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March 13 to March 16, 2002

Radisson Hotel
Melbourne Beach, Florida

CO3 2002 Program Summary

Wednesday March 13 (Evening Sessions 6:15 - 10:15)

6:15 - 6:25 - Welcome to CO3 - 2002……
6:25 - 7:35 - Identity Concepts……..
7:50 - 9:15 - Tool Use, Transitive Inference, & Problem Solving……..
9:25 - 10:15 - Timing……..

Thursday March 14 (Morning Sessions 8:00 - 11:45)

8:00 - 9:15 - Cognitive Maps……..
9:30 - 10:35 - Conditioning I……..
10:50 - 11:45 - Foraging and Food Preferences……

Thursday March 14 (Afternoon Sessions 2:00 - 7:15)

2:00 - 2:55 - Drugs and Genes……..…
3:10 - 4:30 - Number Discrimination……..
4:45 - 6:00 - Visual Discrimination and Perception I……
6:15 - 6:55 - Visual Discrimination and Perception II……..
6:55 - 7:15 - Funding Opportunities for Comparative Cognition……

Friday March 15 (Afternoon Sessions 1:00 - 7:00)

1:00 - 2:20 Spatial Learning and Attention…….
2:30 - 4:05 - Conditioning II …..……..
4:15 - 5:50 - Social Learning and Social Effects on Learning……
6:00 - 7:00 - Featured Presentation (Howard Eichenbaum)……..

Saturday March 16 (Afternoon Sessions 1:20 - 6:30)

1:20 - 2:20 - CCS Business Meeting ……
2:35 - 3:30 - Serial Learning……
3:45 - 5:00 - Auditory Discrimination Learning…….
5:15 - 6:30 - Causal Judgement……

Identity Concepts 6:25 - 7:35

Bob Cook, Chair

6:25-6:35 (1-10)
Pigeons learn both stimulus identity and stimulus relations when the two cues are redundant and relevant
Brett M. Gibson & Edward Wasserman (University of Iowa)
We taught four pigeons to discriminate between displays composed of 16 identical or 16 nonidentical items. Unlike most same-different discrimination studies, both stimulus identity and stimulus relations among the items were relevant during learning. We found that the pigeons learned both stimulus identity and stimulus relations, when these two sources of information served as redundant, relevant cues. These results thus suggest that the pigeon is a most flexible and attentive animal, which is fully able to respond to both specific stimuli and general relations in the environment.

6:40-6:50 (2-10)
Set Size and Concept Learning by Pigeons and Monkeys
Jeffrey S. Katz (Auburn University) & Anthony A. Wright (University of Texas Medecial School at Houston)
A series of experiments with pigeons (Columba livia) and rhesus monkeys (Macaca mulatta) show a direct relationship between concept learning and set size. Both species were trained in virtually identical same/different tasks to discriminate (simultaneously) pairs of pictures as same or different. Initial training with a stimulus set size of eight pictures resulted in no transfer to new stimuli. Further training with progressively larger set sizes of 16, 32, 64, and 128 stimuli resulted in progressively more transfer to novel stimuli and culminated, for the most part, in full concept learning. Controls with a fixed 8-item set size for both species ruled out the possibility that continued training itself was responsible for concept learning.

6:55-7:05 (3-10)
Infant Orang utans (*Pongo pygmaeus*) perceive abstract identity relationships
Karyl B. Swartz (Lehman College/CUNY; National Zoo), Robert W. Shumaker (Krasnow Institute; National Zoo), & Willie Smits (Wanariset-Samboja Orang utan Reintroduction Center)
In a familiarization/novelty procedure using a handling measure, three-year-old orphan orang utans were provided serially with two sets of stimulus pairs. The two items of a pair instantiated either an identity relationship between the items or a nonidentity relationship. When preceded by a pair that instantiated the same relationship (Identity-Identity or Nonidentity-Nonidentity conditions) the infants showed decreased handling of the second pair. When the relationship changed between pairs (Identity-Nonidentity or Nonidentity-Identity conditions) an increase in handling was shown to the second pair. These results are consistent with previous results reported by Oden, Thompson, & Premack (1990) with young chimpanzees, suggesting that great ape infants are able to demonstrate sensitivity to complex abstract relationships.

