M. DeLong (Rochester Institute of Technology)

P24

The purpose of this study was to assess numerical discrimination in goldfish. Four goldfish were trained on the ratio 1 vs. 2 (two fish were rewarded for choosing the smaller quantity and two fish were rewarded for choosing the larger quantity). The stimuli were 2D black shapes (circles, rectangles, triangles) printed on a white background, and the surface area covered by black ink was matched within ratio pairs. During the test phase, the fish were presented with different stimuli representing the training ratio (1 vs. 2) and four novel ratios (1 vs. 4, 1 vs. 3, 2 vs. 3, and 3 vs. 4). Preliminary results indicate that the performance of the fish was significantly above chance on the training ratio and all test ratios except for 2 vs. 3. These results are different from past studies with mosquitofish and do not conform to Weber's law. Another study will be done with numbers higher than 4 and different ratios. These data suggest that goldfish can discriminate between stimuli differing in number, like many other non-human animals.

The detection of ultrasonic calls by adult CBA/CaJ mice across the lifespan

Anastasiya Kobrina, Angela Calabrese, Erikson G. Neilans, & Micheal L. Dent (SUNY University at Buffalo)

P25

Mice are frequently used as an animal model in auditory research, yet their hearing capabilities have not been fully explored. Previous studies (Radziwon et al., 2009; Henry, 2004) have examined auditory threshold sensitivity for pure tone stimuli, but little is known about how mice perceive their own ultrasonic vocalizations (USVs), and nothing is known about how aging influences this perception. These USVs are thought to be important for acoustic communication. In order to determine how well mice detect these complex communication stimuli, several CBA/CaJ mice were trained and tested at various ages on a detection task using operant conditioning procedures. A naturally produced male sweep, 30 kHz harmonic, chevron, inverse chevron, complex call, downsweep, and upsweep USV calls were tested. Mice were able to detect USVs at a lower intensity than pure tones of the same frequency range. Not surprisingly, thresholds also differed for the different USV types. Older mice were able to detect USVs presented at a high intensity. The results suggest that mice are sensitive to their complex vocalizations even into old age, highlighting their likely importance for survival and communication, and laying the groundwork for future studies on acoustic communication and aging in this species.

Pigeons peck more often at illusory than non-illusory motion displays

Kathryn M. Mason, Muhammad A. Qadri, & Robert G. Cook (Tufts University)

P26 Illusions can provide insight into the brain's underlying mechanisms responsible for an organism's perception of the world. Kitaoka's "Rotating Snakes" illusion induces a perception of motion from a static image in humans. This study investigated the perception of this illusory motion in birds. In this study, pigeons were presented grain on either an illusory motion or control background in their home cages. Video analysis revealed that pigeons missed more frequently on illusory motion backgrounds than on control displays. These data suggest pigeons may perceive illusory motion in "Rotating Snakes" which indicates that the mechanisms for detecting motion may be fundamentally similar between pigeons and humans.

A test for sex differences in touchscreen 2-choice visual discrimination learning in rats

Megan E. Miller, Alyssa M. Williams, Nicole V. Orenstein, Karen E. Doyle, Samantha M. Renaud, & Stephen B. Fountain (Kent State University)

P27 Recent research in our lab demonstrated sex differences in discrimination learning when it is observed as a component of rat serial pattern learning. To examine whether a sex difference in rat discrimination learning is generalized, male and female rats were trained to discriminate between an S+ of white horizontal bars on a black background and an S- of a disk that progressed from invisible to equally white in 5 phases of training. In touchscreen chambers, 6 male and 6 female rats were autoshaped with water reinforcement to nose poke the S+ when it appeared randomly either on the left or right, then they began the 5-phase fading discrimination learning task. Correct responses were immediately reinforced and incorrect responses were counted but had no programmed consequences. Criterion for transfer to each successive phase was 70% or more correct responses in a daily session of 480 trials. Rats completed the 5 phases of the task in a mean of 6.36 sessions. Total correct and incorrect responses for each of the five phases were analyzed but no significant sex differences were observed. The results indicate that sex differences in rat discrimination learning vary by task, perhaps as a function of task difficulty.

Brief massed training causes persistent retardation of rat serial pattern learning

Samantha M. Renaud, Carly N. Logan, & Stephen B. Fountain (Kent State University)

P28 The spacing effect is that training spaced across many sessions produces better learning compared to massed training. We observed spacing effects in a study assessing adult serial pattern learning after adolescent nicotine exposure. Rats received serial multiple choice task training on a 24-element pattern of responses, 123-234-345-456-567-678-781-818. This nose-poke pattern, trained in an octagonal 8-position nose-poke chamber, consisted of within-chunk, chunk-boundary, and violation elements to assess different cognitive mechanisms. Rats that received Massed-then-Spaced training performed up to 20 patterns per day for up to 4 days after which they performed 10 patterns per day. Spaced-Only rats always performed 10 patterns per day. All rats completed 490 total patterns. A drug exposure x spacing x 10-pattern training blocks repeated measures ANOVA for each element type found a significant blocks main effect and a blocks x spacing interaction for all three element types and a main effect of spacing for within-chunk and chunk-boundary elements ($ps < .05$). Planned comparisons based on the error term of the appropriate ANOVA indicated slower acquisition for Massed-then-Spaced rats for within-chunk, chunk-boundary, and violation elements. Thus, brief exposure to massed training, even when followed by spaced training, can impair learning of a serial pattern.

