

3:30 PM **Welcome Reception & Light Snacks**

Wednesday Evening

6:50 PM **Opening Remarks - Marcia Spetch**

7:00 PM **Associative Processes (Chair - Marcia Spetch)**

**What is contingency learning for?**

*Helena Matute (Deusto University, Spain), Fernando Blanco (Leuven University, Belgium), Miguel A. Vadillo, Ion Yarritu, & Cristina Orgaz (Deusto University, Spain)*

1 7:00 PM All animals extract contingency information from their environment. Presumably, they use it to infer the predictive and causal value of cues, which in turn are used to predict important events and to prepare for them. This assumption, however, has scarcely been tested in a direct manner and prediction and predictive value have often been taken as synonyms. The very few studies that have explored this issue have been conducted with humans and have shown that they use contingency to infer the causal and the predictive value of cues, but not to predict the outcomes, or to prepare for them. If this were confirmed, it would make little sense that humans (and perhaps other animals) invest resources in learning contingency information. This research further explored this issue with humans and found that they predict the outcome on the basis of contiguity, not contingency. However, we also found that people do only prepare for outcomes that are contingent with cues that are present. Indeed, even when people are certain that an outcome will occur they will not prepare for it unless they infer a high causal or predictive value for the present cue.

**Function and mechanism, or the race between the cart and the horse.**

*Alex Kacelnik (University of Oxford)*

2 7:14 PM The optimality approach typically starts by modelling ecological problems, proceeds to identify optimal strategies and advances to propose behavioural rules that would allow the subjects to deploy such strategies without using goal-directed optimality analyses. Often simple rules are hypothesised, tested in simulations, and contrasted with elements of real behaviour. Thus, mechanistic research is subordinate to functional analysis. I argue that the reverse protocol, namely using knowledge about behavioural mechanisms to make inferences about the problems they have been evolved to solve is often preferable. This is because mechanisms can be more precisely identified than ecological selective forces and because behaviour is more likely to be controlled by a limited set of broad-domain mechanisms than by a vast repertoire of problem-specific rules of thumb or heuristics. The ubiquity of three behavioural phenomena (Associative Learning, Weber's Law and Choice by Latency Competition) illustrates my point. From their ubiquity I infer that detecting correlations, managing information spreading over vast quantitative ranges, and sequential choices were major selective forces. This contrasts with the a-priori choice of energy rate maximisation and/or risk sensitivity as the currencies of optimal foraging models, and fosters ever closer identification between functional and mechanistic behavioural research.

**Additive effect of extinction in multiple contexts and massive extinction in attenuating recovery.**

*Mario A. Laborda & Ralph R. Miller (State University of New York – Binghamton, USA)*

3 7:28 PM In two fear conditioning experiments with rats, we showed that combining two recovery-attenuating treatments reduced recovery of extinguished conditioned responses more than either treatment alone. In Experiment 1, renewal and spontaneous recovery manipulations were combined to demonstrate that the two recovery-from-extinction effects summate and produce larger recovery of extinguished conditioned responses than either manipulation alone. We used this relapse model in Experiment 2 and showed that the combination of massive extinction and extinction in multiple contexts greatly attenuated recovery from extinction more than either recovery-attenuating treatment alone. These results are congruent with related observations by Rosas and Bouton (1998) and Thomas, Vurbic, and Kovac (2009).

**An inverted-U function relating stimulus control to footshock intensity**

*Cody W. Polack, James E. Witnauer, & Ralph R. Miller (SUNY Binghamton)*

4 7:35 PM The purpose of the present experiments was twofold. First, we sought to document that suppression in fear-conditioning is an inverted-U function of footshock intensity as suggested in cross-publication comparisons of prior research. Second, we tested the sometimes competing retrieval (SOCR; Stout & Miller, 2007) model's predictions concerning the effect of US intensity on conditioned suppression and the role of the context in determining the relationship between US intensity and suppression. Experiment 1 measured suppression after training with either 0.3-, 0.8-, 1.3-, or 1.8-mA footshocks. The results demonstrated that responding after training with the most intense shock was less than with moderate intensity shock. Experiment 2 replicated the critical result of Experiment 1, demonstrating that high intensity footshocks produce less suppression than moderate footshocks. Compound conditioning attenuated suppression following the moderate footshock, but not high intensity footshocks. Additionally, posttraining extinction of the context improved responding in the high intensity footshock condition. SOCR's account depends on the context acquiring associative strength more rapidly with a high intensity US. Extinguishing the associative status of the context reduces the context's role as a comparator. During compound conditioning, the overshadowing cue acts as a second-order comparator which counteracts the context, attenuating its influence on suppression.

**Acquisition-extinction interval determines the time course of spontaneous recovery of conditioned fear**

*Justin S. Johnson & Martha Escobar (Auburn University)*

5 7:42 PM Previous research has indicated that the long-term efficacy of extinction of conditioned fear is affected by the acquisition-to-extinction interval. However, the relative benefit of immediate vs. delayed extinction has been inconsistently reported in the literature, with some reports suggesting that immediate extinction is more resistant to spontaneous recovery than delayed extinction and other reports suggesting the opposite. An analysis of the variables that differ among these reports suggested that the recovery functions for immediate and delayed extinction may vary. Rat subjects received either immediate (10 min post-acquisition) or delayed (24 hr post-acquisition) extinction, and were assessed for spontaneous recovery either 1 or 7 days after extinction (acquisition controls received a dummy

stimulus during extinction). Regardless of acquisition-extinction delay, extinction proceeded to comparable levels for all groups. Although all groups exhibited spontaneous recovery, extinction appeared to be more effective in the delayed than the immediate condition if the test was conducted 1 day post-extinction. However, extinction appeared to be more effective in the immediate than the delayed condition if the test was conducted 7 days post-extinction. These results reconcile the seemingly inconsistent previous reports and suggest that acquisition-extinction intervals may determine the time course of spontaneous recovery.

7:54 PM **Canine Cognition (Chair - Bill Roberts)**

**Functional Analysis: An old method with a new purpose.**

*Nicole R. Dorey, Monique A.R. Udell & Clive D.L. Wynne (University of Florida)*

6 7:54 PM Behavioral problems in dogs account for more than one third of the reasons given for relinquishing them to shelters and have been labeled a significant animal welfare issue. A successful method to manage these problems demands an understanding of the mechanisms that control these behaviors. However, for some of the most commonly cited behavioral problems, like jumping up on people, available treatments are not prescribed after a systematic assessment of environmental contingencies. The current study assesses the use of a functional analysis, which traditionally has been used with problem behavior in humans, to determine the controlling variables in dogs that jump up on people. The results show that this methodology is accurate in determining the maintaining variables for a particular individual, leading to more effective treatment.

**Object Permanence in Dogs and Wolves**

*Sylvain Fiset (Université de Moncton in Edmundston)*

7 8:08 PM In this study, five grey wolves were compared with nineteen domestic dogs to determine whether they were able to infer the position of prey and/or social partners that continue to move when out of sight. Unlike previous works in which animals were required to sit-and-stay during the manipulations, the displacement of the object was performed while the animal was moving, mimicking the natural conditions under which tracking of disappearing objects usually take place. The results revealed that wolves and dogs are unable to mentally represent invisible displacement of objects. This study suggests that wolves' and dogs' cognitive limitations to track disappearing objects emerged from a common ancestor and are possibly exhibited by all other canids.

**Do all dogs follow points? What pound dogs can teach us about human-canine interaction**

*Monique A. R. Udell, Nicole R. Dorey & Clive D. L. Wynne (University of Florida)*

8 8:22 PM Pet dogs living in human homes far outnumber other populations of domestic dog (*Canis familiaris*) in studies of social cognition. While almost all claims about the species' social skills are based on data from this demographic, world-wide pet dogs living in human homes make up only a small minority of the population. Unfortunately environmental and experiential factors have often been overlooked in the design and interpretation of studies on canine cognition. In our current study we tested 22 shelter dogs in an object-choice task utilizing a momentary distal point. Only two subjects were spontaneously successful on the task, bringing into question domestic dogs' universal and spontaneous sensitivity to human stimuli. With only a small amount of additional experience, however, 14 of the remaining 20 dogs were able to learn to follow the difficult point at above chance levels. Naïve shelter dogs were able to follow an easier human point if given the opportunity to do so. Looking beyond the pet population can begin to bring environmental factors into focus and may provide us with opportunities to study the acquisition of a behavioral response taken for granted in enriched home environments.

**Taking the "self" out of self control: What dogs can teach us about inhibiting behavior.**

*Holly Miller, Kristina F. Pattison, Rebecca Rayburn-Reeves, C. Nathan DeWall, Thomas Zentall (University of Kentucky)*

9 8:29 PM Self-control constitutes a fundamental aspect of human nature. Yet there is reason to believe that human and non-human self-control processes rely on the same biological mechanism—the availability of glucose in the bloodstream. Two experiments tested this hypothesis by examining the effect of available blood glucose on the ability of dogs to exert self control. Experiment 1 showed that dogs that were required to exert self-control on an initial task, compared to those that were not required to exert self-control, persisted for a shorter time on a subsequent unsolvable task. Experiment 2 demonstrated that providing dogs with a boost of glucose eliminated the negative consequences of prior self-control exertion on persistence, as it appears to do for humans. These findings provide the first evidence that self-control relies on the same limited energy resource among humans and non-humans, with broad implications for the study of self-control processes in human and non-human species.

**The shape of things to come? Sorting strategies in the domestic dog**

*Catriona M. E. Ryan, Joanne Gilbert, & Stephen E. G. Lea (University of Exeter, UK)*

10 8:36 PM Four dogs were trained in a discrimination task where the discriminanda differed in three perfectly correlated dimensions, consisting of a blue star with a spotty surface pattern and an orange circle with a hash pattern. Three of the dogs successfully learned this discrimination and were then tested with probe stimuli in which one of the three stimulus dimensions (colour, shape or pattern) had been reversed while the others remained the same as in training. All three dogs had a strong tendency to respond to transfer stimuli in accordance with the shape dimension, with colour exerting a much smaller influence and texture none. This is in sharp contrast to other species tested with these stimuli (humans, grey squirrels, pigeons and Vasa parrots), all of which were most strongly controlled by the colour dimension. The implications of these findings are discussed.

8:48 PM **Communication, Auditory Discrimination, and Social Learning (Chair - Suzanne MacDonald)**

### Patterns in Sequences of Dolphin Vocalizations

Joshua T. Abbott (Darwin College, University of Cambridge), Heidi E. Harley (New College of Florida; The Seas, Epcot®, Walt Disney World® Resorts), Jenna Clark (New College of Florida), & Wendi Fellner (The Seas, Epcot®, Walt Disney World® Resorts)

- 11 8:48 PM Bottlenose dolphins (*Tursiops truncatus*) vocalize frequently and produce a wide variety of sounds. To date, very few studies have addressed all the categories of dolphin vocalizations within a single analysis or the sequences in which they are produced. We used a multi-hydrophone array to record vocalizations produced by 4 male dolphins interacting in the interconnected pools at Disney's The Seas. Vocalizations were categorized by type (whistles, burst pulses, echolocation click trains). The whistle category was further sub-divided using frequency contour. Another subcategory included simultaneously produced broadband and narrowband sounds. Vocalizations were also labeled by producer when possible. We analyzed sequences of vocalizations using multiple measures including occurrence of vocalizations by category and transitional probabilities (via Markov chain analysis) of pairs of vocalizations. Click trains occurred most frequently; burst pulses occurred least frequently. The most commonly produced whistles were very short (< 150 ms). Sequences of broadly categorized vocalizations appeared to be randomly structured, but inclusion of more fine-tuned information (subcategories) revealed patterns. Sequences began and ended with a well-defined set of vocalizations, and successive vocalizations were strongly correlated. Dolphin vocal sequences have structure.