7:10-7:15 (4-5)
Same-different discrimination of 2-icon displays using differential reinforcement of response rate schedules
Andrea Frank, Matthew Murphy & Edward Wasserman (University of Iowa)
Prior research suggests that pigeons have great difficulty discriminating same vs. different displays containing only two icons. In this experiment, we attempted to train a same vs. different discrimination with two icons using differential reinforcement of low rate responding (DRL) for one type of display and differential reinforcement of high rate responding (DRH) for the other type of display. The pigeons showed no difference in response rate for same vs. different displays. The birds were then given the same task with 16-icon displays; the pigeons now showed rapid discrimination learning. Testing with novel icons yielded high discrimination transfer. Finally, the number of icons was progressively dropped to 8, 4, 3, and then 2 icons. The pigeons' discrimination of same vs. different displays fell with lower number of icons in the display. These results again document same-different discrimination learning and transfer in pigeons, and again suggest that this behavior is based on the variability of the pictured items.

7:15-7:20 (5-5)
Category delayed matching-to-sample by rhesus monkeys (*Macaca mulatta*)

Sharon Himmanen (Lehman College/CUNY) Two adult male rhesus monkeys were given a delayed matching-to-sample (DMTS) task in which the sample and the match were non-identical but from the same category. The stimulus set (N=32) was comprised of four images from each of eight specific natural categories (tree frogs, finches, angelfish, daisies, corn, monarch butterflies, basset hounds, conch shells). The monkeys' accuracy across sessions was consistent and significantly better than chance. These data suggest that one possible criterione for producing successful matching of non-identical items lies in the number of overlapping or similar features within a category.

7:20-7:25 (7-5)
Exclusion and classification in California sea lions
Colleen Reichmuth Kastak & Ron Schusterman University of California, Santa Cruz)
When subjects that are experienced with MTS procedures are presented with a novel sample, a novel comparison, and a familiar comparison most respond by correctly selecting the novel comparison in the presence of the new sample. We expanded this exclusion paradigm with two California sea lions that had previously formed two ten-member equivalence classes. Rather than presenting our subjects with novel samples, we presented any familiar member of one class as the sample. One comparison was any familiar member of the opposing class and the other was a novel stimulus. When forced to choose which comparison matched the sample, the subjects reliably rejected the familiar comparison, and instead selected the unfamiliar comparison. When the subjects were given transfer problems, they immediately grouped the new stimuli into the appropriate classes. Our findings show that exclusion procedures can generate new stimulus relations and can be used to expand stimulus classes.

Tool Use, Transitive Inference, & Problem Solving 7:50 - 9:15

Suzanne MacDonald, Chair

7:50-8:10 (8-20)
Selectivity for tool length in New Caledonian crows
Jackie Chappell & Alex Kacelnik (University of Oxford)
In the wild, New Caledonian crows (Corvus moneduloides) show an impressive degree of use and manufacture of polymorphic tools, but, until now, they have not been tested in captivity on novel tool-using tasks. We tested the ability of two captive New Caledonian crows to select a stick of an appropriate length (from a range of lengths provided) to obtain food placed at a variety of distances in a horizontal transparent pipe. Both birds chose tools matching the distance to the target significantly more often than would be expected by chance. As far as we are aware, this is the first time that tool selectivity has been shown in a non-primate.

8:15-8:25 (9-10)
Corvus brachyrhynchos "habilis"
P.D. Cole & B.R. Moore (Dalhousie University)
In 1965 Hess reported instances of a captive crow using a small plastic cup to transport water to a food pan in order to moisten his food (Beck, 1980). Similar tool-use has been documented in detail in our laboratory. Further, our captive crow, Loki, not only transports water to food (using three different objects), but also transports food to water, and moves multiple items around his room using other objects as trays. He positions and sets in motion a slinky, which he then uses as a head-scratcher. And, perhaps most impressively, he gains access to preferred items that are out of reach by moving a lightweight perch into place (cf. Kohler's 1927 chimps). Videos will illustrate each of these forms of tool-use.

8:30-8:40 (10-10)
Transitive responding in hooded crows (*Corvus cornix L.*)
Olga F. Lazareva (University of Iowa), Maria S. Bagozkaja (Moscow State University), Zoya A. Zorina, & Valdimir V. Rayevsky (Institute of Higher Nervous Activity, Moscow)
An ability to solve transitive inference (TI) task is an ability to deduce that if b > c and c > d then b > d. In verbal experiments the presence of transitive relation between items was considered to be vital for correct deductions.

Nethertheless, in some experiments in animals subjects selected a correct stimulus in the test without physical ordering of stimuli. We tested an ability to solve TI test in hooded crows. Birds could see feedback stimuli (FS) after the choice. For half of the birds FS were ordered by size, for the other half they were not ordered. Due to special procedure, D had richer reinforcement history than B. In the test subjects strongly preferred B over D only when FS were ordered by size. These results, with simulations, suggest that transitive relation is vital for TI formation not only in verbal, but also in non-verbal tests.

