

Poster Session I - Thursday Evening

Wolf Performance on Utilizing Diverse Range of Novel Human Point Types in an Object-Choice Task

Jessica M. Spencer, Monique A.R. Udell, Nicole R. Dorey (University of Florida)

- P1 One existing argument is that dogs may be responsive to a more diverse range of human stimuli than other species, including wolves. While it is true dogs can utilize a wide range of human gestures in object-choice tasks, prior studies conducted with wolves have utilized a restricted range of stimuli preventing an accurate assessment of the range of human gestures socialized wolves may be responsive to. The present study investigated wolves' performance on an object-choice task involving a wide range of novel gestures that have not been previously tested. Wolf performance was compared to that of pet dogs on the same task using the same human stimuli. The results indicated that there were no significant differences between wolf and dog performance, but there were significant differences across point types. This lends support to the hypothesis that dogs are not unique in their ability to utilize a diverse range of human gestures. Prior experience with specific human gestures likely influences whether or not dogs and wolves learn to follow specific points in a communicative context.

To click or not to click: Positive reinforcement methods on the acquisition of behavior.

Alexander G. Blandina, Nicole R. Dorey, Erica Feuerbacher & Clive D. L. Wynne (University of Florida)

- P2 Dog training has a history dating back centuries, yet very few studies have compared different training methods. One currently popular method of training is clicker training. In clicker training a click is produced when the correct behavior occurs and is followed immediately with food. The purpose of this study is to investigate whether the clicker is effective in decreasing training time when compared to other positive reinforcement methods without a clicker. Using naive puppies (aged 2 to 3 months) the current study compares the efficacy of clicker training with 1) the delivery of food alone and 2) the use of a verbal marker. We hypothesize that because both clicker and verbal commands mark the behavior and are discriminative stimuli for food; there will be no differences between these two stimuli. However, delivering the primary reinforcer alone may cause a delay in the acquisition to the target behavior because of an increase in the delay between the target behavior and the delivery of the food reward.

Domesticated dogs' (Canis familiaris) use of the solidity principle

Andres De Los Reyes (University of Maryland – College Park), Shannon M. A. Kundery, Chelsea Taglang, Ayelet Baruch, Rebecca German, Sabrina Molina, Erica Royer, & Rebecca Allen (Hood College)

- P3 A variety of species maintain representations of hidden objects over time. Yet, little is known of the factors underlying predictive reaching, searching, and looking for such objects. We explored adult domestic dogs' knowledge and use of the solidity principle (i.e., one solid object cannot pass through another) by evaluating search behavior. Dogs watched as a small food treat rolled down a clear inclined tube into an opaque box. On some trials, a solid dividing wall was inserted into the center of the box, which divided it in half and blocked the treat's trajectory (i.e., Wall Trials). On other trials, the wall was not inserted into the box (i.e., No Wall Trials). To find the treat, subjects were required to modify their search behavior based on the wall's presence or absence. Results indicated that dogs correctly modified their search behavior to accord with whether the wall was present or absent. Subjects searched near where the tube entered the box on Wall Trials and at the far end of the box on No Wall Trials. Dogs displayed this behavior from the first trial and performed correctly when trial types were intermingled, suggesting dogs directed their searches in accordance with the solidity principle.

Stimulus properties of human pointing: Learning in object choice tasks

James Morrison (UF), Nathan Hall (UF), & Monique Udell (UF)

- P4 Domestic dogs have been shown to follow human social cues like the pointing of arms as well as nodding and bowing to find hidden food in object choice tasks. Sixteen dogs were tested on nine different point-types to determine the effects of learning through prior exposure to human social cues. To establish a baseline comparison, 8 dogs were tested on each individual point. Of the 16 dogs tested on all points, half of them were tested from easiest to most difficult while the others were tested from most difficult to easiest point. Those tested from easiest to most difficult point types performed much better than the other test group on the more difficult points. The baseline group performed similarly to the group tested from most difficult to easiest point type.

Learning effects on interspecific communication between humans and domestic dogs

I. Angel M. Elgier, Adriana Jakovcevic, Gabriela Barrera, Alba E. Mustaca, & Mariana Bentosela (PSEA-IDIM-CONICET)

- P5 Domestic dogs have shown to be successful at following human cues to solve the object choice task. The question is what are the mechanisms involved in these communicative abilities. Many authors proposed that these skills are a domestication product, independent from learning processes. This work present studies considering the effects of associative learning upon these skills. In the first two experiments we aim to evaluate the effect of extinction and reversal learning procedures on the use of the pointing gesture. Also two experiments where dogs' performance in following physical or social cues are presented. The results showed that dogs stopped following the pointing cue in the extinction and that they learned to choose the not pointed container in the reversal learning. Furthermore, the presence of the owners improved the performance of the dogs during the reversal procedure, but delayed the extinction. On the other hand, the training of a colour cue reverses the preference for the social one, concluding that the dogs fundamentally follow those cues that allowed them to obtain reinforcers in their previous learning history. This suggests that instrumental learning plays an important role in interspecific communication between humans and dogs.

Progressive elimination task in dogs: The effect of both the intermediate target's visibility and inter-target distances in the implementation of the visible rule.

Jacinthe LeBlanc & Claude Dumas (Université du Québec à Montréal)

- P6 The visible rule (VR) refers to selecting the visible targets first in a 3-choice progressive elimination task (PET) in which there are visible and hidden targets. Dogs implement the VR when the intermediate target differs from both the external left and right targets in terms of visibility (perceptually distinct) but not when one of the external targets is perceptually distinct. Recent empirical evidence has shown that when the perceptually distinct intermediate target is no longer in line with the dogs' body axis and placed closer to one of the external targets the VR is no longer implemented. This could be linked to the fact that the perceptually distinct intermediate target is no longer in line with the dog's body axis or to the fact that interbowl distances are modified. In the present experiment, dogs (n=10) were administered a PET in which one of the two external targets was placed closer to the perceptually

distinct intermediate target which was in line with the dog's body axis. Data showed that the dogs still implemented the VR when the intermediate target was hidden but not when it was visible. The discussion emphasizes the effect of conflicting parameters in dogs' decision-making.

Breed differences in domestic dogs' (Canis familiaris) emission of communicative signals.

Adriana Jakovcevic, Angel M. Elgier, Gabriela Barrera, Alba E. Mustaca & Mariana Bentosela (IDIM-CONICET-UBA)

- P7 Breed differences in dogs' comprehension of human communicative signals have been reported recently. The present studies were performed to evaluate breed differences in the production of gazing to the human face in a conflictive situation with food at sight but out of reach. Three different breed groups were evaluated (Retriever, Sheepdog and Companion). Two studies were performed, one involving the training and extinction of the gaze response and the other a gazing test without previous training. In Study 1 breed differences were observed during extinction, Retrievers gazed significantly more than Sheepdogs and Companions. Same results were found in Study 2. One possible explanation for the fact that Retrievers gazed more even when no food was obtained, is that another reinforcer was at play during the tasks. The presence of the experimenter, who directs her gaze toward the animal, may work as a social reinforcer that maintains the response. A positive correlation between gaze duration during extinction and duration of physical contact with an unknown human in a sociability test supports this hypothesis. Taking together, results suggest that dogs' communicative abilities involve the interaction of learning, genetics and differential selection of traits in the different breeds.

"Unwilling" vs "Unable": Domestic Dogs Understand Intentions

Puja A. Buch & Ellen E. Furlong (The Ohio State University)

- P8 Domestic dogs have evolved social skills, such as sensitivity to communicative cues like eye gaze and pointing, which help them navigate human society (Bruer et al., 2006; Hare et al., 2002; Miklosi et al., 2003). Such social skills are among the foundations of theory of mind, which includes reasoning about intentions and beliefs. Since dogs have mastered foundational theory of mind skills (i.e., eye gaze and pointing), they may be capable of more complex thought, such as understanding intentions. To test this hypothesis, eleven dogs encountered an experimenter unable or unwilling to provide food, a paradigm often used to explore reasoning about intentions (Call et al., 2004; Phillips et al., 2008). The dog's position relative to the experimenter was recorded for each one-minute trial. When the experimenter was unable to provide food, dogs stayed close (within 18 inches; $t[20] = 3.72, p < .01$); however, when the experimenter was unwilling to provide food, dogs spent more time in proximity (19 – 36 inches; $t[20] = 2.12, p = .04$) or away from the testing location (37 or more inches; $t[20] = 2.45, p = .02$). Dogs differentiate between an unwilling and an unable experimenter, demonstrating capacity to reason about intentions.