Fast massed rats: speeding up the slow-pokes

Betsy Stirbens, Grace A. Porter, Samantha M. Renaud, & Stephen B. Fountain (Kent State University)

P29 Effects of massed versus spaced training on serial pattern learning (SPL) have been observed in the serial multiple choice (SMC) task, but such studies are hindered by rats' slow responding early in acquisition. We assessed which of 4 pre-training procedures better prepared rats for massed SPL training on Day 1 of acquisition. Male rats were first shaped to nose-poke a lit receptacle for water. Three groups were used to test whether more nose-poke pre-training in a single receptacle (2, 5, or 10 days) would facilitate completing 20 patterns per day on Day 1 of acquisition. Another group tested whether 5 days of modified pre-training involving tracking a light randomly-presented in 8 receptacles would affect acquisition differentially. Pre-training was followed by SPL training in the SMC task where rats had to perform twenty 24-element patterns within 90-minute sessions. Rats trained with 10 days of single-receptacle shaping or 5 days of light-tracking completed 20 patterns on Day 1 of SPL training. Rats with 2 days of shaping or 5 days with light-tracking acquired the pattern significantly slower than other groups. Thus, increasing pre-training can facilitate achieving massed training but varying the type of pre-training procedure may independently alter serial pattern acquisition rate.

The effects of sex differences in C3H/HeNHsd mice on single and double alternation learning

Dalisa Kendricks, Crystal Osburn, Sonali Poudel, Holly Boettger-Tong, & James D. Rowan

P30 While recent studies have found sex differences in serial-pattern learning in rats (males learn patterns faster than females), it is not clear if this difference in acquisition generalizes to other species. This set of 2 experiments examines whether C3H/HeNHsd mice also show sex differences in acquisition of simple single and double alternation patterns. Both male and female mice were tested first on acquisition of a single alternation pattern for 18 days and then a double alternation pattern for 18 days. Overall, males' performance on both the single and double alternation patterns was significantly better than females'. These findings support the hypothesis that sex differences in pattern learning are not only found in rats.

The effects of sex differences on acquisition of a perfect runs serial pattern in C57BL/6 mice

Madison McCarty, Aahana Bajracharya, Tsu-Yi Su, Holly Boettger-Tong, & James D. Rowan (Wesleyan College)

P31

Earlier research by Fountain and colleagues has found that mice, like rats, can learn long serial patterns composed of different locations in an octagonal maze. Recently, it has been found that male rats learned serial patterns faster than females. This experiment examines whether sex differences also exist for mice. If differences are found, not only they would it demonstrate that these differences are not unique to rats, but would allow for further clarification through the examination of pattern learning in different strains of mice. Both male and female C57BL/6 (Black 6) mice were tested first on acquisition of a perfect runs pattern for 40 days. Overall, males' performance on the perfect runs patterns was significantly better than females'. These findings support the hypothesis that sex differences in pattern learning are not only found in rats.

The effects of strain differences on acquisition of single and double alternation patterns in Male C57BL/6 and C3H/HeNHsd mice

Taylor Lyle, Jordyn Sessoms, Shakarr Wiggins, Diamond Nelson, Holly Boettger-Tong, & James D. Rowan (Wesleyan College)

P32

Many strains of genetically altered mice have been developed in the last few decades. Often, much is known about the genetic/neurochemical differences that exist in these strains but often little is known about the effects on the mouse behavior. Previous research has shown that pattern learning tasks are sensitive to toxicological and pharmacological manipulations in rats. This type of learning might also be sensitive to strain differences in mice. This set of 2 experiments examines whether male C3H/HeNHsd and C57BL/6 mice also show strain differences in acquisition of simple single and double alternation patterns. Both strains of mice were tested first on acquisition of a single alternation pattern for 18 days and then a double alternation pattern for 18 days. Overall, C3H/HeNHsd mice acquisition on both the single and double alternation patterns was significantly better than C57BL/6 mice. This finding suggests that pattern learning tasks can be useful in discovering strain difference effects in mice and can used to further characterize their behavioral effects.

Do degus (*Octodon degus*) infer food location in social context?

Saho Takagi, Toru Betsuyaku, & Kazuo Fujita (Kyoto University)

P33

Social animals are able to forage more efficiently if they could use others' behavior flexibly to locate food. In this study, we investigated whether degus (Octodon degus), a highly social rodent, would infer food location from another conspecific's behavior in the cross-shaped maze. In the first phase, we examined the strength of inherent tendency of degus to follow their conspecific model without any food as baseline, by releasing subjects into the maze after they observed arm choice by the model. In the second phase, we trained both subjects and models to obtain food reward at the end of the arms. In the final phase that followed, we asked which arm, one the model visited or the other not, the subject would go into. The hypothesis was that degus would choose the unvisited arm if they could infer the location of food left uneaten. Some subjects in fact significantly chose the unvisited arm in the third phase more often than in the first phase, which suggested degus' rudimentary inferential ability. Social relationship between the subject and the model might contribute to the success.

An investigation of social learning in orange-winged Amazon parrots

Alejandra Picard, Lauren Hogan, Megan Lambert, & Katie E. Slocombe (The University of York)

P34

The present study investigates social diffusion of a novel foraging technique in Orange-Winged Amazon (OWA) parrots. Data was collected on three groups of captive parrots, with each group housed in its own aviary. A two-action artificial fruit was used to test whether subjects engaged in stimulus enhancement or imitation of the action required to open the box to retrieve food. Two experimental groups had the opportunity to observe a trained demonstrator open the apparatus door using either a pull (n=15) or slide action (n=22), while control groups did not. The 'pull' experimental group completed control trials prior to their experimental trials and an additional control group consisting of closely related blue-fronted Amazons (BFA) was used (n=20). Results showed that experimental parrots interacted significantly more with the box (26/37) than controls (3/37), with more experimental birds successfully opening the box (10/37) than controls (0/37). The demonstrated method was not used significantly more than the non-demonstrated method. Though strong evidence of stimulus enhancement was found, no evidence was found that the OWAs imitated the demonstrated method. This suggests that being big-brained and highly social are not sufficient to promote the use of imitation to solve basic problems.