8:45-8:55 (11-10)
The structure of individual differences in mouse problem-solving
Chuck Locurto (College of the Holy Cross)
Our lab has been studying the structure of individual differences in mouse problem-solving for the past several years. Our approach mirrors the typical strategy adopted in the study of human intelligence wherein subjects are given a battery of tasks and the structure of individual differences is assessed via principal components or factor analysis. In human research the standard finding is that all tasks correlate positively, suggesting the presence of an over-arching general intelligence factor. As we have expanded our batteries in terms of task-types and motivational conditions we have found an increasingly fractionated, not general, component structure, suggesting that animal intelligence may not mirror human intelligence in this regard.

9:00-9:05 (12-5)
Sex Differences in Transitive Inference in Humans
Melissa M. Adams & Lucia F. Jacobs (University of California at Berkeley)
Transitive inference is a logical deduction made by extending a relationship across adjacent pairs of items (e.g., if A>B and B>C, then A>C). According to the spatial coding hypothesis, both humans and nonhumans make transitive inferences by first creating a linear spatial array of the premises, then determining which item is nearer one end of the array. We hypothesized that allocentric spatial navigation mediates the creation of this array. In navigation by polygynous mammals, including humans, males rely on directional information to locate objects absolutely in space, whereas females rely on landmarks that indicate relative location. According to our model, males use the transitive relationship as they would a directional axis, to locate premise items absolutely. Therefore males, unlike females, preferentially create a linear array of the premise items, facilitating their performance. Experiments using written methods and nonverbal methods both support the model.

9:05-9:10 (13-5)
Transitive Inference with Two Simultaneous Arrays in Pigeons
Janice N. Steirn, Kelly Burke, Marisa Hall, & Maureen Fitzgerald (Georgia Southern University)
When presented with information that A>B, B>C, C>D, and D>E, transitive inference (TI) is demonstrated when the untrained relation, B>D emerges in testing. Transitive inference has been demonstrated in nonhumans, but the mechanisms underlying TI are not yet clear. The current study seeks to better understand these mechanisms by training pigeons on two stimulus arrays (A>B>C>D>E and A<B<C<D<E) simulutaneously, with a conditional cue indicating which array is in effect. The effects of delay and differential outcome on performance with these two arrays are also being examined.

Timing 9:25 - 10:15
Ron Weisman, Chair

9:25-9:45 (14-20)
Evidence for an oscillator representation of time first
Jonathon D. Crystal (University of Georgia)
Efforts to understand the discrimination of time have proceeded along two relatively independent paths. One group of researchers, primarily experimental psychologists, has investigated the discrimination of short intervals - intervals in the range of seconds and minutes. Another group, primarily chronobiologists, has investigated biological rhythms of approximately a day. These efforts have studied different experimental manipulations and

dependent variables, constructed different theoretical frameworks, and communicated findings to different research communities via different journals. These factors have led to the conclusion that the timing of short intervals and circadian rhythms are based on unrelated mechanisms. However, recent findings about the discrimination of short intervals and circadian intervals suggest similarities in timing in these two domains. This presentation will review three independent lines of evidence that are consistent with an oscillator representation of short-interval timing.

9:50-10:00 (15-10)
Interval timing in rufous hummingbirds (*Selasphorus rufus*)
Jonathan Henderson (University of Edinburgh), T.Andrew Hurly (University of Lethbridge), Melissa Bateson (University of Newcastle), & Sue Healy (University of Edinburgh)
Animals often have to learn temporal relationships. For example, rufous hummingbirds (*Selasphorus rufus*) feed on flowers that gradually refill over the course of several hours. To avoid revisiting recently emptied flowers it would be advantageous to birds if they could remember when they last visited individual flowers. We presented territorial males in the field with an array of eight flowers with fixed-interval schedules of reinforcement. All flowers in the array were full at the start of the day. Thereafter, four flowers were refilled 10 minutes after the bird's last visit and the remainder 20 minutes after the last visit. We found that birds were able to simultaneously measure elapsed intervals of time, with visits to both 10 and 20-minute flowers most commonly occurring on or after their time of refill.