Trying to tease apart backward blocking and interference between cues phenomena

Cristina Orgaz, Miguel Ángel Vadillo (University of Deusto), David Luque, Joaquín Morís, Pedro Luis Cobos (University of Málaga), & Helena Matute (University of Deusto)

- P9 Backward blocking (BB) and interference between cues (IbC) are two important effects in associative learning which share some common features suggesting that they could be explained in similar ways. During an IbC experiment the participants see two different associations between a cue and an outcome, both sharing the same outcome (i.e., X-O trials followed by A-O trials). The association learned during the last phase(A-O) hinders the expression of the previously acquired association (X-O). The main methodological difference between IbC and BB is that during the first phase, BB requires the simultaneous presentation of both A and X. Some researchers have obtained both effects in the same experiment, but with differences in the size on the effects. We suggest that the difference between these experiments might be due to a common variable: both of them used a task that suggests a causal relationship between cues and outcomes. The aim of the present experiment is to explore both effects in a non-causal scenario. The use of a neutral scenario should avoid promoting one effect over the other on the basis of causal reasoning processes. The results showed significant effects of both BB and IbC with similar sizes.

The role of outcome inhibition in interference between outcomes

Cristina Orgaz, Miguel Ángel Vadillo (University of Deusto), David Luque, Pedro Luis Cobos (University of Málaga), Helena Matute (University of Deusto), & Francisco José López (University of Málaga)

- P10 Current associative theories of contingency learning assume that inhibitory processes take part in interference between outcomes. Inhibitory processes also seem to underlie some other effects, as, for example, retrieval-induced forgetting. However, inhibition is understood differently in those two research areas. The purpose of the present experiment is to test whether a similar inhibitory process to that seen in retrieval-induced forgetting takes place in interference between outcomes. Using a contingency learning task, we found that interference between outcomes reduces the retrievability of the target outcome even when tested with a different cue and some minutes after training the interfering association. This result has important theoretical implications for associative models of interference and shows that the empirical facts and theories developed in the study of retrieval-induced forgetting might be relevant in the area of associative learning.

The detailed time course of appetitive delayed Pavlovian conditioning in the zebrafish

L. Curtis, M. Lawrence, M. Delgado, & D. T. Cerutti (California State University East Bay)

- P11 Four 90-day-old zebrafish were tested in an appetitive Pavlovian delayed conditioning task. After an intertrial interval of $k \cdot T$ s, a small, translucent vertical pole was illuminated (CS) for T s. Food (US) was automatically presented at $T/2$ s. Various measures of swimming activity were measured by video-tracking software. All four fish showed very abrupt, "step-like" learning of the CS-US pairing. Three fish showed acquisition in the 3rd session, the last fish in the 2nd session. Conditioned responding (CR) is evident in several measures, including increased velocity during the CS, and proximity to the CS. Averaged velocity and proximity CR's are temporally undifferentiated at the outset of training but become differentiated after about 3 sessions. We are presently doing parametric manipulations of trial and CS duration (T) with new fish to see if we can more precisely determine the co-variation between the initial appearance of the CR and temporal differentiation of the CR.

Summation in human causal reasoning

Miguel A. Vadillo, Nerea Ortega-Castro, Pablo Garaizar, & Helena Matute (Universidad de Deusto)

- P12 All theories of causal induction include explicit or implicit assumptions about the way several causes combine to produce a given outcome. According to many associative and rule-based theories, the probability of the outcome given a set of independent and non-interactive causes should be equal to the (non-overlapping) addition of the probabilities of that outcome in the presence of

each of those potential causes presented in isolation. However, the Power PC theory of causal induction assumes that the causal power of a compound cue should be computed as an overlapping probabilistic addition: That is, the causal power of the compound is equal to the addition of the causal power of each cue minus the overlap between them. In a series of decision-making experiments, we show that, contrary to this assumption of the Power PC theory, humans tend to combine the influence of several causes by means of a simple, non-overlapping addition.

Chimpanzees (Pan troglodytes) understanding of weight

Carley Faughn & Daniel Povinelli (University of Louisiana at Lafayette)

- P13 Previous studies have argued that chimpanzees can engage in causal reasoning with regard to object weight (Hanus & Call, 2008). However, other studies examining chimpanzee "folk understanding" of weight suggest that chimpanzees do not have explicit knowledge about the effects of object weight. A series of tasks were implemented to further investigate chimpanzee's sensitivity to weight and their potential for any higher-order, cognitive, understanding. Our research suggests that chimpanzees appear to create sensori-motor expectations about object weight and the load forces necessary to lift objects after just one trial of experience. These expectations were observed through an overcompensation effect when chimpanzees lifted a light object that was visually identical to a previously-lifted, heavy, object. The light object was lifted significantly higher than the heavy object. No similar overcompensation effect was observed when chimpanzees were required to respond to an object's apparent weight based solely on visual and auditory cues in the absence of direct experience. In addition, we tested our chimpanzees' knowledge of weight and understanding of balance mechanics. We found that the chimpanzees were not able to infer the location of a reward based on its weight in a balance apparatus. Our results suggest that chimpanzee's representation of weight is restricted to their sensori-motor system and they do not appear to reason about weight as an object based property.

Causal Roles as Determinants of Blocking

Laura Coursen & Martha Escobar (Auburn University)

- P14 Causal model theories propose that cue competition is affected by the causal roles of competing stimuli and occurs between causes but not between effects, whereas associative models propose that cue competition is unaffected by causal roles and occurs among stimuli presented in a common temporal location (antecedent or subsequent). We assessed the relative importance of causal roles and temporal location using a blocking preparation (A→C then AB→C). Subjects had to assess the relationship between fictitious blood substances and a fictitious disease, Midosis. In all conditions, the blood substances were the antecedent events and Midosis the subsequent event. During the first phase, blood substances were either causes or effects of Midosis. In the second phase, causal roles were reversed by informing subjects that the blood substances were now effects or causes of Midosis, respectively (Reversal condition). For control subjects, the causal roles of the stimuli were maintained (NoReversal condition). Blocking occurred only among causes and only if the causal role of the stimuli was maintained across phases. These results suggest that the causal role of competing cues is an important determinant of stimulus competition and that competition does not occur among stimuli with different causal roles.

Understanding Value and Time in Static and Changing Schedules of Reinforcement

Nicholas Commons-Miller (Tufts University), Commons, Michael (Harvard Medical School), Gane-McCalla, Robin (Dare Institute), Alex Pekker (University of Texas) & Michael Woodford (Columbia University)

- P15 Delay discounting traditionally was studied using samples from schedules as consequences in two link simple concurrent schedules. Risk has been studied in both simple and chained concurrent schedules. The unified theory presented here integrates the initial value of outcomes with delay, risk and sensitivity to change in risk. Risk is defined as the derivative of Mazur's (1987) equation for delay: $-Aik/(kdi+1)^2$. Sensitivity to change in risk, the second derivative of Mazur's equation is: $2k2Ai/(kdi+1)^3$. In this study, unlike the concurrent chain studies, the schedule samples were used as discriminative stimuli. The discrimination procedure here consisted of trials made up of a two-link schedule with the presentation of one of a large number of samples from a t schedule (Schoenfeld & Cole, 1972), as the first link. The second link was a choice between a left key indicating a lean or the right key indicating a rich schedule sample. The perceived sample value was shown to be a quadratic function of how soon before choice a single reinforcer was (the first derivative). Three derivatives of immediate value with respect to time before a choice of a reinforcer describe many properties of discounting accounts of reinforcement schedules.

Use of the Hick task to assess selective attention in a group of baboons (Papio papio).