### Black-capped Chickadee Dominance Signalled in Song

Christopher B. Sturdy, Marisa Hoeschele, Michele K. Moscicki (University of Alberta), Ken A. Otter, Harry van Oort, Kevin T. Fort (University of Northern British Columbia), Tara M. Farrell, Homan Lee, & Scott W.J. Robson (University of Alberta)

- 12 9:02 PM Males of many songbird species use acoustic ornaments (i.e., songs) to attract and retain females (i.e., mates). Similarly, females select males based on song characteristics (e.g., song complexity or dominance status). Bioacoustic analyses of male black-capped chickadee two note fee bee songs reveal a potential acoustic mechanism signaling male dominance status, with the relative amplitude of the two song notes more consistent in dominant males. Using laboratory playback of male fee bee song to female black-capped chickadees we show that females respond differentially to dominant and subordinate song exemplars such that females vocalize and are more active during dominant song playback. Taken together, this set of studies points to an acoustic cue other than a pitch-related cue that indicates dominance status of the singer and that status, as signaled by this acoustic ornament, can be perceived by females.

### Word-Object Recognition in Psittacines: Associating Spoken Words with Three Dimensional Physical Referents

Stephanie E. Jett & Joan M. Sinnott (University of South Alabama)

- 13 9:16 PM This study explored comprehension – the neglected aspect of communication - in four members of the Parrot (Psittacine) order. We used a modified two-alternative, forced choice identification task in which ten vocabulary words representing 3D animal figures were paired, creating five original pairs. In Phase I, the same two visual stimuli were always presented within a session with one (the S+) being paired with an auditory stimulus (label). The bird responded by orienting to either a left or right foot marker based on the position of the S+ at the sound of the label. After mastery of the original five pairs, in Phase II, the birds were tested on novel pairings of the original ten vocabulary words. Phase III utilized the same basic procedure but the S+ varied between trials. Preliminary analyses indicate that the subjects acquired all ten vocabulary words as measured by above chance performance in Phase II, and there do not appear to be significant differences between species.

### Micro-whistles: An overlooked category of vocalizations in Atlantic bottlenose dolphins (*Tursiops truncatus*)

Wendi Fellner (The Seas, Epcot®, Walt Disney World® Resorts), Jenna Clark (New College of Florida), Joshua T. Abbott (Darwin College, Cambridge University) & Heidi E. Harley (New College of Florida & The Seas, Epcot®, Walt Disney World® Resorts)

- 14 9:23 PM Dolphins produce a variety of whistles, including some very short whistles (< 150 ms) which are ignored in most analyses of the dolphin's vocal repertoire. However, dolphins possess a sophisticated auditory processing system that they can use to detect very small differences in frequency, amplitude, and time. For example, their auditory integration time is about 300 μsec compared to 7,000-10,000 μsec in humans. Therefore, short whistles are likely salient to dolphins. In the current study, we used a multi-hydrophone array to record the vocalizations of 4 male dolphins interacting in a variety of contexts. Whistles were categorized by frequency contour, changes in frequency over time. We also identified whistles that were less than 150 ms in duration, i.e., micro-whistles. Of the 859 whistles in our sample, 35% were micro-whistles. There were 14 regularly occurring frequency contours, 11 of which were represented in the micro-whistle category. Whistles of short duration are an important component of the dolphin repertoire.

### Chord perception by songbirds and humans

Marisa Hoeschele, Lauren M. Guillette (University of Alberta), Daniel R. Brooks (University of Iowa), Robert Cook (Tufts University), & Christopher B. Sturdy (University of Alberta)

- 15 9:30 PM Human perception of music appears to be related both to musical experience and fundamental physical properties of sound. We replicated a study with pigeons (Brooks & Cook 2009) using both humans and black-capped chickadees as subjects to compare the way in which they perceive consonance in triad chords where all notes are played simultaneously. We found that the three species (pigeons, Brooks & Cook; humans and chickadees, current study) appeared to respond similarly to the chords overall, but showed differences in the ability to transfer to the same chords with a new root (i.e., played in a new key). We are currently investigating whether the species use similar or different mechanisms in order to process these stimuli, such as a stronger reliance on absolute or relative pitch, a commonly reported difference between humans and avian species.

16	9:37 PM	<p><b>The Role of Memory in Sequential Auditory Same/Different Discrimination Processing in Pigeons (<i>Columba livia</i>)</b>  <i>Murphy, M. S., &amp; Cook, R. G. (Tufts University)</i></p> <p>Pigeons are sensitive to the degree of variability in a sequential auditory display. We conducted further testing to help determine if pecking behavior is controlled by the number of items accessible to memory. Pigeon (n=4) were trained in a go/no-go sequential auditory same/different task and tested with mixed sequences composed of a group of same notes followed by different notes, or vice versa. Data indicate that a memory window is not sufficient to account for response behavior, and an accumulator mechanism may aid memory.</p>
17	9:44 PM	<p><b>Spontaneous point following behavior of Megachiropteran bats</b>  <i>Nathaniel J. Hall, Monique A.R. Udell, Nicole R. Dorey, Allyson L. Walsh, Clive D.L. Wynne (University of Florida)</i></p> <p>Spontaneous point following behavior is generally considered an important marker of social cognitive development in human infants. Recently, domestic dogs have shown to be highly successful in similar tasks involving the following of a human point to a target location. The domestication hypothesis, which proposes that enhanced social cognitive skills have been selected for during domestication, endowing domesticated species with the ability to follow human points, is often used to explain dogs' sensitivity to human gestures. To test if domestication is a necessary component for spontaneous point following, we tested a suborder of non-domesticated social species, five untrained Megachiropteran bats, for the ability to follow human points. We show that three bats were highly successful in following an unfamiliar human's point to a target location. In addition, bats born in captivity were more successful than those introduced to captivity as adults. Thus, domestication is not a requirement for the ability to follow an unfamiliar human's point. Human experience and a phylogenetic proclivity for social interaction may be better predictors of spontaneous point following than domestication. We hope Megachiropteran bats will be better represented in future studies of animal cognition.</p>
18	9:51 PM	<p><b>An investigation of cognitive abilities of the Glaucous-winged Gull in their natural habitat: observational learning</b>  <i>Tanya Obozova, Anna Smirnova, &amp; Zoya Zorina (Lomonosov Moscow State University)</i></p> <p>An experimental approach to investigate some cognitive abilities of the Glaucous-winged Gull in their natural habitat has been developed. Some pilot experiments were carried out in a gull breeding colony on Toporkov Island (the Commander Islands Nature Reserve, Russia). In particular, an experiment with 26 gulls showed that the birds can acquire behavior by observing other conspecifics. Untrained gulls (observers) watched conditioned gulls (demonstrators) performance of two tasks which are not within the range of their natural capacities. Six demonstrators were trained to obtain a food placed into an opaque box. 15 – 41 trials were necessary for them to learn the task. 13 from 14 observers started to obtain a food from the box in the first 3 trials. Other two demonstrators were trained to choose one of four boxes that were differed only in color. 12 – 15 trials were necessary for them to reach a criteria. 3 from 4 observers performed the task correctly in the first trial. These results suggest that observational learning is one of possible ways to transfer skills from one to other individual in a gull colony.</p>
19	9:58 PM	<p><b>Pinyon jays exhibit consistent caching behaviors over time and across situations</b>  <i>Christine Keeffe &amp; Alan Kamil (University of Nebraska)</i></p> <p>Spatial cognition in food hoarding species has been well studied, but much less is known about the effect of social experience on food hoarding behaviours. Previous studies of caching birds, including corvids and parids (Order Passeriformes), have shown that individuals often alter caching behaviour when conspecifics are present which effectively decreases cache pilferage. To evaluate the generality of these findings for highly social birds, we tested pinyon jays (<i>Gymnorhinus cyanocephalus</i>) in an open-room cache-recovery experiment in which they cached either alone or in the presence of an observer. By contrast to findings of studies of other caching animals, pinyon jays did not modify their behaviour as predicted in the presence of an observer. There were, however, consistent individual differences among birds across replications of the experiment and in different social contexts. These findings indicate that behavioral type may influence cache survival and, in turn, could effect fitness in pinyon jays.</p>
Thursday Afternoon		
20	12:00 PM	<p><b>Concept Learning (Chair - Olga Lazareva)</b></p> <p><b>Identity and Category Matching-To-Sample in Pigeons</b>  <i>Edward A. Wasserman, Leyre Castro, &amp; Joe K. Lancaster (The University of Iowa)</i></p> <p>We trained four pigeons on a simultaneous matching-to-sample task with three alternatives in which the correct choice could either be: (a) identical to the sample (identity trials) or (b) nonidentical to the sample, but a member of the same category (category trials). We showed three natural categories: dogs, fish, and flowers, with six exemplars from each. Pigeons learned to match based on both identity and category; learning rate was similar for identity and category trials. Later, we introduced delays of 0, 1, 2, or 4 s between offset of the sample and onset of the choice stimuli; accuracy progressively decreased as the length of the delay was increased, but there was no disparity in accuracy between identity and category trials. Matching two identical items or matching two nonidentical items from the same category seem to be similar for pigeons.</p>
21	12:14 PM	<p><b>Does the 'profound disparity' in analogical reasoning still stand? Analogical humans, apes and paleological monkeys revisited.</b>  <i>Roger Thompson (Franklin &amp; Marshall College), Joel Fagot, (CNRS, Universit�e de Provence), Timothy Flemming (Georgia State University), &amp; Erica Hoy-Kennedy (Frostberg State University)</i></p> <p>Thompson &amp; Oden (2000) argued that monkeys are paleo-logicians whose concepts are based on absolute and relational features bound by perceptual and/or associative similarity. Symbol trained apes, on the other hand, like humans, are analogical in the sense that they perceive abstract analogical similarities spontaneously and that symbol</p>

systems provide the representational scaffolding for explicit judgments of analogical identity in Relational Matching-to-Sample (RMTS) tasks. Does this 'Profound Disparity' (Premack, 1983) still stand? Maybe, then again, maybe not in light of recent evidence presented here for nonsymbolic scaffolding effects on the RMTS performances of capuchins monkeys (*C. apella*) rhesus macaques (*M. mulatta*) and baboons (*P. papio*).

