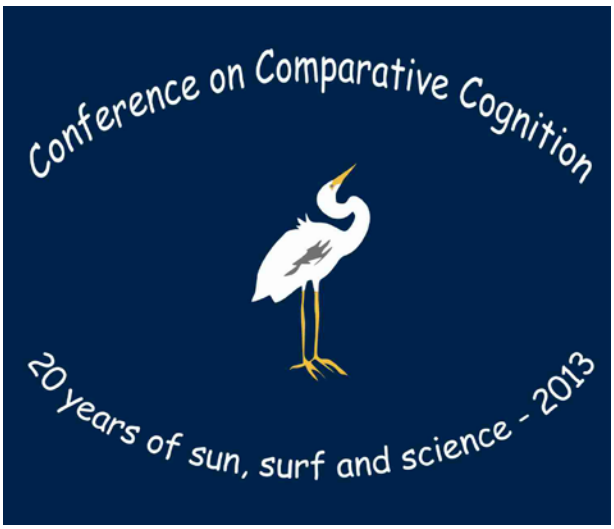
20th Annual International Conference On Comparative Cognition



Sponsored by the Comparative Cognition Society

March 6th to March 9th, 2013

Radisson Hotel

Melbourne Beach, Florida

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

Wednesday Afternoon

3:30 PM Welcome Reception and Check-In

7:00 PM Opening Remarks (Jeff Katz)

7:05 PM Memory (Chair: Jeff Katz)

1

7:05 PM **Source memory in the rat is hippocampal dependent**

Jonathon D. Crystal, Wesley T. Alford, Wenyi Zhou & Andrea G. Hohmann (Indiana University)

Source memory is a representation of the origin (source) of information. When source information is bound together, it makes a memory episodic, allowing us to differentiate one event from another. Here we asked if rats remember the source of encoded information in a hippocampal-dependent fashion. Rats foraged for distinctive flavors of food that replenished (or failed to replenish) at its recently encountered location according to a source-information rule. To predict replenishment, the rats needed to remember where they had encountered a preferred food type with self-generated (walking along a runway encountering the preferred food type) or experimenter-generated (placement at the site of the preferred food type by an experimenter) cues. Rats selectively adjusting revisits to the location with the preferred food based on their memories of the source information. The hippocampus is posited to be a critical processing center in source memory. To test the hypothesis that our behavioral task requires source memory, we asked whether it was similarly hippocampal dependent. Temporary inactivation of the CA3 region of the hippocampus with bilateral infusions of lidocaine selectively eliminated source memory whereas source memory was intact after vehicle infusions. Source memory is dependent upon an intact hippocampus.

2

7:12 PM **Limitations of visual short term memory in rhesus monkeys**

Deepna T. Devkar (University of Texas Health Science Center in Houston), Wei Ji Ma (Baylor College of Medicine), Jeffrey S. Katz (Auburn University) & Anthony A. Wright (University of Texas Health Science Center in Houston)

Understanding the limitations of visual short-term memory (VSTM) is one of the greatest challenges of cognitive science. While multiple-item VSTM tasks are common in human studies, they have rarely been used to test VSTM in other species. We tested two rhesus monkeys in a change localization paradigm. Monkeys viewed two displays: a sample display and a test display. The sample display contained 2-5 oriented lines presented simultaneously (orientations were drawn independently from a uniform distribution), followed by a 1-s delay. Then, a test display containing two items was presented – one item was identical to one of the sample items (same location and orientation), and the other item had randomly changed to a new orientation, also drawn from a uniform distribution. The monkeys were trained to identify which item had changed. We observed a strong effect of both display size (2-5) and magnitude of change (0-180 degrees). Monkeys' behavior can be modeled well using a Bayesian ideal-observer model in which items are internally encoded in a noisy manner and the amount of noise per item increases with display size. Our results show striking parallels between monkey and human VSTM mechanisms.

3

7:19 PM **Visual information load is shown to vary across categories and discrimination difficulty in pigeons (*Columba livia*)**

Adam Goodman (Auburn University), John Magnotti, Anthony Wright (University of Texas Medical School at Houston) & Jeffrey Katz (Auburn University)

Previous studies of human visual short-term memory (see Alvarez & Cavanagh, 2004; Eng, Chen, & Jiang, 2005) have demonstrated that information load can limit estimates of capacity for this temporary storage system. In a follow-up comparative study, Magnotti, Goodman, Daniel, Elmore, Wright, and Katz (in press) used a similar visual search task to provide indices of information load per item for various visual stimulus categories for humans and pigeons. Corresponding visual search rates were shown to demonstrate a strong inverse relationship to performance in a change detection task across species. Here, we show some similar effects on information load in pigeons trained with geometrical shapes and colors. We tested a novel stimulus category (i.e., line orientations) which provided measures of similarity based on orientation in degrees of the targets and distractors in the task. Similarity between target and distractors was shown to affect both reaction times and accuracy in the task. Together these findings provide additional data on the variability of visual information load across stimulus categories and suggest difficulty of discrimination affects these estimates in pigeons.

4 7:26 PM **Hemispheric lateralization of intraocular transfer in a long-term memory task in pigeons (C*olumba livia*)**
Matthew S. Murphy & Robert G. Cook (Tufts University)
Birds as laterally-eyed animals have specialized retinal areas for frontal and lateral vision, which have unique perceptual, anatomical, and cognitive properties. The visual fields largely follow different visual pathways in the brain. Our research suggests a single memory storage area for the two visual fields, but this is potentially complicated by strong hemispheric independence. Lateralized differences in intra- and interocular transfer were tested and will be discussed.

5 7:33 PM **Episodic memory in nonhumans: When will we know what gets us where we want to be?**
Robert R. Hampton (Emory University)
A major pattern in memory evolution is the development of functionally distinct systems adapted to specific cognitive demands. Determining the similarities and differences among human and nonhuman memory systems is therefore critical to understanding the evolution of memory and is a major challenge for comparative cognition and behavioral neuroscience. In pursuit of this understanding, considerable effort has been expended attempting to determine the extent to which episodic memory occurs in animals other than humans. In this talk I will provide a focused and brief evaluation of progress in this work, emphasizing what I hope are the most salient theoretical considerations and empirical findings.

6 7:47 PM **The psychology of extended search in nectar-feeding bees**
Fred C. Dyer & John Townsend-Mehler (Michigan State University)
William James observed that searching for ideas in one's mind resembles a search for objects in physical space. Research with humans and animals suggest that this resemblance arises because cognitive and physical search share common neural mechanisms and a common evolutionary heritage. Among the evidence for this claim are similarities between cognitive search in humans and behavioral search in animals, including invertebrates. However, most animal examples involve simple modulation of search in the vicinity of food, which little resembles the flexible, hierarchical organization of cognitive search. We study bees as they search for food among multiple locations for up to an hour. The behavior reveals that bees maintain multiple search options in memory, adaptively shift which options they pursue over time, and shift between local and global search, implying a hierarchical organization of the underlying memory. Because the work compared honey bees and bumble bees, the results also shed light on the evolutionary pressures that may have shaped search behavior in response to changing incentives. Whether or not we have discovered a homolog of cognitive search, this research sets the stage for further investigations of the neural and evolutionary basis of search behavior in animals.

7 8:01 PM **Foraging and spatial memory in captive grizzly bears**
Moriah Galvan & Jennifer Vonk (Oakland University)
In this study, three juvenile and two adult captive grizzly bears (*Ursus arctos horribillis*) at the Detroit Zoological Society were tested for the use of spatial memory under three testing conditions; spatial, visual, and olfactory. Conditions were presented in counterbalanced order across subjects. The bears were tested with six baited sites. In the spatial condition, the same sites were always baited. In the visual condition, differently colored containers varied by location but the same colors consistently predicted food. In the olfactory condition, distinctive scents will be placed at different locations with the same scents always associated with reward. When the bears reach a criterion, they will undergo a reversal where the opposite sites are baited. We wished to determine the efficacy of cues from different modalities in order to better understand the cues that grizzlies may utilize in the wild to recall the location of food.

8:08 PM *Break*

8:13 PM Communication (Chair: Suzanne MacDonald)

8:13 PM **Co-evolution vs unilateral exploitation in parasite-host communication**

Alex Kacelnik & Ros Gloag (University of Oxford)

For communication to be evolutionarily stable, on average, signalling must benefit emitters and responding must benefit receivers. In the case of begging signals by brood parasitic nestlings, however, responding by increasing food provisioning directly conflicts with the host's interest. One might expect hosts to evolve narrow filtering around their own young's vocalisations, and parasites' signals, in turn, to converge towards each host's responding range. In the case of generalist parasites, calls would as a consequence differ between host species. We investigated acoustic interactions between nestlings of the generalist parasitic shiny cowbird and some hosts, and found that (1) Acoustic structure of cowbirds' calls does not vary between common hosts; (2) A common host (house wren) responds more intensely to calls of cowbirds than to calls of their own chicks, independently of call rate and volume; and (3) An allopatric species (great tit) with no coevolutionary history with cowbirds also responded more to similarly standardised cowbird calls than to those of their own offspring. We conclude that begging calls of shiny cowbirds exploit non-species-specific features of parent-offspring communication in birds to secure host care, but the evolutionary dynamics of such communication systems are yet to be understood and modelled.

8

8:27 PM **Context-dependence of vocal output and personality in songbirds**

Christopher B. Sturdy & Lauren M. Guillette (University of Alberta)

Personality, assessed via measures of exploration, for example, appears to be related to singing behaviour in songbirds. In this study, we wanted to search for a similar relationship between bird calls and songs and exploratory behaviour in black-capped chickadees. Exploration was assessed via a novel environment test, and following this, birds were recorded in two different conditions. Control recordings of spontaneous vocalizations were conducted in a quiet sound attenuating chamber. Experimental "stressful" recordings were conducted in the same chambers but during the playback of chickadee mobbing calls. Repeatability of many vocalizations and behaviours was observed within and across contexts (control and experimental). We detected no relationship between vocalizations and exploration in the control context. However, we did detect a significant relationship between alarm and chickadee calls and exploratory behaviour in the experimental context. Our findings extend our understanding of personality in songbirds to include vocalizations beyond song, and reveal the importance of context when assessing behavioural aspects of personality.

9

8:41 PM **The "SOS" call of *Cataglyphis cursor* ants**

Elise Nowbahari, Céline Amirault, Pyrène Rieu (Université Paris 13), Alain Lenoir (Université François-Rabelais), Chloé Leroy, Jean-Luc Durand (Université Paris 13) & Karen L. Hollis (Mount Holyoke College)

Previous work with *Cataglyphis* cursor ants has shown that they are capable of highly sophisticated rescue behavior in which individuals are able to identify precisely what has trapped their nestmate victims. Furthermore, rescue behavior, like many other tasks, is regulated by a temporal polyethism in which individuals perform different duties as they mature. To explore our understanding of the signals triggering rescue and its ontogenesis, we conducted experiments in which mature rescuers were tested with ensnared workers of different ages, namely newly-hatched ants under 3 days old (callows), young ants (10 days old), and mature adults. Control tests were conducted with same-age anesthetized victims. Volatiles released by victims in each of the three live-victim groups were subject to SPME (Solid Phase Micro Extraction) chromatography. Our results show that rescue behavior was directed toward all three types of live victims. Biochemical analyses revealed the presence of volatile components in both ten-day-old and mature workers, but not in callows. The chemical signal is similar to alarm signals found in Formicinae ants. Rescue behavior elicited by 10-day-old and mature ants likely was triggered by some of the molecules emitted by victims, whereas rescue behavior elicited by callows probably depended upon their strong attractiveness.

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8:55 PM Auditory Discrimination (Chair: Heidi Lyn)

8:55 PM **The trading of frequency and duration cues in CBA/CaJ mice**

Kelly Radziwon & Micheal Dent (University at Buffalo-SUNY)

Complex sound perception in mice using behavioral operant conditioning methods is a relatively unexplored avenue of study in animal acoustic communication. Recent studies, however, suggest that these models for human hearing can be trained to be reliable participants in psychophysical tasks. Here, mice were trained for the first time on an identification paradigm. Half of the subjects were required to place long duration, high frequency tones into one category and short duration, low frequency tones into a separate category, and the other half of the animals were trained on the opposite conditions. All subjects were required to respond by nose poking, and correct responses were reinforced with chocolate milk. After achieving an 85% correct response rate on training trials, probe trials were presented to the mice on approximately 20% of all trials (the other 80% of trials remained the training trials). Responses to the probes were always rewarded since there were no correct answers. The probes consisted of non-trained stimuli (e.g., for animals trained on long high and short low tones, the probes were short high and long low tones). Overwhelmingly, the mice classified the probe stimuli by frequency, seemingly ignoring the duration of the stimuli during identification.

11

9:02 PM **Speech-language disparity: Humans limit interspecies communication**

Michael S. Dalton (Arielle Publishing)

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"What we have here is a failure to communicate." (Cool Hand Luke) Man has communicated using speech for centuries. Despite our familiarity with words, context is a prime mechanism driving perception of language. Performing birds reinforce the cliché, "Parrots mimic what they hear." Opinions differ whether parrots repeat what they hear or whether birds comprehend words; however, research with African Grey parrots indicates that birds can learn word meaning. Most bird owners do not record bird speech, so they miss the opportunity to study unrehearsed statements. Researchers can decode unprompted cognitive speech by replaying unusual recorded statements to resolve communications. Arielle, a blue and gold macaw (*Ara ararauna*) is pragmatically instructed like a child. She is not required to repeat words or verbalize on command. Recordings reveal overlooked evidence for language learning by parrots. Ignored by casual listeners are synonyms obscured in speech—indicating comprehension of words by birds. The probability of a parrot spontaneously speaking a series of three synonymous words at random is infinitesimal (1/~3,000,000,000). In pronoun substitution the speaker denotes an object remote from a reference. Through careful listening, bird keepers worldwide corroborate pronoun substitution by parrots. Inattention to parrot speech limits communication between species and impedes discovery of avian linguistic abilities.

9:16 PM **Lateralized visual stimulation of courtship behavior and mate choice in male zebra finches**

Jennifer Templeton, Brianna McCracken, Melissa Sher & James Mountjoy (Knox College)

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Research on intersexual selection has focused intensively on traits that have evolved due to mate attraction and the consequences of mate choice. However, surprisingly little attention has been paid to the mechanisms that allow the chooser to discriminate among mates and express an attraction to certain traits. Recent reports of lateralized expression of intermediate early genes in the left hemisphere during courtship behavior in zebra finches led us to hypothesize that: 1) visual information from each eye differentially mediates courtship responses to potential mates; and 2) the ability to discriminate among mates and to prefer certain mates over others is lateralized in the right eye-left hemisphere system of zebra finch brains. First, we exposed male zebra finches to females when left, right or both eyes were available. Males courted and sang more when the right eye was available than when only the left eye was available. Secondly, male preference for females – based on beak color as an indicator of female quality - was tested under the three eye conditions. Right-eyed and binocular males preferentially associated with, courted, and sang significantly more to orange-beaked than to gray-beaked females. In contrast, left-eyed males showed an equal preference for both types.

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

14

12:00 PM **Individual level lateralization of visuospatial attention in both social and non-social corvids: A comparison of black-billed magpies and Clark's nutcrackers**

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

Cerebral lateralization, the dominance of one brain hemisphere for processing certain cognitive functions, is widespread amongst vertebrates. However, the pattern of lateralization, as assessed by directional behavioural biases, differs between species. Some species show individual variation in their directional biases (i.e., individual level lateralization), whereas other species show uniformity in their directional biases (i.e., population level lateralization). Social living has been hypothesized to be the primary evolutionary factor that promoted population level lateralization. To examine the effects of sociality on lateralization, we assessed the lateralization of visuospatial attention in two species of corvid. Social black-billed magpies and non-social Clark's nutcrackers were presented with an array of seeds from which the birds could freely select. Lateralization was assessed by each bird's tendency to preferentially select seeds from one side of visual space. Neither species showed strong evidence for population level lateralization of visuospatial attention. Instead, lateralization was either absent or significant for only a subset of individuals within each species. The results suggest that population level lateralization is not ubiquitous amongst social species and that the lateralization of visuospatial attention in corvids may be different from previously studied avian species.

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12:07 PM **Human attention as a proximate function of social play in hand-reared gray wolves (*Canis lupus*) and domestic dogs (*Canis lupus familiaris*)**

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

A scientific understanding of play behavior is hindered by a lack both of experimental evidence and little emphasis on the immediate functions of play in nonhuman animals. Given that humans provide all basic needs for their survival, caretaker attention may be an immediate benefit to animals in captive populations, where food or social reinforcement may often follow. Our objective was to address theoretical gaps in the study of play by using a function-based methodology to determine whether caretaker attention serves as a proximate reinforcer for social play in human-socialized wolves and domestic dogs. Pair-housed subjects underwent three experimental conditions – control (no owner present), owner ignore, and owner attention - counterbalanced across six sessions. Observed levels of social play were significantly higher in the caretaker attention conditions than in either the control or owner ignore conditions. Overall, play in wolves occurred at significantly lower levels than in dogs, providing support for the hypothesis that domesticated species are more likely to play than non-domesticated species. Although used widely for identifying proximate functions of problem behavior in humans, functional analysis appears to be a useful experimental methodology for determining proximate mechanisms of play in canids, and potentially other behaviors and species.

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12:14 PM **Mechanisms of action discrimination in pigeons**

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

Recognizing the behaviors of conspecifics and non-conspecifics (e.g. predator, prey) would be a valuable ability in any environment. These complex behaviors could be discriminated either by memorizing either poses or motion patterns (independent of viewpoint specific form information). Three pigeons trained to discriminate between two complex categories (martial arts versus Indian dance) were tested in a go/no-go paradigm. The reinforcement contingencies were conditional on both actor behavior and state (motion versus static displays). The results indicate that motion features independent of pose information are involved for discrimination and that attention to these motion features can disrupt frame categorization or memory. The implications for biological models of action recognition and discrimination will be discussed.

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12:21 PM **The school of fish: Large quantity discrimination in newborn guppies**

Maria Elena Miletto Petrazzini, Laura Piffer & Christian Agrillo (University of Padova - Italy)

Quantitative abilities have been reported in a wide range of animal species, including fish. Despite recent studies have provided evidence that adult fish can spontaneously select the larger number of conspecifics, this ability seems to be limited at birth because newborn guppies are unable to discriminate among quantities of peers larger than 4. In the present study, we investigated whether newborn guppies can be trained to discriminate between large quantities. Subjects were required to discriminate between groups of dots with a 1:2 ratio in order to obtain a food reward. To dissociate the roles of number and continuous quantities (i.e., area, space and density), fish were tested in three different Experiments. In Experiment 1, number and continuous quantities were simultaneously available (7 vs. 14), in Experiment 2 only number was available (7 vs. 14) and in Experiment 3, only continuous quantities were available (10 vs.10; 1 vs. 1). Subjects successfully solved the tasks in Experiment 1 and 2, providing the first evidence of large number discrimination in newborn fish. No discrimination was found in Experiment 3. A comparison with the onset of numerical abilities observed in the shoal-choice tests suggests that training procedure may enhance the salience of numerical information.

