

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)

7:05 PM **The evolution of problem-solving abilities in carnivores**
Sarah Benson-Amram (University of Wyoming), Eli M. Swanson (University of Minnesota), Greg Stricker, & Kay E. Holekamp (Michigan State University)

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Two leading theories to explain the evolution of intelligence are the Social Intelligence Hypothesis (SIH) and the Ecological Complexity Hypothesis (ECH). The SIH posits that intelligence evolved due to selection pressures associated with life in complex societies, whereas the ECH posits that intelligence evolved due to selection pressures associated with life in challenging ecological conditions. We tested predictions of these (not mutually exclusive) hypotheses by examining whether species that vary in their social and ecological complexity differ in their ability to solve a novel technical problem. We tested 172 individuals from 43 species across 9 families of carnivores. 62 individuals from 23 different species across 8 families successfully solved the problem. We then used a comparative approach to examine which ecological and social factors predict problem solving success as well as persistence and the diversity of exploratory behaviors individuals exhibited when interacting with the problem. The results of this study inform our understanding of the selective pressures leading to the evolution of intelligence in carnivores. Moreover, comparing our results to those from primates helps us better understand the selection pressures that have shaped the evolution of intelligence across mammals more generally.

7:19 PM **Grey squirrels show efficient problem solving requires flexible change of tactics**

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

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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.

7:26 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)

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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.

4

7:33 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).

7:40 PM *Break*7:45 PM **Perception (Chair: Roger Thompson)**

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7:45 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.

7:52 PM

Zöllner illusion in rhesus monkeys (*Macaca mulatta*)

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

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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.

8:06 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)

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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.

- 8** 8:20 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.
- 9** 8:34 PM **No evidence for distinct visual short-term memory systems in pigeons**
John Magnotti (UT Medical School at Houston), & Jeffrey Katz (Auburn University)
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.
- 10** 8:48 PM **Comparative studies on motion perception in pigeons and humans with a visual search paradigm**
Noriyuki Nakamura, & Masako Jitsumori (Chiba University)
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)

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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.

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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.

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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.

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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

Desert ants integrate compass information from two navigational strategies in an averaging fashion

Sebastian Schwarz (University of Manitoba), Antoine Wystrach (University of Sussex), Ken Cheng (Macquarie University), & Debbie M. Kelly (University of Manitoba)

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Mobile animals use different sources of information to navigate. Desert ants possess a navigational toolkit composed of path integration, view-based navigation, systematic search and backtracking behaviour. The sensory integration of multiple cues increases both accuracy and robustness of navigation. Furthermore, depending on the current needs of the travelling ant, these strategies feed into the final navigational behaviour in a flexible manner. After a foraging ant has found a food item, she usually returns using the shortest path to the nest with the help of path integration and view-based navigation. Recently, it has been discovered that when returning forages are displaced (e.g., by wind gust) prior to entering the nest, they backtrack in the direction from which they came to regain familiar terrain. However, displaced ants at the beginning of their homing path follow their path integration information in unfamiliar terrain to find their nest. To investigate the mechanisms underlying integration of these two navigational strategies we artificially set compass information from path integration in conflict with the backtracking direction. Results show that ants integrate the compass direction of the path integrator and the backtracking behaviour in an averaging manner and not in an individually based bimodal fashion.

12:42 PM **Navigation experience and cognitive maps**

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

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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.

12:56 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)

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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.

1:03 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)

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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.

1:10 PM *Break*

1:15 PM **Cognitive Processes I (Chair: Lauren Guillette)**

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1:15 PM

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

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

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.

1:22 PM

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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.

1:29 PM

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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.

1:36 PM

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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.

- 1:50 PM **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.
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- 2:04 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)
 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.
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- 2:18 PM **Substitutional reality system for macaque monkeys**
Yasuo Nagasaka, Tomonori Notoya, & Naotaka Fujii (Laboratory for Adaptive Intelligence; RIKEN BSI; Japan)
 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.
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- 2:32 PM **A call for analysis in comparative cognition**
Clive D. L. Wynne (Arizona State University)
 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.
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- 2:46 PM *Snack Break*

3:26 PM **Social Learning (Chair: Marisa Hoeschele)**

3:26 PM **Follow the leader IV: Flexibility of individual and social learning**

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

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 chose 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.