Elodie Bonté & Joël Fagot (CNRS-Université Aix-Marseille I, Marseille, France; INCM, CNRS-Université Aix-Marseille II, Marseille France)

- P16 The hick (1952) task was used to assess selective attention in 19 group maintained baboons tested with the ALDM test system presented in a companion poster (by J. Fagot). In that task, the baboons have to select (i.e., touch on a touch-screen) a target among a variable number of equidistant distractors. Scores, reaction times and movement times were analyzed as a function of an (1) number of distractors, (2) location of the target on the screen, (3) spatial organization of the distractor-target configuration, (4) social parameters including the social status and indexes of sociability. That research was supported by a PACA-region grant to EB. Hick, W (1952). On the rate of gain of information. Quarterly Journal of Experimental Psychology, 1952, 4, 11-26.

Automatic tests of baboons maintained in their social group.

Joel Fagot (CNRS-Université de Provence, Marseille, France.)

- P17 Fagot & Paleressompouille (2009) published an automated learning device for monkeys (ALDM) to test the cognitive functions of nonhuman primates within their social group, but the efficiency of the ALDM procedure with large groups remained unknown. This poster presents a new research platform based at the CNRS-Rousset-sur-Arc primate center, nearby Aix-en-Provence, in which a set of 10 such ADLM systems are now freely provided to a large social group of 26 baboons maintained in a vast 700 m2 enclosure. I will present that research platform and will highlight its efficiency to assess social and non social cognitive phenomenon in nonhuman primates. References, Fagot & Paleressompouille (Behav Research Methods, 2009), Fagot & Bonté (Behav Research Methods, in press 2010). This project was supported by the PACA-region grant - Volet Exploratoire 2008.

A chimpanzee (Pan troglodytes) shows human-like speech perception abilities

Lisa A. Heimbauer, Michael J. Beran, & Michael J. Owren (Georgia State University & The Language Research Center)

- P18 The human ability to understand incomplete or distorted speech is argued to reflect specialized, species-specific processing. To test this claim, experiments have examined perception of natural versus synthetic speech by a 23-year-old, language-trained

chimpanzee named Panzee. This animal is of particular interest because she was reared from infancy by human caregivers in a language-rich environment, and can identify more than 100 spoken words using graphical symbols (lexigrams). Tests present one of 48 familiar words via computer on each trial, with Panzee choosing a corresponding lexigram from among four alternatives. Studies with words in natural versus incomplete “voiced-only” form (Experiment 1) and natural versus a strongly distorted “noise-vocoded” form (Experiment 2) are complete, while comparisons of natural versus “sine-wave” speech (Experiment 3) are in progress. Panzee’s performance with all stimulus-types in Experiments 1 and 2 was well above chance levels ($p < 0.001$), similar to that of humans, and inconsistent with the claim that functional speech perception in the absence of traditional acoustic cues requires specialized processing. Preliminary outcomes suggest that results with sine-wave speech will be similar, although with lower overall performance, as shown by humans already tested with these stimuli.

Comparative Analyses of Avian Visual Cognition: Shape from Shading in Starlings

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

- P19** To test the generality of earlier results collected with pigeons (a columbiforme species), starlings (a passeriforme species) were tested in a two-alternative shape-from-shading choice task. Using live-in operant chambers, the starlings were shown two stimuli simultaneously and required to land on the appropriate perch to indicate which shaded surface was convex or concave in appearance. The choice-accuracy results were similar to earlier pigeon data, and comparisons between the two species and their acquisition will be presented. Task-specific and daily performance related to the live-in procedure will also be considered.

Auditory brainstem response in the lesser scaup, a species of diving duck

Sara C. Therrien, Catherine E. Carr, Elizabeth F. Brittan-Powell (University of Maryland), & Alicia M. Wells-Berlin (USGS Patuxent Wildlife Research Center)

- P20** The auditory brainstem response (ABR) is an effective approach to describing auditory sensitivity in a variety of animals. In this investigation, we used the ABR to estimate the auditory sensitivity of a species of diving duck, the lesser scaup (*Aythya affinis*). The typical lesser scaup ABR waveform showed two to three prominent peaks that occurred within the first 5 ms after onset of the stimulus. Peak amplitude increased and peak latency decreased with increasing stimulus sound pressure level. Threshold was defined as 2.5 dB below the lowest SPL that evoked a visual response (visual detection method). The best range of hearing for this species was from 500 Hz to 5000 Hz, with sensitivity peaking between 1500 Hz and 3000 Hz. Both the waveform morphology and response characteristics of the peaks to changing stimulus intensity are similar to those found in other avian species, such as screech owls (*Megascops asio*) and budgerigars (*Melopsittacus undulatus*).

Note-type based species classification by black-capped and mountain chickadees

Lauren M. Guillette, Marisa Hoeschele, Tara M. Farrell, Laurie L. Bloomfield & Christopher B. Sturdy (University of Alberta)

- P21** Bloomfield et al. (2008) showed that black-capped and mountain chickadees sorted their chick-a-dee calls into species-level categories. In this task, the terminal “dee” portion was a more efficacious stimulus for species classification than the initial “chick-a” portion. In a separate study, linear discriminant analyses were able to classify notes by species with 100% accuracy using any call note type from either species’ calls (Dawson et al. 2006). In the current, ongoing set of experiments, we aim to determine whether classification into species-level categories are mediated equivalently all call-note types, as suggested by the results of the linear discriminant analysis, or whether some note types are more well suited to aid in species classification to others using a go/nogo operant discrimination. Our results suggest that a simple (sounding) question does not necessarily lead to a simple answer and birds appear to be adopting several strategies to solve the task.

A cross-species linguistic analysis of self-speech

Erin N. Colbert-White (University of Georgia)

- P22** Self-speech (talking while alone) is prevalent in young children and speech-trained African Grey parrots. Because parrots are the only nonhuman taxon that readily learns speech, they are an indispensable comparative model for investigating the relation between speech content and cognitive processes. I compared a 2.5-year old child and 6-year old African Grey parrot’s self-speech. The goal was to identify parallels and dividing lines between the speakers’ linguistic and cognitive abilities. Content similarities in the self-speech include (1) prevalence of sound-play and repetition, which are important features of self-speech in humans, and (2) interrogatories that require a second party to respond (e.g., “What’s that?”). These similarities challenge critics who view parrot speech as random repetitions of mimicked phrases. The analysis also revealed that the parrot never uses the pronoun I in novel phrases and never uses the verb to know. This suggests that the child, but not necessarily the parrot, has developed a sense of self and an understanding of what she and others know and do not know to the extent that she freely talks about it. Overall, the linguistic analysis revealed that both speakers use self-speech in functionally similar ways but are at identifiably different cognitive levels.

Context-Dependent Use of Signature Whistles in the Atlantic Bottlenose Dolphin (*Tursiops truncatus*)

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

- P23** Signature whistles, defined as the most commonly produced whistle by an individual dolphin in isolation and categorized by the unique frequency contour produced by each dolphin, are some of the most well-studied vocalizations of dolphins. These whistles are usually studied in isolated animals but, given their likely purpose as identifiers and cohesion calls, could be expected to play a strong role in the introduction of new dolphins to a social group. We used a multi-hydrophone array to record vocalizations produced by 4 male dolphins at Disney’s The Seas, both during the introduction of 2 new dolphins and comparison periods of similar activity 3 years later. All whistles were labeled by producer and categorized by frequency contour. We calculated the percentage of signature whistles in each file; results varied from 0% to 21%. An inverse relationship between rates of signature whistles and rates of short whistles (<150 ms) appeared in the comparison periods. Periods with fewer whistles had a lower incidence rate of signature whistles and a decreased variety of whistle contours, but signature whistles occurred most during periods when the dolphins were highly aroused whatever the condition. These data support previous findings that signature whistles are used as cohesion calls.