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12:28 PM **Pigeons have a cyclopean eye like humans**

Sho Otaki, Yuya Hataji & Kazuo Fujita (Kyoto University)

The optic nerves from the two eyes partially cross in the primate brain. This structure enables humans to combine two images received from the two eyes and consequently to perceive a single image (a cyclopean image). In contrast, the optic nerves totally cross in the avian brain. Previous research found little evidence that avian species integrate binocular images, except for raptors that have frontal eyes, a large binocular field, and a unique neural connection for binocular integration. In this study, we examined whether pigeons with lateral eyes and a narrow binocular field integrate binocular images. The pigeons wore red-green anaglyph eye-glasses during experimental sessions. They were trained to locate a red or a green target square on a yellow background presented on the monitor. Color property of each target was adjusted so that it could not be perceived through the glass of the corresponding color. In the test condition with red and green targets simultaneously presented in different horizontal positions, locations pecked by the pigeons were fitted the distribution around the center between the two targets. These results demonstrate that pigeons integrate binocular images into a cyclopean image, subserved by a distinct neural connection from that of primates or raptors.

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12:35 PM **Female song production by black-capped chickadees: Sex differences in song acoustic features**

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

Song is traditionally considered a male-produced vocalization in temperate songbirds; however, in many songbird species it is now recognized that both males and females produce song. In the black-capped chickadee (*Poecile atricapillus*), the function and acoustic structure of male-produced *fee-bee* song has been well studied, but in this species, female song has not been quantitatively examined. In the current study, we demonstrate that female black-capped chickadees produce *fee-bee* songs, and using bioacoustic and discriminant function analyses we examine six acoustic features within male and female song. Discriminant function analyses correctly classified songs based on the sex of the signaler and the results indicate that at least one acoustic feature, the frequency decrease within the *fee* note (i.e., *fee* glissando), varies between male- and female-produced songs. This statistical classification suggests that sufficient acoustic differences exist within the songs which would allow birds to identify the sex of the signaler.

12:42 PM Cognitive Processes I (Chair: Stephen Lea)

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12:42 PM **The task-switching pigeon - evidence for associative learning in a task switching paradigm**

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

Humans can easily perform several different tasks on the same stimulus material in rapid alternation even if each task requires the classification of a set of stimuli according to a different stimulus attribute, with each task signalled by a distinct task cue. Such "task switching" performance is often claimed to involve mental reorientation away from the previous task, indicating executive control of behaviour. Alternatively, task switching might simply be based on the retrieval of cue-stimulus-response associations. Pigeons learned go-left/go-right discriminations between grating patterns according to either their spatial frequency or their orientation, depending on the colour of the pattern (the task cue). Humans solving the same tasks according to verbalisable rules responded more slowly and made more errors on trials where they had to switch between tasks than when repeating the same task. Pigeons did not show such "switch costs"; instead, their performance declined heavily when the response (left or right) to a given stimulus varied between tasks than when it stayed the same (a “congruency effect”). Similar patterns were observed in humans learning the tasks by trial and error. These findings point towards the possibility that task switching might be performed independent of executive control processes.

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12:49 PM **The effect of stimulus ambiguity on generalization decrement**

Traci Biedermann & Aaron P. Blaisdell (UCLA)

Bouton et al. (2012) recently demonstrated generalization decrement in Pavlovian nose poke responding when rats were tested on an element, CS A, after having been trained on a compound, CS AB. We replicated this procedure to examine the effect of stimulus ambiguity on generalization decrement. Rats were trained with compound CS AB, consisting of a click train (A) and a diffuse light (B), paired with delivery of sucrose solution. Rats were then tested with non-reinforced probe trials of CS AB or CS A alone. On some CS A trials the diffuse light (B) was covered with an opaque shield, preventing detection of B’s status. On other test trials of CS A, B’s bulb remained uncovered and unlit. Relative to conditioned responding to compound AB during tests, we observed decreased responding to A alone with B uncovered, replicating the generalization decrement reported by Bouton et al. No decrease in conditioned responding, however, was observed on tests of A with B covered. Thus, the cover prevented generalization decrement when testing on A alone. We discuss these results in terms of the effectiveness of an image of B, elicited by its associate A, at test being modulated by the ambiguity of B’s status.

12:56 PM **Food quality and cognition: Effects of a purified, refined diet on performance on a progressive ratio schedule in rats**

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

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Highly processed and refined foods, commonly referred to as "junk foods", are increasingly recognized as having negative impacts on health and disease. Little is known, however, about the impact of a highly processed foods diet on cognition. We placed one group of rats on a purified, refined foods diet (Research Diets D12450B) while another group of rats were maintained on a relatively unrefined, whole foods control diet (LabDiets 5001). After three months on their respective diets, the rats on the Refined diet gained a significant amount of weight, largely through increased adiposity. Rats on the Control diet, however, showed no change in weight. Rats were placed on a progressive ratio 3 (PR3) schedule of lever press reinforcement, in which sucrose solution was delivered only after completing an additional 3 lever presses relative to how many presses were required to earn the previous reinforcer. Rats on the Refined diet made significantly fewer lever presses, and tended towards a lower break point than rats on the Control diet. These results suggest that dietary differences contributed to differences in motivation.

1:03 PM **Flexible encoding of the source pair in a bi-dimensional relational matching to sample task in baboons**

Joël Fagot (CNRS) & Anais Maugard (Aix-Marseille University)

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Recent studies have demonstrated that apes and monkeys can match relations with relations, suggesting that these species have basic abilities for analogical reasoning. However, analogical reasoning in humans entails cognitive processes which remain unexplored in animals, in particular the ability to flexibly re-encode the relations instantiated by the source (sample) domain as a function of the relational properties of the target (comparison) domain. In this research, baboons had to solve a relational matching task considering the (same/different) relation expressed by either the shape or the color of the two items composing the sample pair. The sample dimension to be process in each trial was indicated by the properties of the comparison pair. Baboons could solve the test in spite of a randomization of these two kinds of trials, showing that they did flexibly re-encoded, on a trial to trial basis, the sample pairs considering the properties of the comparison pairs. They could furthermore successfully match same and different relations across the shape and color dimensions.

1:17 PM **Now you see it, now you don't – object permanence in a jumping spider**

Fiona Cross & Robert Jackson (University of Canterbury)

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Jumping spiders (family Salticidae) have unique, complex eyes and a capacity for spatial vision exceeding that for any other animals of similar size. Individuals from one genus in this family, Portia, are known to specialize at preying on other spiders, and previous research has shown that individuals can discriminate between spiders and insects, and between different spider species, on the basis of vision alone. Although little is known about the role of object permanence in Portia's predatory behaviour, we examined this in new research using *Portia africana*, a species from Kenya. At the beginning of each trial, we presented individuals with a prey spider. This prey was a lure made from either Arachnura, which is found in two colour morphs (brown or yellow), or from *Pychacantha tribulus*. After *P. africana* was presented with this prey, we hid the prey behind a screen. When the screen was raised again during the trial, the same type of prey spider or a different type (either different morph or species) was visible. If the type of spider had changed, *P. africana* was less likely to leap toward it. We also saw greater hesitation to leap when the prey species, in particular, had changed.

1:31 PM *Break*

1:36 PM Discrimination Learning (Chair: Olga Lazareva)

1:36 PM **Pigeons use low rather than high spatial frequency information to make visual category discriminations**

Stephen E. G. Lea (University of Exeter, UK), Guido De Filippo (Alma Mater Studiorum Università di Bologna, Italy), Ruth Dakin & Christina Meier (University of Exeter, UK)

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Pigeons were trained to discriminate photographs of cat faces from dog faces. They were then presented with test stimuli in which the training stimuli had been subjected to either high- or low-pass spatial frequency filtering. Discrimination was maintained with both types of filtered stimuli, though it was increasingly impaired the more information was filtered out, and high-pass filtering impaired discrimination more than low-pass filtering. The pigeons were then exposed to hybrid stimuli in which high-pass filtered dog faces were combined with low-pass filtered cat faces, and vice versa. Response to hybrid stimuli was determined more by the low spatial frequency content than by the high frequency content, whereas humans viewing the same stimuli at corresponding viewing distance respond more strongly to the high-frequency content. These results are unexpected given that, compared with humans, pigeons' behavior tends to be controlled by the local details of visual stimuli rather than their global appearance, and local details are necessarily carried by higher spatial frequencies.

1:50 PM

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Are individual differences in cognitive performance on a perceptual discrimination task related to exploration?
Lauren M. Guillette, Danielle M. Lubyk, Christopher B. Sturdy & Marcia L. Spetch (University of Alberta)
Until very recently the field of animal personality has focused mainly on examining individual differences in behavioural traits such as exploration, boldness, sociability, aggression, and activity. However, a few research groups have begun to examine how individual differences in cognition may interact with these behavioural traits. For instance, two studies from our laboratory have shown that learning speed is related to exploratory behaviour. In the current study, our goal was to examine learning in a finer grained manner by asking whether individual differences in expertise at discriminating visual test stimuli from trained stimuli correlate with exploratory behaviour. Pigeons (*Columba livia*) were first run in a novel environment task to assess exploratory behaviour. Pigeons were then trained using a go/no-go operant procedure on a line-orientation generalization task. In line with our earlier work examining learning speed, we predicted that fast-exploring birds would have broader response gradients (i.e., less expertise in discriminating novel stimuli that are similar to trained stimuli) suggesting more superficial representations of environmental stimuli, compared to slow-exploring birds. To the contrary, we found evidence suggesting that fast-exploring pigeon may be more expert discriminators.

2:04 PM

27

Pigeons make few errors on a variable mid-session reversal task with visual/spatial cue dimensions
Neil McMillan, Chelsea R. Kirk & William A. Roberts (University of Western Ontario)
It has been shown previously that pigeons make surprising anticipatory and perseverative errors on a visually-based mid-session reversal task. We trained birds with red always presented on the right sidekey and green always on the left, with one color rewarded in the first part of the session (S1) and the other color rewarded in the latter part of the session (S2). The trial number of the reversal point varied between sessions. Several birds showed perfect or near-perfect reversal performance, with few anticipatory or perseverative errors regardless of the reversal location. This result will be discussed in the context of spatially-based mid-session reversal tasks in rats and pigeons.

2:11 PM

28

Problems with your rats? Now there is an App for that
Joshua Wolf, Catherine Urbano, Chad Ruprecht & Kenneth Leising (Texas Christian University)
The increasing demand for highly automated and flexible tasks capable of assessing visual learning and memory in non-human animals has led to the exciting development of a wide array of touchscreen-equipped chambers. However, the high cost of prefabricated touchscreen-equipped chambers has caused many researchers to develop or modify their own preexisting equipment. Our lab has explored the use of an iPad (Apple, Cupertino, California) as an alternative to prefabricated chambers and developed an App for data collection. The touchscreen technology offered by the iPad is attractive to researchers due to its affordability, reliability, and resistance to false inputs from whiskers, tails breaking, etc. We will highlight these, as well as other benefits of using the iPad and present evidence for visual discrimination learning with rats in an iPad-equipped chamber.

2:18 PM

29

Near-optimal win-stay/lose-shift performance found on a simultaneous-spatial-discrimination, midsession-reversal task with short intertrial intervals is not maintained with visual discriminations
Jennifer R. Laude, Becky R. Reeves, Jessica P. Stagner & Thomas R. Zentall (University of Kentucky)
In the simultaneous-discrimination, midsession reversal task one stimulus is correct for half of the session and the other stimulus is correct for the remainder of the session. After many sessions of training, pigeons appear to use the passage of time into the session as a cue to reverse (they respond to the second stimulus before the reversal and continue to respond to first stimulus after the reversal). Using a spatial discrimination, we found a similar pattern of errors. We hypothesized that errors around the reversal point resulted in part from the inability to remember both the choice and the outcome from the preceding trial (a memory deficit) because we found that pigeons with a short intertrial interval (ITI) showed close to optimal win-stay/lose-shift accuracy on a spatial mid-session reversal task. In the present study we tested the hypothesis that the spatial discrimination allowed the pigeons to use their behavior as a cue to anticipate where they would peck next following reinforcement (and nonreinforcement) by giving pigeons a visual discrimination wherein stimuli varied in location throughout the session. In support of this hypothesis, we found that pigeons given the visual discrimination with a shorter ITI did not show near-optimal win-stay/lose-shift performance.

2:25 PM **Monkey see, monkey sync**

Yasuo Nagasaka, Zenas C. Chao, Naomi Hasegawa, Tomonori Notoya & Naotaka Fujii (Lab. for Adaptive Intelligence BSI RIKEN Japan)

30

The studies in perception and action in social context revealed that unintentional synchronization facilitated smooth social interaction in humans. However, little is known about the behavioral synchronization in social animals such as monkeys. Here we examined an unintentionally-synchronized behavior in monkeys occurred in a social context. We individually trained three Japanese monkeys to push two buttons alternately. The unintentional synchronization was quantified by changes in button-pressing behavior while two monkeys were seated facing each other. After synchronized behavior was observed, different experimental conditions were applied to explore interferences of visual and auditory information on the speed of rhythmic behavior. We found that the speed of button-pressing changed, either up or down, toward to synchronization, where the pressing frequency of one monkey was a multiple of that of another. Moreover, sounds and visuals of partner's behavior influenced the speed of button-pressing. These results indicate that unintentional motor synchronization exists in non-human social animals. This unintentional change in behavior occurred when the subject merely saw or heard partner's action, which suggests that social bonds play an important role in behavioral synchronization through visuo-motor and auditory-motor coupling to other's behaviors.

2:39 PM **Toward a behavioral ecology of rescue behavior in ants**

Katherine Taylor, Allison Visvadar (Mount Holyoke College), Elise Nowbahari (Université Paris 13) & Karen L. Hollis (Mount Holyoke College)

31

Following a recently-published comparative study of rescue behavior in Mediterranean ants, we investigated two North American ant species that allowed us to test some predictions concerning the importance of risk and relatedness to the ability to rescue trapped conspecifics. Using the same experimental protocol as in earlier work, individual Tetramorium sp. *E* and *Prenolepis imparis* ants were held in artificial snares simulating capture. T. sp. E, but not P. imparis, exhibited digging, pulling and snare biting, the latter precisely targeted to the object binding the victim. These results are the first to document precision rescue in a North American ant species. Moreover, unlike rescue in other ants, T. sp. E rescues conspecifics from different colonies, mirroring their highly likely unicolonial social structure, namely the development of large multiple nests between which ants move freely. In a second study designed to demonstrate rescue from an actual predator, T. sp. E victims were dropped into an antlion's pit and the behavior of a single rescuer was observed. Results showed that T. sp. E not only attempted to release the victim, but also risked attacking the predator, suggesting that precision rescue may play an important role in this species' antipredator behavior.

2:53 PM *Snack Break*

3:33 PM Canine Cognition (Chair: David Stahlman)

3:33 PM **The effect of Pavlovian conditioning on an operant odor-detection task in dogs**

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

32

Dogs require extensive training to become reliable odor detectors. Exposure learning may be a simple way to prepare dogs for later operant discrimination training. Pavlovian procedures may also facilitate an operant odor-discrimination. In the present experiment, we tested whether passive odor exposure facilitates canine performance on an operant odor-discrimination task compared to a no-exposure control group and two Pavlovian pairing groups. Thirty-two dogs were randomly assigned to four groups and given five days treatment prior to operant training. Dogs in the exposure group were exposed to anise extract for 30 minutes each day. Dogs in the Pavlovian relevant pairing group received daily six trials of a 10 sec anise odor presentation followed by food. The Pavlovian irrelevant pairing group was identical except that an odorant irrelevant to future detection training was used. Dogs in the control group received no treatment prior to operant training. All dogs were then trained to detect anise extract. Operant performance levels between the exposure group, control group, and Pavlovian irrelevant pairing group were indistinguishable, whereas performance in the Pavlovian relevant group was significantly better. Only Pavlovian conditioning to the relevant odor enhanced odor-detection performance.

3:40 PM **33**

Correlation between stereotypies and behavioral persistence in pet dogs

Alexandra Protopopova, Nathaniel J. Hall & Clive D. L. Wynne (University of Florida)

Behavioral stereotypies in pet dogs are a serious health problem that negatively impacts both dogs and their owners. We aim to improve upon the current understanding of stereotypic behavior in dogs, such as light chasing, spinning, and excessive licking, by comparing the behavior of dogs with and without stereotypies. We hypothesize that dogs that exhibit stereotypies show general differences in response to the environment. Specifically, we evaluated whether these dogs showed higher behavioral persistence, which was measured through resistance to extinction on a simple training task, than normal dogs. Each dog was trained with 40 trials using a food reinforcer to nose-touch the experimenter's hand on a continuous reinforcement schedule. After acquisition, the dogs entered a 1 min extinction phase, during which food was no longer delivered. The number of nose-touches as well as inter-response times during this phase was recorded. As predicted, with the exception of one outlier in the control group, the dogs with stereotypies showed higher behavioral persistance than normal dogs, suggesting that these dogs respond more repetitively to their environment than a normal population of dogs. The results suggest that dogs with stereotypies differ from the normal population in their general sensitivity to environmental variables.

3:47 PM **34**

The case of the magic bones: Dogs' memory of the physical properties of objects

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

Dogs' memory for properties of occluded objects was assessed using a looking-time procedure. The looking-time procedure has been used to indicate that a change in expectation has been observed with longer looking times associated with change as compared with no change. In our experiments, a bone-shaped dog biscuit (bone) was placed behind a horizontal screen that then rotated up to occlude the object before the screen returned to its horizontal position. Dogs were shown one of two test events. In one (congruent) event, the screen rotated up to obscure the bone and then rotated back down to reveal the unchanged bone. In the other (incongruent) event, the screen rotated up to obscure the bone and then rotated back down to reveal a bone that had changed in size (Exp. 1) or color (Exp. 2). Looking times were measured to assess which events represented the detection of a change. Increased looking time on incongruent trials indicated that the dogs remembered the size and color of the occluded object.

3:54 PM **35**

Numerical discrimination and interval timing in the domestic dog

Krista Macpherson & William A. Roberts (University of Western Ontario)

Animals track fixed time intervals of a given duration and "count" by making discriminations between varying numbers of stimuli. Neither process, however, has been studied thoroughly in domestic dogs. Sedona, a female rough collie, was taught to make numerical discriminations in a simultaneous two-choice task. Geometric shapes were presented to Sedona on two magnet boards. If Sedona chose the board with the larger number of items, she was rewarded. She received no reinforcement for incorrect responses. Sedona was tested on ratios of 0vs1, 0vs3, 1vs2, 1vs3, 1vs9, 2vs4, 3vs4, 3vs9, 4vs8, 6vs8, 6vs9, and 8vs9, and performed significantly above chance on all ratios except 8vs9. Sedona's accuracy decreased as the smaller/larger ratio became larger, meaning her performance agreed with Weber's Law. In a second study, Sedona was taught to press a button in order to receive a reward from a dispenser. A 1-minute fixed-interval schedule was then imposed, making it impossible for Sedona to receive a reward until the machine was armed at 1-minute. Sedona's pattern of responding showed an increase from a low rate at the beginning of the interval to a high rate at the end of the interval.

4:01 PM **36**

Persistence and deference: The (un)solvable task from the canine perspective

Monique A.R. Udell (University of Oregon), Jennifer Gibson & Stephanie Scavelli (Flagler College)

Pet domestic dogs have been found to gaze towards humans when faced with an unsolvable task. Wolves, on the other hand, have been found to persist, looking less towards humans, and more towards the puzzle. Typically a dog's wiliness to look to humans sooner and longer during such a task has been viewed as a cognitive advancement. Given that a task is indeed unsolvable, looking towards the nearest human might be the best solution. However, some dogs may simply lack persistence on physical problem solving tasks compared to wolves. Many pet dogs are also specifically forbidden from tearing open sealed food containers. This could lead to conflicting responses when expected to engage in such behavior in the presence of their owner. Conversely, wolves living outdoors in a physically enriching environment - tearing open carcasses for food, digging open logs, etc.. - encounter natural puzzles on a daily basis without fear of punishment. In the current study pet dogs, shelter dogs and socialized wolves were presented with a challenging but solvable food getting task. Subject performance, persistence, and the effect of human presence and demeanor on canine behavior were evaluated.