#### **The effect of category structure on pigeons' category discrimination**

*Stephen E. G. Lea, Andy J. Wills, Lisa A. Leaver, Catriona M. E. Ryan (University of Exeter) & Emmanuel M. Pothos (Swansea University)*

22 12:28 PM Pigeons learned conditional discriminations between circles that differed in both hue and diameter. Three different stimuli signalled reinforcement to the left and three signalled reinforcement to the right. Two training conditions differed in the way the positive and negative stimulus sets were arranged in the 2-dimensional space defined by hue and diameter values. The distances between stimuli (effectively, inter-stimulus similarities) within each set were identical in the two conditions, but the distances between stimuli in different sets were greater in one condition ("high simplicity") than the other ("low simplicity"). However if the space was collapsed to a single dimension, the inter-set distances were identical in both conditions. Thus if the pigeons' behaviour was controlled by both dimensions, the high-simplicity condition should give faster learning than the low-simplicity condition, but if it was only controlled by a single dimension, learning rates under the two conditions should be identical. Learning rates did not differ between conditions, suggesting unidimensional control over behaviour. However data on transfer to novel combinations of hue and diameter showed that the pigeons had come under the control of both stimulus dimensions. We conclude that stimulus similarity, however defined, may act in different ways under training and generalization conditions.

#### **Action Category Discrimination by Pigeons**

*Yael Klein & Robert G. Cook (Tufts University)*

23 12:42 PM Detecting the behaviors and intentions of other animals is an important skill for pigeons. While noun category discriminations have been well established in pigeons, verb categories have received less attention. We trained four pigeons to discriminate digitally rendered videos of walking and running animals. This discrimination was easily acquired and transferred to novel representations of walking and running in a variety of animals, camera angles, and orientations. The results support the possibility that pigeons can form action categories. The relevance of speed of motion will be discussed.

#### **Matching Emotion and Activity Categories: Testing Social versus Physical Reasoning in a Chimpanzee**

*Tamra Beckman, Alex Biondillo & Jennifer Vonk (University of Southern Mississippi)*

24 12:49 PM An adult male chimpanzee was tested in a match to sample (MTS) paradigm in which he was required to match images based on whether the individual depicted was either a) displaying the same emotion as the individual in the sample or b) engaged in the same physical activity as the individual in the sample. Four different emotion and activity categories were used in each test. The experiment was designed to differentiate between reasoning about an element of the social or mental environment (emotions) versus an element of the physical environment (activities). After twenty 12-trial sessions of each type of task, with images involving humans, the chimpanzee did not perform above chance on either the social or physical MTS tests, and did not perform differentially between the two tests. Testing on chimpanzee-specific images is currently underway.

#### **First Order Relational Matching in Chimpanzees (*Pan troglodytes*)**

*Jennifer Vonk (University of Southern Mississippi)*

25 12:56 PM Two adult male chimpanzees were presented with a match-to-sample task on a touch-screen computer in which they were required to match images based on whether they were the same shape or color as the sample. Each session consisted of 18 trials, nine color-match and nine shape-match trials, in random order. The stimuli were three different geometric shapes in three different colors each. Incorrect comparison images did not match the sample on either color or shape. Criterion was set at 83.33% correct for four consecutive sessions, which neither chimpanzee achieved in over 175 sessions. This result is in contrast to Vonk (2003) in which four orangutans and one gorilla performed above chance on a first and second order relational matching task in fewer than twenty sessions. However, the result is consistent with other research showing that relational matching with only two items in the stimulus array is extremely difficult for non-humans. The results indicate that both chimpanzees found it easier to match based on color than shape. Overall, they performed at about 70% accuracy on color match trials, and at chance on shape match trials, suggesting that they used a perceptual process rather than matching based on relations.

#### **1:08 PM Discrimination Learning and Perception (Chair - David Stahlman)**

#### **The effect of reward magnitude and delay to reinforcement on behavioral variability**

*W. David Stahlman & Aaron P. Blaisdell (UCLA)*

26 1:08 PM Recent studies have demonstrated that the expectation of reward delivery has a negative relationship with operant behavioral variability (Gharib, Gade, & Roberts, 2004; Stahlman, Roberts, & Blaisdell, in press). Research thus far has been narrowly focused on one aspect of reinforcement – namely, the likelihood of food delivery. In two experiments with pigeons, we examined the effect of two other aspects of reinforcement: the magnitude of the reward and the temporal delay between trial termination (determined by the operant peck response) and outcome delivery. In the first experiment, we found that a large reward magnitude resulted in reduced spatiotemporal variability in pigeons' pecking behavior. In the second experiment, we found that a 4-s delay between trial termination and reward delivery increased operant variability. Importantly, each of these factors significantly interacted with reward probability, such that magnitude and delay manipulations were only effective in modulating behavior at certain levels of reward probability. These results suggest that a central construct is mediating behavioral variability.

**Use of stimulus relations to solve a visual discrimination task by Eastern box turtles (*Terrapene carolina*)**

*Katherine A. Leighty, Margaret A. Maloney, Victoria L. Pittman-Courte, & Tammie Bettinger (Animal Programs and Environmental Initiatives, Disney's Animal Kingdom)*

- 27 1:22 PM Little is known of the cognitive and perceptual abilities of chelonians (and of reptiles in general). We trained two Eastern box turtles on a simple two-choice discrimination task using black, white, and medium gray paddles. One turtle was initially trained to select the lighter choice and the opposite was true for the second turtle. On subsequent non-reinforced probe trials with added choices of a light gray and dark gray paddle, the turtles demonstrated responding in accordance with lighter/darker relations. Subjects then generalized knowledge of this relationship to an array of blue paddles. Results demonstrate that turtles can utilize stimulus relations in addition to stimulus value to guide their actions.

**Acquired Equivalence Between Stimuli Trained in the Same Context**

*Mikael Molet (University of Lille, North of France) Holly C. Miller, Jennifer R. Laude, & Thomas R. Zentall (University of Kentucky)*

- 28 1:36 PM We investigated the role of the context in human and pigeon acquired equivalence. Both species were trained on four conditional relations in two different conditional discriminations. In both conditional discriminations each of two conditional relations was trained in one of two different colored background contexts. On test trials, when conditional stimuli from the two conditional discriminations were interchanged and presented in a neutral context, positive transfer resulted. Thus, stimuli that have shared a common context at different times can come to be treated as equivalent.

**Cognitive Processes Mediate Representation of Absent Events in Rats**

*Cynthia D. Fast & Aaron P. Blaisdell (UCLA)*

- 29 1:50 PM We investigated the role of prior learning on discriminations involving ambiguous situations. We previously found in a Negative-Patterning discrimination (A+, B+, AB-) with visual stimuli, that covering one light (B) at test caused a difficulty in the subjects determining whether each trial on which A was presented was an elemental or compound trial. Covering B's light failed to significantly affect responding to A on a Positive-Patterning discrimination (A-, B-, AB+), however. We tested the hypothesis that the non-linear solution to Negative Patterning engaged representational processing capacities necessary for representing absent events, but that these processes were not engaged by the linear solution to Positive Patterning discrimination. Rats were trained concurrently on both Positive and Negative Patterning discriminations (with different stimuli). In contrast to our prior findings, rats tested on A in the Positive Patterning discrimination DID show sensitivity to covering B's light at test, thereby supporting our hypothesis. These results have interesting implications for representational processes engaged in problem solving.

**Effect of position of discriminative stimuli on discrimination learning in pigeons**

*Olga Lazareva, Jeremy Goh, & Joyce Yuen (Drake University)*

- 30 1:57 PM Earlier, we have demonstrated that pigeons show robust relational learning after multiple-pair transposition training (Lazareva, Young, & Wasserman, 2005; Lazareva, Miner, Young, & Wasserman, 2008). These experiments, however, displayed discriminative stimuli in the same two locations providing an opportunity for the pigeons to employ a lower-level, perceptual strategy instead of learning the relation among the stimuli. In the present experiment, we used a 3 x 3 array of locations to display the discriminative stimuli. We first trained pigeons to discriminate two pairs of circles displayed horizontally: 1+ 2- and 2+ 3- or 1- 2+ and 2- 3+ (digits denote circle diameters and plus and minus signs denote reward and nonreward, respectively). Then, the pigeons were given the same pairs in diagonal and vertical orientations and any choice was nondifferentially reinforced. Pigeons were selecting the correct stimulus in novel orientation significantly above chance, indicating no reliance on alternative, perceptual strategy.

**Pigeons Discriminate Angle Size**

*James F. Reichert and Debbie M. Kelly (University of Saskatchewan)*

- 31 2:04 PM In a forced choice discrimination task, pigeons searched for a food reward hidden in front of one of two wooden objects located inside an experimental room. Each object consisted of two identical pieces of wood joined together with a hinge so that the pieces could expand or contract to form an angle of varying degrees. Pigeons were divided into groups based on the size of their training angle: group 60° or group 120°. During training the pigeons were rewarded for searching at their trained angle (S+) and avoiding searching at the unrewarded angle (S-). During non-reinforced testing, the pigeons were presented with their trained angle and a transformed angle that was either larger or smaller than their trained angle. Choices revealed a trend toward responding to angles beyond the S+ in a direction away from the S-. This effect was stronger for pigeons in group 60° compared to pigeons in group 120°.

**Simultaneous vs successive generalization and transposition by the infant chicken**

*Viktor Sarris & Jeanne Poci (Frankfurt University)*

- 32 2:11 PM In our former studies we investigated the role of absolute versus relative training on the generalization gradients of baby chicks; relational responding was found to be more frequent under relative training, and vice versa (Hauf, Prior & Sarris, 2008). In our present study the successive, instead of the simultaneous, training and generalization-testing procedure (2AFC method) was used with still other groups of infant chicks for 2 different dimensions, size and color, to test the context-dependent performance of this much harder task. The results of this follow-up study will be presented in the light of our former relational psychophysics paradigm.

**Touch, Hearing, and Vision of the Florida Manatee, *Trichechus manatus latirostris***

*Gordon B Bauer (New College of Florida; Mote Marine Laboratory), Joseph C. Gaspard (Mote Marine Laboratory; University of Florida), Deborah E. Colbert (Association of Zoos & Aquariums), Roger L. Reep (University of Florida), David Mann (University of South Florida)*

- 33 2:25 PM Manatees are tactile/auditory specialists with limited visual acuity, a pattern consistent with the frequently turbid underwater environment these herbivores inhabit. Using the vibrissae-rich facial area, manatees demonstrate fine discrimination of texture gratings at levels comparable to human index finger performance. They are exquisitely

sensitive to low frequency vibrotactile stimulation, detecting particle displacement less than a micron within the 15 Hz – 150 Hz range, presumably through hydrodynamic sensation involving the vibrissae that cover their bodies, an arrangement unique among mammals. Anatomical evidence suggests that the vibrissae form a three dimensional array for detecting subtle changes in water movement, analogous to the lateral line of fish. The manatee auditory temporal processing rate is high, exceeding that for humans by a factor of 10, but less than that of dolphins, which are active echolocators. Their hearing extends up to 90.5 kHz, with peak sensitivity from 8 – 32 kHz. They have good ability to hear masked tones in this peak range, which encompasses vocal frequencies potentially relevant to individual recognition. Directional hearing for broadband stimuli is excellent, but localization of tonal sounds is poor. They have dichromatic color vision, unique among marine mammals, but visual acuity is probably no better than 20 arc minutes.