Reducing Irrelevant Relations Facilitates Learning Rules from a Response Series Lacking a Consistent Motor Sequence in Rats

Shannon M. A. Kundery (Hood College) & Stephen B. Fountain (Kent State University)

Earlier we reported that rats could learn a response pattern in a circular array of levers that was not a set motor sequence. Rats learned either a structured (12345678) or an unstructured (17356428) subpattern interleaved with responses on randomly presented levers (X): 1X2X3X4X5X6X7X8X or 1X7X3X5X6X4X2X8X, respectively. The structured, but not the unstructured, group learned their pattern. In a new study, we hypothesized that irrelevant relations between random elements and fixed subpattern elements might have slowed learning in the earlier study, as they do in humans (Hersh, 1974). Using the same structured and unstructured subpatterns used earlier, we restricted the set from which random elements were drawn so that irrelevant relations were prevented. As before, rats learned the structured subpattern faster than the unstructured subpattern. However, learning by the structured group was facilitated. The results provide further evidence that sequential structure across nonadjacent elements can mediate better pattern learning even when the rule relating those elements cannot be abstracted from a set motor pattern. Furthermore, the results suggest that irrelevant relations in serial patterns interfere with detecting and encoding pattern structure in rats as they do in humans.

Scopolamine dissociates cognitive processes responsible for phrasing effects versus violation element performance in rats
Amber M. Chenoweth & Stephen B. Fountain (Kent State University)

P25 In serial pattern learning, “phrasing cues” positioned at chunk boundaries can facilitate learning transitions between chunks which are harder to learn than elements within chunks. We have shown before that disruptions in chunk boundary performance occur when phrasing cues are removed or when scopolamine, a muscarinic cholinergic antagonist, is administered. The present study examined the effects of both manipulations combined. Rats were trained to nosepoke one of two patterns in a circular array: Perfect: 123-234-345-456-567-678-781-812 Violation: 123-234-345-456-567-678-781-818 where digits indicate positions of correct responses, dashes indicate 3-s phrasing cues, intertrial intervals were 1 s, and the last element of the Violation sequence violated pattern structure. After acquisition, phrasing cues were removed concurrently with injections of either scopolamine (0.6 mg/kg) or saline. Scopolamine produced a large deficit in performance relative to saline at chunk boundaries where phrasing cues previously signaled responses, but produced no effect at the violation element. These results indicate that scopolamine dissociated the cognitive systems necessary for performing chunk boundary versus violation element responses. Given that we have already shown that these processes are dissociable from within-chunk rule learning, the results suggest that at least three dissociable cognitive processes are used concurrently in rat sequential learning.

Serial Pattern Learning in Rats: Rule Induction and Pattern Tracking in Patterns Containing 2, 4, or 8 Interleaved Random Elements

Karen E. Doyle & Stephen B. Fountain (Kent State University)

P26 In a serial pattern learning task, rats typically acquire a simple rule-based pattern rapidly whereas presentation of the same simple pattern with interleaved random elements severely retards acquisition. Since previous results have indicated that rats encode rules when learning a serial pattern presented in this manner, it is unclear why introduction of interleaved random elements impairs learning to such an extreme. One possible explanation for this impairment is that random elements increase the difficulty of parsing together related elements from the simple pattern in order to extract the rule. The present study was designed to examine whether performance would improve if more of the simple pattern were presented between interleaved random elements by altering the number and positioning of those elements. Rats learned to perform a simple pattern of responses in a circular array of 8 nosepoke receptacles. The simple pattern was 1-2-3-4-5-6-7-8, where digits indicate the successive clockwise positions of correct responses in the array. Random elements were interleaved after every 1, 2, or 4 elements of the pattern. Acquisition occurred faster when fewer interleaved elements were presented in the same simple pattern, suggesting that interleaved random elements interfered with rule detection.

Rat Basketball as a Class Project for Freshman Laboratory Courses

Alliston K. Reid (Wofford College)

P27 We have developed a semester-long rat basketball project as a way of providing a fun, educational experience to freshman undergraduate students in their first laboratory course in behavior analysis. After rats are trained to play competitive one-on-one basketball, the project culminates in a championship tournament open to the public and the local media. The training process involves about 50 steps, and students learn to identify stimulus control, reinforcement contingencies, shaping, instinctive drift, tool use, and other basic behavioral principles that we want students to understand. Video clips of the tournament will be presented, and we will explain how this project can be implemented inexpensively in other schools.

Sex Differences in Adult Rat Serial Pattern Learning

Laura R. G. Pickens, Kristen L. Kolar & Stephen B. Fountain (Kent State University)

P28 Several studies have demonstrated that males perform better than females in spatial learning tasks such as the radial and water maze in rats (cf. Williams & Meek, 1991; Jonasson, 2005). Male rats also exhibit greater contextual freezing than females in Pavlovian fear conditioning (Maren et al., 1994). We examined whether similar sex differences would appear in rat serial pattern learning. Male and female Long Evans rats (12 per group) were trained for 49 days on a 24-element serial pattern: 123-234-345-456-567-678-781-818, where digits indicate the clockwise position of correct receptacles within a circular array of an octagonal chamber. Acquisition analyses revealed a sexual dimorphism for chunk boundary and violation element types, with males learning significantly faster than females. We will also discuss trial-by-trial data and provide an analysis of error types to ascertain whether or not male and female rats differ qualitatively in how they encode their serial pattern. One conclusion from these results with perhaps far-reaching implications is that sex differences may be more common in different rat learning paradigms involving complex cognitive processes than has been previously appreciated.

Housing and activity in the laboratory pigeon.

Delgado, M., Curtis, L., Wendel, L., & Cerutti, D. (University of California, East Bay)

P29 We have recently studied the inter-session behavior of seven laboratory pigeons serving in experiments on operant behavior. A previous study found a difference in activity levels in their home cages to that in an aviary with various “enrichment” features such as cubbies and perches. We next measured this behavior in different sized aviaries to determine if there was a linear relationship between activity level and the size of the enriched space. Eating/drinking, grooming, walking (pacing when caged), ambulation and flying (attempting to flap wings when caged) were considered “activities.” The percentage of observations where the pigeon displayed activity was calculated for each bird in each condition. A repeated measures ANOVA found a significant difference ($F(4, 24) = 4.096, p = .011$) between the activity level in the cages (which ranged from .15 to .65) from that in the aviaries (which ranged

from .33 to .71), and that this difference followed a quadratic, not linear, function. There were some individual differences among the birds' patterns of behavior. We anticipate that our findings will be relevant to concerns about appropriate housing for the laboratory pigeon.

Concurrent object learning in rats using a transitive inference paradigm

Diana B. Klimas (Bowling Green State University), Crosby Wilson, Thomas J. Budroe, & Matthew J. Anderson (Saint Joseph)

P30 Transitive inference is the ability to infer relationships about non adjacent items within a hierarchical list. The subjects are presented a list of objects as pairs, where one object in each pair is reinforced to create a hierarchy (A>B>C>D>E). After training, two objects which have been equally reinforced are paired to form a novel pair (B-D). If the subject chooses B>D, it has demonstrated transitive inference. The current study employed an object recognition based method analogous to procedures used previously in primate studies (Treichler & Van Tilburg, 1996). The specific goals included investigating the mechanisms rats employ to learn lists of items, testing the rats' ability to demonstrate transitive inference in an object based task, as well as develop unified procedures to test learning across species. Rats were assigned to three groups and taught a list of five, ten, or fifteen items over a 30 day training period. After training, the rats were tested to see if they could infer indirect relationships between items in the list. Although the rats were unable to demonstrate transitive inference, all groups were able to exhibit learning of the pairs, suggesting they did not organize the objects as a list, but as individual pairs.

Rhesus monkeys demonstrate the cognitive capacities necessary for learning dominance hierarchies by transitive inference

Regina Paxton and Robert R. Hampton (Emory University)

P31 The social environments of many primate species are composed of linear dominance hierarchies in which transgressions result in aggression. Therefore, cognitive mechanisms that allow for learning hierarchies rapidly and safely through observation, rather than through many costly social encounters, would be advantageous for these species. One such mechanism may be transitive inference (if A>B and B>C then A>C). Using transitive inference, animals could observe a subset of possible interactions between individuals, then use that information to infer the full dominance hierarchy. If transitive inference in rhesus monkeys has been under selection pressures related to dominance hierarchy learning, then monkeys should 1) learn dominance relationships from observed social interactions, 2) recognize individuals visually, 3) be competent in transitive inference. In Experiment 1 monkeys viewed videos of artificially created dominance interactions. From the videos, monkeys were able to classify seven initially unfamiliar monkeys based on identity and simultaneously select the dominant individual. In Experiment 2 monkeys performed above chance on transitive inference tests and inferred the relationship between pairs of clip-art stimuli that had never been paired before. This work positions us to directly test for transitive inference in dominance hierarchy learning in monkeys.