4:15 PM *Break*

4:20 PM Spatial Cognition I (Chair: Ken Cheng)

4:20 PM **A survey of spatial memory and transposition in primates and children with autism**

Stephanie E. Jett, Heidi Lyn & Michael Mong (University of Southern Mississippi)

37

Utilizing tasks taken from the Primate Cognitive Test Battery (PCTB), we investigated the spatial memory and transposition abilities of a variety of primate species and children with Autism. The PCTB was originally designed to be used with all primate species, but to date it has only been used with great apes. There are reasons to believe that there would be differences in spatial memory and transposition abilities between and among primates due to variations in phylogenetic history and evolutionary pressures. Similarly, children with Autism may differ from typically functioning children as they show deficits in executive functioning and processing skills resulting in lowered social and other cognitive abilities. The results of the current study suggest that there are differences in spatial memory and transposition abilities between and within primate species. Preliminary results for the Autism group show that there are significant differences between children with high IQs and low IQs for the higher complexity spatial memory task and the transposition tasks. This project is part of a larger goal to expand the PCTB for use in not only primates, including humans, but other species to allow for direct comparisons of cognitive abilities utilizing the same tasks and methodology.

4:27 PM **Space, the final frontier: These are the voyages of pigeons and humans during occasion setting**

Chad M. Ruprecht, Josh E. Wolf & Kenneth J. Leising (Texas Christian University)

38

It is no secret that animals (e.g., Bonardi & Hall, 1994; Ross & Holland, 1981) and humans (e.g., Baeyns et al., 2001; 2004) can learn the basic occasion-setting (OS) contingency, but we were curious as to how OS operated in space. In the present task, a feature, X (e.g., a colored background), set the occasion for whether a spatially distinct response (e.g., pecking left vs. right) made in relation to a target, A (e.g., a patterned landmark), was followed by a reinforcer. OS training (i.e., XA+ / A-), X should disambiguate the target-reinforcer relationship. We hypothesized that both pigeons and humans would evidence knowledge that X set the occasion for reinforcing a spatially specific response in relation to A. Across 4 experiments, pigeons pecked a touchscreen for grain, while TCU Undergraduates blasted a monitor for treasure. Numerous Feature-Target combinations (including novel pairs) were tested. Across both species, the target maintained higher spatial control over peck/shot distributions when compared to the feature; pigeon distributions favored the target, where as humans distributions were more difficult to interpret. These are the first studies utilizing the OS paradigm to examine higher order relations in space.

4:34 PM **Effects of feature-based and spatial-based attention on pigeons' visual search behaviors**

Kazuhiro Goto (Sagami Women's University), Sho Otaki (Kyoto University) & Shigeru Watanabe (Keio University)

39

In the foraging literature, it is well documented that animals are sensitive to both visual features of prey and the locations where they encountered the prey. Thus, these two types of information could become effective signals to detect the visually similar prey type or the prey on the same location when appearing in succession. In this study, we examined how visual features and spatial information of previously encountered prey items affect animals' subsequent search behavior in pigeons. Pigeons were trained to search for three target items among distractors. The four conditions tested were: 1) the same target item appeared in succession (feature runs), 2) the various target items appeared in the same location (spatial runs), 3) the same target appeared in the same location in succession (combination runs), and 4) neither the same target nor its location were repeated in succession (control runs). The facilitation effects were similar under the feature and spatial runs. Furthermore, the facilitation effects became most effective under the combination runs. These results suggest that the repetitions of the visual feature and the target location independently operate to guide animals' attention.

4:48 PM **Geometric vs featural processing: Are they lateralized in humans?**

Stephanie Tanninen & David R. Brodbeck (Algoma University)

40

To locate an object, rats use shape as a cue and disregard features. Adult humans use both the shape of the environment and features. As chicks show brain localization of shape and feature processing, this study attempted to address whether shape and feature cues are also processed in different brain hemispheres in adult humans. University students observed two types of rectangles (either plain or banded) with a red dot in one corner spinning on a computer screen. The red dot disappeared as the rectangle spun. When it stopped, the participants selected the corner of the rectangle where they thought the red dot had been. The participants watched the rectangle with their left visual field, both visual fields, or their right visual field. There were no differences between visual fields. This suggests that cue processing in adult humans can be best understood as a non-hemispherically localized process

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

See Poster Abstracts Starting on Page 23

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

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

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12:00 PM **Social behavior of zebrafish**
Robert Gerlai (University of Toronto Mississauga)
The zebrafish is increasingly used in behavioral neuroscience and neurobehavioral genetics research as this species is argued to represent a good translational tool. An important feature of our own species is our highly social nature. The zebrafish is the most social species utilized in biomedical research and thus some has suggested that features and mechanisms of such human diseases as autism, schizophrenia or social anxiety may be modeled using the zebrafish. Zebrafish form shoals in nature and in the laboratory. We have started the characterization of this behavior. We have described distinct parameters of group forming, developed methods of quantification of these parameters and designed behavioral test paradigms with which we induce and can manipulate this behavior. In the current talk, I will summarize our initial results on both the ontogenesis (long time scale) and dynamic (short time scale) changes in group forming behavior in zebrafish. I will also discuss results on what the ideal shoal-mate may be for zebrafish and what neurobiological mechanisms may underlie the motivation to form groups in this species.

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12:25 PM **Follow the leader III: The influence of social information in a spatial search task**
Teagan A. Bisbing & Michael F. Brown (Villanova University)
Over the last two years we have presented a series of studies exploring rats' use of social cues during a spatial search task. Results of these studies have suggested that social cues are only used in the absence of personal information about the locations of reward. In the current study, we explore this interpretation further. Model rats were each trained to find bait in a unique set of locations. Subject rats, naïve to the baited locations, were paired with different Model rats from trial to trial. With the limited availability of personal information about the baited locations, Subject rats should use the social cues of the Model rat partner to a greater extent than in prior experiments. Analyses will compare the spatial choices of the Subject rat as a function of the Model rats' baiting patterns and the Model rats' spatial choices throughout trials.

43

12:32 PM **Bonobos share with strangers**
Jingzhi Tan & Brian Hare (Duke University)
Prosocial behaviors toward strangers are prevalent in human societies and are thought to be unique to humans. This phenomenon has lead many to suggest that such ultra-prosociality is a product of human language, social norms, warfare and/or cooperative breeding. Here we show that bonobos will voluntarily forgo desirable food in their possession to facilitate a social interaction with a stranger. Moreover, they will unselfishly help strangers acquire out-of-reach food even when such social interaction was no possible. These findings indicate that prosociality toward strangers is not unique to humans, and it may evolve due to the benefits of expanding individual social networks.

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12:39 PM **The effects of collective behavior on learning and decision-making**
Noam Miller, Albert Kao, Colin Torney, Andrew Hartnett & Iain Couzin (Princeton University)
Animals that live and move in groups also learn in groups and their learning (and other cognitive functions) is affected by interactions between group-members. For example, consensus decision-making, which is common in many group-living species, requires that some individuals repress their own 'opinions' in order to remain with the group, which affects their future learning and preferences. I will present an associative learning model of collective learning and some experimental data that show how groups integrate different information held by their members. Existing studies and models of learning have mostly focused on single subjects and studies of collective motion have ignored learning. By integrating these two approaches, we reveal novel and fundamental dynamics of collective learning.

45

12:53 PM **Group size predicts social but not nonsocial cognition in lemurs**
Evan MacLean (Duke University), Aaron Sandel (University of Michigan), Joel Bray (Duke University), Ricki Oldenkamp (Northern Michigan University), Rachna Reddy & Brian Hare (Duke University)
The social intelligence hypothesis suggests that living in large social networks was the primary selective pressure for the evolution of complex cognition in primates. This hypothesis is supported by studies demonstrating a positive relationship between social group size and relative brain size across primates. However, the relationship between brain size and cognition remains equivocal. Moreover, there have been no experimental studies directly testing the association between group size and cognition across primates. We tested the social intelligence hypothesis by comparing 6 primate species (96 individuals) characterized by different group sizes on two cognitive tasks. We show that social group size predicts performance on cognitive measures of social cognition, but not a nonsocial measure of inhibitory control. We also show that brain size (in absolute or relative terms) does not predict performance on either task in these species. These data provide direct evidence for a relationship between group size, and social cognition in primates, and reveal the potential for cognitive evolution without concomitant changes in brain size. Further they underscore the need for empirical studies of animal cognition, which have the power to reveal species differences in cognition, not detectable by proxy variables, such as brain size.

1:07 PM *Break*

1:12 PM Spatial Cognition II (Chair: John Magnotti)

1:12 PM **Spatial pattern learning by rats in ARENA**

Julia Schroeder, Aaron Blaisdell & Dennis Garlick (UCLA)

46

Spatial pattern learning tasks are useful for exploring cognitive processes. We adapted Brown et al.'s (2010) procedure for humans for an automated open field task called ARENA with rats. Rats were presented with a 3 x 3 array of identical objects on the ARENA floor. Five of the nine objects were targets, the remaining four were distractors. Rats received a food reward delivered in an adjacent chamber after all 5 targets had been visited at least once. Targets were arranged in one of two ways for separate groups of rats. For group Pattern, the targets conformed to a plus-shaped pattern. For group Pseudo, targets were initially arranged haphazardly, but remained in that arrangement for the duration of the experiment. Thus, while rats in both groups could memorize the spatial layout of rewarded locations to complete trials efficiently, the Pattern group could perform more efficiently by abstracting the plus pattern. Rats in the Pattern condition acquired the task at a faster rate and with fewer errors. These results suggest that rats abstracted the spatial pattern of rewarded locations. Expansion tests involving additional objects added to extend the array beyond the training locations were more equivocal, however.

1:19 PM **Geometric cues, reference frames, and the equivalence of experienced-aligned and novel-aligned views in human spatial memory**

Bradley R. Sturz (Georgia Southern University), Lori A. Sjolund & Jonathan W. Kelly (Iowa State University)

47

Spatial memories are organized around reference frames, and environmental shape provides a salient cue to reference frame selection. Yet, the environmental cues responsible for influencing reference frame selection remain unknown. To connect research on reference frame selection with that on orientation via environmental shape, we explored the extent to which geometric cues were incidentally encoded and represented in memory by evaluating their influence on reference frame selection. Using a head-mounted-display, we presented participants with to-be-remembered object arrays. We manipulated whether the experienced viewpoint was aligned or misaligned with global (principal axis of space) or local (wall orientations) geometric cues. During subsequent judgments of relative direction (participants imagined standing at one object, facing a second, and pointed toward a third), we show that performance was best when imagining perspectives aligned with these geometric cues; moreover, global geometric cues were sufficient for reference frame selection, global and local geometric cues were capable of exerting differential influence on reference frame selection, and performance from experienced-imagined perspectives was equivalent to novel-imagined perspectives aligned with geometric cues. Results explicitly connect theory regarding spatial reference frame selection and spatial orientation via environmental shape and indicate that spatial memories are organized around fundamental geometric properties of space.

1:33 PM **Effects of separate and combined visual and spatial cues on rats' missing object recognition working memory**

Corrine Keshen & Jerome Cohen (University of Windsor)

48

In the missing object recognition working memory task, a rat must choose the one of four objects in a test array that might not have previously occurred in a previous study array of three objects. In the present study, we examined rats' accuracy for finding the target object when each object's global (within the foraging area) or its local (within the foraging area) positions or both were always fixed (Combined Cues groups) or always varied (Separated Cues groups) over segmented trials. Occasionally the objects' spatial cues on a test array were changed from those in their trial's study array or identical objects replaced the different objects. These probe test array manipulations only disrupted Combined Cues rats' accuracy for finding the correct target object, but either had no effect or, under some conditions, improved Separated Cues rats' performance. We also examined choice preference patterns on probe test arrays to determine whether rats in the Combined Cues groups simultaneously processed objects' visual and spatial information or separately processed them differently from rats in the Separated Cues groups.

1:47 PM **Encoding of geometric angles differs between real-world and virtual environments**

James F. Reichert & Debbie M. Kelly (University of Manitoba)

49

In a replication of a real-world study, adult humans learned to discriminate between two objects shaped as geometric angles presented to them in first-person perspective on a desktop computer. One object projected a 50° angle and the other object projected a 75° angle and participants were grouped based on training angle size. During testing each respective training angle was individually paired with one of a series of novel test angles that was either smaller or larger than the training angle. Across a series of experiments participants manually navigated toward the angles, were automatically transported to a position in front of the angles, or remained stationary (no movement) before making a choice. Results showed that movement in the virtual environment, regardless of whether it was participant-directed or automatic, resulted in relative encoding of both sizes of training angle. However, when participants' viewpoint remained stationary the smaller angle was encoded absolutely and the larger angle relatively, a finding similar to a real-world version of the same task. Results suggest that motion cues may influence the encoding of spatial properties in virtual environments.

2:01 PM **Cognitive mechanisms for navigation in sea turtles: What do Kemp's ridleys do in a radial maze?**
Heidi Lyn, Megan Broadway, Jamie Klaus, Delphine Shannon, Tim Hoffland, Andrew Coleman & Moby Solangi (University of Southern Mississippi and Institute for Marine Mammal Studies)

50

Sea turtles exploit such navigational cues as wave motion, sunlight, and earth's magnetic fields during their life cycle. However, these behaviors are considered innate and little is known about learned behavior as it relates to navigation or foraging behavior in sea turtles. As an attempt to measure and document foraging abilities in rehabilitated Kemp's ridley sea turtles before release into the Mississippi Sound, eight turtles were placed in a large exercise pool with a 6-arm radial maze, which had two baited arms, integrated visual cues, as well as extra-maze cues. Initial analysis indicated that the turtles did not learn which arms were baited and that each turtle followed a different strategy when exploring the maze. Some evidence of sunlight-guided exploration was found in one turtle, but not in the other turtles. Sequential analysis will determine whether the turtles followed specific patterns in their searches. Our results suggest that rehabilitated Kemp's ridley sea turtles likely do not rely on learning locations within a small area to locate their prey, relying instead on vision and/or chemoreception. Further research exploring the use of these and other mechanisms over short and long ranges would allow for direct comparisons with other sea turtle species.

2:15 PM *Break*

2:20 PM Cognitive Processes II (Chair: Jonathon Crystal)

2:20 PM **Gustatory imagination in an orangutan**
Mathias Osvath, Gabriela-Alina Sauciuc, Christian Balkenius & Tomas Persson (Lund University Cognitive Science)

51

The ability to mentally recombine previously experienced perceptual elements into (potentially novel) compound perceptions is one possible definition of "imagination". (Imagine eating a Popsicle that tastes of liver.) Can a nonhuman mind, in a similar vein, simulate what it has never experienced by recombining perceptual elements? Specifically, can it predict future gustatory experiences? In the present experiment the preferential choices of an adult male Sumatran orangutan (*Pongo abelii*), faced with novel combinations (mixes) of previously learned colored liquids of various tastes, were observed in a two-alternative forced choice procedure. The results reveal that the orangutan flexibly updated his choices depending on whether previously established preferences were either upgraded or downgraded, relative to the non-mixed comparison liquids, as a result of mixing. Simple strategies of consistently avoiding certain component liquids or always choosing certain component liquids do not reliably account for responses to the mixed compound liquids, suggesting that the orangutan predicted the tastes resulting from the mixing, and used a relational strategy to decide whether this was a preferred choice or not. The response pattern of the orangutan was similar to that of human subjects performing an identical task, arguably evidencing the two species used similar strategies.

2:34 PM **Functional segregation of the entopallium in pigeons**
Tadd B. Patton (Georgia Regents University), Robert G. Cook (Tufts University) & Toru Shimizu (University of South Florida)

52

In birds, the entopallium is the principal telencephalic target of the major visual ascending route called the tectofugal pathway. This pathway is often functionally compared to the primate geniculo-striate pathway and its subsequent telencephalic regions, the latter processes visual information in a parallel fashion in terms of anatomy, physiology, and function. However, is not clear whether or how information is segregated or integrated in the avian brain. Here, we examined whether or not the visual features: color, form, and motion are selectively processed by different portions of the entopallium. After training on visual tasks requiring discrimination of different combinations of color, form and motion cues, pigeons received lesions to either the anterior or the posterior entopallium. Pigeons with anterior lesions exhibited reduced performance in tasks most dependent on color and form discrimination, but showed no deficit on a task involving discriminations among moving forms. Pigeons that received posterior lesions exhibited reductions in discriminating moving and static forms, but minor color discrimination deficits. This functional segregation of visual information processing within the entopallium indicates a convergence between birds and primates regarding the parallel processing and separation of information within their phylogenetically distinct visual pathways.

2:48 PM **The systematic squirrel: Cache organization and implications for memory**
Mikel Delgado & Lucia Jacobs (University of California at Berkeley)

53

The use of memory for cache retrieval has been demonstrated in several species, yet the mechanisms that would aid the retrieval of thousands of food stores are not fully understood. One possible solution would be a hierarchical cognitive representation known as chunking. An example of this would be caching food items in particular locations based on food type. We presented fox squirrels with a series of sixteen nuts, in one of four possible conditions: A (two nut types in clusters of eight); B (two nuts types in clusters of four); C (four nut types in clusters of four); D (four nut types presented in random order). Cache locations were recorded using handheld GPS to allow for spatial analysis of data. If squirrels segregate their caches by nut type, conditions A and C should present the lowest memory burden. Conditions B and D would place a higher burden on memory, causing more overlap in caches. Our results suggest that squirrels cluster nuts in small groups regardless of nut type, but they may employ a chunking strategy for larger quantities of nuts. Changing nut type may lead to retroactive interference in memory for cache location for large quantities of food.

2:55 PM **The cognitive and ecological challenges of scatter-hoarding**

Mario B. Pesendorfer, Amy J. Ort, Alan B. Bond & Alan C. Kamil (University of Nebraska - Lincoln)

54 Comparative studies of scatter-hoarding often examine how anatomical or behavioral variation among species correlates with dependence on cached food. But how should reliance on caching or the cognitive demands thereof be measured in a biologically meaningful way? Some assume that annual number of caches best characterizes dependence on stored food. Others, in contrast, assume that stomach contents during winter best capture degree of specialization. The cognitive challenges of scatter-hoarding are also multidimensional in their nature. For example, the relative importance of duration versus accuracy of cache memory may vary as a function of the caching environment. While these traits are difficult to quantify, they are also subject to natural selection that shapes cognitive abilities associated with scatter-hoarding. Using corvids (crows, jays, nutcrackers and allies) as an example, we propose a framework that emphasizes the variation in the ecological and cognitive demands of scatter-hoarding. This variation needs to be addressed in an explicitly quantitative manner when making comparisons between scatter-hoarding species.

3:02 PM *Snack Break*

4:15 PM In Honor of Al Kamil (Chair: Debbie Kelly)

4:15 PM **Relational representation and flexibility in operant transitive inference**

Alan B. Bond & Alan C. Kamil (University of Nebraska - Lincoln)

55 Operant transitive inference involves two contrasting forms of cognitive representation. Direct representation derives from the previous history of reward for each stimulus. Relational representation derives from memory of the association between each stimulus and the next one in the sequence. The presumed adaptive significance of relational encoding is that it is better able to represent complex, dynamic network structures. Life history features such as social complexity or reliance on cached food should, therefore, promote greater use of relational representation. To test this prediction, we emulated natural fluctuations in an implicit hierarchy, comparing three corvid species with contrasting natural histories – pinyon jays, scrub jays, and Clark's nutcrackers – to determine whether relational encoding enables faster, more flexible responses to changes in hierarchy structure. Birds received baseline training on a six-stimulus hierarchy (A>B>C>D>E>F) and were then given two successive experimental treatments: first, the insertion of a novel seventh stimulus (A>B>C>X>D>E>F), and then the inversion of the third and fifth stimuli (A>B>D>X>C>E>F). Subjects that made greater use of relational representation acquired the baseline task faster and to a higher level of accuracy, and they subsequently adjusted more rapidly to changes in stimulus sequence.