10:05-10:10 (16-5)
A Feeding-Entrainable Oscillator Representation of Time
Matthew J. Pizzo & Jonathon D. Crystal (University of Georgia)
We tested ordinal, interval, and circadian mechanisms of solving a time-place task. Rats searched for food twice in the morning and once in the afternoon (group AB-C, n=5) or once in the morning and twice in the afternoon (group A-BC, n=5) in a box with 4 food troughs. The food location depended on the time of day (12-12 light-dark cycle). The rats visited correct locations prior to food availability. On non-rewarded probes, the time of the middle search (B) was shifted late (for AB-C) or early (for A-BC). The rats visited B at chance, contrary to an ordinal mechanism. When the post-testing meal and light-dark transitions were omitted, the rats visited correct locations at above chance levels on non-rewarded probes, contrary to an interval mechanism. Following lesions to the suprachiasmatic nucleus, rats visited correct locations. The results are consistent with a feeding-entrainable oscillator representation of time.

10:10 (17-5)
Extinction of a Temporal Discrimination
Paulo Guilhardi (Brown University)
The problem was to determine how extinction affects the temporal pattern of responding. Twenty-four rats were trained on three fixed intervals (30, 60, and 120 s) signaled by three different stimuli (noise, light, and clicker). Then they received 50 2-hr sessions of extinction of these temporal discriminations. Although there was a substantial decrease in the mean response rate, many of the properties of the temporal pattern of responding were maintained.

Thursday March 14 (Morning Sessions 8:00 - 12:05)

Cognitive Maps 8:00 - 9:15
Mike Brown, Chair

8:00-8:20 (18-20)
Can Rats Integrate Two Separate Cognitive Maps of the 4-arm Radial Maze?
Jerome Cohen & Kristine Bussey (University of Windsor)
Rats' ability to form two separate topological cognitive maps was determined by training them to select a final baited arm after having been forced into three baited arms in the 4-arm radial maze. On one of two trials in a

session, the arms were differentiated by objects within them and on the other trial, by visual, tactile arm inserts. The relative locations of arms remained constant for each set during initial training. In subsequent training, a two-arm segment from each configuration was combined to form two different configurations. The question asked was whether rats would learn these new configurations more easily when the relative locations of each arm within each segment remain the same or was varied. Conditions under which this effect did and did not occur over subsequent recombinations suggest the way rats initially learned to represent each item (arm) within each topological cognitive map.

8:25-8:45 (19-20)
Hierarchical cognitive maps
Nestor Schmajuk & Horatiu Voicu (Duke University)
Voicu and Schmajuk (2001) presented a neural network model of spatial navigation that includes an action system and a cognitive map. In the cognitive map, the environment is represented as a set of places, each of size comparable to the size of the agent. By spreading activation between the representations of two places in the cognitive map and storing the resulting activities in a working memory, the action system can plan the shortest path between those places. Because the capacity of the working memory might be too small to store the activity of all intermediate places when navigating in a large environment, the cognitive map needs to be organized in a hierarchical way. In this case, the environment is represented at multiple levels, each level with a number of parts equal to the size of the working memory. Path planning starts at the level that contains the points between which navigation is desired, and ends at the lowest level, at which motion is produced.

8:50-9:00 (19-10)
Sex differences in spatial cognition in rats?
Catherine Jones & Sue Healy (Edinburgh University)
Laboratory rats are often used as models for sex differences in spatial cognition, but sex differences are not consistently found. When found, differences are often only apparent during acquisition of a task. We manipulated factors that are only present during acquisition to see if they differentially affected male and female performance in water and radial arm mazes. We tested for sex differences in the rate of learning reward position and room landmarks by moving the reward(s) and landmarks during the maze task. We did not find sex differences at any stage in our experiments, which suggests that male and female rats learn these features at an equal rate. Stress is associated with task novelty and has been suggested to interfere with females' cognition more than males'. However, mild additional stress (15 mins in a restraint tube prior to the task) did not differentially affect the sexes performance.

9:05-9:10 (20-5)
Integration of spatial maps acquired through sensory preconditioning using a touch-screen task with pigeons
Aaron P. Blaisdell (University of California, Los Angeles) & Robert G. Cook (Tufts University)
We presented an experiment last year on spatial memory in foraging pigeons using an open-field search task. Pigeons were trained in separate phases on an A-B and a B-Goal spatial relationship, where A and B were visual landmarks and the Goal was food hidden in a specific location. When presented with Landmark A at test, pigeons searched for the goal most often at a location consistent with their having integrated the A-B and B-Goal experiences. This integration allowed subjects to compute a novel A-Goal spatial relationship. We report here a new experiment that replicates and extends these findings using a touch-screen search task. The many benefits the touch-screen procedure provides over an open-field procedure will be discussed.