The development & topography of beluga sexual and agonistic interactions

Mariyah McKinnon (University of Texas at San Antonio), Sarah Dietrich (St. Mary's University), Heather Hill, & Steve Aibel (SeaWorld San Antonio)

P35

The purpose of the study was to document the frequency and topography of sexual and agonistic interactions displayed by four beluga calves at SeaWorld San Antonio in over 912 hours of focal follows collected across five years. Sexual interactions began at 11 to 13 months. There were four acts of calf-initiated sexual interactions in the second year of life and 38 events in the third year of life. Aggressive behaviors initiated by calves also began at 11 to 13 months. Between the four calves, there were 13 events during the first year of life, 57 in the second year of life, and 32 in the third year of life. As the belugas neared adolescence, the topography of the sexual interactions became more similar to the topography of adult sexual interactions. The displayed behaviors occur in both contexts but vary in their topographies. Other behaviors were specific to the context: sexual interactions included a lateralized swim, pecfin raised, erection, genital rub, and an intromission attempt and agonistic interactions included chin jerks and jaw pops. A finer examination of these behaviors suggested that some sexual interactions may include a sequenced chain of behaviors while agonistic behaviors seem to be displayed independently.

P36

Extended counterconditioning training enhances the efficacy of immediate and delayed counterconditioning

Elizabeth P. Dunaway, & Martha Escobar (Auburn University)

Relapse in the form of spontaneous recovery can present a challenge to the efficacy of interpolation paradigms such as extinction and counterconditioning when used as treatments to attenuate conditioned fear. Manipulating the interval between fear acquisition and extinction or the interval between fear acquisition and counterconditioning can affect the amount of fear recovery observed at test. Specifically, interpolation conducted immediately after acquisition appears to be more prone to fear relapse than delayed interpolation (e.g., Powell, Escobar, & Kimble, 2013). Moreover, relapse of fear after extinction can be reduced by increasing the number of extinction trials (e.g., Denniston, Chang, & Miller, 2003). However, this effect has not been observed in the counterconditioning preparation. The present studies attempted to replicate the effect of immediate versus delayed counterconditioning found by Powell et al. (2013) and attempted to assess whether increased counterconditioning trials would reduce the discrepancy between immediate and delayed counterconditioning. Rats were trained with Few or Many counterconditioning trials to assess the efficacy of Immediate and Delayed counterconditioning. In subsequent extinction tests, Immediate counterconditioning resulted in more savings than Delayed counterconditioning with either number of counterconditioning trials. Delayed counterconditioning only resulted in savings with extended counterconditioning training.

P37

Contingency degradation in the garden slug, *Lehmannia valentiana*

Kristen Haynes, Martha Escobar, & Elizabeth Dunaway (Auburn University)

Cue-outcome contingencies can be degraded if either element occurs without the other. Two experiments using the common garden slug (*Lehmannia valentiana*) explored acquisition of an aversive response before (extinction) and after (latent inhibition) contingency degradation via presentations of the cue alone. Subjects were trained to avoid a food-related odor by pairing this odor with an aversive stimulus. This conditioning procedure resulted in high levels of avoidance of the odor. However, when contingency degradation was implemented either before or after conditioning, attenuated responding was observed. Furthermore, responding recovered after a retention interval. Thus, the memory of the aversive response was maintained even if behavioral expression of the cue-outcome association was decreased by contingency degradation.

P38

Effects of forced swim procedure and degree of context change on renewal of fear in rats

Haruka Miyashita, Akira Kurihara, & Kosuke Sawa (Senshu University)

Forced swim procedure has been used to induce various changes in rodents, such as increasing corticosterone level, inducing immobility, and decreasing immobility with antidepressant medications. This procedure has also been used to create animal model of depression. We studied the influence of forced swim procedure on the sensitivity of context change in conditioned fear renewal by using lever-press conditioned suppression in rats. First, subjects received Pavlovian fear conditioning to acquire the fear response. Second, subjects received forced swim procedure for 20 minutes. Third, subjects received fear extinction sessions in different context. Finally, subjects were returned to conditioning context and then received renewal test. In present experiment, the degree of contextual difference between conditioning and extinction was manipulated, such as widely different or slightly different context. In testing, subjects that received extinction in widely different context showed strong renewal and disrupt extinction of fear. In other hand, subjects that received extinction in a slightly different context showed attenuated renewal. Widely different context has many features associated with the US, although slightly different context has a few. Present results implied that forced swim stress strengthen associative memory between the future of context and US.

P39

Are spatial relations readily encoded in occasion setting? For pigeons, training history matters

Jacey Harris, Joe Leyva, Megan McKeehan, Chad Ruprecht, & Kenneth Leising (Texas Christian University)

It is easy to imagine the time of day (12pm vs. 5pm) setting the occasion for which direction you take on your commute home. Studies on occasion setting (e.g., XA+/A-) have found that the effectiveness of an occasion setter, X, in facilitating responding to a target stimulus, A, (e.g., the intersection,) is determined by both A's training history (e.g., Swartzentruber, 1985) and X's temporal contiguity with A (Bonardi & Jennings, 2007, Holland, 1997). We asked similar questions but varied spatial parameters. Pigeons learned that the spatial location of the hidden goal, in relation to a landmark, was conditional on the occasion setter paired with it (e.g., ←XA; XB →). During transfer tests, we hypothesized that landmarks already participating in occasion setting , and landmarks indicating a reinforcer in the same direction, would elicit the highest magnitude and accuracy of pecks. Exp. 1 revealed that the landmark's training history for pigeons, unlike humans, was key to transfer; moreover, rendering the landmark ambiguous during training (Exp. 2), allowed for explicitly spatial information to be encoded solely by the occasion-setter (e.g., time of day). The results are discussed within the backdrop of current configural/hierarchical accounts of conditional responding.