4:30 PM **Clark's nutcrackers (*Nucifraga columbiana*) rely heavily on geometric information for spatial orientation**

Debbie M. Kelly (University of Manitoba)

56 All mobile species must orient, yet we know little about how this process is achieved. Orientation is the fundamental step required for navigation, as it allows the traveler to determine in which direction to begin heading. Only once one has successfully oriented can navigation begin. Classic studies have shown that the two types of cues used by animals to orient are features and geometry. Features are objects within an environment (e.g., trees or buildings), whereas geometry is the metric relationship between objects or surfaces (e.g., distances or directions). However, the mechanisms by which these spatial cues are integrated are not known. We investigated the effect of experience on the weighting of featural and geometric cues during a spatial search task by a food-storing bird, the Clark's nutcracker. Four groups of birds were trained to locate food hidden at one corner of a fully-enclosed rectangular arena. Two groups were initially trained with features whereas two other groups were trained with geometry. Of the featurally trained groups, one was retrained with geometry. Likewise, of the geometrically trained groups, one was retrained with features. We found that unlike other avian species examined using similar procedures, nutcrackers showed a primary weighting of geometric information.

4:45 PM **Investigating cache protection by Clark's nutcrackers**

Brett Gibson & Jan Tornick (University of New Hampshire)

57 Past work has indicated that the scrub jay, a social corvid, is sensitive to the presence of conspecifics while hiding food. In a series of experiments Dally, Emery, and Clayton (2004, 2005a,b) found that scrub jays engage in a variety of cache protection strategies when hiding food. Scrub jays may be more predisposed to engage in cache protection because of the rich social environment in which they have evolved. Here we used procedures similar to those used by Dally, Emery, and Clayton to examine the extent that the related but relatively asocial Clark's nutcracker engages in cache protection. Our findings indicate that nutcrackers do engage in limited cache protection, but less prominently so than scrub jays given comparable test.

5:00 PM **Comparative perspectives on the evolution of complex brains and behaviors in cephalopods**

Jennifer A. Basil (City University of NY Graduate Center)

58 Cephalopods are an ancient group of marine molluscs with complex brain organization and sophisticated behaviors. Predatory cephalopods, extinct and extant, compete(d) with marine vertebrates because they often occupy similar ecological niches. Convergent processes may thus be acting upon both groups. A major division among extant species falls between those retaining external shells (the slow, scavenging Nautiloids), considered ancestral, and those with reduced shells (the fast, predatory Coleoids), a more recent modification. Brain complexity follows similar lines: the nautiloid brain is considered plesiomorphic, while coleoid brains more derived. Evidence supports that the post-Devonian radiation of coleoids was driven, in part, by mutual competition with marine vertebrates. Recent advances in our understanding of Nautilus brains and behavior suggest that brain expansion coincident with the coleoid radiation may be built upon an ancient architecture that predates the advent of bony fishes, perhaps from prior competition with other cephalopods and marine forms. Indeed, the learning and memory capabilities of nautiluses share marked similarities with the coleoids in capacity, duration and flexibility. Coleoid brain complexity may thus have resulted from at least two phases of interspecifc competition: one before and one after the advent of bony fishes.

5:15 PM **Desert ants in different habitats use their navigational tool kit differently**

Ken Cheng, Patrick Schultheiss (Macquarie University), Sebastian Schwarz (McMaster University), Cornelia Bühlmann (Max Planck Institute for Chemical Ecology) & Rüdiger Wehner (University of Zurich)

59 A good deal about insect navigation has been learned from the study of desert ants. Different species inhabiting different habitats, however, might differ in how they use their navigational toolkit. Desert ants inhabiting semi-arid habitats can see many tussocks, bushes, and even trees in their visual surround, while ants inhabiting salt-pans face a visually barren landscape. Our research has so far found that ants inhabiting bare habitats rely more on vector-based navigation, based on keeping track of the distance and direction traveled, while ants inhabiting visually cluttered habitats rely more on using the terrestrial panorama for visually guided navigation. When displaced from a feeder to a test location far away, the former ants run off a longer proportion of their vector before engaging in search behavior to look for terrestrial cues.

5:30 PM **Cognition-mediated floral evolution: non-linear preferences for multiple reward dimensions leads to the selection of low-sugar flower nectar when competition between individuals is high**

York Winter (Humboldt University – Berlin), Alan Kamil, Alan Bond (University of Nebraska-Lincoln) & Vladislav Nachev (Humboldt University – Berlin)

60 Floral rewards evolved under the selection of pollinator decisions. While nectar-feeding bats and hummingbirds prefer high nectar sugar concentrations under experimental conditions, natural flowers have remarkably dilute nectars. To understand the complex, reciprocal dynamics of pollinator-plant interactions we performed a virtual evolution experiment inspired by the “virtual ecology” approach pioneered by Kamil and Bond. We also determined psychometric functions underlying the discrimination of nectar volumes and nectar sugar concentrations by nectar-feeding bats (*Glossophaga*). We found that bats selected for low sugar concentration. This outcome depended on the degree of competition between individuals for limited nectar. This result can be explained as a consequence of non-linear psychometric functions underlying discrimination and choice for quantity and quality. In a situation of unequal variance the parameter with higher variance was selectively driven to higher values. At flowers with fixed nectar secretion nectar availability becomes more variable as more individuals compete. Thus high competition increased the water component of nectar leading to more volume but also to more dilute solutions. When rewards are evaluated along multiple dimensions and preference follows a non-linear scale then differences in variance increase the sensitivity for one reward dimension over the other. This can also lead to uneconomical choice.

5:45 PM Break

5:55 PM Introduction – Alan Bond

6:00 PM Master Lecture:

Alan Kamil (University of Nebraska – Lincoln)

61

Biology and Animal Cognition: Progress and Challenges

The presentation will be organized around three topics: I will begin with a discussion of the sequence of events that focused my attention on evolutionary approaches to animal cognition. In the second part of the talk, I will discuss some of the research that resulted from applying evolutionary ideas to animal cognition. I will conclude by outlining two of the major issues confronting research on animal cognition in the present and the not-so-distant future.

7:30 PM Banquet

Behavioural Processes is pleased to present the Best Graduate Student Talk and the Best Graduate Student Poster at the International Conference on Comparative Cognition 2013.

Saturday Afternoon

12:00 PM Business Meeting of the Comparative Cognition Society

1:10 PM Group Photo Shoot – Smile ☺

1:30 PM Metacognition and Causality (Chair: Stephen Fountain)

62

1:30 PM **Information seeking in the rat**

Chelsea R. Kirk & William A. Roberts (University of Western Ontario)

Metacognition is awareness of what one does and does not know. Students given a choice between studying material they have learned well and material they have learned poorly prefer to study the less mastered material (Metcalfe, 2009). Recent studies suggest that primates also know about the state of their own knowledge and will seek unknown information to complete a task (Call & Carpenter, 2001; Hampton et al., 2004). We used a radial arm maze to look for metacognition-like behavior in rats. Each maze arm had a bulb mounted on it to serve as a signal light. Rats were trained to go to whichever arm was lit on a trial for reward. They then were trained to press a bar in the maze hub that led to immediate food reward and turned on a light in one randomly chosen arm of the maze. Once the rats learned to press the bar, the reward for bar pressing was discontinued. We report on the rats' readiness to press the bar for information about the location of reward under conditions that varied the presence or absence information and amount of information to be gained.

63

1:37 PM **Do bats see themselves in the mirror?**

Jennifer Vonk, Jonathan Saulter, Callie Pederson & Gerry Carter (Oakland University, University of Maryland)

Various animal species have been tested for self-awareness by exposing them to mirrors and observing touches to previously unseen marked areas. Alternatively, researchers have considered contingent body movements in the presence of reflective surfaces to be indicative of self-recognition. Only apes and elephants have conclusively passed the mark test. Despite the complexity of their social environments and evidence of social learning and 'altruism', bats have not previously been tested in a self-recognition paradigm. We exposed 19 bats of six species to a series of observation periods in the presence of a reflective mirror, a sham mirror, and a live conspecific in a transparent case, and recorded their behavior. The bats spent more time looking in and touching the reflective mirror, compared to the sham mirror, even though they did not spend a greater amount of time in front of the mirror. However, we did not observe any behaviors that strongly indicated self-awareness. We conclude that the bats' behavior is more consistent with the notion that they see a strange bat in the mirror, similar to what has been observed in monkeys.

64

1:51 PM **Causal structure in predatory motivational systems**

Robert I. Bowers & William D. Timberlake (Indiana University)

Rats in an operant chamber display patterns of behavior predicted by normative theories of causal cognition. Such observations are sometimes taken to suggest an abstract, general capacity for causal reasoning, particularly demonstrations that appear to preclude most theories of associative learning. The present research takes a behavior systems approach, which focuses on the development of specific and interdependent motivational systems. We present evidence that the structure of the motivational system underlying predation in rats is biased in a manner that provides patterns of behavior appropriate to the causality in a typical predatory circumstance. This may provide the rat the scaffolding necessary to develop proficient causal reasoning about predation.

1:58 PM Perception and Attention (Chair: Lauren Guillette)

65

1:58 PM **Mechanisms of avian shape recognition tested with a genetic algorithm**

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

This study used a genetic algorithm and contour deletion to examine the mechanisms of shape recognition in four pigeons. Using a dynamically adjusted simultaneous choice discrimination between triangle and square contours, different portions of the figures were removed (vertices versus midsegments). Results indicated that the figural vertices were more critical to recovering the shape of the test stimuli than the midsegments of the lines. Results are discussed in relation to different theories of visual object recognition and their generality across species.

2:12 PM **Change detection and change blindness in pigeons (*Columba livia*) and humans (*Homo sapiens*)**
Walter Herbranson (Whitman College)

66 Change blindness is a phenomenon in which even obvious visual details in a scene change without being noticed. Such a prominent failure of attention is intuitively surprising because it would seem to be maladaptive. Thus, a cross-species investigation of change blindness might prove to be valuable by providing insights into its ultimate causes. Pigeons and humans learned a change detection task, in which they had to indicate the location of a change in a stimulus display. Both species were worse at detecting changes if the original and modified stimulus displays were separated by a brief interstimulus interval, during which the display was blank, and this result matches the general pattern seen in previous studies of change blindness in humans. Subsequent experiments attempted to identify specific stimulus characteristics that most reliably produced a failure to detect changes. Change detection was more difficult for both species when interstimulus intervals were longer and when the change was iterated fewer times.

2:26 PM Associative Processes and Choice (Chair: Karen Hollis)

2:26 PM **Context specificity of ambiguous information**
Ralph R. Miller, Gonzalo Miguez (SUNY-Binghamton) & Mario A. Laborda (University of Chile)

67 When a cue is paired with one outcome in Phase 1 and a different outcome in Phase 2, subjects use contextual cues (as well as temporal cues and relative associative strengths) to help resolve the ambiguity at test. Renewal following extinction of a previously learned association is an example of this. Here we examine the role of contextual cues as a function of differing types of outcomes. When both outcomes involve overt reinforcement (i.e., counterconditioning), the second-learned outcome is seen to be more context specific. When one outcome involves reinforcement and the other outcome involves nonreinforcement in the form of omission of an expected reinforcer (i.e., conditioned inhibition training), again the second-learned outcome (whether it was reinforcement or nonreinforcement) is seen to be more context specific. But when one outcome involves reinforcement and the other outcome involves nonreinforcement in the form of a simple void of reinforcement (e.g., CS preexposure), then memory of the nonreinforced training (whether it was learned first or second) is more context specific. The functional value of this distinction will be considered.

2:40 PM **Finding features in a configural world**
J.W.(Bill) Whitlow & Phillip Loatman (Rutgers University - Camden)

68 A key contrast between associative theories that emphasize the importance of configural cues and those that do not is the relative ease of negative patterning and biconditional discriminations. We describe results from a procedure that produces a striking advantage for configural accounts by showing that negative patterning is much more difficult than biconditional discriminations when features must be extracted from constantly changing compounds.

2:54 PM **Wait, there's more: Opportunity costs in intertemporal choices**
Jeffrey R. Stevens (University of Nebraska-Lincoln), Elsa Addessi & Fabio Paglieri (Institute of Cognitive Science and Technologies - Rome)

69 When investing money in a certificate of deposit (CD), we do not have to wait until the CD matures to invest in another CD. However, when animals in intertemporal choice studies choose a larger, later reward over a smaller, sooner reward, they can make another choice only after receiving the previously chosen reward. Thus, delayed rewards have high opportunity costs because choosing them forgoes the opportunity to make further choices. We hypothesized that reducing opportunity costs will increase choices for delayed options. We tested capuchin monkeys (*Cebus apella*) in three experimental conditions in which they chose between a smaller food reward that they could consume immediately and a larger food reward that they could consume later. In the high cost condition, subjects could not choose again until they had consumed their food from the previous choice. In the low cost condition, subjects could choose during the delay of a previous choice. A third condition controlled for intake rate differences between the first two conditions. We found that the capuchins chose the larger, later options more in the low opportunity cost condition, suggesting that removing the barrier of high opportunity costs reduces impulsive choice.

3:08 PM **Unlike humans, pigeons do not prefer gambles that include "near misses"**
Jessica P. Stagner, Mary F. Sticklen & Thomas R. Zentall (University of Kentucky)

70 On a three-reel slot machine, what is referred to as a "near miss" (or more accurately a near hit) occurs when the winning symbols on the first two reels line up on the payoff line but the winning symbol on the third reel does not. This may be perceived by humans as closer to a win than a clear loss and may encourage more gambling behavior. Maclin, Dixon, Daugherty and Small (2007) found that when given a choice between two slot machines with wins and losses on the two machines equated, people preferred the machine that resulted in more near hits. We tested pigeons on a similar task by giving them a choice between two alternatives, one that sometimes provided near hit trials while the other did not. With the probability of reinforcement equated, pigeons showed a clear preference for the alternative that did not include near hit trials. We attribute the difference between humans and pigeons to the illusion of control by humans (humans overgeneralize from contexts in which their behavior affects the outcome, e.g., shooting a basketball) whereas the effect of near hits on pigeons appears to be the devaluation of the conditioned reinforcer.

3:15 PM *Break*

3:20 PM Concept Learning and Problem Solving (Chair: Jennifer Basil)

71

Prior experience affects how pigeons solve an oddity-from-concept task

3:20 PM *Thomas A. Daniel (Auburn University), Anthony A. Wright (University of Texas Health Science Center at Houston) & Jeffrey S. Katz (Auburn University)*

Pigeons were trained on oddity-from-sample through a set-size expansion method previously used in Same/Different (Katz & Wright, 2006) and matching-to-sample (Bodily, Katz & Wright, 2008). After reaching criterion performance in the task (85% accuracy), the set size was systematically doubled from the original 3-item training set 8 times to the final 768-item set. 8 pigeons were grouped based on whether they were naïve or had previous experience (same/different). Both groups showed full concept learning by the 384-item set-size, however the naïve birds showed full-concept learning at a much earlier set (the 24-item set-size) followed by a subsequent decrease in transfer performance. Prior experience affected performance transferring to novel items and acquiring new configurations; naïve birds' performance benefited from higher levels of early transfer and faster rates of acquisition at all set sizes. Further analyses show that differences between these groups are partially due to naïve pigeons' susceptibility to the Oddity Preference Effect and other forms of stimulus control.

72

Categorization of photographic images by rats using shape-based image dimensions

3:27 PM *Daniel I. Brooks (Brown University), John H. Freeman & Edward A. Wasserman (University of Iowa)*

Strong interest exists in developing a rodent model of visual cognition to conduct research into the neural mechanisms of visual categorization. Yet, doubt remains as to whether rats perform visual categorization tasks as do humans and nonhuman primates. Here, we trained eight rats on two visual categorization tasks using photographs of eight objects from each of four basic-level categories: chairs, flowers, cars, and humans. In Experiment 1, rats learned to categorize chairs vs. flowers; in Experiment 2, rats learned to categorize cars vs. humans. After rats learned each discrimination, we tested them with eight novel pictures from each of the categories. The rats performed at reliably above-chance levels during these generalization tests. To determine which dimension(s) of the stimuli controlled the rats' behavior, we conducted regression analyses using several image dimensions. The chair vs. flower discrimination was mainly controlled by the convexity of the stimuli, whereas the car vs. human discrimination was mainly controlled by the aspect ratio of the stimuli. These results demonstrate that rats can categorize complex visual objects using shape-based properties of photographs.

73

Clark's nutcrackers learn an abstract same/different concept at small training set sizes

3:41 PM *John Magnotti (UT Medical School at Houston), Jeffrey Katz (Auburn University), Anthony Wright (UT Medical School at Houston) & Debbie M. Kelly (University of Manitoba)*

The ability to learn abstract relationships between stimuli is fundamental to higher-order cognition. Previous research on same/different abstract-concept learning has shown a wide range of species capable of this feat, once thought to be unique to humans and nonhuman primates. What differs among species is the size of the training set (e.g., number of unique pictures) to learn the abstract relation. We trained 7 wild-caught Clark's Nutcrackers in a simultaneous visual same/different task with an expanding training set (8, 16, 32, 64, etc.) and assessed relational learning via transfer tests with novel stimuli after learning at each set size. The experimental design was one used previously with monkeys (rhesus, capuchin) and pigeons. The majority of nutcrackers learned the abstract-concept with a training set of 32 and all had learned by training set of 64, surpassing both monkey species (128 set size) and pigeons (256 set size). While the ability of nutcrackers is well known for seed-cache recovery, these results indicate an advantage in their ability to learn an abstract same/different relationship as well.

74

Comparative audio-visual rhythm processing by birds and humans

3:55 PM *Carl Hagmann (Tufts University)*

Rhythms occur in nature in multiple sensory modalities and across variable time scales. Humans most commonly conceive of rhythms as occurring in the auditory modality, but we are sensitive to visual rhythms as well. Is this due to our vocal learning ability? In order to better understand the effect of vocal learning on rhythm processing, I trained and tested three species: humans, starlings, and pigeons. The vocal learning starlings and humans exhibited many similar behaviors, including sensitivity to beat onset and timbre organization in the auditory modality. The avian starlings and pigeons appeared to process visual rhythms similarly, but pigeons were unable to transfer their discrimination crossmodally. Differences between vocal and non-vocal learners became more apparent with tests of multimodal sequences. Overall, results suggest a strong impact of vocal learning ability on auditory tempo integration.

4:09 PM **Pigeons learn virtual patterned-string problems in a computerized touchscreen environment**

Edward A. Wasserman (University of Iowa), Yasuo Nagasaka (Riken Brain Science Institute), Leyre Castro & Stephen J. Brzykcy (University of Iowa)

75 For many decades, comparative psychologists have used various string tasks to assess the perceptual and cognitive capabilities of different species. The most important and widely studied of these problems are patterned-string tasks, in which the organism is shown two or more strings, only one of which is connected to a reward. The organism must determine which string is attached to the reward and pull it. We report a new way to implement patterned-string tasks via a computerized touchscreen apparatus. Pigeons successfully learned such virtual patterned-string tasks and exhibited the same general performance profile as animals given conventional patterned-string tasks. In addition, variations in the length, separation, and alignment of the strings reliably affected the pigeons' virtual string-pulling behavior. These results not only testify to the power and versatility of our computerized string task, but they also demonstrate that pigeons can concurrently contend with a broad range of demanding patterned-string problems, thereby eliminating many alternative interpretations of their behavior. The virtual patterned-string task may thus permit expanded exploration of other species and variables which would be unlikely to be undertaken either because of inadequacies of conventional methodology or sensory-motor limitations of the studied organisms.