#### **The role of real-life experience on visual processing in the pigeon**

*Anna Wilkinson & Ludwig Huber (University of Vienna)*

34 2:39 PM Humans process faces quite differently from the way they process most other stimuli and rely on the configuration of features for recognition; this results in unusual behavioral effects, such as delayed recognition when a face is inverted. It has been proposed that this is the result of a special facial processing area in the human brain. However, there is evidence to suggest that the effect may be the result of expertise; humans are experts at discriminating faces. To test this, pigeons were trained to be experts in categorizing complex natural images that they did not evolve to discriminate: human faces. Two groups of pigeons were used; one group was housed in a normal aviary set up whilst the other was visually isolated and had no real-life experience of human faces. The pigeons were presented with 24 images of male faces, half of which were positive and half negative (arbitrarily assigned). Both groups of pigeons had difficulty learning the task, but this did not differ on the basis of real-life experience. They were then presented with inverted versions of the trained images. The differences in processing between the face familiar and the face naïve pigeons will be discussed.

#### **Interaction between identity and emotional expression in pigeons' perception of human faces**

*Fabian A. Soto & Edward A. Wasserman (University of Iowa)*

35 2:43 PM The human visual system appears to process the individual identity of faces independently of their emotional expression. One possible explanation for this finding is that identity is processed by an independent, modular perceptual system. A second possibility is that this finding results from general principles of perceptual processing working over stimuli with a specific structure. Studying animals which are not believed to have a specialized perceptual system for discriminating faces may shed particular light on this issue. Here, eight pigeons were trained on a go/no go discrimination involving black-and-white photographs of 4 people displaying 4 different facial emotions. For each pigeon, responding to only one identity-emotion combination was reinforced and responding to all 16 possible combinations was measured. A spatial model of multidimensional generalization was fit to these data in order to analyze the interaction between individual identity and emotional expression in pigeons' perception of human faces. For all pigeons, a Euclidean metric best fit the data, suggesting integral processing of the two dimensions.

#### 3:03 PM **Tool Use & Problem Solving (Chair - Kelly Jaakkola)**

#### **Cognitive cooperation in Asian elephants**

*Joshua M. Plotnik & Frans B.M. de Waal (Living Links, Yerkes Primate Center and Emory University)*

36 3:03 PM Cooperative behavior is expressed through various evolutionary mechanisms in the animal kingdom, but the cognition underlying complex cooperation is not well understood. Studies on non-human primates, including capuchins and chimpanzees, seem to indicate some level of understanding of the need for a partner in cooperative tasks. Here, we demonstrate that Asian elephants (*Elephas maximus*) have a similar understanding. We used a modified apparatus originally designed for use with chimpanzees that consists of a single rope fed through a table that is placed at a distance from the animals. Both rope ends (which, unlike the table, are available to the subjects) must be pulled simultaneously to retrieve the food rewards placed on the table. In our study, elephants not only learned to coordinate their behavior by waiting for the arrival of a partner before pulling, but also learned that both the presence of and action by the partner was necessary to successfully pull in the table. This work suggests that research on elephant behavior may yield further insight into the convergent cognitive evolution of socially complex species.

#### **Chain of Thought?: Problem-solving in Asian Elephants (*Elephas maximus*)**

*Preston Foerder (The Graduate Center of the City University of New York) & Diana Reiss (Hunter College of the City University of New York)*

37 3:10 PM Few studies have investigated elephant problem solving abilities but it has been speculated that they do not demonstrate insightful behavior. Based on an experiment from Wolfgang Köhler's landmark chimpanzee studies, a problem solving task was presented to three elephants at the Smithsonian National Zoological Park, Washington, D.C. A chain anchored at one end was positioned on the floor outside the bars of the elephant's stall with a piece of fruit attached partway up. The chain was placed at an angle so that the elephant could reach the free end through the bars but pulling on it from that position did not move the fruit within reach. To reach the food, the elephant needed to pull and release the chain and reposition itself further down the bars to the newly reachable part of the chain, repeating this pattern until the fruit could be obtained. All three elephants solved the task, two using trial and error. In terms of "insight", the third elephant did not attempt to pull the chain or obtain the food until the third session. In this session, the elephant solved the problem on the first trial, and showed increased efficiency in the task in the following trials

#### **How do capuchins stack up against chimpanzees and humans? Assessing combinatory manipulation in a block stacking task**

*Brian W. Stone, Tephillah Jeyaraj, & Dorothy Fragaszy (University of Georgia)*

38 3:17 PM Combinatory object manipulation, a prerequisite for common forms of tool use, has been assessed in human infants and chimpanzees using a block stacking task (Hayashi 2009). Monkeys have not been tested using this paradigm, yet capuchin monkeys (*Cebus apella*) are a dexterous, tool-using species that frequently combine objects. In this study,

we first demonstrated that with shaping two capuchins could stack four cubic blocks. In the test phase, we manipulated the spatial relations involved in the task by replacing one or two of the cubic blocks with novel asymmetrical blocks (cubes with large bumps on two sides) which could only be stacked in particular orders or orientations. Subjects were given 10 trials per session, one session per day, with an inter-trial interval of approximately 15 seconds, and were non-contingently reinforced in the test phase. Both subjects quickly became proficient in stacking the asymmetrical blocks. Their performance was videotaped and coded to test whether the subjects corrected for the added spatial-relational complexity with planful object rotations and placement order, and to investigate individual differences in strategy. This study sheds light on combinatory manipulation skills in capuchins and allows direct comparison of this species with chimpanzees and humans on the same task.

3:29 PM **Snack Break**

4:19 PM **Geometry, Orientation, Numerosity, & Serial Processes (Chair - Kent Bodily)**

**Influence of age on the use of features and geometry for orientation in the domestic chicken**

*Inga Tiemann & Debbie M. Kelly (University of Saskatchewan)*

39 4:19 PM Orientation is a critical first step of navigation. Studies examining human orientation suggest that development may strongly influence how spatial cues are used for orientation. Studies using adult rats, adult pigeons or young chicks suggest that the integration of geometric and featural information may differ across species. However, differences in developmental stages may also be an important variable. We trained two groups of domestic chickens (*Gallus gallus* f.d.), differing in ages, in a rectangular arena to find food consistently located in one corner. The birds were either trained with distinctive features present at each corner or without distinctive cues requiring them to use only the geometric properties of the arena. Our results suggest that the weighting of cues for reorientation changes across the lifespan. Furthermore, in comparison to previous studies that used a different chicken breed, our results suggest that cue use may differ among chicken breeds.

**Encoding of relative enclosure size in a dynamic three-dimensional virtual environment by humans**

*Debbie M. Kelly (University of Saskatchewan) & Bradley R. Sturz (Armstrong Atlantic State University)*

40 4:33 PM Human participants searched in a dynamic three-dimensional virtual-environment rectangular enclosure for a distinctly colored bin located in one of the four corners. During test trials, all bins were rendered identical in color, and the shape of the rectangular search space either remained the same or was modified to a relatively-sized contracted rectangle, an expanded rectangle, or a square. Participants made one choice response during test trials. In the rectangular enclosures, more of participants' choice responses were allocated to the geometrically correct corners than to the geometrically incorrect corners. In the square enclosure, participants' choice responses were allocated equivalently to each of the four corners. Results replicate previous enclosure size studies demonstrating encoding of enclosure geometry with human and non-human animal subjects conducted in real environments and extend these results to include encoding of relative enclosure geometry.

**How robust is the geometric module? Impact of age and sex on the orientation behaviour of domestic pigeons**

*Mareike Fellmin (Heinrich-Heine University), Inga Tiemann & Debbie M. Kelly (University of Saskatchewan)*

41 4:47 PM Homing pigeons are selected for outstanding relocation abilities. Studies using a rectangular arena have examined the ability of pigeons to encode geometric and featural properties of an environment. Whether geometric information is represented in an orientation-free manner and if these abilities are subject to the individual's ontogeny was examined. We trained young (30 days), mature (3-5 years) and aged (9 years and older) pigeons to locate food at a consistent corner, containing a distinctive feature, within a rectangular arena. After successful training, the features were removed; thus requiring the pigeons to use geometric information exclusively. In one testing condition, the birds used the same entrance points as during training (Geometry Only test), whereas in another testing condition, the birds used a novel entrance point (Geometry Novel Entry test). The results from the Geometry Only test confirm those of previous studies and show that pigeons encode geometric information of the environment across all ages. However, the results from the Geometry Novel Entry test showed a different pattern of choices. The pigeons did not choose the geometrically correct corners significantly more often than the geometrically incorrect corners. Further effects of age and sex will be discussed.

**Wild spotted hyenas show spontaneous numerical assessment when played calls from unfamiliar conspecifics**

*Sarah Benson-Amram, Virginia Heinen and Kay Holekamp (Michigan State University)*

42 4:54 PM The ability to assess numerical advantage should be prevalent among species with intergroup contests. This is especially true for species in fission-fusion societies, which encounter greater numerical imbalances than species with other social systems (Wrangham 1999). Previous playback experiments demonstrated that lions and chimpanzees spontaneously exhibit basic numerical abilities (McComb 1994; Wilson 2001). We hypothesize that spotted hyenas will show comparable abilities as all three species live in fission-fusion societies, demonstrate coalitionary aggression, hunt cooperatively, and have potentially lethal intergroup conflicts (McComb 1994; Wilson 2001; Holekamp 2007). We conducted playback experiments to test whether wild spotted hyenas can spontaneously assess numerical advantage. We played lone hyenas consecutive non-overlapping calls from 1, 2, or 3 unfamiliar conspecifics. We used the long-distance vocalization of spotted hyenas, which contain information on individual identity. Hyenas spent a significantly greater proportion of the playback period oriented to the hidden speaker during the playback of calls from multiple versus a single hyena. Thus far we have found no evidence that spotted hyenas respond differentially to calls of 2 versus 3 unfamiliar conspecifics. The results support our hypothesis that spotted hyenas show comparable abilities to assess numerical advantage as those demonstrated in playbacks with lions and chimpanzees.

**Tests of implicit chaining in Cotton-top tamarins (*Saguinus oedipus*) III**

*Charles Locurto, Meaghan Collins, Maura Conway, Taylor Cormack, Kate Cunningham & Laura Radville (College of the Holy Cross)*

43 5:01 PM

Three experiments examined characteristics of implicit chaining in Cotton-top tamarins when reinforcement was randomly delivered across elements of the chain. The procedure presented tamarins with a five-element chain in which an icon was presented serially on a touchscreen according to a spatial pattern. Tamarins had to touch the icon each time it appeared to advance the chain to the next element, but knowledge of the pattern was not necessary for reinforcement. Across the three experiments, delay to reinforcement for individual elements was varied by manipulating both the inter-stimulus intervals within the chain (ISIs), and the intertrial intervals (ITIs) between successive presentations of the chain. Results indicated that tamarins learned something about the chain even when delay to reinforcement was equated.