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3:33 PM **Can Clark's nutcrackers flexibly adapt caching behaviours in a cooperative context?**

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

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.

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3:40 PM **Sex differences in copying behaviour**

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

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.

29

3:54 PM **The advantages of search images in collective foraging**

Noam Miller, & Iain Couzin (Princeton University)

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.

30

31

4:08 PM

Dissociation of social affiliation and social memory in social influence on spatial choice*Marie Saxon, Andrew Stokesbury, Chase Phillips, & Michael Brown (Villanova University)*

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.

32

4:15 PM

Experimental study of skills transmission in wild large-billed crows (*Corvus macrorhynchos*)*Tanya Obozova, Anna Smirnova, & Zoya Zorina (Lomonosov Moscow State University)*

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 fled 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.

33

4:22 PM

Learning to play. What belugas do.*Dominique Ramirez, Heather Hill, & Abby Arroyos (St. Mary's University)*

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.

4:29 PM *Break*4:34 PM **Canine Cognition (Chair: Stan Kuczaj)**

34

4:34 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)*

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.

35

4:41 PM

Interval timing in the domestic dog

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

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.

36

4:48 PM

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)

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.

37

4:55 PM

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 ##

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

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)

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”.

38

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

12:14 PM *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)*

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.

39

Pigeons use a default strategy to learn a pseudoconcept

12:28 PM *Thomas A. Daniel (Auburn University), Anthony A. Wright (The University of Texas Health Science Center at Houston), & Jeffrey S. Katz (Auburn University)*

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.

40

Natural concept formation at three levels of abstraction in young children

12:35 PM *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.

41

42

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

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, CDDBA 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)**

43

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

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.

44

1:01 PM

Reanalysis of reinforcement history and successive-pair training: Expansion of the theory

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.

45

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)

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)

46 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)

47 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)

48 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 *Break*

2:09 PM **Cognitive Processes II (Chair: Jonathon Crystal)**

2:09 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**

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

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.”

2:23 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)

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.

50

2:37 PM

Brainy birds have complex neural machinery

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

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.

51

2:44 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)

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.

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2:51 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)

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.

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- 54 3:05 PM **Dynamic interactions of cognitive monitoring and cognitive control in monkeys**
Robert R. Hampton (Emory University)
 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.
- 3:19 PM *Snack Break*
- 4:15 PM **In Honor of Tom Zentall (Chair: Mike Brown)**
- 55 4:15 PM **Personal information and social information in spatial choice**
Michael Brown, Teagan Bisbing, & Marie Saxon (Villanova University)
 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 compete 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.
- 56 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)
 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.
- 57 4:45 PM **Why is time so powerful?**
Kimberly Kirkpatrick, & Andrew Marshall (Kansas State University)
 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.
- 58 5:00 PM **The interaction of working and reference memory in pigeons**
William A. Roberts, Caroline Strang, & Krista Macpherson (Western University Canada)
 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.

- 59 5:15 PM **Transitive and anti-transitive emergent relations in pigeons' successive matching**
Peter J. Urcuioli, & Melissa J. Swisher (Purdue University)
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.
- 60 5:30 PM **Multiple necessary cue discrimination learning by pigeons**
Ed Wasserman, & Yuejia Teng (University of Iowa)
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 - 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)

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.

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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)

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.

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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)

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.

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2:12 PM

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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

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

T. 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

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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

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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)

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.

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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)

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.

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3:15 PM *Snack Break*

3:55 PM **Associative Processes (Chair: Marco Vasconcelos)**

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

Beatriz Alvarez, & Ignacio Loy (Universidad de Oviedo)

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).

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

Duncan Amegbletor, & Francisco Arcediano (Auburn University)

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.

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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.

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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.

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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 assess 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.

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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)

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)

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)

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)

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.

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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)

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 persevere 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.

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5:24 PM

Motion improves numerical discrimination in the guppy (*Poecilia reticulata*)

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

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 (Jeff Katz)

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

See Poster Abstracts Starting on Page ##

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