Dorsal hippocampus modulates behavioral sensitivity to ambiguous situations in Rats

Esther W. Yang, Michelle Y. Cho, Cynthia D. Fast, M. Melissa Flesher, Nathaniel A. Nocera, Michael S. Fanselow, & Aaron P. Blaisdell (UCLA)

P40

Fast & Blaisdell (2011) discovered that prior learning influences how rats discriminate between the ambiguous and explicit absence of a discriminative cue. Rats that learned a non-linear negative patterning discrimination (NP; A+/B+/AB-) responded significantly less during probe trials with A present and B Covered (ambiguously absent) compared to when B was Uncovered and unlit (explicitly absent). Conversely, rats that learned a similar, but computationally simpler, linear positive patterning discrimination (PP; A-/B-/AB+) failed to treat the probe trials differently. Presently, we examined the neural mechanisms underlying this sensitivity to an ambiguous event. In Experiment 1, we investigated the role of cholinergic modulation in the dorsal hippocampus (DH) during ambiguous (Covered) versus unambiguous (Uncovered) tests. Rats were first trained on both NP and PP then tested as in Fast & Blaisdell (2011) following micro-infusions of either the cholinergic antagonist scopolamine or saline. Scopolamine disrupted sensitivity to ambiguity that rats otherwise demonstrated. Experiment 2 further explored DH and prefrontal cortical region involvement by examining expression of the immediate early gene c-fos. Collectively, the results offer insight into neural mechanisms involved in representational processes active during performance of a complex instrumental discrimination in an ambiguous situation.

An investigation of visual causality in vultures

Adam M Stern (University of South Alabama), Stephanie E Jett, & Heidi Lyn (University of Southern Mississippi)

P41

This project is small part of a long-term effort to create a multi-species, broad spectrum cognitive test array, based on the Primate Cognitive Test Battery (PCTB - Herrmann, Call, Hernandez-Lloreda, Hare, & Tomasello, 2007; Russell, Lyn, Schaeffer, & Hopkins, 2011), permitting direct comparisons between and among a wide range of species. We presented two turkey vultures (*Cathartes aura*) and one black vulture (*Coragyps atratus*) with a visual causality task in which food was placed under one of two boards, causing the baited board to be elevated. Preliminary analyses indicate that the birds seem to understand that the food caused the board to be elevated, suggesting the presence of basic visual cause-and-effect reasoning capabilities in these species. In addition, we are in the process of adapting other tasks from the PCTB for use with these species, as well as developing tasks to assess their ability to judge mass via olfactory cues alone. By utilizing truly comparative methodologies with a diverse variety of species, we can begin to clarify the phylogenetic roots of cognition.

Learned helplessness in a 3D virtual environment: Mild inescapable aversive stimulus decreases subsequent escape responding in humans

Zachary A. Kilday, & Kent D. Bodily (Georgia Southern University)

P42

Exposure to an inescapable aversive stimulus decreases escape responses to subsequent escapable aversive stimuli. This is known as the learned helplessness effect. In the present experiment, human participants were trained in an immersive, 3D virtual environment analog of an operant chamber with an inescapable aversive stimulus, an escapable aversive stimulus, or no aversive stimulus. Then, all participants were tested using an immersive, 3D virtual environment analog of a shuttle box with an escapable aversive stimulus. Participants trained with an inescapable aversive stimulus were slower to escape during testing than participants trained with an escapable aversive stimulus. The current results demonstrate that the learned helplessness effect can be established in humans using 3D virtual environments and a mild aversive stimulus.

The effects of certain outcome magnitude on probabilistic choice in rats

Andrew T. Marshall (Kansas State University), Erica Fardette (State University of New York - Brockport), & Kimberly Kirkpatrick (Kansas State University)

P43

Probabilistic outcomes are distinguished as gains or losses based on an individual's subjective reference point. Probabilistic choice procedures deliver choices between certain-smaller versus uncertain-larger outcomes, with choice of the uncertain outcome indicating risk preference. Previous research in our laboratory has suggested that the expected value of the certain outcome may serve as the reference point for evaluating uncertain outcomes as gains and losses in rats (Marshall, 2013). The goal of this experiment was to directly determine how manipulations of the magnitude (expected value) of the certain choice outcome influence probabilistic choice behavior. Rats chose between a certain outcome that always resulted in food and an uncertain outcome that probabilistically resulted in food (0, 1, 11 pellets). The magnitude of the certain outcome was manipulated across phases (1, 3, 5 pellets). The rats made more choices for the certain outcome as its magnitude increased. Additionally, the rats' tendency to make uncertain choices following both certain and uncertain outcomes was affected by the certain outcome magnitude. In conjunction with previous research, the results suggest that the expected value of an alternative choice may govern behavior to a greater degree than the expected value of the choice that was made.

Measurement of impulsive choice in rats: II. Test-retest reliability

Jennifer R. Peterson (Kansas State University), Catherine Hill (University of the Incarnate Word), & Kimberly Kirkpatrick (Kansas State University)

P44

Three impulsive choice procedures were assessed to determine alternate-form and same-form test-retest reliability in rats. Impulsive choice procedures assess preferences between smaller-sooner (SS) and larger-later (LL) outcomes, with choices of the SS indicating impulsivity. Forty-eight male Sprague-Dawley rats were randomly assigned to one of three groups (n =16). The SS outcome was always a 5-s delay for 1 pellet and the LL was always 2 pellets but the delay was altered. In the systematic, slow procedure (Green & Estle, 2003) the LL delay incremented across phases, whereas in the systematic, fast procedure (Evenden & Ryan, 1996) the LL delays incremented within each session: 5◊15◊30◊60 s. In the adjusting procedure (Mazur, 1987), the LL delay increased or decreased by 1 s as a function of the rats' most recent choice. After 20 sessions, the rats were tested on one of the other two choice procedures to assess alternate-form test-re-test reliability and then later were re-tested on the second procedure to assess same-form test-re-test reliability. The results suggest that different factors may contribute to the different procedures, raising challenges for the interchangeable use of alternative measurements of impulsive choice.