Environmental and social structuring, affect in the interactions in male vervet monkeys (*Cercopithecus aethiops*)

April D. Takahashi & Carling Nugent (University of Lethbridge)

P32 The demands of social life are thought to have shaped the size and structure of the brain and the particular way in which monkeys, apes and humans think about the world. While much work has focussed on attempting to identify the kinds of high-level conceptual knowledge that primates hold, an alternative approach is to consider that primate social cognition is geared to producing flexible responses to unpredictable contingencies, and is both 'embodied' as well as 'embedded' in the environment. Using this latter framework, I have investigated the various ways in which male vervet monkeys regulate and control their signalling behaviours during the mating season. Interactions between males from two habituated troops in the Samara Game Reserve, South Africa were video recorded during the mating season (Apr-Jun09). These data were then notated and analyzed to test the hypothesis that male-male interactions fall on a continuum that ranges from expressive emotional responses detectable in movement to the strategic use of emotions to 'negotiate' social interactions in ways that serve an actor's immediate social goals.

Poster Session II - Saturday Evening

Conceptual thresholds for same and different in old and new world monkeys

Timothy Flemming & Michael Beran (Georgia State University)

P33 The judgment of relational information has proven difficult for several nonhuman animal species (e.g. Fagot, Wasserman & Young, 2001; Flemming, Beran & Washburn, 2007) hindering their ability to reason analogically. In the current study, we further examine the extent of this so-called difficulty by presenting old- (*Macaca mulatta*) and new world monkeys (*Cebus apella*) with relational discrimination paradigms of varying entropy across trials. 2 of 6 completely naïve capuchin monkeys succeeded at levels significantly above chance on a 2-item (two-choice same/different) discrimination within 500 trials. In experiment 2, we presented rhesus monkeys the same two-choice discrimination task but with the addition of a self-selecting measure of task difficulty at each level of entropy titration (8 to 2 items). At each subsequent level, reward was increased two-fold, raising motivation to maintain the current level of performance. While rhesus monkeys all successfully reached the most difficult level within 2000 trials, fluctuation between trials, specifically between 3-4 and 2-3-item thresholds may suggest a marked difficulty with lower entropy levels, further lending support to the notion of perceptual dependency in concepts for rhesus monkeys not observed to the same degree in capuchins.

Does ontogeny play a role in horses' (*Equus ferus caballus*) ability to understand human points?

Alicia M. Hall, Nicole R. Dorey, Clive D. L. Wynne, Monique A. R. Udell (University of Florida)

P34 Over a decade of research into the ability of dogs to follow human pointing gestures to locate food has led to controversy on the relative importance of genetic domestication and individual ontogenetic experience in this skill. To further explore the importance of domestication and experience we tested two groups of horses (*Equus caballus*). Unlike dogs, horses do not usually live in human homes, and the manner of typical human-horse communication is quite different between the two species. This study examines the role of ontogeny by testing horses that has been trained using two different methods: Parelli natural horsemanship and traditional. The results of this study show that horses trained using the Parelli method, which involves more exposure to different human social cues, learned how to follow a momentary distal point significantly faster than those that were trained by traditional methods.

Natural concepts in domestic dogs

P35 *I. Erica Feuerbacher & Jesus Rosales-Ruiz (University of North Texas)*

The current study investigated concept formation in domestic dogs, specifically that of a toy concept. The dog's differential

responding (retrieval vs. non-retrieval) to two sets of stimuli suggested a toy concept. Differential responding occurred from the very first trial, indicating that the concept had been formed in the natural environment, not during the experiment. It was hypothesized that a common response may be responsible for the emergence of the class in the natural environment. The results demonstrated that it was possible to expand the class by adding previously non-retrieved objects to the toy class through a common response. It was also shown that the toy concept passed the more stringent criterion (transfer of function test) required to validate it as a concept.

Same/Different Reversal Learning in Pigeons

Adam M. Goodman, Jeffrey S. Katz (Auburn University), & Anthony A. Wright (University of Texas Medical School at Houston)

P36 Reversal learning is a common procedure for studying discrimination learning, but has yet to be studied in a same/different abstract-concept learning task. In the present study, the ability to learn a same/different task with repeated contingency reversals was assessed in 4 pigeons with extensive experience in a two-item same/different task. Subjects were shown a sample picture (FR 14), then, simultaneously presented below the sample, another picture and a white rectangle. If the two pictures were the same, the correct response was to touch the lower picture. If the two pictures were different, the correct response was to touch the rectangle. Once steady-state performance was obtained, the contingencies were reversed such that if the two pictures were the same, the correct response was to touch the rectangle. If the two pictures were different, the correct response was to touch the lower picture. Upon reaching criterion, a reversal back to the initial contingency was implemented followed by subsequent repeated contingency reversals. The results indicated pigeons can learn same/different reversals and continue to solve the same/different task relationally.

Effects of Set-Size on Abstract Concept Learning in Rats Using Olfactory (N)MTS Procedures

Lucia Lazarowski, Rachel Eure, Mallory Gleason, Adam Goodman, Aly Mack, Alex McLean, Preston Stakias, Aaron Ward, Mark Galizio, & Kate Bruce (University of North Carolina Wilmington)

P37 Match (MTS) and Non-Match-to-sample (NMTS) procedures are used to assess concepts of identity and oddity across species and are measured by transfer performance to novel stimuli. Number of exemplars used in training (set-size) may affect learning; when set-size was systematically increased, performance on novel tests improved in pigeons (Bodily, 2008). Type of procedure (MTS vs. NMTS) may affect acquisition of conditional discriminations with mixed findings on which procedure is learned faster. We explored the effects of set-size and procedure on concept learning in rats using olfactory stimuli. Rats were trained to either MTS or NMTS with 2 or 10 stimuli, and then tested for concept learning by presenting 10 novel stimuli. No difference was found between MTS and NMTS, but rats trained with 10 stimuli performed better on novel tests than rats trained with 2. When set-size was expanded from 2 to 10 and rats were re-tested with 10 novel stimuli, performance increased demonstrating that training with multiple exemplars facilitates concept learning.

Contextual Equivalence

Jennifer R. Laude, Holly C. Miller, & Thomas R. Zentall (University of Kentucky), Mikael Molet (Université de Lille)

P38 Evidence for functional stimulus equivalence has been found with a transfer of training design using two matching-to-sample tasks. Training a novel association where an emergent relation is demonstrated confirms equivalence. Our current experiments aim to assess whether an emergent relation will form between two sample stimuli that share a common context despite never occurring together. We trained pigeons on two matching to sample tasks. In one task, the two samples, A and B, were each presented in a different context X and Y. In the second task, two different samples, C and D, were each presented in one of the two contexts, C in context X and D in context Y. On test trials, in a neutral context, we presented a sample from one task with the comparisons from the other task. We asked if context, not present on test trials, could serve to mediate an emergent relation between novel combinations of samples and comparison stimuli (A-C, B-D). That is, can context become the basis for an emergent relation and the formation of a functional equivalent class.

Monkeys show recognition, but not priming, in a categorization task

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

P39 Humans show visual perceptual priming by identifying degraded images faster and more accurately if they have seen the original images before, while simultaneously lacking recognition memory for those same images. Priming is commonly thought, with little evidence, to be widely distributed phylogenetically. Following Brodbeck (1997), we trained rhesus monkeys (*Macaca mulatta*) to categorize photographs according to content (e.g., birds, fish, flowers, people). In probe trials, we tested whether monkeys were faster or more accurate at categorizing degraded versions of previously seen images (primed) than degraded versions of novel images (unprimed). Monkeys showed good categorization, but no benefit from having seen the images before. This finding was robust across manipulations of image quality (color, grayscale, outlines), type of image degradation (occlusion, blurring), levels of processing, and number of repetitions of the prime. By contrast, in probe trials using a matching paradigm, monkeys recognized the primes, even when the images were degraded. Monkeys could therefore remember the primes and discriminate them from other images in the same category under the same conditions used for categorization. Recognition without priming under the same conditions presents a puzzle.