#### **Performance of zoo-living chimpanzees and gorillas on a computerized sequencing task**

*Katherine E. Wagner & Stephen R. Ross (Lester E. Fisher Center for the Study and Conservation of Apes, Lincoln Park Zoo)*

44 5:15 PM Multiple primate species have demonstrated a propensity for sequence learning across different contexts. Analyses suggest an understanding of serial order that differs from many tested non-primates along several dimensions. However these reports often exclude acquisition, during which responses may be differently influenced by individual and species traits compared to skilled performance. Furthermore, many tests are limited to a single subject-species – with small sample sizes - introducing facility and methodological differences that challenge the validity of cross-species comparisons. To explore serial acquisition across two ape species, gorillas (n=3) and chimpanzees (n=3) learned to sequence 3, 4, and 5-item progressively-long lists of arbitrary stimuli on a touchscreen computer. Across list length, gorillas exhibited higher performance ( $F(1,944)=149.1$ ,  $p<0.001$ ) and longer response latencies ( $F(1,944)=89.2$ ,  $p<0.001$ ) compared to chimpanzees. However, both chimpanzees and gorillas performed more accurately on longer lists – at the level of the complete sequence ( $F(2,944)=20.1$ ,  $p<0.001$ ) and at each position ( $F(2,1832)=130.56$ ,  $p<0.001$ ). Additionally, both species more accurately selected the correct symbol in the first position, compared to the second ( $F(1,1832)=124.30$ ,  $p<0.001$ ). Within the context of a primate-typical sequencing strategy, these results point to potential species differences in serial order acquisition which may stem from social, attention, and arousal-related differences.

#### 5:34 PM **Causality (Chair - Chris Sturdy)**

##### **Causal learning in rats**

*Ralph R. Miller, Cody W. Polack, & Bridget L. McConnell (SUNY-Binghamton)*

45 5:34 PM Some researchers have argued that humans have a unique ability to learn causal relationships. This is illustrated by our throwing a switch to turn on a light, but not calling the weatherman to ask that it not rain. Thus, behavior differentiates between causal learning and mere signaling of outcomes. Based on this distinction, we assessed the ability of rats to learn causal relationships between paired exogenous stimuli. Graphical surgery techniques were used to determine whether rats learned that one exogenous stimulus ‘caused’ another exogenous stimulus, as evidenced by their manipulation of the candidate cause. First, barpressing was paired with a tone. Then, with the bar absent, the tone was followed by an aversively loud noise. Finally, the bar was returned and the rats were observed to barpress less relative to various control conditions, including those for which the noise was devalued and those for which the tone was extinguished. The behavior of the different groups within and across experiments indicated that the rats viewed the tone as the cause of the noise. Control conditions demonstrated that the tone was not a second-order conditioned stimulus. Thus, rats appear to have a sense of causality that is qualitatively like that of humans.

##### **Causal Reasoning in Rats in an Aversive Preparation**

*Jared Wong & Aaron P. Blaisdell (UCLA)*

46 5:58 PM Blaisdell, Sawa, Leising, and Waldmann (2006) reported evidence of causal reasoning in rats. A Light was established as a common cause of Tone and Food (Tone $\leftarrow$ Light $\rightarrow$ Food) by first giving rats Light $\rightarrow$ Tone pairings in Phase 1 of training, followed by Light $\rightarrow$ Food pairings in Phase 2. During testing, rats that observed the Tone looked for food in the magazine more than rats that intervened on the Tone with a lever press. This suggests that they attributed the intervened-on Tone to their own action rather than the Light, which resulted in discounting of Light and therefore of food. We tested the generality of this effect by replicating the Blaisdell et al. (2006) design using a conditioned-suppression procedure that substituted footshock for food. Thus, Rats received Light $\rightarrow$ Tone pairings in Phase 1, and Light $\rightarrow$ Footshock pairings in Phase 2 of training. Rats that intervened on the Tone at test through a lever press were less fearful of the Tone than were rats that merely observed the Tone at test. This replicates and extends the effect of an intervention on causal reasoning in rats to an aversive paradigm.

##### **Role of pre-sample responses during acquisition of 2-item change detection task**

*John Magnotti (Auburn University), Jacquelyne Rivera, Caitlin Elmore, Anthony Wright, (U Texas Med School-Houston), Jeffrey Katz (Auburn University)*

47 6:05 PM Change detection (CD) is a popular procedure for determining the capacity and nature of human visual working memory (VWM). Experiments in our laboratories have demonstrated the paradigm is viable for studying VWM in nonhumans. In our task, pigeons view a two-item sample array of colored circles, followed by a brief blank interval, and finally a two-item comparison array of colored circles, with one circle changing in color. In order to detect a change, subjects must rely on a comparison with the stored representation of the sample array. During acquisition, we noted observing-like responses to the sample array, which the schedule did not require. Because responses to the comparison array may bias choice responses, the current analysis explores the relationship between these responses during acquisition, using contour plots to show any peck biases. Our results suggest that early in acquisition subjects were biased by sample-peck location, and the reduction of this bias was crucial for acquisition of the CD task. The results also show that the contour plots are a useful mid-acquisition diagnostic and may provide more insight into strategy usage than dependent measures based solely on final-choice responses (e.g., accuracy or response time).

**Poster Session I (8:00 - 10:30)**

8:00 PM **See Poster Abstracts Starting on Page XX**  
**Poster Presenters: Please set up your posters between 7:30 and 8:00**

Friday Afternoon

12:00 PM **Spatial Cognition and Temporal Processing (Chair - Jeff Katz)**

**Keeping an eye on things: A neighbour's spatial location influences arousal in vervet monkeys**

*Petra McDougall (University of Lethbridge)*

Self-directed behaviours (SDB) were used as an indicator of arousal in free-ranging vervet monkeys (*Chlorocebus aethiops*) to determine whether an individual's level of arousal was influenced by their neighbour's spatial location. 468 hours of focal data were collected from 11 free-ranging female vervet monkeys inhabiting the Karoo region of South Africa. Results indicated that a female's rate of SDB when her nearest neighbour was behind her was significantly lower than baseline (i.e. no neighbours within five metres), and this trend held regardless of whether her nearest neighbour was dominant, male or female, or an associate or non-associate. All other conditions (i.e. nearest neighbour in front, or to the left or right) did not differ from each other, nor from the focal individual's baseline rate of SDB. These results are consistent with the hypothesis that female vervet monkeys are aware of neighbours which are out-of-sight (behind them), and that they may only turn their backs on neighbours when the need for social monitoring is low.

48

12:00 PM

**Local and Global Cue Use in Children**

*Amanda Y. Funk, Alexandra D. Twyman, & Nora S. Newcombe (Temple University)*

For many mobile organisms, it is important to be able to remember a goal location, such as a cache of food, or a nesting location. One way of improving accuracy in remembering a goal location is to encode multiple sources of information. The use of multiple cues reduces error, and is also good back-up system, in case a particular cue is no longer available due to changing environmental conditions. Past research with pigeons (*Columba livia*) has asked how the encoding of multiple cues is integrated and organized in spatial memory. Initial studies demonstrated a hierarchy of local and global cues (Spetch & Edwards, 1988). We have extended this research by comparing the performance of pigeons and children. In the current study, children 36-41 months of age were trained to find a goal location in relation to redundant global and local cues. After initial training, probe tests were conducted to determine which cues children encoded, and their relative weighting. Initial data suggests that children, like pigeons in an open-field experiment, weight local cues more heavily than global cues.

49

12:07 PM

**The role of landmark-goal distance on spatial control in pigeons**

*Dennis Garlick, Cynthia D. Fast & Aaron P. Blaisdell (UCLA)*

Pigeons were trained to peck to a grid of dots presented on a touchscreen, with one of these dots being the goal and leading to reward. The screen location of the goal dot varied from trial to trial. Different landmarks signaled the location of the goal as being either near to, at an intermediate distance, or far from the landmark (only one type of landmark appeared on each trial). We found that pigeons showed significantly lower spatial variance when responding to the near location, while spatial variance to the medium and far locations did not differ significantly from each other. This suggests that longer landmark-goal spatial relationships result in less precision in the spatial control of responding. This finding has important implications regarding how spatial information is integrated in spatial maps.

50

12:14 PM

**Latent Learning in Zebrafish (*Danio rerio*)**

*Luis M. Gómez-Laplaza (Universidad de Oviedo) & Robert Gerlai (University of Toronto Mississauga)*

The zebrafish may have utility in the analysis of the biological mechanisms of learning and memory. Although learning and memory have been extensively studied and hundreds of underlying molecular mechanisms have been identified, this number may represent only the fraction of genes involved. Large scale mutagenesis screens thus may have utility. In order for such screens to succeed, appropriate screening paradigms must be developed. The first step in this research is the characterization of learning and memory capabilities of zebrafish and the development of automatable tasks. Here we show that zebrafish are capable of latent learning, i.e. can acquire memory of their environment after being allowed to explore it. Experimental zebrafish that experienced an open left tunnel or an open right tunnel of a maze during the unrewarded exploration phase of the test showed the appropriate side bias during a probe trial when they had to swim to a group of conspecifics (the reward). Given that exploration of the maze does not require the presence of the experimenter and the probe trial, during which the subjects are video-recorded and their memory is tested, is short, we argue that the paradigm has utility in high throughput screening.

51

12:21 PM

**Rats' memory for the standard duration in a duration-comparison procedure.**

*Angelo Santi, Claire Hoover, & Sabrina Simmons (Wilfrid Laurier University)*

Eight rats were trained in a duration-comparison task to press one lever if the comparison duration (c) was 1.2-s shorter than a standard duration (s), and another lever if c was 1.2-s longer than s. The interval between the s and c duration was 1 s. The ten duration pairs used during training controlled for the absolute duration of c and the total duration of an s-c pair. The total duration of an s-c pair was not predictive of the correct choice. Four of the rats exhibited a significantly greater percentage of long responses (i.e., c > s) when the comparison duration was longer than the standard than when it was shorter. On equal duration pair test trials as the interval between s and c was increased from 1 s to 4 s, the number of long responses (i.e., c > s) did not significantly increase. This is the first study to demonstrate that rats can acquire a relational duration discrimination. However, unlike humans and pigeons tested with a similar methodology, rats do not exhibit subjective shortening of the standard duration as the s-c interval is increased.