Environmental rearing effects on behavioral flexibility

Zhe Wang, Andrew T. Marshall, & Kimberly Kirkpatrick (Kansas State University)

P45

The goal of the current study was to test the effect of the early-life rearing environment, especially novel object and/or social enrichment, on impulsive and risky choice behaviors and behavioral flexibility in rats. Four rearing conditions were implemented (n = 6): isolated, isolated with novel objects, socially paired, and socially paired with novel objects. Subsequently, the rats experienced delay and probability discounting tasks: smaller sooner/certain reward was 1 pellet delivered with 7.5-s delay at 100% probability, and larger later/uncertain reward was 2 pellets with 7.5, 15, 30, and 60-s delay at 100% probability, or, 100%, 50%, 25%, and 12.5% probability at a 7.5 s delay. The delay or probability was manipulated within each session. All rats were then tested on a visual discrimination to response discrimination set-switching task to assess their behavioral flexibility. The rats were sensitive to changes in both delay to and probability of reward. Rats from different rearing conditions showed varying choice preferences in both discounting tasks and different acquisition rates in the behavioral flexibility task. The results suggest that novelty and social enrichment are underlying factors that affect the choice of delayed and probabilistic outcomes as well as the adaptability in rule-governed learning.

Evaluation of presentation of environmental enrichment for a Pantropical spotted dolphin (*Stenella attenuata*).

Barbara Perez, Lindsay Mehrkam, & Dr. Nicole Dorey (University of Florida)

P46

Environmental enrichment is a crucial element of animal welfare for captive animals. However, it is usually not formally evaluated by animal care staff because of the time and labor intensiveness of such evaluations. Furthermore, there is little empirical evidence of enrichment evaluation for small species of cetaceans. It can be informative to look at a wide range of variables that might potentially influence enrichment efficacy. Other aspects of enrichment such as presentation can prove to be equally consequential to an animal's behavior and interaction. In our study, we isolated specific variables that enrichment interaction and behavior were contingent upon during normal training and observation sessions with trainers. The study was conducted at Mote Marine Laboratory and Aquarium in Sarasota, Florida, with one subject, a Pantropical spotted dolphin (*Stenella attenuata*). These variables such as presentation, location, and time were observationally evaluated and compared in order to form a baseline evaluation of enrichment efficacy in terms of different presentation of enrichment. The results suggest that certain presentations of enrichment tend to correlate with increased enrichment interaction, as well as increased levels of species typical behaviors and stereotypic behaviors.

Choice and control of enrichment for captive Atlantic bottlenose dolphins

Heidi Lyn, Megan Broadway, & Hannah Bahe (University of Southern Mississippi)

P47

Animals living under human care experience stress related to a lack of control over their environment. One way to remedy this is through the use of cognitive enrichment, such as allowing choice and control of enrichment. This type of enrichment has been shown to have benefits for animals under human care including increased activity and social interactions. To determine if choice and control was more beneficial than enrichment alone, a three year old male Atlantic bottlenose dolphin (*Tursiops truncatus*) was exposed to novel enrichment items in two conditions. For the first condition, the animal was given a novel object. During the second condition, the animal was asked to choose between two novel enrichment items and the selected item was added to his environment. Activity level, habitat usage, social and play behaviors were recorded following the addition of the novel item to the animal's environment. The results indicated an increase in social activity, cooperative play and displacement. These results suggest that cognitive enrichment is beneficial, particularly with social aspects. Data collection is ongoing with a second animal.

Measurement of impulsive choice in rats: I. Preliminary assessment

Catherine Hill (University of the Incarnate Word), Jennifer R. Peterson, & Kimberly Kirkpatrick (Kansas State University)

P48

Impulsive choice has been found to underlie maladaptive behaviors such as gambling, substance abuse, and obesity. Impulsive choice procedures assess choice behavior between a smaller-sooner (SS) versus a larger-later (LL) reward, with choices of the SS indicating impulsivity. Several different procedures have been used to assess impulsive choice and it is generally assumed that the procedures measure the same underlying construct. However, a direct comparison of procedures for studying impulsive choice in rats has not been previously completed. The present experiment trained rats on a systematic, slow choice procedure adapted from Green and Estle (2003) in which the delay to the SS outcome was manipulated across phases and then transferred the rats to either a systematic, fast procedure adapted from Evenden and Ryan (1996) or an adjusting delay procedure adapted from Mazur (1987). Individual differences in choice behavior in the two systematic procedures were moderately correlated, but the between-phase systematic procedure did not correlate with the adjusting procedure. In addition, timing analyses suggested that the systematic procedures resulted in better learning of the delays to reward.

Tests of emergent relations in rats

Alyse Kaszubski, Duncan Bordeaux, Mark Galizio, & Kate Bruce (University of North Carolina Wilmington)

P49

According to Sidman (1971), following the initial training of four conditional discriminations (A1-B1+, A2-B2+, B1-C1+, B2-C2+), fourteen new abstract relations should emerge – six reflexivity, four symmetry, two transitivity, and two equivalence relations. While previous research has had success demonstrating the emergence of reflexivity and transitivity through a variety of procedures, the other relations – especially those related to symmetry – have been more elusive. However, Bunsey & Eichenbaum (1996) reported transitivity and symmetry in rats following conditional discrimination training, using scented sand stimuli. In the present study, we designed a systematic replication of Bunsey & Eichenbaum using scented lids in a plus-maze with three comparison locations. After training two rats on the four conditional discriminations, probes for transitivity and symmetry have not yielded the consistent observation of either relation. We are currently developing procedural alterations that may aid in detecting these emergent properties.

Discrimination of 3-D rotating objects by horses

Tammy McKenzie, & Brett Baloun (Brandon University)

P50

Horses within their environments experience objects from many different perspectives. Hanggi's (2010) research is the only reported study examining horses' ability to create 3-D mental representations of objects allowing the horses to identify objects from new vantage points. In her study the objects were stationary, as has been the case for all of the objects used to examine visual learning in horses. However, in an animal's environment, the animal often has to deal with moving objects and need to be able to recognize the object quickly from various vantage points in order to know how to respond to that object appropriately (Cook, Shaw, & Blaisdell, 2001). The present study examined horses' ability to recognize rotating objects when presented to them in novel rotations. Horses were trained to discriminate between pairs of rotating objects. They were trained on four pairs of objects and then tested using novel rotations. The horses learned to discriminate between the objects and some were able to recognize the objects in new rotations. The information gained from this research could be beneficial in determining better training and handling practices for horses, as it furthers our understanding of how horses' process information from moving objects.