4:23 PM **Snake recognition in monkeys: A reappraisal**

Gordon Burghardt (University of Tennessee), Nobuyuki Kawai (Nagoya University), Masahiro Shibasaki (Kyoto University Primate Research Institute), Akira Mori (Kyoto University) & Nobuo Masataka (Kyoto University Primate Research Institute)

76 It is commonly accepted, based on several studies, that young rhesus macaques learn, perhaps socially, to fear and avoid snakes, though they may be predisposed to do so readily. Studies with colleagues on the closely related Japanese macaques show that adult monkeys without prior experience with snakes both recognize and evidence signs of fear and avoidance of live snakes in controlled experiments with a modified WGTA apparatus. However, issues of individual variation, habituation, sensitization, novelty, and snake species and behavior complicate and confound simple interpretation of the responses seen in the 8 monkeys tested over hundreds of trials. Indeed, a main methodological finding is that repeated tests over sessions separated by weeks produce a clearer picture of reactions to snakes than testing monkeys with only a few trials with live or model snakes. The cognitive processes involved in processing highly charged stimuli mandate different methods to establish discrimination than may obtain with more neutral stimuli. Comparable data with capuchin monkeys have also been collected.

4:37 PM Numerosity and Serial Processes (Chair: Robert Cook)

4:37 PM **Numerosity in a native New Zealand songbird, *Petroica longipes***

Alexis Garland, Jason Low & KC Burns (Victoria University of Wellington)

77 Food caching in naïve robins of New Zealand offers a unique opportunity to key in to behavior that may shed some light on how core cognitive mechanisms work in the wild. A series of experiments were conducted exploring paired quantity comparisons (contiguous and spatially distributed), both contiguously located and distributed, and addition and subtraction of artificially cached items, in the aim of looking at the North Island Robin (*Petroica longipes*) as a model system for comparison. Response to numerosity and agency were investigated in this songbird by testing visuospatial memory of hidden food caches containing small and large numbers of mealworm prey (*Tenebrio molitor*), using either Violation of Expectancy (VoE) or a choice task. These trials, conducted within a wild population of the insectivorous food-hoarding New Zealand robins, demonstrate that this songbird displays behavior indicative of the fundamental hallmarks of numerical representation system, and additionally a unique contrast in some ways to a primate-based understanding of large quantity.

4:44 PM **Similar numerical systems among vertebrates? An inter-specific study in teleost fish**

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

78 Human and non-human animals are thought to possess similar non-verbal numerical systems, but there is considerable debate regarding whether vertebrates share the same numerical abilities. Despite an abundance of studies, cross-species comparison remains difficult because the methodology employed and the context of species examination vary considerably across studies. To fill this gap, we used the same apparatus, procedure, stimuli to compare numerical abilities of five teleost fish: redtail splitfin, guppies, zebrafish, Siamese fighting fish, and angelfish. Subjects were trained to discriminate between two sets of figures using a food reward. Once they reached the learning criterion in a 0.50 ratio discrimination (5 vs. 10 and 6 vs. 12), they were subjected to non-reinforced probe trials with different numerical ratios (8 vs. 12 and 9 vs. 12). They also were subjected to probe trials in which the ratio was constant, but the total set size was increased (25 vs. 50) or decreased (2 vs. 4). Overall, fish generalized to numerosities with a 0.67 ratio, but failed with a 0.75 ratio; they generalized to a smaller set size, but not to a larger one. Only minor differences were observed among the species, thus suggesting the existence of similar numerical systems among fish.

4:58 PM **Spatial-magnitude congruity in apes (*Pongo pygmaeus, P. abelli*, and *Gorilla gorilla*)**

Regina Paxton Gazes & Tara S. Stoinski (Zoo Atlanta)

79

Human responses to magnitude are highly spatial, with responses to 'smaller' items being faster when they are located on the left and 'larger' items when they are located on the right. This effect, known as the spatial numerical association of response codes (SNARC) effect, has been observed across a variety of dimensions—quantity, size, emotional valence. However, it is unclear to what extent the direction of this spatial representation occurs naturally or is mediated by training with reading and number lines. To determine if other primates also represent magnitude spatially, we experimentally assessed the SNARC effect in two apes, orangutans (*Pongo pygmaeus* and *P. abelli*) and gorillas (Gorilla gorilla). Two items appeared on the left and right sides of a touch screen. Animals were trained to indicate the item with either the larger ("pick larger" condition) or smaller ("pick smaller" condition) magnitude. Response latencies were examined for interactions between condition ("pick larger" vs "pick smaller") and screen location of the correct item ("left" vs "right"). The implications of the results for the evolution and use of spatial representations of magnitude will be discussed.

5:05 PM **Bilateral hippocampal lesion impairs transitive responding in pigeons**

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

80

We trained pigeons to discriminate four pairs of overlapping visual stimuli (A+ B-, B+ C-, C+ D-, and D+ E- where plus and minus denote reinforcement and nonreinforcement). We also controlled reinforcement history of stimuli B and D comprising a critical testing pair BD by using massed presentation of the pair D+ E- (Lazareva & Wasserman, 2006). After the first test involving the critical pair BD, we performed a bilateral lesion of hippocampus, and conducted the second test after a period of recovery. During pre-lesion test pigeons displayed two distinctively different strategies. Some birds selected stimulus B over stimulus D contrary to predictions of reinforcement-based models while others predominantly selected more richly reinforced stimulus D over stimulus B. Hippocampal lesion had no effect on post-lesion performance when preferred the stimulus D in a pair BD. When birds preferred stimulus B in a pair BD, hippocampal lesion had significantly reduced this preference to near-chance performance. Hippocampal lesion had no effect on performance in other testing pairs (e.g., AE or AC). These results suggest that hippocampus may be involved in creating a representation of an ordered series of the stimuli instead of maintaining associative history of each stimulus.

5:19 PM **Does spatial arrangement of the training stimuli enhance nonverbal transitive inference?**

Olga F. Lazareva (Drake University), Regina Paxton Gazes (Zoo Atlanta) & Robert Hampton (Emory University)

81

We trained adult human participants to discriminate six pairs of overlapping visual stimuli (A+ B-, B+ C-, C+ D-, D+ E-, E+ F-, and F+ G- where plus and minus denote reinforcement and nonreinforcement). Participants also received an additional spatial training in which the stimuli were arranged from top to bottom; this order was either congruent (A highest and D lowest) or incongruent with transitive training. Participants in the Congruent condition learned the training pairs more quickly, were more accurate and faster in selecting the "transitively correct" stimulus in testing pairs, and showed higher awareness of the underlying linear order of the stimuli that could be used to solve the task. Together, these results suggest that spatial representation facilitates transitive inference in a nonverbal transitive task.

5:33 PM Closing Remarks (Jeff Katz)

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

See Poster Abstracts Starting on Page 30

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

Posters

Poster Session I - Thursday Evening

Formation of auditory objects in pigeons and humans

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

P1 The formation of auditory stimulation into perceptual objects requires the temporal grouping of different sounds. Using a same/different paradigm, this study investigates the discrimination of tonal sequences by pigeons and humans. When tested with melodic vs. randomized sequences at different presentation rates, pigeons and humans were found to organize them in similar auditory groups dependent on rate and inter-group spacing. These results suggest commonalities in the capacity of pigeons and humans to group discrete sounds into larger hierarchical units.

Squirrel monkeys prefer familiar music over novel one

Yushi Kadono (Kyoto University), Toyomi Matsuno (Hosei University) & Kazuo Fujita (Kyoto University)

P2 We examined whether and how squirrel monkeys prefer various musical pieces in two experiments. In Experiment 1, 9 squirrel monkeys were tested for their naive preference for unfamiliar music. They spent 16 minutes in the 3-box test chamber, during which a U.S. popular songs was played for a fixed duration with no-sound interval of 20 seconds from either speaker placed at each end of the box. The monkeys showed no difference in staying time between the boxes near and far from the playing speaker. This suggests that the monkeys had no a priori preference for music. In Experiment 2, 7 monkeys were tested for their preference between novel and familiar musical pieces for 20 seconds. Familiar pieces were those that they had heard 20 times before the test. During the 16 minutes in the test chamber the monkeys were able to play a particular piece by depressing the floor of the box. The monkeys stayed longer in the box that played familiar music than the box that played novel music. We suggest that squirrel monkeys show no a priori preference for music, but their preference for a certain musical piece can be established by the repeated experience of the particular piece.

What do dogs (*Canis familiaris*) understand about human vocal commands?

Jennifer Gibson (Flagler College), Stephanie Scavelli, Chester Udell & Monique Udell (University of Oregon)

P3 In the wild vocalizations often carry information about the psychological state of different animals. In this study, domestic dogs from a shelter were tested for their capacity to extract information from human scolding vocalizations. Recordings of male and female scolding vocalizations were manipulated to create four different experimental conditions: natural scolding, scripted scolding, distorted scolding and robot (computer generated scolding). A speaker was placed in a medium sized dog cage and then covered with a blanket. The researcher stood next to it. A dog bowl, holding dry food and a bone, was then placed in front of the cage and a predetermined scolding vocalization was played. Canine behavior was measured by the amount of food consumed, distance from bowl and eye gaze. Distressed and curious responses were also recorded. Analyzing different responses in the presences of similar, but strategically manipulated, human commands can be used to see whether canines truly understand and respond to the psychological state associated with human words, providing information about cross-species communication and improving training techniques through a better understanding of canine cognition.

Reasoning by inference: Further studies on exclusion in grey parrots (P*sittacus erithacus*)

Irene M. Pepperberg (Harvard University), Adrienne Koepke (CUNY Hunter College), Paige Livingston (Harvard University) & Leigh Ann Hartsfield. (Phoenix Landing.)

P4 Grey parrot (*Psittacus erithacus*) abilities for visual inferential reasoning by exclusion were tested in two experiments. The first replicated the Grey parrot study of Mikolasch et al. (2011), which in turn replicated that of Premack and Premack (1994) with apes, to learn if our subjects could succeed on this task. Parrots watched an experimenter hide two equally desirable foods under two separate opaque cups, surreptitiously remove and then, in view of the birds, eat one of the foods, leaving birds to find the still baited cup. The experiment contained controls for alternative explanations for the birds' behavior, but birds might still have avoided a cup from which something had been removed rather than specifically tracking the eaten food. Thus, in the second experiment, some trials were run with one food more preferred than the other, during which two items of each type were hidden and only one of the items were removed from one cup. Sessions also included Experiment 1-type trials to see if birds tracked when and when not to use exclusion. Thus birds would be rewarded for attending closely to all experimental aspects needed to infer how to receive their preferred treat. Three of four birds succeeded fully.

A network model of transposition: Combining relational and associative modules to predict choice

Bryce A. Kennedy (University of Nebraska-Lincoln)

P5 A two-module network model is proposed to account for recent non-human transposition research. This model applies to contexts in which subjects are trained to discriminate between two different-sized stimuli on the basis of relative size. Using distinct strategies, the two modules in the network choose a stimulus independently and in parallel. One module chooses based on the absolute reward history associated with a single stimulus. The other module chooses based on the relative size of the stimuli within each pair. Each module sends their choice to a gate, which acts as a filter. The gate generates the best final output based on the information it receives from the two modules. The modules then receive feedback from the environment, learning through both reinforcement and punishment. This model accounts for various findings in the transposition literature, including increased transposition after multiple pair training, performance differences based on reward history, and relational responses to some stimuli in the test set, but not others. This model moves us one step closer to understanding the cognitive mechanisms involved in transposition.

Does the spatial arrangement of the training stimulus pairs affect transitive inference by pigeons?

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

P6 Transitive Inference (TI) involves training with four pairs of arbitrary stimuli: A+B-, B+C-, C+D-, D+E- (+= reinforced alternative – = nonreinforced alternative). After training subjects are presented with the novel test pair BD. TI is found when subjects choose B over D. Interestingly; TI effects have been shown in many nonhuman animals including pigeons. Several noncognitive, associative theories that have been proposed to explain TI effects have failed to account for the variety of conditions under which TI effects have been found. One cognitive account of TI performance is that organisms are able to form a mental representation of the series (A>B>C>D>E). If so, presentation of the pairs of stimuli in a linear array should facilitate TI performance, whereas presentation of the pairs of stimuli in a circular array should not. We trained pigeons on either a linear or circular arrangement of stimuli. Results indicate that pigeons show TI under both conditions suggesting that the linear presentation of the stimuli is not necessary to obtain TI in pigeons.

Implicit relational learning in multiple-object tracking task: Do people really track the objects?

Tiffany N. Williams & Olga F. Lazareva (Drake University)

P7 Earlier, we showed that multiple-object tracking task can be used to examine explicit relational learning. In this task, participants were instructed to track four out of eight objects and report at the end of the trial whether a single cued object was among those they tracked (yes/no task). The display also contained two strips of different width. In Informative condition, the location of the cued object predicted the correct choice. If the answer was "yes", then the object was located next to the narrower strip; otherwise, it was located next to the wider strip (or vice versa). In Random condition, the location of the object did not predict the correct choice. We found earlier that Informative condition produced significantly more accurate performance than Random condition. However, it remained unclear whether participants in Informative condition actually tracked the objects. In this study, we found that participants in Informative condition were more accurate when instructed to track 2 out of 8 objects than when instructed to track 4 out 8 objects. This result suggests that participants in Informative condition do track the objects, even though their answer at the end of the trial is clearly influenced by the contextual background information.

Object matching of rotated objects by a dolphin

Heidi E. Harley (New College of Florida), Wendi Fellner & Kim Odell (Disney's The Seas)

P8 One of the bottlenose dolphin's adaptations for marine life is its natural locomotion, allowing it to move easily through three dimensions and to rotate its body along these dimensions. This study targeted this flexibility in body orientation to determine whether a dolphin would spontaneously change its orientation to an object to perform a visual matching task in which a sample was presented at a different orientation from its match in a 3-alternative choice array. Stimuli were novel or familiar; samples were presented at 6 angles (0°, +/- 45°, +/- 135°, 180°) relative to upright (0°); alternatives were presented at 0°. Objects were balanced for surface area; sessions were balanced for sample identity and alternative location. The dolphin did not change its body orientation, and familiarity with the objects improved accuracy. Performance accuracy averaged 87% for 3 familiar object sets and 65% for 3 novel sets (5 sessions with each; chance=33%). After 5 sessions of matching 0°-to 0° with the three previously novel sets (M=78%), matching with rotated objects improved (M=74%). As with many animals, the dolphin was better at matching rotated objects after gaining experience with those objects and did not change its body orientation to perform the task.

Object-picture recognition in a California sea lion

Kristy L. Biolsi & Jeannette Raymond (St. Francis College)

P9 There has been much debate in the literature on whether or not nonhumans can use pictures of objects to represent the objects themselves. Research on this has yielded conflicting results and much of the current work has used bird subjects consisting primarily of pigeons and chickens. It is therefore important to study this further using well controlled laboratory tests as well to test a variety of species, including mammals. The present study investigated transfer performance from objects to pictures in a simple discrimination procedure with two sea lion subjects (*Zalophus californianus*). Both subjects demonstrated successful performance on transfer test trials. This work gives us further insight into how animals represent their world and provides support for using pictures as stimuli in cognitive studies with nonhumans.

Object recognition: Effects of stimulus similarity and retention interval

Rocío Angulo & Naiara Arriola Gumersinda Alonso (University of the Basque Country UPV/EHU)

P10 The effect of stimulus similarity and retention interval was assessed in an object recognition task in three experiments. Rats received a short pre-exposure to two identical objects followed by a single test (1h or 24h later) in which approaches (time and number) to the familiar and a novel object were recorded. The objects presented on test were the pre-exposed stimulus and another similar stimulus differing in a different number of features. When the objects differed in form and colour, rats expended more time near, and made a greater number of approaches to, the new object than the familiar one, both 1h and 24h later. This result was not found when the objects differed only in form. In this case, preference was reversed at the 24h-test, with rats spending more time exploring the familiar object. The discussion focuses on whether the inconsistent results obtained in these experiments regarding preference for the novel or the familiar object, could be explained in terms of perceptual learning.

Visual features used by goldfish (*Carassius auratus*) on a 2D object discrimination task

Caroline DeLong, Ashlynn Keller, Susan Keenan & Amanda Heberle (Rochester Institute of Technology)

P11 The goal of this study was to determine visual features goldfish use to discriminate among 2D objects (e.g., length, width, surface area, and diameter). Two goldfish were trained individually in 5 gallon test tanks to eat a mixture of flake food and water from a 1.0 ml syringe. Then the fish were trained to tap a circle with a 2 cm diameter to receive the food reward. Black stimuli on white backgrounds were printed on laminated paper, attached to a piece of corrugated plastic, and presented underwater. Five object pairs that were previously used with reef fish were presented to the goldfish: (1) a solid circle and rectangle matched for surface area, (2) a solid circle and rectangle matched for length, (3) a solid circle and square matched for width, (4) an open circle and four-blade fan matched for diameter and surface area, and (5) a bulls-eye and six-blade fan matched for diameter and surface area. Both fish successfully discriminated between objects across all five pairs (M = 80%). There were individual differences in performance on all pairs except object pair 2, which suggests that each fish may have been attending to different features of the stimuli.

Olfactory discrimination in a captive turkey vulture (C*athartes aura*)

Jessica Beckstrom (Wheaton College)

P12 Research has shown that a number of bird species use olfactory cues to locate food, roosts, or mates. The turkey vulture (*Cathartes aura*) is one such species suggested to use olfaction to locate carrion. The present study seeks to empirically assess the ability of a turkey vulture to discriminate between odorants, and specifically, to discriminate between carrion at different stages of decomposition using olfactory cues. Training a discrimination learning set using visual cues preceded training for the olfactory discrimination task. Within 381 trials over the course of one month, the vulture discriminated between seven different objects of varying shape, size, and color and chose the correct object in 87% of trials. Discrimination training techniques for this species will be discussed, as will be preliminary results from the second study of olfactory discrimination ability in this animal.

Acquisition rate of a discrimination rule in an equine

Kathryn M. Mason (Wheaton College)

P13 The ability of a horse to learn a rule and transfer that rule to a variety of discrimination tasks was examined during this study, focusing particularly on both symbol and color discrimination. The horse was first trained to position itself on cue at a target using R+ as the primary approach to training. Once the horse was consistently responding to the cue, the horse was then trained to use a testing board. The testing board included two hinged doors with a tray placed behind each, allowing the horse to self-reinforce when cued to choose between the stimuli presented on each door. Response criterion was set at 80%. The subject was able to reach criterion for both symbol and color discrimination tasks; however, reaching criterion for the color discrimination task took four times the number of trials required for the symbol discrimination task. Results suggest that equines are capable of learning a discrimination rule and transferring it to a variety of discriminatory tasks.

Can horses discriminate between or categorize objects based on speed or direction of motion?