Ordered list presentation may affect response patterns by an orangutan in an unrestricted report task.

Erin E. Stromberg (Smithsonian's National Zoo), Sharon A. Himmanen (Cedar Crest College), & Karyl B. Swartz (Great Ape Trust)

P40 In a list-learning task, two orangutans developed and used a right-to-left spatial response strategy when reporting items from lists that had been presented randomly on a touch-sensitive video screen. When list items from familiar lists were presented in a constant order, one animal abandoned the spatial response strategy but returned to using the response pattern when those lists were presented in random order (Stromberg, Himmanen & Swartz, CO3, 2007). In the present study we presented novel ordered and unordered lists to determine whether the previous return to the spatial response strategy during unordered presentation was a function of the familiarity of the lists. Two sets of novel lists were presented, one set with ordered presentation and the other with unordered (random) presentation. As before, the orangutan who had abandoned the spatial response strategy in the ordered presentation condition showed evidence of using the spatial response pattern less during ordered presentation than during random presentation. This shift in strategy, shown with familiar and novel lists, contrasts with the persistent use of the right-to-left response strategy by four other orangutans, three of whom had learned only ordered lists.

Memory Monitoring in Rhesus Monkeys (*Macaca mulatta*)

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

P41 Recently developed metamemory paradigms provide objective behavioral measures of the accessibility of memory in nonhumans. Animals that can monitor their memory should perform better on memory tests if given the choice to decline trials when memory is weak, compared to when there is no option to decline tests. There is growing evidence that rhesus monkeys selectively decline tests when memory is weak (Hampton, 2001; Smith et al., 2003), but such evidence is limited. The goal of the present study was to test the robustness of monkeys' ability to monitor their own memory using a new foraging-like spatial test with a decline-test response. Six rhesus monkeys performed a four choice delayed matching to location task. Monkeys performed significantly better on trials with the decline option available than on trials without it, indicating that they appropriately declined tests when memory was weak. Monkeys transferred appropriate use of the decline-test response under three conditions that assessed generalization: two transfer tests weakened memory and one transfer test enhanced memory. These results provide converging evidence that rhesus monkeys are able to monitor their memory.

Do orangutans know when they do not remember?

Chikako Suda-King & Francys Subiaul (The George Washington University, Smithsonian National Zoological Park)

P42 In a series of studies, we evaluated whether five orangutans escaped spatial and object recognition memory tests when they did not remember. In the study, two grapes were hidden in one of four containers (A, B, C, & D). The apes were allowed to choose one of the containers or an escape response, which resulted in one grape. This procedure was used in two types of trials: difficult and easy. During difficult trials, the ape witnessed the baiting in one of four different containers and after a delay, during which all containers were hidden from view, the subject was allowed to choose one of the four containers. During easy trials, the baiting occurred in front of the subject and the containers never left the sight of the ape. All the orangutans, at the individual level, were significantly more likely to decline difficult trials than easy ones, and they were significantly more successful at selecting the baited container when the escape option was available than when it was not. This result, together with earlier work (Suda-King, 2008), suggests that apes monitor their own attention and the strength of their memories.

Mirror-Induced, Mark-Directed Behavior in the Clark's Nutcracker, But Not the Western Scrub Jay

Kristy Gould, Andrew Hrvol, Karl Gilbertson, Corey Christensen, and Morgan Ames (Luther College)

P43 For many years, it was only thought that great apes could use a mirror to recognize a mark placed on an out-of-sight location on their body. Then two papers reported mirror-induced, mark-directed behaviors in dolphins and elephants. Finally, Prior et al. (2008) demonstrated this behavior in the European magpie. Magpies are members of the corvid family, which includes many species of birds that are good at cognitive tasks. Two examples are the Clark's nutcracker, which has a tremendous spatial memory, and the Western scrub jay, which demonstrates episodic-like memory and future planning. Therefore, we were interested in whether these two species of birds might also show mirror-induced, mark-directed behaviors. We directly replicated Prior et al. with six Clark's nutcrackers and six scrub jays. We found one nutcracker showed significant mark-directed behavior in the presence of a mirror when a colored sticker was placed on the nape of its neck, as compared to control conditions. This is similar to what Prior et al. showed in their study. None of the scrub jays in our study demonstrated this behavior. We plan to investigate if the remaining nutcrackers, given further mirror experience, may also demonstrate the same behavior.

Future anticipation in black-capped chickadees

Miranda C. Feeney, William A. Roberts, & David F. Sherry (University of Western Ontario)

P44 Mental time travel (MTT) entails the ability to recall personally experienced past events and to envision or plan for possible future scenarios. We have previously observed retrospective, what-where-when memory (WWW memory) in black-capped chickadees (Feeney, Roberts, & Sherry, 2009). The current research encompasses two experiments designed to test the prospective, future anticipation abilities of black-capped chickadees. In Experiment 1, modeled after Flaherty & Checke (1982), chickadees exhibited anticipatory contrast between nutritive foods. That is, if access to less preferred sunflower seeds was followed some time into the future by the delivery of favoured mealworms, birds inhibited consumption of sunflower seeds in anticipation of mealworms. Inhibition of sunflower seed consumption was observed over 5-, 10-, and 30-min delays prior to mealworm delivery. When tested in an aviary under naturalistic foraging conditions (Experiment 2), birds also anticipated future states of food patches based on current choices over a 30-min delay, making choices that ensured the future availability of favoured mealworms. Demonstration of WWW memory (Feeney et al., 2009), and now future anticipation, suggests that black-capped chickadees are capable of a form of MTT into both the past and the future.

Blindfolded imitation in a bottlenose dolphin

Emily Guarino, Kelly Jaakkola, & Mandy Rodriguez (Dolphin Research Center)

P45 This study investigated the ability of a bottlenose dolphin to adapt a previously learned do-as-I-do procedure to copy behaviors of another dolphin while blindfolded (i.e., wearing eyecups). Experiment 1 demonstrated that the dolphin could copy both vocal and motor behaviors, whether blindfolded or sighted. Although he echolocated during many of the motor behaviors while blindfolded, this echolocation did not correlate with the accuracy of his imitation. Experiment 2 showed that blindfolded human trainers were able to identify many of these same model behaviors on the basis of their characteristic sounds. While it thus remains unclear whether the dolphin recognized the motor behaviors via echolocation or their characteristic sounds, this is the first demonstration of such flexibility in using a new perceptual route to motor imitation in a nonhuman animal.

Social learning and diffusion of novel foraging tasks in orangutans (*Pongo pygmaeus* and *Pongo abelii*)

Marietta Dindo, Tara Stoinski, Francys Subiaul, & Andrew Whiten (The George Washington University and Smithsonian National Zoological Park)

P46 The present study used a diffusion chain paradigm to investigate whether a novel foraging task could be observationally learned by zoo-living orangutans (*Pongo pygmaeus* x *Pongo abelii*) and then transmitted along a chain of individuals. Either of two methods (slide or lift) could be used to open the door of a foraging apparatus to retrieve food. One adult male was trained to exclusively slide the door and demonstrate this method to another orangutan in his social group. The observer then had the opportunity to manipulate the apparatus to gain access to food. If the observer was able to open the apparatus twenty times by either method, it then became the demonstrator for a new subject in the group, thus simulating the spread of a foraging tradition among 'generations' of group members. Observers in the slide group [n1=5] were all from the same group, while three smaller groups [n2=6] took part in the lift condition of the study. Since the groups did not always have complete visual access to

demonstrations, video-tapes were used to demonstrate the model's actions. The model-seeded technique was successfully transmitted along both experimental chains with consistent preference for the respective method [n1=3, 59/60 slide, two-tailed binomial $p < 0.0001$; n2=5; 100/100 lift; two-tailed binomial $p < 0.0001$]. These results are consistent with claims for social transmission of foraging methods in wild orangutans.