52

12:35 PM

- Temporal “Extrapolation” by rats in the Peak-Interval Procedure**  
*Matthew S. Matell (Villanova) Matthew Hughes (Villanova) Allison Kurti (Villanova)*  
 We have previously demonstrated that rats trained on a peak-interval procedure with two different modal signals associated with two different durations (e.g., tone = 10s, light = 30s) will peak at the geometric average of these durations when tested with the simultaneous compound (tone+light) in extinction. In the present experiment, we evaluated whether rats would “reverse” this averaging process, or extrapolate, after being trained that one cue (tone or light, counterbalanced) indicated reinforcement availability at 10s while the simultaneous compound indicated reinforcement availability at 20s. Results revealed a modality-duration relationship effect, with robust responding to the untrained light (10s tone-trained group), but weak, temporally variable responding to the untrained tone (10s light-trained group). In the group tested with the light cue, responding peaked at 36s, in an approximately scalar manner (CVs of the peaks did not significantly differ across cues). Remarkably, this time was not significantly different from 35s, the time expected if the rats were extrapolating the appropriate time of reward based upon the compound peak occurring at the geometric mean of the component cues (i.e., long peak time = compound peak time<sup>2</sup>/short peak time). We will also present data resulting from the reverse training condition (long duration and compound trained).
- 53 12:49 PM
- Chimpanzees and orangutans plan for future exchange**  
*Mathias Osvath (Lund University), Tomas Persson (Lund University)*  
 Planning for future, perceptually uncued, events has been studied in great apes in recent years. Most results have been positive, with the exception of one study (Dufour and Sterck, 2008) which suggested that chimpanzees are unable to plan for a future exchange event with a human - a specific item is exchanged for a food reward. Our study suggest that it is premature to conclude that chimpanzees are unable to plan for such events. Moreover it appears that such planning is also within the capacity of the phylogenetically more distant orangutans. Our study relied on a set up where the subject had the opportunity to select one item among four; only one item being the exchangeable (established in prior training). After a delay an experimenter, different from the one in the selection procedure, conducted the exchange. We conclude that the exchange act itself might be non-trivial to an ape, and that prior extensive experience with such events might be necessary for them to succeed. The results also support the idea that great apes can plan for social acts.
- 54 1:03 PM
- 1:13 PM **Cognitive Processes I (Chair - Jonathon Crystal)**
- Modulation of decision-making by affective state**  
*Michael Mendl & Elizabeth Paul (University of Bristol)*  
 The interface between cognition and emotion has been extensively studied in humans but much less so in non-human animals. A robust finding is that background affective state influences attention, memory and decision-making. For example, people in negative states attend to threats, retrieve negative memories, and make negative judgements about ambiguous stimuli more than happier people. We have developed a novel paradigm to investigate whether such affect-induced ‘cognitive biases’ also occur in animals. Animals are trained that one cue predicts a positive event and another cue predicts a less positive / negative event, and are then presented with ambiguous (intermediate) cues. The hypothesis is that animals in a negative affective state will be more likely to respond to these ambiguous cues as if they predict the negative event (a ‘pessimistic’ response) than animals in a more positive state. Recent experimental studies on a range of species (rats, dogs, monkeys, starlings, sheep) provide face-value support for this hypothesis. The approach allows us to start investigating the role that affect may play in guiding animal decisions. It also allows us to use objective measures of cognitive performance as indicators of the more elusive and less easily measured affective states that influence them.
- 55 1:13 PM
- The voodoo bucket: Dolphins’ consistent but unexplained response pattern in a spatial cognition task**  
*Kelly Jaakkola, Emily Guarino, Mandy Rodriguez, & Linda Erb (Dolphin Research Center)*  
 Over several studies, we trained and tested 4 dolphins on multiple versions of a find-the-object task. Across all versions, an object was hidden in one of three containers while the dolphin watched, and the dolphin was asked to select the container that held the object. Although the dolphins performed well on most versions of this task (with the exception of invisible displacement versions; Jaakkola et al., in press), all of them evidenced a peculiar response pattern when certain changes were introduced (e.g., when lids were put on the containers, when the hiding trajectory was changed, or when the interval between hiding and response was increased). This pattern (“the voodoo bucket”) was characterized by a high level of correct responding coupled with complete avoidance of a particular container. Notably, dolphins varied on which particular container they avoided, and which changes triggered this response pattern.
- 56 1:27 PM
- Mental rotation in a dolphin?**  
*Stan Kuczaj (University of Southern Mississippi), Adam Pack (University of Hawaii - Hilo), Lou Herman (University of Hawaii)*  
 Previous work using a match-to-sample paradigm has demonstrated that dolphins can discriminate and recognize two-dimensional designs as well as three-dimensional objects. In the present study, we asked a dolphin to match a 2-D shape to one of two alternatives, with the alternatives being unrotated, rotated 90°, or rotated 180°. The dolphin was able to correctly choose the correct alternative in all conditions, although rotated alternatives did result in fewer correct choices. Although it is possible that the dolphin’s performance resulted from some form of stimulus generalization, her pattern of responding is consistent with the notion that she used mental rotation when faced with rotated alternatives.
- 57 1:41 PM
- Environmental Effects on Great Ape Cognition**  
*Heidi Lyn (Agnes Scott College), Jamie L. Russell, Jennifer Schaeffer (Yerkes National Primate Research Center), and William D. Hopkins (Agnes Scott College and Yerkes National Primate Research Center)*
- 58 1:55 PM

While many researchers look at cognitive and behavioral differences between species, diverse experiences also can produce differential abilities, even within the same species. We recently showed that apes with enriched socio-communicative environments out-performed those with standard rearing in an object-choice task (Lyn, Russell, and Hopkins, in press). Here we explore the differences between cognitive, communicative, and behavioral abilities in bonobos and chimpanzees from distinct rearing environments. All of the apes were tested on a series of tasks, modeled after the tasks in Hermann et al, 2007, to test their understanding of the physical world, tool use, social cognition, and communication. Results suggest that apes reared in an enriched environment perform significantly better on communicative tasks and quantitative tasks, but not on tasks that measure their understanding of the physical world or on tasks that measure social cognition. These results suggest that apes' numerical and communicative abilities may be more subject to environmental adaptation than other cognitive processes. From an evolutionary perspective, these findings may reinforce the idea that language and mathematical abilities in humans are more socially supported than other cognitive processes.

**Will chimpanzees delay gratification by accepting tokens in lieu of rewards?**

*Theodore A. Evans, Michael J. Beran (Language Research Center, Georgia State University), & Daniel Hoyle (Department of Biology, Georgia State University)*

Tokens inherently introduce an element of delay between behavior and reward. For this reason, token studies may help us understand how animals process delays and anticipate future events. In this light, we presented 4 chimpanzees with choices between visible food items that were immediately available for consumption and tokens that could be later exchanged for food items on a one-to-one basis. In one test in which chimpanzees were allowed to exchange tokens for rewards after each choice trial, they were willing to choose tokens over food items when there were more tokens than visible rewards, and given that delay to reward was equated across response options. However, when chimpanzees were presented with repeated choices between two different token amounts and were allowed to exchange tokens for rewards only once at the end of each session, they quickly learned to collect at least a moderate number of tokens before ending the session and exchanging the tokens. Therefore, chimpanzees were willing to delay gratification by selecting and holding tokens, but only when no visible food items could be selected and immediately consumed.

59 2:09 PM

2:21 PM **Memory (Chair - Jennifer Vonk)**

**Episodic memory in human toddlers tested on a what-where-context task**

*Frances Balcomb, Nora S. Newcombe, Katrina Ferrara, & Amanda Y. Funk (Temple University)*

The developmental origins of episodic memory (EM) are poorly understood. Children don't show compelling evidence of EM until 2-3 years, although in infancy they show complex, but arguably semantic, declarative memory. In humans, EM is typically tested verbally. In non-human animals, EM has been explored by testing memory for combinations of bound associations, e.g. what-where-when, or what-where-context. In two experiments adapted from animal work (Eacott and Norman, 2004) children's ability to remember bound associations (what-where-context) was tested at 16-24 months. Children learned that a toy was hidden in one of four containers in two different rooms, each room containing the same containers but varying in contextual cues including features and spatial configuration. Although the containers in both rooms were the same, the toy was hidden in a different container per room, requiring children to remember the unique context to find the toy. After 1 familiarization trial per room, children's recall for the toy's location was tested in each room. Data from both experiments suggest that the ability to make bound contextual associations emerges at about 20 months, but only when children are provided with explicit (Exp 1) vs. indirect (Exp 2) recall cues.

60 2:21 PM

**Rapid Change-Detection Learning**

*Anthony Wright (U Texas Med School-Houston), John Magnotti (Auburn University), Almut Carolus (U Texas Med School-Houston), Jacquelyne Rivera (U Texas Med School-Houston), Sarah Baum (U Texas Med School-Houston), Caitlin Elmore (U Texas Med School-Houston), Jeffrey Katz (Auburn University)*

Pigeons were trained to observe, but not respond to object pictures in a sample array. They readily learned to choose the changed object in a test array. They learned change-detection in a fraction (1/10) of the time, performed at a substantially higher accuracy, and transferred considerably better to new objects than pigeons not trained to withhold responding to sample objects.

61 2:35 PM

**Array Location Stability and Object Variability Affect Rats' Working Memory for Missing Object**

*Marium Arain, Jouseph Barkho, Jerome Cohen (University of Windsor)*

We report a series of experiments in which rats have to remember a missing object from an array of objects arranged in a square (four objects) or a rectangle (six objects) in a foraging chamber. Various types of information rats might use to retain the missing object are investigated by systematically manipulating array locations and within-array object positions. We report that rats' accuracy for finding the missing object is greater when array location and object positions are maintained than when either is varied between 'study' and 'test' segments of a trial. Varying the orientation of the rectangular array has a greater disruptive effect when the array consists of identical than different objects.

62 2:49 PM

**Rats retrieve episodic memory when their memory is probed**

*Wenyi Zhou & Jonathon D. Crystal (University of Georgia)*

The objective was to document that rats retrieve episodic memories when their memory is probed. Rats encountered chocolate at one and chow at three randomly selected radial-maze arms in a daily study phase. After a 2-minute retention interval, all doors were opened and chow was available at previously inaccessible locations. The replenishment of chocolate (at its study-phase location) depended on two factors: time of day (morning vs. afternoon) and the presence or absence of chocolate pellets in the central hub at the start of the test phase. Because replenishment could not be decoded until the test phase, rats could not use differential encoding at study to solve the

63 3:03 PM

task. Instead, to predict chocolate replenishment, the rats had to retrieve a memory about the study episode at the time of test. The rats revisited the chocolate location more in replenishment than non-replenishment conditions, which documents episodic-memory retrieval. Next, we transferred the rats to an unfamiliar time of test while maintaining the familiar time of study and observed immediate transfer, which documents memory of when the study episode occurred. We conclude that rats retrieved episodic memories of the study episode when their memory was probed.

#### **Delayed alternation by California sea lions with naturally occurring hippocampal damage**

*Peter Cook & Colleen Reichmuth (University of California Santa Cruz)*

64 3:10 PM The hippocampus is essential for memory function. Its exact role, however, and those of the surrounding medial temporal brain areas, has not been determined in humans or animals. New research suggests that the hippocampus may support explicit recollection and the surrounding brain areas a feeling of familiarity; further, stimulus recognition, which has been the paradigm of most of the hippocampal ablation work in animals to date, may be supported independently by both memory mechanisms, thus accounting for spared recognition ability in ablated animals. By contrast, performance in a delayed alternation procedure in a T-Maze should be supported predominately by recollection, not familiarity. Restricted hippocampal damage does not interfere with rats' ability to acquire this basic alternation task, which is likely supported by procedural learning, but damage strongly impairs delayed testing. In the present experiment, stranded California sea lions with naturally occurring hippocampal damage, and control animals without damage, were tested on alternation in a T-Maze at two delay durations. MRIs were conducted on each subject following testing. Training and testing is remote and does not interfere with potential release. More than 12 sea lions have successfully completed testing, and preliminary findings indicate that the paradigm is sensitive to hippocampal damage.