Tammy L.B. McKenzie (Brandon University)

P14 The ability to perceive and utilize aspects of motion should be beneficial to many species and may play a role in the recognition, discrimination, and categorization of objects (Loidolt et al., 2006). This research examined whether horses can discriminate or categorize based on: motion vs no motion, speed of motion, or direction of motion. In experiment one, using a two-key response-choice task, horses were simultaneously presented with two square grids, one static and one moving up-down. All horses learned to discriminate between the moving and static grid and some appeared to create categories of motion and non-motion. In experiment two, horses were simultaneously presented with two triangle grids moving up-down, with one moving faster than the other. All horses learned to discriminate between the triangle grids based on speed and some appeared to create categories based on speed. In experiment three, horses were simultaneously presented with the same stimulus on each monitor, moving the same speed, but moving in different directions, up-down versus left-right. Some of the horses learned to discriminate based on direction of motion. This research indicates that horses are sensitive to different aspects of motion and most likely use this information to discriminate and potentially categorize objects.

Comparing negative patterning and biconditional discrimination in a simulated foraging task

Phillip A. Loatman & J.W Whitlow Jr. (Rutgers University)

P15 One problem with past comparisons between patterning and biconditional discriminations is that patterning tasks have individual stimuli (A or B), whereas biconditional discrimination stimuli are all compounds (AB or CD). In human discrimination learning especially, it might be the case that participants learn to disregard the reinforcement history of stimuli, and only choose to respond to individual vs. compound stimuli. Another problem with past comparisons is the extent to which human participants treat outcomes as fundamentally distinct events. Livesey (2008) noted that humans may treat reinforced vs. non-reinforced stimuli merely as “outcome 1” and “outcome 2.” Failure to control for these variables may be the reason why researchers have found a variety of different patterning discrimination learning results among humans. The present study used a new procedure to compare patterning and biconditional discriminations under conditions in which all trials in both discriminations involved compound events. This was achieved by presenting the single cues in the patterning tasks with novel cues that were used only once in the experiment. A health bar was also implemented to ensure that reinforced and non-reinforced stimuli were treated as different events. Finally, the simulated foraging task was designed to actively engage participants in the task.

The near miss effect in pigeons

Mary Sticklen, Jessica Stagner & Thomas Zentall (University of Kentucky)

P16 When humans gamble, getting close to a winning lottery number or getting two of three winning slot matching symbols (a near miss) has been shown to be frustrating yet, promote gambling persistence. In the present study we asked if pigeons would prefer an alternative that contained near miss trials over an alternative that had none. Choice of the near miss alternative led to a signal for reinforcement 50% of the time and a signal for the absence of reinforcement 25% of the time. On the remaining 25% of the trials, a signal for reinforcement changed to a signal for the absence of reinforcement, and no reinforcement followed. Choice of the non-near-miss alternative led to a signal for reinforcement 50% of the time and a signal for the absence of reinforcement 50% of the time. Thus, the probability of reinforcement associated with the two alternatives was equated. Contrary to human choice behavior, the pigeons showed a strong preference for the non-near-miss alternative suggesting that near miss trials devalued the signal for reinforcement. In humans, it may be that the illusion of control causes them to believe that when near misses occur, they have done something to get them closer to winning.

Can the honeybee (*Apis mellifera*) learn oddity and nonoddity?

Nicole Muszynski & P.A. Couvillon (University of Hawaii at Manoa)

P17 Numerous experiments have explored oddity-learning across many different vertebrate species. One invertebrate species, the octopus, has been tested with an oddity problem (Boal, 1991). The experiments here are the first to explore oddity-learning in honeybees. Free-flying forager honeybees were trained individually to visit a laboratory window. The procedure was trial-unique; a unique pair of stimuli, two identical and one different, was presented in each trial. If the bee chose correctly, it drank sucrose, flew to the hive to unload its sucrose and returned for the next trial. If the bee chose incorrectly, it tasted stevia solution and was free to correct its choice. In Experiment 1, choice of the odd stimulus was reinforced with sucrose and choice of the nonodd stimuli was "punished" with stevia. The honeybees learned to choose the odd stimulus at levels greater than chance. The next experiment was conducted to determine whether bees had an unlearned preference for oddity. In Experiment 2, choice of either of the nonodd stimuli was reinforced and choice of the odd stimulus was punished. The honeybees learned to choose a nonodd stimulus at levels greater than chance. These results provide compelling evidence of oddity and nonoddity learning in honeybees.

More than a feeling: Incidental learning of array geometry by blind-folded adult humans revealed through touch

Marshall L. Green (Georgia Southern University), Katherine A. Gaskin, Alicia C. Evans, April A. Graves, Jonathan E. Roberts (Armstrong Atlantic State University) & Bradley R. Sturz (Georgia Southern University)

P18 Recent success of view-based matching theories to explain the orientation behavior of insects and birds raises questions regarding the extent to which such an explanation generalizes to other species. In the present study, we attempted to determine the extent to which view-based matching theories may explain the orientation behavior of a mammalian species (adult humans). We modified a traditional enclosure orientation task so that it involved only the use of the haptic sense. A haptic orientation task appeared ideal because it provided an opportunity to explicitly prohibit the use of vision. We trained disoriented and blind-folded human participants to search by touch for a target object hidden in one of four locations marked by distinctive textural cues located atop four discrete landmarks arranged in a rectangular array. Following training, we removed the distinctive textural cues and probed the extent to which participants learned the geometry of the landmark array. In the absence of vision and the trained textural cues, participants showed evidence that they learned the geometry of the landmark array. Such evidence cannot be explained by an appeal to view-based matching strategies and is consistent with explanations of spatial orientation related to the incidental learning of environmental geometry.

Does the presence of a non-coincident visual spatial pattern facilitate the learning of spatial relations among locations?

Scott Katz & Bradley Sturz (Georgia Southern University)

P19 Spatial pattern learning has been suggested to be a distinct form of learning because it appears immune to cue competition and occurs in the absence of discrete visual landmarks and environmental geometry. In the present experiment, we investigated the distinctness of spatial pattern learning. Human participants searched in virtual environment open-field task for four unmarked goal locations arranged in a diamond configuration located within a 5 x 5 matrix. The pattern itself moved to a random location from trial-to-trial, but goal locations always maintained the same spatial relations to each other (i.e., diamond pattern). Participants were randomly assigned to a group in which visual stimuli (i.e., four red bins) were arranged in a pattern consistent but not coincident with the unmarked goal locations (Visual Pattern group) or to a group in which visual stimuli were randomly arranged in the in the environment (Visual Random group). To the extent that spatial pattern learning is a distinct form of learning, exposure to the structured visual cues (i.e., Visual Pattern group) should facilitate the learning of spatial relations among locations compared to exposure to random visual cues (i.e., Visual random group). Results and implications will be discussed.

What's in a rule? or What rules do rats acquire from fixed and varied sequences in the 5-choice serial reaction time task?

Michael Tavolieri & Jerome Cohen (University of Windsor)

P20 In the 5-choice serial reaction task, rats press one of five keys when briefly lit to receive a food pellet for pressing the fifth lit key. In our preparation, some rats received a fixed pattern in every sequence (Fixed sequence group), while other rats received varied patterns across sequences (Varied Sequence group). The question we asked is whether both groups would learn that the position of each successively lit key was always changed in a sequence but only the Fixed Sequence group would learn where each successive lit signal occurred in a sequence. To answer this question, we examined rats' reaction times (ms) to each correct signal, their errors (pressing unlit keys), and the disruptive effects of occasional sequence violations (signal position switching and repetition). Rats in the Fixed sequence group were more disrupted by sequence violations (i.e., increased their reactions times) than rats in the varied sequence group. These and other findings indicate that the Fixed Sequence rats learned the 'rules' of their sequence while the Varied Sequence rats only learned to follow the lit key.

Human and rat encoding of structural ambiguity in serial pattern learning

Shannon M. A. Kundey (Hood College), James D. Rowan (Wesleyan College), Weston Dennen, Olivia Wolz, William Haller, Raymond L. Rivera-Roman, Catherine Dennen, Shaina D. Alvarez & Sarah George (Hood College)

P21 Fountain, Rowan, and Carman (2007) explored rats' learning of ambiguous sequences in a serial multiple-choice paradigm, attempting to bias separate groups of rats to view a sequence as a series of "runs" (1234-3456-5678-7812…) or "trills" (1212-3434-5656-7878…). Each group learned their sequence, but their errors suggested that both groups represented the sequence in two ways simultaneously—as a runs version and as a trills version. Though one group was only reinforced for producing a runs sequence, they still held a trills representation. Likewise, though the other group was only ever reinforced for producing a trills sequence, they maintained a runs representation. We further explored the notion of multiple representations of sequences in rats and humans by exploring performance of runs and trills sequences where a cue signaled the type of sequence to perform. Rats performed sequences in an octagonal operant chamber whereas humans completed a computer analogue of the task. Similarities and differences between the performance of humans and rats are discussed.

Phrasing of serial-patterns with a locational cue: Runs versus trills phrasing in rats and humans

James D. Rowan, Shannon M.A. Kundey, Tsu-Yi (Franca) Su, Kelly Steele & Ah Bin Kim (Wesleyan College)

P22 Studies examining the effects of phrasing on acquisition of serial patterns in rats and human have traditionally used temporal phrasing cues (pauses) to parse the pattern either consistently or inconsistently with the structure of the pattern Wallace, Rowan & Fountain (2007) found that temporal phrasing cues consistent with pattern structure improved pattern acquisition over ones that were inconsistent in rats. One problem with only using temporal cues is that subjects may not only be making more errors because of poor parsing of the pattern but also because of the disruption of the rhythm in responding. In these studies, pattern acquisition was compared between 2 groups that learned the same serial patterns that were phrased (or parsed) by different placement of a locational phrasing cue, instead of a temporal phrasing cue. One group learned the pattern with runs phrasing while the other received the same pattern with trills phrasing. The runs pattern was learned significantly faster than the trills pattern in both humans and rats. These findings not only show phrasing effects that cannot be attributed to the disruption of the temporal rhythm but also allows for the comparison of the cognitive representation of Runs and Trills rules.

Cognitive mechanisms for sequence learning in monkeys

Victoria L. Templer & Robert R. Hampton (Emory University)

P23 The ability to learn arbitrary sequences is critical for intelligent action, and may have important implications for diverse cognitive feats, including planning and counting. We examined the nature of the memory representations used to correctly reproduce five-item lists (e.g., List 1: A1-> B1-> C1-> D1-> E1; List 2: A2-> B2-> C2-> D2-> E2) in rhesus monkeys (*Macaca mulatta*). We replicated earlier findings that monkeys remember ordinal position in both within-list probe tests (e.g., A1-> C1) and between-list probe tests (e.g., D2-> E1). We inserted distractors between choices during list execution and found that monkeys made mistakes by skipping ahead to items later in the list, indicating that they used a prospective code, rather than a retrospective code, to execute the sequence. To determine if these results were indeed caused by planning, rather than counting, multiple distractor tests were interposed in between list items. Errors did not correspond to the number of distractors, indicating that monkeys were not tracking the number of responses made. Evidence presented here indicates that monkeys plan execution of routinized sequences at least two responses ahead using an ordinal representation. This is a surprisingly flexible memory process for execution of habits, rather than a procedural one.

Using reinforcement-based models of transitive inference to simulate primate data

Clara Bergene (Drake University), Regina Paxton Gazes (Zoo Atlanta), Robert Hampton (Emory University) & Olga F. Lazareva (Drake University)

P24 The ability of reinforcement-based models to predict TI behavior has been extensively documented. However, most of the research on models of TI has relied on data from pigeons. Pigeons are usually trained sequentially (first A+ B-, then B+ C-, etc.); the number of stimuli is limited to 5; and, correction trials are used during training. In contrast, primates can be trained with 7 stimuli (A to G) introduced simultaneously with no correction trials. Can the models still accurately account for these data? We used two configural models (Wynne, 1995; Siemann & Delius, 1998) to evaluate the extent to which these models accurately predict choice after 7-item training, and after linking of two lists. Preliminary results suggest that reinforcement-based models do not account for symbolic distance effect after the sequential backward training (first F+ G-, then E+ F-, and so on), but provide somewhat better predictions after simultaneous training. Surprisingly, the models provide a relatively good fit of list linking data, contrary to common belief that list linking design presents a challenge for such models.

Serial pattern acquisition in a touchscreen task for rats II. Element acquisition as a function of memory load and pattern structure

Karen E. Doyle, Samantha M. Renaud (Kent State University), Dennis Garlick, Aaron P. Blaisdell (UCLA) & Stephen B. Fountain (Kent State University)

P25 We reported earlier that rats in a touchscreen serial-multiple choice (SMC) task did not learn a standard serial pattern as predicted by rule-learning theory (Doyle et al., 2012). Rats learned to nosepoke 8 spots in a circular array to obtain water below the array. The serial pattern was composed of eight 3-element chunks with the last element violating pattern structure. When water reinforcement was delivered at the end of 3-element chunks, the first element of each chunk was learned very slowly and the violation element was learned nearly as fast as any other pattern element, contrary to rule-learning theory. In the current study, reinforcement was delivered after each element of the pattern instead of at the end of 3-element chunks. This procedure produced overall very slow acquisition, but we observed relatively fast acquisition for elements within chunks, slower acquisition for the first element chunks, and dramatically slower acquisition of the violation element, results consistent with rule-learning theory and similar to those obtained in our traditional SMC task (Fountain & Rowan, 1995). Because rats in the touchscreen task must move away from the stimulus array to obtain reinforcement, differential memory load may explain dramatically different results produced by different reinforcement procedures.

P26 **Distractor task hinders human escape/avoidance learning in a virtual environment**

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

The purpose of this study was to examine the effects of differential outcomes and instructions on human escape/avoidance learning. We developed a virtual-environment analog of a free-operant chamber. The virtual environment consisted of a circular room (608 x 608 x 240 vu) containing two contact-activated buttons with differential outcomes. Button activations turned off an aversive noise (75 dB), and delayed its onset for either 16 (long-delay button) or 8 (short-delay button) seconds. Once on, the alarm sounded until a response was made. Additionally, half of the participants were instructed to find invisible goal items (distractor task), whereas the other half received no task-specific instruction. Results revealed that the differential button outcomes did not produce differential responding, and instruction of the distractor task conflicted with successful escape/avoidance. Further results and implications will be discussed.

P27 **The effect of filled and empty intervals on clock and memory processes in pigeons**

Elizabeth Price & Angelo Santi (Wilfrid Laurier University)

Pigeons were trained in a between-subjects design to discriminate empty intervals (bound by two 1-s visual markers) and filled intervals (a continuous visual signal). The intervals were signaled by different visual stimuli and they required responses to different sets of comparison stimuli. Empty intervals were judged longer than filled intervals. The difference between the point of subjective equality (PSE) for the empty intervals and the PSE for filled intervals increased proportionally as the magnitude of the anchor-duration pairs was increased from 2s and 8s to 4s and 16s. These results closely replicate the results previously reported using a within-subjects design. According to the mixed memory model (Penney, Gibbon, & Meck, 2000), different clock rates for stimuli with different non-temporal properties must be stored within a single reference memory distribution in order to detect a difference between the clock rates of the different signals. The present results from a between-subjects design indicate that memory mixing is not necessary for detecting a clock rate difference between empty and filled intervals.

P28 **What to expect when you're overexpecting: Temporal properties of the overexpectation effect in rats**

Chad M. Ruprecht, Haydee Izurieta, Josh E. Wolf & Kenneth J. Leising (Texas Christian University)

The overexpectation effect (OXE) describes that following compound training with two asymptotic elements, animals respond less during tests of either element alone (e.g., Rescorla and Wagner, 1972). The temporal relationship between a conditioned stimulus and an unconditioned stimulus modulates both the nature (e.g., timing) and magnitude of the conditioned response (Catania, 1970; Roberts 1981). In three experiments, we used a conditioned magazine approach paradigm to evaluate the role of timing in the OXE. We hypothesized that the response decrement seen following overexpectation would manifest as temporally specific drops in nose-poking during tests of X. In Phase 1, rats were given separate trials of X (40 s in duration) and A (10 s in duration) signaling the arrival of a common US (e.g., 10 s of sucrose). The delivery of the US, moreover, occurred either 30s (Experiment 1), 15 s (Experiment 2) or 5 s (Experiment 3) after the onset of X. In Phase 2, we embedded A into X such that both elements contemporaneously signaled the arrival of the US. Tests of X revealed that rats nose-poked less during the time periods in which sucrose was previously overexpected. These are the first studies demonstrating a temporally specific OXE.

P29 **Examination of time/place learning in cotton-top tamarins (S*aguinus oedipus*)**

Eric L. Hoffmaster & Erica H. Kennedy (Frostburg State University)

Although there has been much discussion of time-place learning in animal models, most research has focused on rats and pigeons. This study was the first to our knowledge to examine time-place learning in cotton-top tamarins, a New World primate species. Seven tamarins were presented with a wooden apparatus with 12 covered wells. A triangle and circle were randomly placed on the well covers to indicate the location of hidden food. The triangle represented the correct search location in the morning, while a circle represented the correct location in the afternoon. Success was measured by examining first search responses as a function of cue (circle or triangle) associated with the time of day. Preliminary analyses suggest that this is a difficult task for the tamarins, but that certain individuals are beginning to search in the correct location at levels above chance according to binomial tests ($p<0.05$). Data collection is ongoing and we hope to gain a better understanding of how tamarins process time-place associations with this research.

P30 **Site fidelity of juvenile Kemp's ridley sea turtles in the northern Gulf of Mexico: A cognitive mystery**

Megan Broadway (Institute for Marine Mammal Studies), Heidi Lyn (University of Southern Mississippi), Andrew Coleman, Jamie Klaus & Jonathan Pitchford (Institute for Marine Mammal Studies)

Strict site fidelity has been observed in numerous sea turtle studies. Adults undergo long distance migrations between nesting and foraging grounds and there are multiple accounts of turtles returning to specific locations after being relocated hundreds of kilometers away. To better understand site fidelity in juvenile Kemp's ridley turtles in the northern Gulf of Mexico, IMMS tracked two groups of turtles via satellite telemetry. One group of six turtles was released in Mississippi (MS) in November 2010, and a second group of six turtles was released in the Florida (FL) panhandle in April 2011. Turtles released in MS exhibited a north-south migration over winter returning to MS the following spring. Turtles released in FL tended to travel in a westerly direction, potentially returning to their rescue site in MS. These findings provide additional evidence that turtles may have a sense of location. However, the criteria that turtles use in their initial site selection are unknown. Is site selection random or are turtles attracted by certain features such as geomagnetic location or some other attribute? Future research into the cognitive aspects of sea turtle site selection could show how the cognitive abilities of turtles have contributed to their survival.

P31 **Turning up the heat on snake learning: Operant conditioning and thermal discrimination training in wild Burmese pythons**

Sherri Emer (Florida Institute of Technology), Cordula Mora (Bowling Green State University), Mark Harvey & Michael Grace (Florida Institute of Technology)

Large pythons have biological requirements and functions that are extremely different from traditional animal models often used in discrimination experiments. For example, the poorly understood thermal imaging system is a unique sensory modality that enables pythons to "see" thermal images in complete darkness using facial structures called pits. We report here behavioral conditioning of Burmese pythons, and the first experiments on pit organ-based thermal discrimination by pythons using operant conditioning. Wild pythons transitioned from sessions with a live free-roaming adult rat, to sessions during which access to each of six, pre-killed juvenile mice was contingent on pushbutton contact. Learning was demonstrated by decreased latencies over the course of training sessions. Pythons then performed left and right responses to 25°C and 37°C stimuli, respectively, for which mean percentage of correct choices was 71%, which was significantly greater than chance. Pit occlusion significantly decreased correct choices (mean = 49%). These techniques can be used to create a detailed description of behaviors associated with thermal stimuli, producing a better understanding of the functional relationship between the brain, behavior and environment, which contributes to ecological success of invasive pythons in the southern United States.