Orientation in Trapezoid-Shaped Enclosures: Determination of Geometric Features Controlling Spatial Choice

Taylor Gurley (Georgia Southern University), Bradley R. Sturz (Armstrong Atlantic State University) & Kent D. Bodily (Georgia Southern University)

- P47 Human participants learned to select one of four distinctively marked corners (i.e., red, yellow, blue and green) in a rectangular virtual enclosure. After training, test trials were interspersed with training trials. On test trials, all markers were equivalent in color (i.e., white), and the geometric structure of the enclosure was manipulated. For each test trial, a single long wall or short wall of the enclosure increased twice as long or half as long as the training enclosure. These manipulations produced eight unique trapezoid-shaped enclosures and one rectangular enclosure (i.e., control). Participants were allowed to select only one corner during test trials. Selected corners during test trials revealed which geometric features of the enclosures were controlling choice behavior. For example, participants may have learned to approach 90° angles, a long-wall to the left or right, a short-wall to the left or right, a ratio of long-to-short walls, or some combination of these geometric features. Results and theoretical implications will be discussed.

Encoding of variability of landmark-based spatial information

S. Paul Cooke, Stephanie M. Diemer, Caroline K. Eastman, Martha R. Forloines, Rebecca A. Hattaway, Sebastian N. Krzywanski, (Armstrong Atlantic State University), Kent D. Bodily (Georgia Southern University), & Bradley R. Sturz (Armstrong Atlantic State University)

- P48 In a three-dimensional virtual-environment open-field search task, we provide evidence that human participants encoded the variability of landmark-based spatial information. Specifically, participants searched for a hidden goal location in a 5 x 5 matrix of raised bins. Participants experienced five training phases in which they searched for a hidden goal that maintained a unique spatial relationship to each of four distinct landmarks. Each landmark was assigned an a priori value of locational uncertainty such that each varied in its ability to predict a goal (i.e., varied in number of potential goal locations). Following training, participants experienced conflict trials in which two distinct landmarks were presented simultaneously. Participants preferentially responded to the landmark with the lower uncertainty value (i.e., smaller number of potential goal locations). Results provide empirical evidence for the encoding of variability of landmark-based spatial information and have implications for theoretical accounts of spatial learning.

Discrimination of Hidden Spatial Structures by Pigeons

Allison A. Cook (Clark School) & Robert G. Cook (Tufts University)

- P49 Three pigeons learned to discriminate invisible spatial structures in a fixed area of a computer monitor. The procedure used a go/no-go discrimination in which a variably located dot was moved around from trial-to-trial in the fixed area. The pigeons learned to discriminate the regularities in simple hidden structures, such as when only the locations on the left half of the screen were reinforced. Different possible accounts of their performance are considered.

A novel assessment of object permanence in orangutans

Suma Mallavarapu (Kennesaw State University), Bonnie M. Perdue (Georgia Institute of Technology), Tara S. Stoinski (Zoo Atlanta), Terry L. Maple (Georgia Institute of Technology, Palm Beach Zoo)

- P50 Object permanence (OP) is the understanding that objects continue to exist even when not perceived. Many species tested so far have failed one of the tasks in the standard OP test battery, namely, the non-adjacent double invisible displacement (DID). It has been hypothesized that this failure is because of an inability to inhibit sequential search when boxes are close together, and that performance might improve if boxes are far enough apart to require subjects moving around when making choices. The present study compared performance of orangutans (a species which has failed the non-adjacent DID in previous studies) on standard OP tasks and on tasks conducted in a large-scale locomotive space. As in previous studies, orangutans passed all standard OP tasks, except the non-adjacent DID. Testing in locomotive space did not improve performance on this task. Previous researchers have controlled for the possibility that subjects could be solving OP tasks by using certain simple search strategies, without a true understanding of object permanence. While the present study also controlled for these strategies, we found that an additional step in data analysis is required, before all possible strategies can be ruled out. This finding warrants a re-evaluation of previous studies of OP.

Does Travel Time Affect Cognitive Maps?

Mary Carol Way, Steven Smith, & Kent D. Bodily (Georgia Southern University)

- P51 The present experiment tested novel shortcutting in a desktop-virtual environment Y-maze. Ps were trained to carry colored flags (Red, Blue) from the start room (Yellow) to the corresponding end room (Red, Blue). On test trials, Ps began in any of the three end rooms with a flag color which matched one of the other two end rooms. The training alleys were closed, and 15 novel alleys were available. The novel alleys radiated from the end room in a sunburst fashion, and which alley Ps chose was of interest. Additionally, Ps were assigned to one of three training groups: Control, Red Fast, and Red Slow. The movement speed for the Control group was constant. However, the movement speed for Red Fast was 150% faster than Control when approaching the Red end room, and the movement speed for Red Slow was 50% as fast as Control when approaching the Red end room. How movement speed affects novel alley choice suggests how travel time affects spatial representation. Results will be discussed.

Landmarks Exert Greater Control Over Human Navigation Than Dead Reckoning

T. Alexander Daniel & Kent D. Bodily (Georgia Southern University)

- P52 Foo et al. (2007) suggested that humans rely on external landmarks (i.e., piloting) rather than an internal sense of direction (i.e., dead reckoning) when the two are put into conflict. In the present study, conducted in a desktop virtual environment, participants navigated from the center of a landmark cluster to a marker (8m), then rotated (105 deg) and navigated to a second marker (8m). All participants then navigated to where they estimated the start of the path to be. However, the cluster of landmarks that was centered on the starting point at the beginning of the path changed location to the left, right, forward, backward, or was absent when participants made their return estimates. Half of the participants were informed that the landmarks may change location and the other half were not informed. The results indicated that when the landmarks were not available, participants could accurately

return to the start. However, when the landmarks were available, participants approached them even though they had changed location. That is, similar to what has been found in pigeons (Sutton & Shettleworth, 2005) and hamsters (Etienne et al., 2004), when landmark information conflicted with dead reckoning, landmarks were preferred.

Capuchin monkeys (*Cebus apella*) Choose Efficient Routes Using a Laser Pointer Apparatus

Allison Eury (University of Georgia)

P53 Choosing an efficient path through a series of goal sites is a problem with survival implications for nonhuman primates. In a laboratory setting, tufted capuchin monkeys (*Cebus apella*) were presented with a traveling salesman problem consisting of two goal sites. A laser pointer apparatus allowed stationary subjects to choose goal sites in sequence by manipulating a joystick controlling a laser dot. As the subjects are stationary, the perspective of the animal does not change with each subsequent choice. Distance ratios (i.e., 1:1, 1:2, 1:3, and 1:4) between the laser dot and the goal sites resulted in two potential path choices: efficient and inefficient. When both goal sites were equidistant from the subject, capuchin monkeys were capable of making efficient path choices at all distance ratios. The ability to make efficient choices when goal sites vary in their distance from the subject itself is discussed. The ability to make efficient route choices without a change in the perspective of the subject itself is essential to planning a future route.

Pigeons' learning of target-related spatial cues in a high-resolution satellite map

Tomokazu Ushitani, Koki Makino, & Masako Jitsumori (Chiba University)

P54 We trained pigeons in a simulated navigation task using a high-resolution satellite map presented on a computer monitor. The task was to move the target (a building on the map) to the goal (a circle superimposed on the center of the display). At the beginning of each trial, a section of the map was presented in the display, and the target was located to either the left or right of the goal. Whenever the pigeons pecked at the left half of the goal, the map scrolled to the left, and whenever they pecked at the right half of the goal, the map scrolled to the right. The pigeons were rewarded when the target reached the goal. When the error responses moved the target outside of the display for a specified time, an intertrial interval immediately followed. In a subsequent testing, the pigeons were able to move the target to the goal from its initial position outside of the display. These results suggest that the pigeons learned to use not only the target itself but also other target-related cues on the map.