Outcome devaluation effects in discrimination learning in rats

Atsuhito Yamagishi, & Nobuya Sato (Kwansei Gakuin University)

P51

To investigate the animal's ability to predict outcome information, we examined the change of stimulus discrimination behavior by using devaluation procedure to the reward associated with the stimulus. In Experiment 1, rats were trained to discriminate two types of floor pairs in Y-maze. Chocolate food pellets and sucrose solution were presented to correct responses for the first and second floor pairs, respectively. Once the subjects show reliable discrimination, preference test between the two correct floors were conducted before and after the outcome devaluation, in which either the chocolate food pellets or the sucrose solution was paired with LiCl. Preference to the correct floors did not change before and after the outcome devaluation. Experiment 2 was identical to Experiment 1 except that the subjects were presented to chocolate food pellets or sucrose solution at the start point of Y-maze just before the trial during discrimination training. This modification decreased the preference for the floor associated with the devalued outcome in the preference test. These results suggest the primacy of pre-trial reward presentation for the outcome devaluation in discrimination learning.

Discrimination of conspecific behavior in pigeons

Joanna L. Kornstein, Muhammad A. Qadri, & Robert G. Cook (Tufts University)

P52

Like all social animals, pigeons must be able to recognize and categorize conspecific behavior to respond appropriately. In this experiment, two pigeons were trained to discriminate between video clips depicting different categories of pigeon behavior. In a go/no-go procedure, pigeons responded to video clips of conspecifics walking or courting, or random static frames from the same videos. Motion and posed cues and were isolated by rewarding pecking during dynamic videos of walking pigeons and during static images of courting pigeons. Both pigeons learned the dynamic discrimination faster and more accurately than the static discrimination. Both pigeons demonstrated partial transfer of the motion discrimination to new videos. These results indicate that birds primarily use dynamic cues to categorize the behavior of conspecifics.

Failure to obtain symmetry following arbitrary successive discrimination training in rats

Ashley Prichard, Danielle Panoz-Brown, Katie Dyer, Samantha Hess, Erin Lackey, Melissa Deal, Megan Halloran, Mark Galizio, & Kate Bruce (University of North Carolina Wilmington)

P53

The issue of equivalence class formation via trained conditional discriminations in nonhumans remains controversial. While humans show evidence of emergent symmetry after training of AB relations, most studies of emergent symmetry in nonhumans have yielded negative results. However, Urcuioli and colleagues have demonstrated symmetry in pigeons using visual stimuli in a successive discrimination procedure. We replicated the Urcuioli procedure in rats using olfactory stimuli using an automated olfactometer. Fourteen rats were trained initially on either identity or arbitrary conditional discriminations or a mixture of both types. Only seven rats met criteria to be tested for symmetry, and no rats showed emergence of symmetry. Three additional rats were trained on identity conditional discriminations with four different odors and then tested with four additional scents. All three showed evidence of generalized identity responding which shows that rats do show some emergent relations using the successive discrimination methodology.

Developing tests of cognitive control in rhesus monkeys

Emily Kathryn Brown, & Robert R. Hampton (Emory University)

P54 Cognitive control is the active, top-down adjustment of information processing. Effective learners maximize use of limited cognitive resources by focusing cognitive effort on the most important information. Humans can improve memory through rehearsal (Sheard & MacLeod, 2005). For example, to remember an item to get at the store, you might rehearse it subvocally. Directed forgetting, a paradigm often used to evaluate cognitive control of memory in humans, has proven challenging to adapt for use with nonhumans (Roper & Zentall, 1993). We used novel adaptations to the directed forgetting paradigm to distinguish rehearsal from alternative processes. Monkeys were presented with a sample image, followed by one of two distinctive cues during the retention interval. The "remember" cue typically predicted a 4-choice match to sample test, whereas the "forget" cue typically predicted one of five perceptual discriminations. Discrimination test accuracy and memory test accuracy were matched to provide a valid comparison of the effect of "remember" and "forget" cues in the two tests. On rare probe trials, the test not predicted by the cue was administered. We compared performance on regular and probe tests to determine the extent to which the "remember" cue elicited cognitive control of memory.

What do pigeons remember? Stimulus and category memory in matching-to-sample

Darin Casler, Zhaohui Hu, & Edward Wasserman (University of Iowa)

P55 Do pigeons differentially remember stimulus and category information in delayed matching-to-sample? To find out, we trained four pigeons to peck one of four choice keys that matched one of four sample stimuli in a matching-to-sample task. The four stimuli came from two categories: fish and flowers. During simultaneous matching-to-sample training, pigeons committed most errors to the incorrect stimulus from the correct category, suggesting that the birds had encoded both stimulus and category information. After the pigeons had successfully completed training on the matching-to-sample task, they were moved to sets of sample-test delays ranging from 0 s to 10 s. We had expected pigeons' errors to rise with increasing delays and, given the acquisition data, for within-category errors to exceed between-category errors. Overall errors did rise with increasing delays, but we obtained mixed results regarding the preponderance of within-category errors over between-category errors, particularly when we progressively shifted the pigeons to longer and longer retention intervals. Overtraining might have weakened the salience of category information and weakened the salience of stimulus information.