P32 **Compliance and task acquisition in miniature horses: A comparison of positive and negative reinforcement techniques**

Kathleen Morgan, Kathryn Mason, Jessica Beckstrom, Shari Morris, Alexandra Lund & Jocelyn Ryan-Small (Wheaton College Norton MA)

In the world of contemporary animal training, horse training is unique in that it relies almost exclusively on negative reinforcement (NR). Despite the fact that miniature horses are not ridden and are, in fact, shown "in hand" similar to how dogs are shown, the majority of training techniques used to shape mini-horse behavior are nonetheless the same as those used to train their larger equine relatives: NR. In this study, we compared compliance and rates of task acquisition in mini-horses trained using conventional NR techniques with those trained using only positive reinforcement (PR). The PR minis were also at liberty at all times during training. Preliminary data analysis show that PR minis spend more time looking at the trainer, and show fewer behavioral indicators of resistance (i.e., ears back or pinned; delay in responding to trainer prompts). Rates of task acquisition between the two groups were similar. Results suggest that PR techniques are just as successful with mini-horses as NR techniques, may lead to improved trainer-animal bonding compared to NR techniques, and thus to improved compliance and animal well-being over time.

P33 **Use of human gesture and gaze information in a two-choice hidden food task by blue jays**

Kristy Gould, Katy Lindstrom, Jonathan Nerdig, Emily Kratovil, Marty Mitchell & Brian Kurtz (Luther College)

The use of gestures and gaze direction to draw attention to external objects is something utilized by humans as part of our communication. Some birds in the Corvid family (jackdaws, Von Bayern & Emery 2009; Clark's nutcrackers, Tornick et al. 2011) also seem to understand or quickly learn the gesturing or gazing of humans. Utilizing the same methodology of Tornick et al., we looked at the ability of five blue jays to use human touch, pointing, and gaze alternation cues in a two-choice hidden food design. One bird chose the correct location using touch information at 75% correct within the first block of 8 testing days. The same bird also learned to use point information at 75% correct within the second block of 8 testing days and by the third block, was at 87.5%. Another bird learned to use gaze information at 75% correct within the third block of 8 testing days. The remaining three birds showed side biases, neophobic behavior, or lack of motivation due to sensitivity to target weight fluctuations. The contribution of these individual differences to performance, especially neophobia, will also be discussed in light of the results.

Variability in instrumental behavior predicts Pavlovian learning in a latent inhibition task

Matthew Lau (UCLA) & W. David Stahlman (University of Mary Washington)

P34 Research has indicated that creative behavior in humans is associated with a reduced latent inhibition effect. Individuals that engage in creative behavior tend to learn about the importance of formerly inconsequential cues more quickly than non-creative individuals (Carson et al., 2003). We were interested in examining whether this relationship exists in a non-human animal model, the laboratory rat. We conducted an experiment in two phases. In a CS-preexposure phase, rats were exposed to trials of a flashing light stimulus alone; after many trials, the light was then forward-paired with sucrose and Pavlovian learning was assessed. In a second phase, rats were trained to lever-press for sucrose based on a discriminative tone. Variability in behavior was measured in this phase. We discovered a significant correlation between instrumental variability and Pavlovian learning during a latent inhibition task. This result mirrors that of prior work in humans.

Active avoidance conditioning in the jumping spider (*Servaea incana*)

Tina Peckmezian, Phil Taylor & Ken Cheng (Macquarie University)

P35 The ability to learn from negative experiences is widespread across invertebrates, yet little is known about the cognitive mechanisms that enable animals to acquire, recall, and act on these experiences. Here, I assess the capacity of field-caught *Servaea incana* jumping spiders to learn an active avoidance task, in which experimental spiders are trained to learn that a visual stimulus reliably predicts an aversive event. A moving-dot video stimulus serves as the CS and electric shock as the US in a stationary, two-sided enclosure, with both stimuli occurring on one side only. In order to isolate the role that each stimulus plays in learning this task, 4 control groups are additionally assessed: C1 receives the CS alone, C2 receives the US alone, C3 is yoked to the experimental spider (identical CS/US exposure; non-contingent with behaviour) and C4 experiences the CS/US exposure with unreliable external cues (arena rotates over trials). Avoidance, escape and latency data are recorded, and the results reveal an unexpected finding: while spiders learn to escape the US, they do not acquire the CS-US association, with the visual stimulus contributing little to overall performance. For an animal that is known for its visually-mediated behaviour, these results are surprising.

Effects of forced swim procedure on renewal of conditioned fear response in rats

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

P36 The forced swim procedure has been widely used in rodents and Porsolt's forced swim test (1977) is one the typical procedure. The immobility of subjects in Porsolt's procedure has been interpreted as 'learned hopelessness', and shown to decrease with antidepressant medications. So immobility has been an index of depressive-like behavior. We studied the influence of Porsolt's forced swim procedure on context-specificity of conditioned fear renewal in rats, an animal model for the relapse of human phobias. Using lever-press conditioned suppression, we demonstrated ABA renewal when fear extinction was conducted different context. First, subjects were received Pavlovian fear conditioning in Context A, to acquired fear response. Second, subjects were received Porsolt's forced swim test. Third, subjects received fear extinction sessions in Context B. After fear response was extinguished, subjects were returned to Context A and then received fear renewal test. In testing, subject received two-day forced swim showed attenuated renewal. In other hand, no significant difference about immobility time between day 1 and day 2. That forced swim procedure in present experiment didn't induce depressive-like behavior. These results implied that acute stress task with no medication administration, attenuate the recurrence of fear.

Choice and enrichment efficacy for zoo-housed Galapagos tortoises: Using preference assessments to improve animal welfare

Lindsay R. Mehrkam, Brandon Perez & Nicole R. Dorey (University of Florida)

P37 Choice in animals is a wide area of interest in the field of comparative cognition, but is often not applied directly for the purposes of improving animal welfare. Our objective was to determine if preference assessments – widely used in humans to identify preferred reinforcers – could be used to predict the effectiveness of environmental enrichment strategies of three captive Galapagos tortoises housed at the Santa Fe College Teaching Zoo. First, we conducted an observational study to evaluate the effects of both traditional forms of enrichment and human-keeper interactions on behavioral welfare. We then compared the results from the observational study to the results of a preference assessment, in which the tortoises freely chose the enrichment strategy to be implemented. Preference assessments had high predictive validity for determining the relative effectiveness of enrichment strategies. Subjects' preferences for enrichment items matched the effectiveness of these items with respect to increasing species-typical behaviors and enclosure use, but not increasing activity levels. In addition, systematic individual differences were observed. We hope that this is the first of many studies evaluating the validity and practicality of preference assessments for improving animal welfare in a wide range of species housed in captivity.

The A not B task in pigeons: Pigeons perseverate much like young children

Jordan C. Wade, Jennifer R. Laude & Thomas R. Zentall (University of Kentucky)

P38 In the A not B task, subjects are shown an object (reinforcement) placed in Cup A or under inverted Cup A on three successive trials and they are permitted to retrieve the object. On Trial 4, they are shown the object placed in Cup A but immediately moved to Cup B. Although subjects could see the object move from Cup A to Cup B, young children (about the age of 22-months) often perseverate and look for the object in Cup A. Older children (about the age of 66-months), on the other hand, look in Cup B. When this procedure has been used with primates using food as the reinforcer, apes (chimpanzees and bonobos) have been found to be very accurate (100% correct), whereas monkeys (capuchins and macaques) have been found to be somewhat worse (75% correct). We explored this task with pigeons and found that they did significantly worse than the monkeys, choosing B on Trial 4 only about 43% of the time, however, we also found large individual differences among the pigeons.

Scene-based contextual cueing in pigeons: Responding on cue

Edward A. Wasserman, Yuejia Teng (University of Iowa) & Daniel I. Brooks (Brown University)

P39 Repeated pairings of a visual context with the location of a target stimulus facilitate target search in humans. We studied contextual cueing in pigeons plus we explored the possibility of attentional guidance participating in the effect. We trained pigeons to peck a target which appeared in one of four locations in real-world scenes. On half of the trials, each of four scenes was consistently paired with one of four possible target locations; on the other half of the trials, each of four different scenes was randomly paired with the four possible target locations. In Experiment 1, we presented the target 2 s after onset of the background and we recorded anticipatory pecks to the location of the upcoming target. In Experiment 2, we varied the background-target delay from 0 to 8 s to assess the time course of contextual cueing. In Experiment 3, we trained other pigeons with a 0-s delay between background and target to see if contextual cueing would also be observed. Pigeons exhibited a robust contextual cueing effect at all background-target delays. At nonzero delays, anticipatory responses toward the site of the upcoming target suggest that attentional guidance contributes to the contextual cueing effect.

P40 Poster Withdrawn

Do dogs prefer pointing gesture by trustworthy person?

Akiko Takaoka & Kazuo Fujita (Kyoto University)

P41 Dogs are sensitive to human social gestures (e.g. pointing), but they do not always follow them blindly. They change responses flexibly depending on situations. Resent study showed that dogs evaluate humans based on observing third-party interactions (Marshall-Pescin et al, 2011). We investigated whether dogs evaluate person "reliability" on the basis of observing behaviors and extend the knowledge to gauge future trustworthiness of the person. The experimenter did what the dog expected her to do in the observing phase of the high reliability group, but did not do it in the low reliability group. In the following test phases, many dogs in the high reliability group followed the pointing gesture provided by the experimenter, but fewer dogs in low reliability group did. Experimenter did not reinforce dogs with food in either case in the observation phase. The only difference between the two groups was whether she did what dogs expected or not. This result suggests that dogs judged the Experimenter's "reliability" only by observing her behavior, and generalized to a subsequent situation.

Canine attachment in the presence of resources

Stephanie Scavelli, Jennifer Gibson (Flagler College) & Monique Udell (Flagler College and University of Oregon)

P42 Canines have developed in tandem with humans, beginning with the early domestication of the species. The symbiotic relationship between humans and canines has led to a unique attachment bond that has been studied over the years. We choose to focus on the strength of this bond by examining how well an attachment is maintained in the presence of the resource of food. The study we conducted modified the Ainsworth strange situation scenario to assess the strength of attachment and then compared the behaviors we found to canine preference in a human versus food scenario. This was done with pet canines and shelter canines. Results of the study will expand on the already present literature and provide new insight to the strength of the human-canine attachment bond.

Vocalizations in nut-cracking by wild capuchin monkeys (*Sapajus libidinosus*) in Piaui, Brazil

Qing Liu, Patience Fortner (University of North Carolina at Pembroke USA) & Antonio Souto (Universidade Federal de Pernambuco Brazil)

P43 Tool use is considered to be a probable correlate to evolution of language in the human lineage (Steele et al. 2012). Percussive tool use, such as nut-cracking, is likely among the first hominine technological innovations. Vandervert (2012) speculated that the cerebro-cerebellar blending of visual-spatial working memory and vocalizations that occur in percussive tool use and that require recursive sequences, such as occur in nut-cracking, may be one mechanism that supported the emergence of human language. Wild bearded capuchin monkeys (*Sapajus libidinosus*) routinely use hammer stones to crack hard nuts that they place on an anvil (Fragaszy et al. 2004). Therefore capuchins serve as a unique and interesting reference point in the discussion of the possible scenario of coevolution of language and tool use. We recorded seven wild capuchins in Piaui, Brazil during nut-cracking in a pilot dataset (305 episodes, 225 vocalizations). In this presentation, we describe capuchins' vocalizations during nut-cracking and provide results of acoustic analyses and contextual information of these vocalizations. With further data collection, we hope to determine if there are specific vocalizations or combinations of vocalizations, and/or specific temporal patterns of vocalizations during episodes of tool use in this population of tool-using capuchin monkeys.

Acquisition of vocal communication in squirrel monkeys

Yoshie Yamaguchi (Rikkyo Univ. Japan) & Yasuo Nagasaka (BSI RIKEN Japan)

P44 The aim of the present study is to explore acquisition of vocal communication in nonhuman primates. We recorded and analyzed vocal interaction between 6 pairs of squirrel monkeys (*Saimiri sciureus*). Two pairs were mother-infant pairs, and the infants were 10 months and 4 years old. The recording was performed in isolated room, and the pairs could not see each other. In total, 4863 instances of 6 different types of vocalizations (or calls) were recorded. The number of occurrences of each call and the intervals between calls were analyzed for each pair. We found that the frequency of each call was age-dependent; adult monkeys frequently uttered affiliative calls, or Chuck. The occurrence of interval between successive calls was high until 0.5 s after the first call, and this tendency was observed in all pairs. Furthermore, the adults called back with Chuck to the partner's Chuck. However, the infants called back with various calls, especially the youngest monkey. These results suggested that the monkeys could learn a "timing rule" of communication at least until 10 months after birth, but it appears to take more time for monkeys to learn to respond with appropriate call to others.

Go-No-Go identity and arbitrary training in rats

Ashley Prichard, Megan Halloran, Alyse Kaszubski, Sarah Maggio, Elizabeth Rigsby, Megan Taig-Johnston, Courtney Anderson, C. Chen, Brook April, Mark Galizio & Kate Bruce (University of North Carolina Wilmington)

P45 The purpose of the study was to evaluate whether emergent conditional relations (symmetry) could be established using a Go-No-Go procedure in rats. The procedure was conducted in an operant chamber with olfactory stimuli presented through an olfactometer. During identity training, responses (nose pokes) emitted in the presence of correct identity stimulus pairs (A1A2, B1B2, C1C2, and D1D2) were reinforced with sugar pellets and incorrect stimulus pairs (A1C2, B1D2, C1A2, D1B2) were not reinforced. During arbitrary training, responses emitted in the presence of correct arbitrary stimulus pairs (A1B2, C1D2) were reinforced and incorrect stimulus pairs (A1D2, C1B2) were not reinforced. Rats were initially trained on a baseline with mixed identity and arbitrary training trials, but most failed to meet criterion levels of accuracy even after extensive training. One rat met criterion on both identity and arbitrary training and received unreinforced symmetry probes (B1A2, D1C2), with some evidence of emergent symmetry. These data extend the findings of Urcuioli (2008) to rats.

Do pigeons (*Columba livia*) demonstrate behavioral sensitivity to connectedness and effort in the virtual string task?

Stephen Brzykcy, Edward A. Wasserman (University of Iowa), Yasuo Nagasaka (Riken Brain Science Institute) & Sacha Perez-Acevedo (University of Puerto Rico)

P46 Physical concepts such as connectedness are relatively easy for humans to appreciate, but evidence for other species' understanding this concept has been difficult to obtain. One familiar test of connectedness involves variations of the string task. Using a virtual string task, we presented pigeons with a pair of strings from which to choose: one which was connected to a full dish of food and the other which was disconnected from a second full food dish. The pigeons were not initially sensitive to connectedness, by failing to choose the connected string rather than the connected one. But, they later learned to choose the connected string under conditions of differential reinforcement. In a related experiment, we placed the two food dishes at one of three locations along the lengths of the two strings. The pigeons tended to choose the string that was attached to the nearer food dish. These results attest to the utility and sensitivity of the virtual string task.

Receiver operating characteristic (ROC) curves for hedonic samples in rats: Evidence for a signal detection account of asymmetrical presence/absence retention functions

Sabrina Simmons & Angelo Santi (Wilfrid Laurier University)

P47 Rats trained in a delayed matching-to-sample procedure to discriminate sample stimuli consisting of the presence of food or absence of food show more forgetting of the food sample than of the no-food sample. According to the single-code/default strategy, rats code only the food sample and make the response correct for the no-food sample by default when there is no memory of the food sample. The signal detection account claims that instead a memory for the no-food sample does exist, and the animal is using a self-set decision criterion in order to make the response (Wixted, 1993). In Experiment 1, ROC curves were generated for each of five retention intervals (0-16 s) by manipulating the probability of reward for hits and correct rejections (0.6/0.6. 0.2/1.0, 1.0/0.2, 0.4/0.8, 0.8/0.4). The best-fitting ROC curvilinear functions based on signal detection theory accounted for more of the variance than the best-fitting linear functions based on the default response account. In Experiment 2, the ratio of food to no-food trials was manipulated(50/50, 60/40, 40/60, 80/40, 40/80) and ROC curves were generated for each of five retention intervals. Preliminary analysis suggests a curvilinear trend for these ROC curves which also supports the signal detection account.

Source memory and source confusion in rhesus monkeys

Benjamin M. Basile & Robert R. Hampton (Emory University)

P48 You likely treat a news story differently depending on whether you read it in the New York Times or in The Onion. Explicit source memory is one hallmark of human episodic memory. The degree to which nonhumans remember the source of memories is unclear. A previous study found that rhesus monkeys confused to-be-remembered information they saw with irrelevant information they heard, but only after an extended memory delay. This suggests that they initially remembered the source of the information but suffered from source confusion as time passed. To further explore this phenomenon, we tested monkeys' memories for information that had been learned in different ways: touched images were always necessary to remember and classified images were always irrelevant. As in the previous study, monkeys learned to suppress responding to recent irrelevant images, but became confused after longer memory delays. Some monkeys learned to report images from either source on cue, suggesting that they remembered both images and discriminated between the images based on how they had been learned. These results provide preliminary evidence for source memory and source confusion in monkeys.

Characterization of odor span task performance in humans

David MacQueen, Emily Cutolo, Justin Cornell (Moffitt Cancer Center and University of South Florida), David Diamond (James Haley VA Hospital and University of South Florida) & David Drobes (Moffitt Cancer Center and University of South Florida)

P49 The present study sought to characterize human performance of an olfactory incrementing non-match to sample procedure (the odor span task; OST) developed in rodents. Participants (9 Males and 16 females) were presented with opaque test tubes containing common odorants (household spices). On the initial trial of each session participants were presented with a single odorant which they were instructed to sample and remember. Subsequently, participants were presented with odor pairs comprised of one novel odorant and one odorant which had been presented on an earlier trial. On each trial (20 trials total), participants were asked to identify which tube contained the novel odor, and were given verbal feedback on their choice. Dependent measures included percent correct responses, the number of trials completed without error from the start of the procedure (span), and the longest string of trials completed without error. As is observed in rodents, performance declined as the number of stimuli to be remembered increased. Human OST performance will be presented alongside data collected from 4 male Sprague Dawley rats trained to stability and repeatedly tested on an analogous two-choice version of the OST using identical odorants.

Scrub jays show no evidence of memory binding during an episodic memory task

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

P50 An interesting question in comparative cognition is whether animals have true human-like episodic memory. Recent animal research has found evidence for some aspects of this ability in foraging contexts (see Crystal 2010), but the type of paradigm used is incapable of detecting one integral aspect of true episodic memory: a binding of multiple elements into a single memory trace. Skov-Rackette et al (2006) used a clever operant method to test for bound memories and found that, while pigeons could remember multiple dimensions of a stimulus, each element seemed to be remembered independently. We ran a replication of this study with scrub jays, which are frequent subjects in episodic-like memory research. While the jays were highly accurate at remembering what, where, and when a stimulus appeared, there was no evidence that these elements were integrated together into a single memory. This suggests that, while animals may display behaviors similar to human episodic memory, the underlying mechanism may be quite different.

Shape span task in rats

Victoria Willetts, Kate Bruce & Alyse Kaszubski (University of North Carolina Wilmington)

P51 The Odor Span Task (Dudchenko, Wood & Eichenbaum, 2000) has been used extensively to study working memory in rats. Rats are trained to remove scented lids with reinforcement contingent on removal of the lid with the scent that has not be presented already in the session. Rats perform the test with high accuracy even with as many as 72 scents in a session (April, et al, under review), suggesting that the task is not analogous to working memory in humans. We are developing a modification of the OST, the Shape Span Task (SST), as an alternative model for working memory in rats; because rats must rely on visual cues, it is a more difficult task. Rats are trained to remove lids that have Lego objects of different shapes attached to them, with reinforcement contingent on removing the lid of the shape that is novel for a particular test session. Testing thus far reveals that the task is more difficult for the rats to learn but their behavior can come under control of the novelty of the shape.