Concrete Order 8 organizes two or more binary actions

Michael Commons (Harvard Medical School)

P55 Concrete Order 8 actions organize Primary Order 7 actions. The stage of performance of an action is determined based on the hierarchical complexity of the task being addressed. This paper illustrates how Concrete Order actions coordinate actions from the Primary order. For example, de Waal and Lanting (1997) describe the captive Bonobo chimpanzee Kanzi making stone flakes by throwing a rock against a hard surface, producing many flakes at once. First Kanzi made simple flake tools, a Primary Stage 7 action. Then, Kanzi tested each flake with his lips, rejecting non-sharp ones, another Primary Stage 7 action and finally used the sharp stone flakes. Thus Kanzi organized three Primary Stage 5 actions into a Concrete Stage 8 action. De Waal (1996) describes how a beta male chimpanzee broke up conflicts in an impartial manner. To act "impartially", the beta male considered the perspectives of the other chimps along with his own perspective. Whereas his awareness of each of these perspectives is a primary stage action, his ability to integrate all of these perspectives together was Concrete Stage 8 action.

Primary Stage 7 performances in animals

Patrice Miller (Salem State College)

P56 Primary Order 7 actions organize Preoperational Order 6 actions. The stage of performance of an action is based on the hierarchical complexity of the task being addressed. This paper illustrates the difference between these two orders using examples from some non-human animals and school aged children. Primary Order 7 actions may organize counts of organized objects from the Preoperational Order 6 tasks and apply them to very large numbers of random objects. Washburn and Rumbaugh (1991) trained Rhesus monkeys to select Arabic numerals associated with a number of food pellets. They reliably chose the numeral associated with the larger number of food pellets in a random array of up to 5 numerals. Rumbaugh, Hopkins, et al (1989) showed an adult female chimpanzee removing from a TV display the number of boxes appropriate to the value of a randomly selected Arabic numeral, 1, 2 or 3. Children count 100's of objects.

Why the Abstract Order may not be reached in non-human animals and how it makes higher stage performances possible in humans

Lucas Commons-Miller (Dart Institute) & Michael Commons (Harvard Medical School)

P57 In the Model of Hierarchical Complexity, Abstract Order 9 actions organize Concrete Order 8 actions. At the Concrete Order, actions consist of a small number of specific instances, such as making a particular gesture to close a deal. At the abstract order, actions consist of large or indefinite sized-sets of instances, often referred to as variables when ordered. For example, at the Concrete Order, one might have a hunting party of individuals who know each other. At the Abstract Order, a larger "war or hunting unit" may use symbolic representations to denote group membership. To do this, one must have arbitrary words, symbols or pictures to represent large sets. Language is the means most often used. Language with arbitrary words is acquired at the Nominal Order 4. This makes designations at Abstract Order 9 possible. Many animals successfully complete tasks at Nominal Order 4, not because they have language, per se, but they have some analogous mechanism. This analogous, representational mechanism lacks some key characteristics of language. In particular, language is more likely to become decontextualized and so is more likely to serve as a symbol as development proceeds, as will be shown in a number of examples.

The potential relationship between personality and success on training and problem-solving tasks

Brooke Alexander, Erin Mahoney, Jessica Boucher, Elizabeth Flores, Sarah Nadler (Eckerd College), Monica Mogilewsky (Myakka City Lemur Reserve) Stan Kuczaj (University of Southern Mississippi), & Lauren Highfill (Eckerd College)

P58 The study of animal personality has blossomed over the past few decades, and the possibility that individual animals exhibit distinct personality traits has been explored in a number of species. However, there is little research on the extent to which different personality traits covary with differences in cognitive abilities. This study used ethological coding and behavioral tests to assess the relationship between lemur behavior and personality traits. Behaviors of interest included level of activity, solitary and social tendencies, curiosity, and perseverance. Learning rates on a target training task and success rates on a problem-solving task were also measured. Preliminary data indicate that certain personality traits, such as curiosity, may be related to learning rates and

problem-solving capabilities in lemurs.

Multiple-pair transposition based on relative speed of rotation

Gwendolyn Carlson, Emily Leiker, & Olga Lazareva (Drake University)

P59 Pigeons demonstrate robust relational learning after multiple-pair transposition training (Lazareva, Young, & Wasserman, 2005; Lazareva, Miner, Young, & Wasserman, 2008). These studies, however, employed the stimuli varying along the same dimension (i.e., size), raising concerns about generality of the findings. We trained pigeons to select the faster (or the slower) of the two stimuli rotating around X-axis. The first group of pigeons was trained with the pairs 1+ 2- and 2+ 3- (or 1- 2+ and 2- 3+; digits denote speed of rotation and plus and minus signs denote reward and nonreward, respectively). The second group of pigeons was trained with the pairs 1+ 2-, 2+ 3-, and 3+ 4- (or 1- 2+, 2- 3+, and 3- 4+). We expect to replicate an increase in relational learning from two-pair to three-pair training. We will also explore whether relational disparity (i.e., the dissimilarity of the two testing stimuli) and novelty (i.e., Euclidean distance from the testing pair to the training pair) will affect relational responding as it was reported earlier.

Differential stimulus control during acquisition, generalization, and discrimination in "Target-Training" of individual group-housed capuchin monkeys (C. Apella)

Lillian Basom, Caitlin Knierim, & Roger Thompson (Franklin & Marshall College)

P60 Target-Training has become a popular application of conditioning procedures to facilitate 'voluntary cooperation' by captive animals in the conduct of husbandry practices and veterinary examinations by bringing their behavior under auditory or visual stimulus control. Target training was used here to control movement of individual capuchin monkeys (C. apella) to and from their group-housing enclosure to adjacent test chambers by rewarding them for approaching, following and touching their respective physical colored geometric target. In a simultaneous discrimination task paired individuals attempted to touch the other animal's target as often as their own suggesting that their behavior was not controlled by their target's specific features. However, when tested individually animals accurately discriminated their specific target from that of others and subsequently also with a novel stimulus set consisting of all possible shape/color combinations. The animals' above chance (>80%) performances transferred to differently sized targets presented physically behind mesh or glass or digitally on a touch-screen. The few errors that occurred were made to stimuli with neither shape nor color overlap with an individual's target revealing temporary preferences for stimulus novelty and, in rare cases, individual preferences for specific shapes &/or colors.

Interval Timing Behavior in Response to Stimulus Compounds as a Function of Reinforcement Probability

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P61 Previous studies investigating stimulus compounding on the peak-interval procedure have reported that scalar responding at the geometric mean of the anchor durations occurs on simultaneous compound trials (light+tone) in rats trained that an auditory stimulus (tone) signals a short duration, while a visual stimulus (houselight) signals a long duration. However, in the reverse training condition, rats respond in a non-scalar rightward skewed manner that began at the short duration, and ended at a time in-between the short and long peaks. In the present study, rats were initially trained on a two duration peak-interval (PI) procedure in which a tone signaled a short duration (4s) and the houselight signaled a long duration (12s). We provided reinforcement on 50% of short tone trials, and on 25%, 50%, or 75% of long light trials. In contrast to previous results, both scalar and non-scalar response patterns were seen on compound trials. However, the frequency of the non-scalar pattern was an inverse function of the reinforcement probability for the long trial. These findings suggest that reinforcement value influences the selection of memories for initiating and terminating temporally controlled responding.

Associative learning in newborn babies

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P62 Associative learning is a determinant factor in adaptation to the environment in which we have to live and therefore should start very early in life. In order to test the ability of newborn babies to learn the association between two events in their environment, 32 two-day-old participants were exposed to eight repeated associations of a short sound immediately followed by a significant modification of brightness in the experimental room. Sucking was recorded through a non nutritive nipple connected to a pressure detector. The sound followed by the visual stimulus always occurred at the beginning of a sucking burst. Their first reaction to the visual event was a clear interruption of sucking though this response very rapidly habituated. Most interestingly, the same response occurred when the second event was "omitted" after only eight presentations of the association hence showing the ability of very young humans to learn, in only a few trials, to predict an expected outcome. These results are discussed in terms of how babies learn to adapt themselves to the new environment they have to learn.