Future-oriented information-seeking in human children

Sumie Iwasaki, Hika Kuroshima, Shoji Itakura, & Kazuo Fujita (Kyoto University)

P56 Future-oriented behavior may involve a form of abilities of mental time travel that are essential for self-continuity. Studies have demonstrated that young children and apes may prepare for adaptive physical environment such as tools usable in the future. However, human adults can also prepare for mental environment such as knowledge usable in the future. In this study, we examined whether 4- to 5-year-old human children would metacognitively seek information for their future knowledge state in advance in a newly devised method requiring no verbal reports. Participants were requested to find out a sticker hidden in one of five opaque or transparent cups after waiting in the next room for the experimenter to complete hiding. Children peeped out the hider from behind the partition, though they were implicitly told not to do so. This peeping behavior was longer in duration for opaque cups, for which the sticker would be invisible, than for transparent cups in 5-year-olds, but 4-year-olds failed to show such differential behavior. These results suggest that 5-year-old children could monitor their mental states in the future and appropriately control their information-collecting behavior. We propose that this non-verbal method is applicable to nonhuman participants to test future-oriented metacognitive information-seeking.

Proto-counting in baboons

Stephen Ferrigno, & Jessica Cantlon (University of Rochester)

P57 Although many experiments have shown that monkeys can discriminate quantities, few studies have examined the mental comparison algorithm. Here we report that monkeys spontaneously use a sequential and iterative comparison algorithm to judge numerical values. During a food choice task, monkeys (*Papio anubis*) were presented with two sequentially baited cups in which one set was completely baited (one item at a time) before baiting the second set. We observed that on a significant portion of trials, the monkeys spontaneously moved from their position in front of the first cup to sit in front of the second cup before the second cup was fully baited. Interestingly, the point at which a monkey switched position was systematically related to numerical value; monkeys were more likely to switch as the value of set 2 approached and exceeded the value of set 1. This suggests that the animal is mentally updating and comparing the changing values of the second set on an item-by-item basis. Evidence that monkeys continuously update and compare numerical values suggests that they are using the kind of iterative, sequential numerical comparison algorithm that would be a necessary precursor to the evolution and development of verbal counting.

A look back: 20 years of CO3

Martha R. Forloines, & Jeffrey S. Katz (Auburn University)

P58 Last year was the 20th anniversary of the International Conference on Comparative Cognition (CO3) of the Comparative Cognition Society. The conference has grown from 32 presentations and zero posters in 1994, to 81 presentations and 62 posters in 2013. We present analyses of how topics have evolved throughout the past 20 years at CO3. Presentation titles from each year were analyzed for key words using the conference programs online. The data was transferred into word clouds and quasi-cladograms to show the evolution of topics through the past 20 years. The results show the variability, selection and retention of comparative cognition research interests.

Perspective taking or behavior reading? Food competition in the highly social pinyon jay

Amy Ort, Alan Kamil, & Alan Bond (University of Nebraska-Lincoln)

P59 Visual perspective taking refers to the ability of one animal to infer that they can see things that other individuals cannot. Previous research on this topic has produced an array of conflicting findings about whether non-humans are capable of this type of behavior, largely due to alternative explanations, such as behavior reading, that are never directly tested. The present study was designed to expand upon this line of research by examining the behavior of pinyon jays, highly social birds with primate-like social structures, during natural food competition to determine whether they utilize perspective taking, behavior reading, or other strategies. By examining the decision process itself rather than trying to explicitly elicit one specific strategy, we will be able to better predict which circumstances may produce definitive evidence for perspective taking in future research. Preliminary results suggest that, in accordance with previous primate research, jays do alter their behavior as a function of the visual occlusion of others, but that in most situations, this is likely due to strategies other than perspective taking.

Cultural evolution of zebra finch song towards a wild type song phenotype

Beatriz Adriana Diez (University of Western Ontario)

P60 In both songbirds and humans exposure to conspecific vocalizations is required in order to produce effective communication signals. Birds reared in isolation produce an abnormal isolate song. However, birds tutored with isolate songs progressed toward a more species-typical version over generations (Feher et al. 2009 Nature 459:564-568). Thus zebra finches (ZF) may have a biased predisposition to sing their conspecific song, but tutoring is required in order to transform the isolate song toward a wild type (WT) song. Here, I explore if this effect is associated with the fact that the first tutor was an isolate ZF that sang a song with ZF characteristics, or if the social interaction with a tutor is what matters. I raised birds over multiple generations starting with WT song, isolate song, and song of ZF tutored by heterospecific Bengalese finches (BF). The tutee of each generation served as the tutor for the next over 3-4 generations. Preliminary results show phonological and syntactic changes occur over generations from a BF-like song and isolate-like song toward more WT song. Thus in both cases it appears that the birds have an inherent bias to use song features from their tutor that most closely match their species-typical songs.

An asymmetry in shape and shape word interference: Evidence for core geometric knowledge

Joshua E. Edwards, Ty W. Boyer, & Bradley R. Sturz (Georgia Southern University)

P61 Nativists have postulated fundamental geometric knowledge that predates linguistic and symbolic thought. Central to these claims is the existence of an isolated cognitive system dedicated to processing geometric information. Testing such hypotheses presents challenges due to difficulties in eliminating the combination of geometric and non-geometric information through language. We present evidence using a modified matching interference paradigm that an incongruent shape word interferes with identifying a shape, but an incongruent shape does not interfere with identifying a shape word. This asymmetry in shape and shape word interference suggests that shape words activate spatial representations of shapes but shapes do not activate linguistic representations of shape words. Results are consistent with hypotheses concerning a cognitive system dedicated to processing geometric information isolated from linguistic processing and provide evidence consistent with hypotheses concerning core knowledge of geometric properties of space that predates linguistic and symbolic thought.

Orientation via enclosure geometry by blind-folded adults: Evidence against view-based matching theories of spatial orientation

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P62 Although spatial orientation via geometric properties of an environment is an ability shared across species, debate remains concerning similarities and differences in the underlying mechanism(s). One theoretical account of spatial orientation suggests that participants match visual memories to current visual perception and navigate to reduce discrepancy between the two. We tested a view-based matching account of spatial orientation by training disoriented and blind-folded human participants to search by touch for a target object hidden in one of four locations marked by distinctive textural cues located in the corners of a rectangular enclosure. Following training, we removed the distinctive textural cues and probed the extent to which participants learned the geometry of the enclosure. Even in the absence of vision and unique textural cues, search behavior was consistent with evidence for the encoding of enclosure geometry. A follow-up experiment in which participants were trained in a rectangle but tested in a square provided evidence that search behavior was influenced by the geometric properties of the enclosure. Results suggest that in the absence of vision, participant learned the geometric properties of the enclosure. Results appear inconsistent with theories of spatial orientation based upon matching visual memories with current visual perception.