Symbolic matching-to-sample with short and long delays in honeybees

Gentaro Shishimi, Amber J. Mira & P. A. Couvillon (University of Hawaii at Manoa)

P52 Honeybees showed delayed symbolic matching-to-sample with a 5-second delay. The present experiments tested longer delays to explore the working memory capacity of honeybees. In Experiment 1, free-flying honeybees were trained to visit two adjacent windows. On each trial, the subject received a small drop of sucrose on a colored sample (orange or green) in one window and then flew to the adjacent window to choose between yellow and blue. The delay between sample and choice averaged 12 seconds. The correct color contained sucrose and the incorrect color contained an aversive solution. Initial choice was recorded and correction was permitted. The bee drank the sucrose, flew to the hive to unload, and returned to the windows for another trial. In Experiment 2, the bees were trained to visit a single window, found a large drop of sucrose on the sample, drank and flew to the hive. When they returned, they found the choice colors. The delay between sample and choice averaged 206 seconds. The sample and choice trials continued to alternate. The bees showed better-than-chance performance in both experiments, suggesting short and long working memory. Future studies will explore retention interval in identity matching- and nonmatching-to-sample problems.

Effect of pharmacological manipulation of nucleus subpretectalis on figure-ground discrimination in pigeons

Hannah E. Moses, Erin N. Scully (Drake University), Martin J. Acerbo (Iowa State University) & Olga F. Lazareva (Drake University)

P53 Our earlier research has shown that nucleus rotundus (Rt), a thalamic nucleus processing visual information in pigeons, together with its inhibitory complex, nucleus subpretectalis/interstitio-pretecto-subpretectalis (SP/IPS), had significantly higher activity than control after figure-ground discrimination (Acerbo et al., 2012). In a follow-up study, we also found that bilateral lesion of SP selectively impairs figure-ground discrimination. Here, we conducted bilateral microinjections of GABAergic receptor antagonist (bicuculline) to further clarify a role of SP in figure-ground discrimination. Overall, the blockade of GABA receptors had most pronounced effect on accuracy on background trials while leaving figure trials relatively intact. These results suggest that inhibitory projections from SP might be suppressing activity of neurons in nucleus rotundus responding to features belonging to background regions. Preliminary results of the injection of GABAergic receptor agonist (muscimol) and glutamatergic receptor antagonists (CNQX and MK-801) will be presented.

Detection thresholds and two-choice localization of hydrodynamic stimuli by Florida manatees (*Trichechus manatus latirostris*)

Joseph C. Gaspard III (University of Florida), Gordon B. Bauer (New College of Florida), Roger L. Reep (University of Florida), Katharine Nicolaisen, Laura Denum (Mote Marine Laboratory) & David A. Mann (University of South Florida-College of Marine Science)

P54 Manatees possess a unique arrangement of specialized sensory hairs (vibrissae), present on the face and across the body. These hairs appear to be represented in the somatosensory cortex by neuronal aggregations similar to the barrels in rodents. Previous research conducted on the facial and post-cranial vibrissae demonstrated that touch may be the manatee's primary sensory system highlighted by sensitive active touch discrimination (JND = 0.025) and acute detection of oscillatory water movement with a particle displacement threshold of less than 1 μm for most frequencies tested and as low as 1 nm at 150 Hz. In current research manatees were tested for their ability to discriminate the direction of hydrodynamic stimuli. The stimuli, ranging from 25 – 125 Hz, were generated by two sinusoidal oscillating spheres which generated dipole fields to the left or right of the subject. The subject pressed a paddle on the side from which the stimulus arrived or stayed in place on catch (stimulus absent) trials. Subjects correctly identified left-right differences in dipole oscillation at well above chance levels (> 95%). Manatees may utilize their vibrissae as a sensory array, analogous to the lateral line system of a fish.

Comparison of prospective and concurrent metamemory judgments in Rhesus monkeys (*Macaca mulatta*)

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

P55 Metamemory is the ability to access one's own memory states and respond to them adaptively. Here, we evaluate the conditions under which rhesus monkeys (*Macaca mulatta*) are able to make successful metamemory judgments. Rhesus monkeys performed a four-choice delayed match-to-sample task. On some trials, monkeys were allowed to decline the memory test and receive a small, guaranteed reward. On other trials they were required to take the memory test. Monkeys alternated between sessions of prospective tests, on which they chose to accept or decline the test before the test stimuli appeared, and sessions of concurrent tests, on which they chose to accept or decline the test with the test stimuli visible. On both prospective and concurrent tasks, monkeys were significantly more accurate on tests they chose to take than on tests they were forced to take, suggesting that they monitored their memory and appropriately declined tests when memory was relatively poor. This benefit was greater on concurrent tests than prospective tests, indicating that although monkeys have some basis for prospective judgments, adaptive responding was improved by the additional information provided when the test was available at choice.

Prospective metacognition on the reference memory task in pigeons (*Columba livia*)?

Sumie Iwasaki (Kyoto University), Sota Watanabe (Osaka Kyoiku University) & Kazuo Fujita (Kyoto University)

P56 Although several mammalian species have shown evidence for metacognition in previous studies, the evidence is weaker in pigeons. However, the negative results may not necessarily suggest lack of metacognitive ability in pigeons. We suspect that primary tasks such as matching-to-sample commonly used in the previous studies might be too demanding for pigeons to leave room for metacognitive processing within their cognitive resource. In this experiment, we examined whether pigeons could show metacognitive response on a three-item sequence learning task, a reference memory task supposedly requiring less working memory capacity. This experiment used two types of lists: "the constant list," which always presented the same items, and "the variable list," which was varied every session. The subjects were able to distinguish the two by the start icon, and they had a choice between to seek hint to solve the task or not before appearance of list items. Three of four pigeons sought hint more often in the variable lists than in the constant lists. This result may suggest that pigeons have prospective metacognition ability.

Beyond rhesus monkeys: Information seeking in old-world primates

Heidi L. Marsh (Bucknell University)

P57 The current literature on adaptive information seeking behavior in primates seems to suggest a divide between old- and new- world monkeys, with the former regularly outperforming the latter. However, to date research has been limited to a single species from each lineage (i.e., rhesus and capuchin monkeys). Moreover, although rhesus monkeys gather information when necessary to solve a problem, it remains unclear whether this behavior represents a rote response in the face of uncertainty, or whether metacognitive control might moderate this ability. The present research addressed these issues by testing the flexibility of information gathering in two different old-world monkey species: lion-tailed macaques (*Macaca silenus*) and hamadryas baboons (*Papio hamadryas*). Monkeys were tested for their propensity to seek information in the face of changing variables, such as task difficulty and value of reward. Results are discussed with respect to the phylogenetic emergence of adaptive information gathering and the possibility of metacognition.

Pinyon Jays voluntarily share food with others....sometimes? Factors influencing prosocial behavior

Juan F. Duque & Jeffrey R. Stevens (University of Nebraska)

P58 Many animals share food with one another, such that a recipient gains an immediate benefit at the expense of a donor. Though such sharing is expected in parent-offspring dyads, it is unclear why and under what circumstances sharing occurs in unrelated pairs. We examined several potential factors influencing food sharing in the social corvid pinyon jays (*Gymnorhinus cyanocephalus*). We observed situations in which an individual with access to food actively shared food with a nearby individual without access to food. These sharing events occurred across a number of dyadic relationships (e.g., male-female, male-male, female-female pairs) and a number of motivational states (hungry-sated, hungry-hungry, sated-sated). Though some jays demonstrated remarkable flexibility in with whom they shared, other individuals never shared nor received food. While preliminary, the data suggest strong individual differences in the propensity to share food. Furthermore, these individual differences may carry over into dyad-specific effects, leading to more sharing among specific pairings of birds. The voluntary, spontaneous sharing events observed here provide a foundation for exploring the cognition underlying prosocial behaviors such as these.

Do degus (*Octodon degus*) recognize one individual from another by their odor?

Toru Betsuyaku, Sho Otaki, Yushi Kadono, Hitomi Chijiiwa & Kazuo Fujita (Kyoto University)

P59 Degus (*Octodon degus*), a diurnal, group-living hystricomorph rodent found common in Chile, are gradually getting attention as a subject of the research especially regarding with their social aspects. Using a simple habituation-dishabituation method, we examined whether they can discriminate the olfactory stimulus derived from one individual from that of another. We collected the odor stimuli by rubbing with cloth the whole body of the model degus. In the three trials of the habituation phase, subjects freely explored a square arena (50 (W) x 50 (H) x 35cm (D)) in which the single stimulus (the cloth covered by wire mesh) was presented. In the test phase (1 trial) that followed, we replaced the odor stimulus to the one derived from another individual. We recorded the walking distance and the duration of exploration of the stimulus in each trial to examine whether their exploration of the new odor increased in the test phase. Results will be discussed with respect to their ability for individual recognition, social relationship, and possible ecological factors.

Big ideas from tiny minds: Vicarious learning in jumping spiders

R. Matt Adams & Alan Kamil (University of Nebraska-Lincoln)

P60 Learning vicariously is considered a cognitively challenging task, one that might seem beyond the capabilities of arthropods. Jumping spiders (family Salticidae), however, are prime candidates for this type of learning. Salticids possess advanced cognitive capabilities and very acute vision in terms of both acuity and color perception. In addition, the natural history of some salticids suggests such learning could increase foraging success in the field. We hypothesized that salticids might learn about novel prey solely by watching a conspecific interact with a prey item, i.e. through vicarious learning. Our first two experiments established that Salticids altered their foraging behavior when exposed to movies of either conspecifics either feeding on or rejecting a novel prey item. Spiders that saw the prey rejection had significantly slower attack times than spiders who saw spiders feeding on the same prey type. However, observing another spider that was active but not foraging also affected attack latency. A third experiment exploring the dynamics of these effects is currently underway. The results of all three experiments and a discussion of the possible mechanism(s) of these effects of observing conspecifics in salticids will be presented at the meeting.

How does stimulus modality and field of view affect human surface-based reorientation?

Samuel P. Police & Kent D. Bodily (Georgia Southern University)

P61 After learning to search for a goal near a landmark placed in one corner of a rectangular enclosure, humans (adults and children) and other animals (e.g., rats, pigeons, chickens) search in the correct and the rotationally-equivalent (opposite) corners when the landmark is removed. This finding suggests that participants learn to orient to properties of the enclosure shape. Visual landmarks, which have been utilized in all previous studies using human participants, may influence the perception of the shape (e.g., occlusion). The purpose of the present study was to investigate whether the stimulus modality of the landmark (i.e., visual, auditory) and how much of the environment is simultaneously viewable (i.e., field of view; FOV) influenced orientation. Utilizing a dynamic 3D virtual environment, we trained two groups of human participants to find a goal location, marked by either a visual of auditory landmark, in a rectangular enclosure (approx. 7.0 x 14.0 x 6.6m). Each modality group was further divided into FOV 90° and FOV 120° groups. Testing consisted of four probe trials (Control, No Landmark, Square, Affine), each presented once (counterbalanced to control for possible order effects). Results and implications will be discussed.

The use of multiple landmarks by humans (*Homo sapiens*) in open-field search task

Katsuo Sekiguchi (Senshu University), Tomokazu Ushitani (Chiba University) & Kosuke Sawa (Senshu University)

P62 An open-field search task was conducted to investigate whether humans, like pigeons, can flexibly use multiple spatial cues that redundantly indicate the position of a target. During training, participants learned to locate a target in one of 25 buckets, arranged in a 5 x 5 grid. Red and blue arrow-shaped landmarks were placed on top of buckets adjacent to the target and pointed to the target location. The absolute location and arrow directions varied across trials, but their configuration was constant (i.e. when standing at the target and facing the red arrow, the blue arrow was always to the right). Thus, both global configural information (spatial relationship of the two distinctive arrows and the target) and the local vector information (direction of either arrow and its distance from the target) could be used to locate the target. On subsequent test trials, arrow directions were changed to conflict with each other and with the global configural information. Results showed that on test trials human participants, unlike pigeons, used vector information from the arrows but ignored configural information. Our results also suggest further ways to explore the conditions necessary for humans to use configural information without being overshadowed by local landmark information.

A comparison of problem solving and tool use in orangutans (*Pongo pygmaeus pygmaeus*), raccoons (*Procyon lotor*), and children (*Homo sapiens*)

Ashlynn Keller & Caroline DeLong (Rochester Institute of Technology)

P63 The purpose of this study was to compare differences among orangutans, raccoons, and 5-10 year-old children in the ability to use tools to solve a series of mazes. The maze apparatus was a transparent box with seven levels and moveable plastic inserts that created three easy, three moderate, and three difficult maze configurations. Three wood and three plastic stick tools were presented with each maze. Results showed that 100% of the 26 children solved the easy and intermediate mazes, but only 78% solved the difficult mazes on their first attempt. Girls took longer to solve the intermediate mazes while boys took longer to solve the difficult mazes. The majority of the children preferred to solve seven of the mazes with the plastic tools and two of the mazes with the wood tools. Preliminary results indicate that the three raccoons successfully solved one of the easy mazes presented, but without the use of tools. The experimenter modeling tool use did not prompt the raccoons to use a tool to solve the mazes. The experiment with the three orangutans is currently in progress. We hypothesize that orangutans' performance will be more similar to the human children than to the raccoons.

"Tool use" by squirrel monkeys (*Saimiri sciureus*) supports the extractive foraging hypothesis for distinguishing between conceptual & non-conceptual performances by nonhuman primates.

Emily Seidl, Abigail Machernis & Roger Thompson (Franklin & Marshall College)

P64 Captive squirrel monkeys (*Saimiri sciureus*) retrieved food-cups that were either attached to straight sticks or enclosed within a hook. When presented with a choice of two hooks or two straight tools they chose the hooked or attached food-cup. However, they never learned to purposefully 'hook' or 'stab' and retrieve unenclosed or unattached food-cups. These results indicate that the squirrel monkeys, similar to vervet monkeys (*Chlorocebus aethiops*) (Dore et al 2012), acquired a simple reach-and-pull retrieval response mediated by their discrimination of perceptual differences between rewards attached, or not attached, to a tool and enclosed, or not enclosed, by a hook's boundaries. Overall, these results support the hypothesis that, unlike facile nonhuman primate tool users in the wild and captivity, squirrel monkeys are not extractive foragers and hence insensitive to the functional affordances of objects unattached to the body for purposeful, goal directed action.

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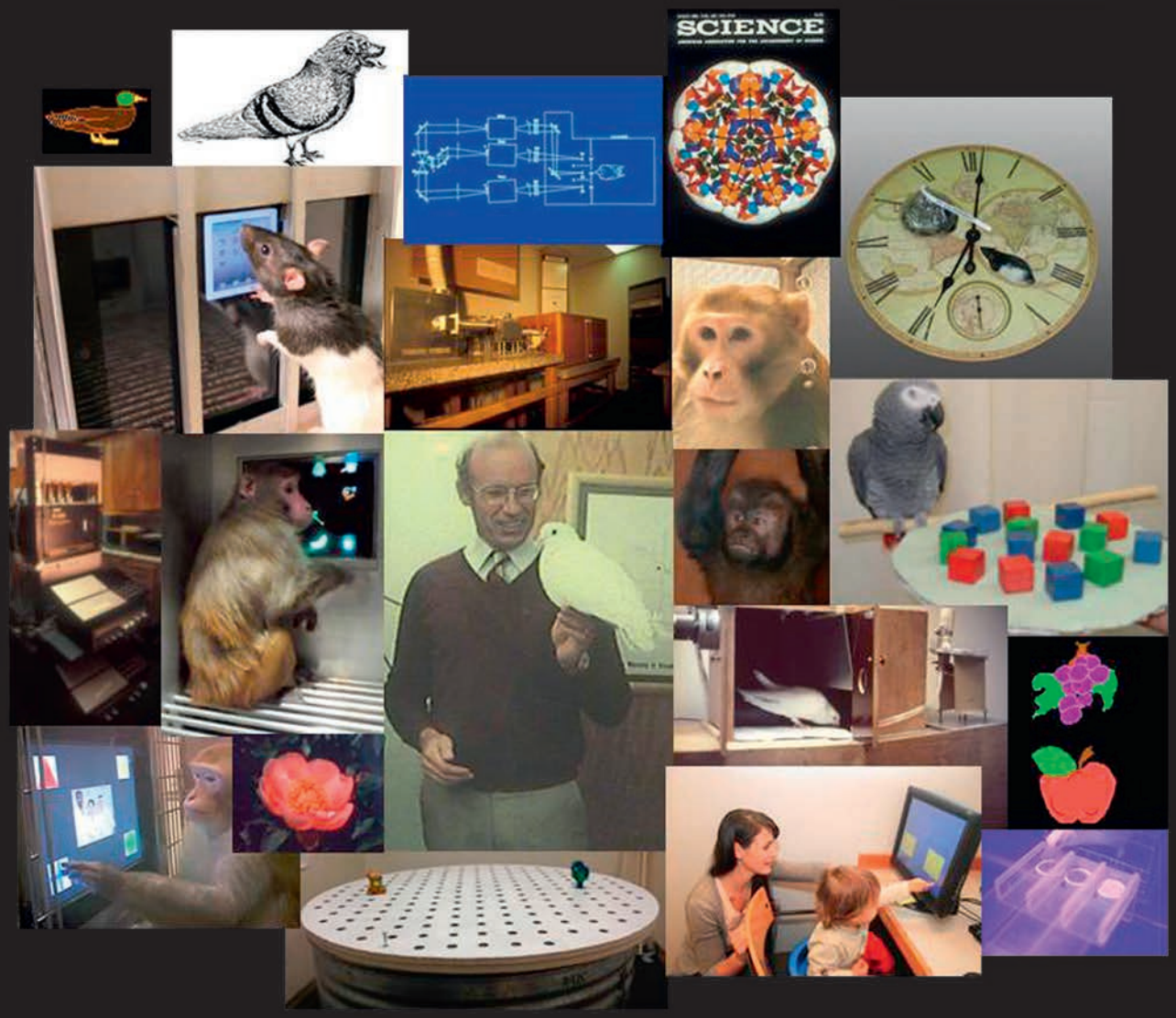

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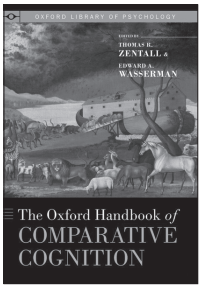

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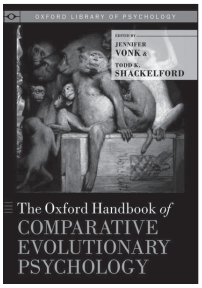

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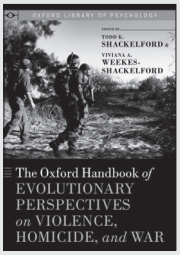

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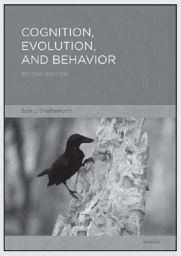

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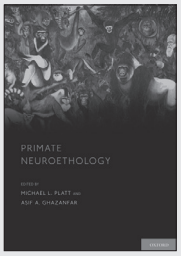

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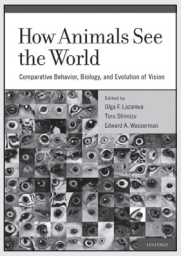

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