#### **Source Memory in Rhesus Monkeys: Distinguishing Between Performed and Observed Events**

*Megan L. Hoffman (Georgia State University)*

65 3:17 PM The comparative study of episodic memory has provided compelling evidence that various species are capable of episodic-like memory that meets several behavioral criteria of episodic memory, including the integration of multiple components (what-where-when) in memory and retrieval from long-term memory. However, one defining feature of episodic memory is that retrieval involves a sense of agency and personal ownership of the memory (i.e., the person recalling the event remembers this as an event that they performed, not an event that they observed). Therefore, another component that might be useful in examining event memory in animals is to determine whether they can discriminate between performed and observed events. In the present study, we examined whether rhesus monkeys were able to discriminate between events that they performed on a computer screen (using a joystick to move an object to a pre-determined location) and events they observed (the same event occurring independent of their own involvement). The monkeys were significantly above chance (50%) at discriminating between performed and observed trials, even when joystick speed, cursor path, and the monkey's hand position were all equated across trials, suggesting that monkeys encode the source of event memories in terms of their own involvement in the event.

3:26 PM **Snack Break**

4:20 PM **In Honor of the Contributions of Donald A. Riley (Chair - Mike Brown)**

#### **Maladaptive Choice Behavior by Pigeons: An Animal Model of Human Gambling Behavior**

*Thomas R. Zentall & Jessica P. Stagner (University of Kentucky)*

66 4:20 PM Contrary to optimal foraging theory, pigeons show maladaptive choice behavior by choosing an alternative that provides 20% reinforcement over another that provides 50% reinforcement. They choose the 20% reinforcement alternative when that choice results in a stimulus that always predicts reinforcement (20% of the time) or another stimulus that predicts its absence (80% of the time), compared with the 50% reinforcement alternative that results in a stimulus that predicts reinforcement half the time. This suboptimal choice behavior does not depend on the certainty of reinforcement associated with the low frequency (20%) stimulus. If the probability of reinforcement associated with that stimulus is reduced to 80% pigeons still prefer that alternative. Nor does it depend on the uncertainty of reinforcement associated with the 50% reinforcement alternative. If the choice is between a 100% probability of receiving 3 pellets and a 20% probability of receiving 10 pellets or an 80% probability of receiving no pellets, the small (20%) chance of receiving 10 pellets is still preferred. This maladaptive choice behavior mimics human monetary gambling behavior because it overemphasizes the infrequent occurrence of the winning event and underemphasizes the more frequent occurrence of the losing event.

#### **Species differences in the cognitive representation of symbolic hierarchies in jays**

*Alan B. Bond, Alan C. Kamil, & Cynthia A. Wei (University of Nebraska, Lincoln)*

67 4:35 PM In operant transitive inference, subjects train on adjacent pairs in an implicit, linear stimulus hierarchy, where responses to higher ranked stimuli are rewarded. The task entails two contrasting forms of cognitive representation. Direct representation derives from associative memory for the proportion of responses to each stimulus that have previously been rewarded. Relational representation derives from configural memory, producing a linked list in which each stimulus representation is connected to the next one down in the sequence. Life history features that demand higher use of configural memory, such as social complexity or reliance on cached food, should theoretically promote greater use of relational representation. To test this evolutionary hypothesis, we trained individuals of four corvid species with contrasting natural histories on the transitive inference task. Simulation of a simple associative process found three accuracy measures that were reliably indicative of direct representation. We extracted the three measures for each subject and used principal components analysis to obtain the best aggregate measure of reliance on each type of representation. Regression of component scores against rankings of life history features indicated that both social

complexity and caching reliance were significantly and independently associated with greater use of relational representation in operant transitive inference.

#### **Spatial pattern learning and transposition**

*Michael F. Brown (Villanova University)*

- 68 4:50 PM Spatial pattern learning is the control of spatial choice by abstracted spatial relationships among otherwise hidden goal locations (Brown & Terrinoni, 1996; Brown, 2006). It requires discriminative responding to stimulus elements depending on the presence of other stimulus elements with different values (locations) but of the same type. The control by relations among stimuli at the core of spatial pattern learning is reminiscent of transposition (Kohler, 1918; Riley, 1968). Using data from spatial pattern learning experiments with rats and humans, some empirical and conceptual similarities of spatial pattern learning and transposition will be described and examined, with an eye toward exploring the possibility that common mechanisms may be involved in the two phenomena.

#### **Developing an operant analog of episodic-like memory in Western scrub jays**

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

- 69 5:05 PM One of the major contributions of Al Riley and his collaborators was the development of operant matching-to-sample (MTS) procedures to explore animal cognition. We have recently followed Al's lead, developing a version of MTS as a direct analog of procedures developed by Clayton and Dickinson for the study of What-When-Where memory in scrub jays. In our paradigm, jays are shown a trial-unique sample stimulus, followed by either a 2- or 7-s retention interval. The retention interval is followed by a choice test; two stimuli are presented, the sample in the original location and another trial-unique stimulus in a different location. The birds are required to match after one retention interval and nonmatch after the other (counterbalanced across jays). Five of the six scrub jays learned this task rapidly, to high levels of asymptotic performance, clearly demonstrating the feasibility of our approach. Probe tests are currently underway to determine the extent to which behavior is controlled by the what and where components of the sample. Additional experiments will soon begin in which scrub jays are required to separately track what and where during acquisition.

#### **Findings from a random-walk model of discriminative reaction-times**

*Donald S. Blough (Brown University)*

- 70 5:20 PM In several discrete-trial experiments pigeons discriminated among colored spots that varied in their similarity to each other and in their association with reward. A random-walk model was used to fit the resulting RT distributions. This model says that stimulus-related information accumulates until, upon reaching a threshold, it triggers a response. Simulations showed that changes in stimulus hue altered the speed with which the input information accumulates, whereas changes in reward altered the amount of information needed to trigger a response. This sort of model may be a way to broaden our understanding of animal discrimination: (a) the finding that separate parameters go with similarity and reward suggests that the random-walk can instantiate the "sensitivity" and "bias" parameters of signal detection; (b) the random-walk and related models have been widely used to explore human discrimination and cognition; (c) the random-walk can be linked to existing memory and associative models of animal discrimination.

#### **Comparative Pro Musica: An Avian Perspective**

*Robert G. Cook (Tufts University)*

- 71 5:35 PM Music is an almost defining characteristic of our species. The universal production and perception of music is foundational to human culture, and it has powerful effects on our thoughts and emotions. Nevertheless, the melodic, harmonic and rhythmic components that form music must have had some cognitive precursors in non-human animals. This talk will review recent experiments conducted in our lab examining how pigeons process different musically-related features, including the perception of chords, consonance and dissonance, musical intervals, rhythmic and melodic grouping. Speculations about the comparative origins of music will be considered.

5:55 PM **Introduction - Mike Brown**

6:00 PM **Master Lecture - Donald A. Riley (University of California, Berkeley)**  
**Relational Responding in Animals**

7:30 PM **Banquet**

#### **Saturday Afternoon**

1:00 PM **Business Meeting of the Comparative Cognition Society**  
**All Invited to Attend - CCS Members May Vote on any Motions Made**

2:10 PM **(: Group Photo Shoot - SMILE :)**

2:30 PM **Cognitive Processes II (Chair - Roger Thompson)**

- 72 2:30 PM **Adventures in comparative cognition: training wild elephants in northern Kenya**  
*Suzanne E. MacDonald and Marc Dupuis-Desormeaux (York University)*  
Elephant crop raiding behavior is a pervasive problem throughout Africa, one which is difficult to predict and

expensive to defend. Subsistence farmers that suffer crop raiding are less likely to support local conservation efforts, and so eliminating this behavior is important in order to maintain viable elephant populations. Most efforts to minimize crop-raiding have used deterrents such as noise, chili peppers and bees to punish unwanted behavior, which often results in counterproductive frustration and aggression in the elephants. We are exploring the use of positive reinforcement in the form of elephant attractants to mitigate crop-raiding behavior. We conducted a two-phase food preference study on wild elephants in northern Kenya during an extended drought. In the first phase, we found that elephants preferred Fever tree to other available food sources. In the second phase, we added vanilla extract and found that all elephants showed considerable interest in this novel scent. We discuss the next steps of this on-going study and the implications for training elephants to use a newly created migratory corridor.

#### **Change Detection by Monkeys and Pigeons**

*Caitlin Elmore (U Texas Med School-Houston), Anthony A. Wright (U Texas Med School-Houston), John Magnotti (Auburn University), Jacquelyne J. Rivera (U Texas Med School-Houston), Jeffrey Katz (Auburn University)*

73 2:44 PM

Monkeys and pigeons were compared on visual change-detection tasks in terms of: learning rate, asymptotic performance, object & location transfer, and number of memory items. Both species learned at a similar rate and monkey asymptotic and transfer performance was higher than pigeons. These initial findings indicate a quantitative difference but qualitative similarity in how these species detect change.

#### **Prospective memory in the rat**

*A. George Wilson & Jonathon D. Crystal (University of Georgia)*

74 2:51 PM

Prospective memory is defined as remembering to carry out an intended action at an appropriate time in the future. Studies with human participants have found that intended future actions have a deleterious effect on ongoing performance. Our study sought to determine whether a time-based intention in rats creates task interference. To this end, we examined performance in an ongoing activity (duration discrimination) and a prospective task (the future onset of a small meal). Twenty rats were trained to judge short (2 seconds) vs. long (8 seconds) gaps between brief white noise pulses in daily 90-minute sessions. Immediately after completing each duration discrimination session, half of the rats earned a small meal (8 grams of food in 30 minutes) by breaking a photobeam in the food trough; the other rats remained in the boxes but did not receive meals. Anticipation of the meal impaired time perception as the upcoming meal became imminent. We propose that the intention to collect the meal was associated with the temporal context. Thus, allocation of limited attentional resources between ongoing duration discrimination and anticipation of the meal interfered with performance in a time-based fashion.

#### **The Perception of Goal-Directed Actions by Cotton-top Tamarins**

*Kate M. Chapman, Angela Hill, Stephanie Bay & Daniel J. Weiss (The Pennsylvania State University)*

75 2:58 PM

Human children and adults readily interpret action sequences with respect to their intended goal. Research with a variety of nonhuman primate species suggests that this type of action perception may have a lengthy evolutionary history. In a series of experiments, we investigated this ability in cotton-top tamarins, a highly social primate species. In Experiment 1, we replicated previous research by Wood and colleagues (2007), by presenting our subjects with a two-alternative forced choice task in which they chose between two bowls: one contacted in a goal-directed manner by a human experimenter and one contacted incidentally. In Experiment 2, we conducted a similar experiment, using a less canonical hand gesture to contact the bowls. Unlike Experiment 1, subjects were at chance in their selection of bowls. In Experiment 3, we failed to replicate findings suggesting that tamarins infer goal structures based on the actor's rational constraints. In Experiment 4, we trained the monkeys to use a marker to indicate the location of a food reward, and then varied the method of placement (e.g., Call and Tomasello, 1998). Overall, our experimental results suggest that the tamarins' abilities to infer the goal structure of human actions are less sophisticated than previously supposed.