A limited use of multiple sets of spatial information by humans (Homo sapiens) in a computer screen-based goal-searching task

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P63 Our previous study suggested that humans remarkably used vector information over configural information in an open-field goal-searching task by using arrow-shaped landmarks. In the current study, we conducted a computer screen-based goal-searching task using red and blue, asymmetrical landmarks. Participants were trained to locate a hidden target in one of 25 cells arranged in a 5 x 5 grid. Each of the two landmarks appeared in different cells adjacent to the target location. The absolute location and directions of the landmarks varied across trials, but their configuration (when standing at the target and facing the red landmark, the blue landmark was always on the right) and their relative direction to the target location were constant. Thus, both configural information and vector information could be used to locate the target. On subsequent test trials, the landmark directions were changed to conflict with each other and with the configural information. Results showed that participants used not only vector information but also metric information between the landmarks and the target location, but revealed no evidence of the use of configural information. Such a limited learning of redundant sets of spatial information may enable humans to navigate promptly with limited amount of spatial information.

Global vs. local control of contextual cueing in pigeons

Yuejia Teng, & Ed Wasserman (University of Iowa)

P64 Repeated pairings of a particular visual context with a specific location of a target stimulus facilitate target detection in pigeons—the contextual cueing effect. However, whether global properties of the scenes or local features surrounding the target are responsible for this contextual cueing effect has not been investigated. Our study involved both vertical and horizontal scene reversals to see whether global or local cues contribute to contextual cueing. Specifically, in the Training Phase, we required pigeons to peck a target that could appear in one of four possible locations on eight possible photographic scenes. On half of the trials, we consistently paired each of four Predictive scenes with one of the four target locations; on the other half of the trials, each of four Random scenes was randomly paired with all four possible locations. In the Testing Phase, we vertically and horizontally reversed the Predictive scenes. Additionally, we presented the target in both reversed locations and in its original location. The results suggested that global contexts more effectively directed the pigeons' attention than did local features, although local cues did contribute to target detection.

Encoding of features and geometry across the lifespan

Kevin Leonard, & Debbie M. Kelly (University of Manitoba)

P65 Geometric (e.g., distance and direction) and featural cues (e.g., colour and texture) within an environment can be used by mobile animals to guide reorientation. Many species studied to date have shown an implicit encoding of geometric cues, even within a feature-rich environment. During the presented study, three month old mice (*Mus musculus*) were trained to search for a hidden platform in one corner of a feature-rich rectangular water maze. Upon completion of training, transformation tests which manipulated specific properties of the environment were conducted to examine whether the mice used geometric cues to reorient in the absence of features, as well as whether the mice showed a preference for geometric or featural cues when the cues provided conflicting information as to the location of a hidden platform. The same mice were then trained and tested at 15 months to evaluate their retention of spatial knowledge and their ability to recuperate previously learned associations. Differences in the encoding and use of featural and geometric information across the lifespan will be discussed.

Spatial Working Memory in Horses

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

P66 The extent to which grazing foragers use spatial working memory while foraging is largely unknown. The trainability of domestic horses makes them an ideal grazing species in which to test spatial working memory. Experiment 1 was designed to characterize the natural search strategy of grazers in a spatial array. Horses were released individually into an arena with eight rewarded locations. Once a reward was taken, that location was depleted for the duration of the trial. Horses were allowed to search until all locations were depleted. In each session, rewarded locations were changed to eliminate reference memory cues. Visits to rewarded locations were scored as correct choices and visits to already depleted locations were scored as incorrect choices. Experiment 2 measured the contribution of working memory to performance in Experiment 1. At the start of each trial, horses were led to four locations and allowed to retrieve the rewards. Horses then were released to search until all locations were depleted. The horses' ability to avoid revisiting the four forced choice locations served as a measure of working memory. Results of both Experiments 1 and 2 suggest that horses preferentially use a systematic search strategy when foraging within a patch.

Rats' object-recognition working memory for simultaneously and separately processed non-spatial and spatial information

Matteo Bernabo, Corrine Keshen, & Jerome Cohen (University of Windsor)

P67 In the first of two experiments, rats learned to find which one of four objects had been missing from a previously exposed array when either objects' locations were fixed (Fixed Location group) or were varied (Varied Locations group) over trials. Increasing the interval between the 'study' array of three objects and the 'test' array of four objects (the retention interval) reduced rats' accuracy for finding the missing (target) object more in the varied than fixed locations group when both non-spatial and combined relative and global spatial cues were relevant. In that experiment, however, rats in either group selected the target object based on its combined spatial cues in opposed-cues probe trials. We report a second experiment with these animals where only objects' relative positions within a trial will remain the same in each group. In this study we expect the fixed location group to select a target object based on its relative position while the varied position group to either have no preference or prefer the target object's non-spatial features on opposed-cues probe tests.

Anticipation of a broken rung on the inclined ladder by rats: Non-spatial vs. spatial cues

Daniel Lopatin, Jordynne Ropat, & Jerome Cohen (University of Windsor)

P68 We examined rats' use of spatial and non-spatial cues that signal potential 'danger' on their path back to their 'home' base. Rats had to traverse a slightly inclined ladder to their individual holding cages for their end-of-day food rations. One of the rungs at the mid-line position on the ladder always collapsed when the rat stepped on it. On some trials, the broken rung was also cued by an extra 'safe' rung that occurred just before it and on other trials the broken rung occurred without this 'extra' safe rung. We accessed rats' use of these two kinds of information to anticipate the broken rung by measuring where they began to reduce their speed as they approached it and if they stepped over it by changing its climbing gait pattern.

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