#### **The role of body orientation in the assessment of visual attention by Western lowland gorillas**

*Amanda E. Bania & Erin E. Stromberg (Smithsonian's National Zoological Park)*

76 3:05 PM

Six Western lowland gorillas were tested in a visual attention task that aimed to investigate not only the apes' understanding of what a human experimenter sees, but also what information they used to make these judgments. Based on Reaux et al.'s (1999) series of experiments in which chimpanzees were asked to choose between an attentive and inattentive experimenter under six different conditions, we tested the gorillas' ability to appropriately select a "seeing" experimenter to receive a food reward. The gorillas were able to use body and head orientation as cues to attention, but not the 'face rule' or 'eye rule' proposed in previous studies. In addition, the gorillas were more successful in naturalistic, or socially relevant conditions, that did not include the use of a prop (i.e. buckets, screens, blindfolds). Based on these results, a second experiment was conducted to further examine the gorillas' use of an experimenter's body posture in their judgment of attention. The gorillas showed that they were not able to make appropriate judgments of the face and eyes when in the presence of an overt body orientation. In a third experiment, when faced with a more neutral body orientation, gorillas showed significant improvement in their performance.

3:17 PM **Choice (Chair - Matt Matell)**

#### **Do pigeons fall prey to the Concord effect?**

*Kristina F. Pattison & Thomas Zentall (University of Kentucky)*

77 3:17 PM

The Concord (or sunk cost) effect involves staying with an alternative even when there is a better alternative available ("should I stay or should I switch"). At various points during responding on a Fixed Ratio (FR30) schedule (5, 10, 15, 20, 25 pecks) we gave pigeons a choice between completing the FR30 schedule and switching to an FR15 schedule in which the "cost" of staying or switching was exactly the same. Pigeons that were sensitive to the changing conditions showed a bias to stay, consistent with a Concorde effect. Other pigeons were insensitive to the changing conditions (they always stayed or always switched independent of where in the FR30 the choice occurred).

78	3:24 PM	<p><b>Pigeons' Acquisition of a Simultaneous-Discrimination Midsession Reversal: Anticipation of the Switch and Perseveration After the Switch</b>  <i>Rebecca Rayburn-Reeves, &amp; Thomas Zentall (University of Kentucky), Mikael Molet (University of Lille)</i></p> <p>When pigeons encounter a food source, they typically will return to that location, a strategy that has been termed win-stay. As a direct test of a win-stay strategy in pigeons, a discrete trials procedure was used with a simple, simultaneous color discrimination with one color correct for half of the session and the other color correct for the remainder of the session. If the pigeons acquire a win-stay strategy they should demonstrate control by local feedback (i.e., the absence of reinforcement following the switch). Results indicate, however, that the pigeons began to switch prior to the contingency shift and tended to perseverate (choose the originally correct stimulus) after the shift. When testing humans under similar conditions, similar anticipatory errors were found but not perseverative errors. Neither pigeons nor humans showed a clear win-stay strategy and only humans showed a clear lose-shift strategy. Taken together, these results point to a difference between human and pigeon reversal strategies.</p>
79	3:31 PM	<p><b>Mechanisms of Change Detection in Pigeons and Humans</b>  <i>Carl Erick Haggmann &amp; Bob Cook (Tufts University)</i></p> <p>Change and event detection involve a combination of perceptual and memory mechanisms. When changes in visual events occur too slowly for perceptual mechanisms to detect, working memory is used. To help understand how these two mechanisms interact, we tested pigeons and humans with varying numbers of changing and non-changing elements to manipulate working memory load. This made changes that require working memory more difficult to detect, while perceptually available changes were less severely affected. The pigeons were tested with a go/no-go choice task that measured peck rate. Humans were tested with a choice task that measured reaction time. Similarities and differences between the tasks and the performance of the two species will be discussed.</p>
80	3:31 PM	<p><b>A Bigger House or a Shorter Commute? The Decoy Effect and Primate Decision Making</b>  <i>Emily D. Klein, Michael J. Beran, &amp; Theodore A. Evans (Language Research Center, Georgia State University)</i></p> <p>Decisions often require an evaluation of multiple options that involve a tradeoff between two or more desirable attributes. For example, many home buyers must decide between a large house with a long commute and a smaller house with a shorter commute. Previous research finds that preferences for the original set of two options change when a normatively irrelevant third option (a "decoy") is added to the choice set. Although the decoy effect has been well documented in humans, it is not yet known whether nonhuman animals are also susceptible. We will present data investigating the decoy effect in rhesus monkeys.</p>
	3:43 PM	<p><b>Metacognition (Chair - Tom Zentall)</b></p>
81	3:43 PM	<p><b>Rats and dogs choose to know: Evidence for metacognition?</b>  <i>William A. Roberts, Evanya Musolino, Mark Cole, Shannon McMahon, Krista MacPherson (University of Western Ontario)</i></p> <p>Experiments with children, apes, and monkeys have found that, in the absence of information, they will make an observing response that reveals the location of a hidden food reward. We asked if similar evidence of information seeking could be found in rats and dogs. In initial experiments, both rats and dogs failed to make a novel observing response to obtain information about the correct rewarded response to a visual discrimination problem. In subsequent experiments, both species were given a binary choice between a response that led to information that could be used to obtain food reward and a response that led to no information. Both species showed significant preference for the response that led to information. Whether these findings constitute evidence of metacognition in rats and dogs is discussed.</p>
82	3:57 PM	<p><b>Knowing what to ask for: Monkeys seek information before matching-to-sample</b>  <i>Michael J. Beran (Georgia State University), J. David Smith (University at Buffalo)</i></p> <p>The metacognitive abilities of nonhuman animals have been investigated through different paradigms including those that involve uncertainty monitoring and those that involve information seeking. Recently, it was reported that pigeons showed difficulty in acquiring all necessary information they needed before making a response to a matching-to-sample test (Roberts et al. 2009). We adapted and extended this test for use with rhesus monkeys and capuchin monkeys. Monkeys learned that each of two response options operated to provide information by revealing the sample or the match choices, and monkeys could choose which response options to select before making a matching response. Unlike pigeons, both monkey species quickly learned to ask to see the sample before the matches. Subsequent variations provided all possible initial states to a test trial – only sample already present, only matches already present, everything present, or nothing present. Rhesus monkeys negotiated all of these variations by only asking for information not already present. Capuchins showed more difficulty, particularly with redundant information seeking responses. Thus, although both species were generally successful in matching performance, the efficient information-seeking responses of these two species differed, and the advantage shown by rhesus monkeys matched that previously observed in uncertainty monitoring paradigms.</p>
83	4:11 PM	<p><b>"Play it Again": A New Method for Testing Metacognition in Animals</b>  <i>Allison L. Foote &amp; Jonathon D. Crystal (The University of Georgia)</i></p> <p>Putative metacognition data in animals may be explained by non-metacognition models (e.g., stimulus generalization; Smith et al., 2008). The objective of the present study was to develop a new method for testing metacognition in animals that cannot be explained by non-metacognition models. Animals are sometimes in a high or low state of performance. Metacognition is the hypothesis that animals know that they are in a high or low state. On a difficult problem we assume that animals choose to repeat a stimulus if they are in a low state of performance. Rats were first presented with a brief noise duration which they would subsequently classify as short or long. Rats were sometimes forced to take an immediate duration test, forced to repeat the same duration, or had the choice to take the test or</p>

repeat the duration. Metacognition, but not alternative non-metacognition models, predicts that accuracy on difficult durations is higher when subjects are forced to repeat the stimulus compared to trials in which the subject chose to repeat the stimulus, a pattern observed in our data. Simulations with two non-metacognition models support the conclusion that our data document metacognition in rats.

#### **Recognition of confidence about perceptual decisions in pigeons and bantams**

*Noriyuki Nakamura (Chiba University, JSPS), Sota Watanabe (Kyoto University, JSPS), Toru Betsuyaku, & Kazuo Fujita (Kyoto University)*

84 4:18 PM

We examined whether pigeons and bantams were able to recognize confidence about perceptual decisions by using a betting procedure. We trained pigeons and bantams to search for a differently colored disk (a target) among others (distracters) displayed on a touch-sensitive monitor. In test, the birds were required to choose one of two confidence icons, "risk" and "safe", after the visual search. A peck at the "risk" icon after a correct response in the visual search (i.e., a peck at a target) was reinforced by food and light, while that after an incorrect response (i.e., a peck at a distracter) resulted in a timeout. A peck at the "safe" icon was always reinforced by food and light or reinforced only by light, regardless of correct or incorrect responses in the visual search. The percentages of "safe" choices after incorrect responses were higher than those after correct ones in six pigeons and two bantams. We confirmed transfers of this behavior to novel stimuli in some birds, and to a novel perceptual task (a line classification task) in a pigeon. These results suggest that the two species, or perhaps avian species, have a metacognitive ability to recognize confidence about perceptual decisions.

#### **Choosing information in pigeons: Evidence for metamemory?**

*Neil McMillan, Shauna Hamat, & William A. Roberts (University of Western Ontario)*

85 4:25 PM

Previous research has shown that human and nonhuman primates make an observing response that yields information about the location of food reward. In the present study we used a conditional discrimination paradigm to ask whether pigeons would perform in a similar manner. Pigeons were presented with either a triangle (informative trial) or circle (noninformative trial) sidekey, and pecking the stimulus was followed by a red or green center key with two white sidekeys. On informative trials, reward was contingent on sidekey choice (right for red and left for green). On noninformative trials, reward was uncorrelated with sidekey responses. On test trials, the triangle and circle stimuli were presented concurrently and pigeons chose between informative or noninformative conditions. Pigeons preferred the informative sidekey on choice trials. In experiment 2, probability of reward on noninformative trials was matched with probability of reinforcement on informative trials. Results suggest that pigeons choose information that leads to a correct response.

#### **Pigeons Prefer "Information" Over its Absence**

*Jessica P. Stagner & Thomas R. Zentall (University of Kentucky)*

86 4:32 PM

Recently, Roberts, Feeney, McMillan, MacPherson, Musolino, and Petter (2009) have suggested that pigeons performing delayed matching-to-sample appear unwilling to request to see the sample again (or even for the first time) prior to choice, even if that would result in an increase in matching accuracy. In each of their four experiments, however, presentation (Experiment 4) or re-presentation of the sample (Experiments 1-3) resulted in an added delay to reinforcement thus, the pigeons had to choose between an immediate reinforcer on about 50% of the trials and a delayed reinforcer on a significantly higher percentage of the trials. When we equated the two alternatives for delay to reinforcement we found that most of the pigeons showed a significant preference for trials with a relevant sample over trials with an irrelevant sample. When the contingencies were reversed, most of the pigeons reversed their preference. Although these results do not present evidence for metacognition, they do show that pigeons are not insensitive to the potential for a higher probability of reinforcement when delay to reinforcement is controlled.

4:39 PM **Closing Remarks - Jonathon Crystal**

8:00 PM **Poster Session II (8:00 - 10:30)**

**See Poster Abstracts Starting on Page XX**

**Poster Presenters: Please set up your posters between 7:30 and 8:00**