Conditioning I 9:30 - 10:35

Russ Church, Chair

9:30-9:50 (21-20)
Evidence for Spontaneous Recovery of a Conditioned Flavor Preference

Nina L. Tarner (Shippensburg University), Jerome Frieman (Kansas State University), & Ron Mehiel (Shippensburg University)
The current research expanded on the findings for extinction of a conditioned flavor preference (Tarner, Frieman, and Mehiel, 2000). Forty-eight rats were first conditioned to prefer one flavor to another by presenting the one flavor with saccharin (CS-) and the other flavor with sucrose (CS+). Following conditioning, the rats were extinguished of their conditioned flavor preference by presenting the CS+ flavor without the calories (no sucrose). A two-bottle spontaneous recovery test was then conducted on the 7th, 14th, or 21st day following the two-bottle extinction test. Evidence for spontaneous recovery of an extinguished flavor preference was found on all three tests.

9:55-10:15 (22-20)
Mediation as a Function of Trial Spacing and Number of Training Trials
Steven C. Stout & Ralph R. Miller (SUNY-Binghamton)
Submit your information abstract: Mediation refers to cases in which responding to a target stimulus is a function of the response potential of a companion stimulus with associations to the target. Mediation has been seen to be both positive (e.g., second-order conditioning and mediated extinction) and negative (e.g., conditioned inhibition and stimulus interference). However, little is known about the variables that determine whether it will be positive or negative; the procedures that produce each are highly similar. We will present data demonstrating that trial spacing and number of training trials are among the critical variables. (Presented by R. Miller)

10:20-10:25 (22-5)
Context mediation of excitatory backward and forward conditioning: Posttraining Context Extinction
Raymond Chang, Steven Stout, & Ralph Miller (SUNY-Binghamton)
We investigated the differential roles of training context in mediating the excitatory potential of backward and forward CSs. Using a Pavlovian lick suppression preparation with rats as subjects, we found that massive posttraining extinction of the training context attenuated the excitatory response potential of a backward CS, whereas this same manipulation augmented the excitatory response potential of a forward CS. Apparently, the conditioning context positively and negatively mediates the excitatory potential of a backward CS and a forward CS, respectively. Thus, these data indicate that the conditioning context has different roles in mediating the excitatory potential of backward and forward CSs.

10:25-10:30 (23-5)
Context mediation of excitatory backwards and forward conditioning: US Pre-exposure
Daniel Wheeler, Raymond Chang, Doreen Yirenchi, & Ralph Miller (SUNY-Binghamton)
A previous experiment in our lab demonstrated that the extinction of the training context following associative conditioning has a differential effect upon the excitatory behavioral control of forward and backward conditioned stimuli. It was hypothesized that the context–US association negatively mediates excitatory control of the CS in forward conditioning, and positively mediates excitatory control of the CS in backward conditioning. To further investigate this possibility, we conducted a conditioned lick suppression experiment with rats to determine the effects of inflating the context–US association prior to forward or backward conditioning. The data indicate that the differential effects of context upon forward and backward conditioning may be seen with the inflation of the context–US association as well as with posttraining extinction of the context.

Foraging and Food Preferences 10:50 - 11:45

Sharon Himmanen, Chair

10:50-11:10 (24-20)
Irrationality in hummingbird foraging decisions

Melissa Bateson (University of Newcastle, UK), T Andrew Hurly (University of Lethbridge, Alberta) & Susan D Healy (University of Edinburgh, UK)
It is conventionally assumed that when animals evaluate alternative options the value assigned to an option is absolute, and independent of the other options available. It follows that animal choices should exhibit the rational property of regularity whereby the proportion of choices for an option cannot be increased by the addition of further options to the choice set. However, violations of regularity occur in human decision-making, suggesting that humans may use comparative evaluation mechanisms whereby the value of an option is computed relative to the other options available. For example, in the asymmetrically dominated decoy effect the preference for a target option over a competitor is altered by the addition of a decoy option, that is inferior to the target and competitor on one attribute, but lies between them on a second. We tested whether foraging wild rufous hummingbirds (*Selasphorus rufus*) would demonstrate violations of regularity in response to an asymmetrically dominated decoy, and confirmed that their choices are affected by the range of options available.

11:15-11:25 (25-10)
A Quantitative Analysis of Amount and Delay in Starlings
Martin S. Shapiro & Alex Kacelnik (Oxford University)
A parametric study was undertaken to investigate how both amount and delay of reward affect the attractiveness of food sources for starlings. Six symbols representing six amount-delay combinations (2 pellets of food after a 5 second delay, 4/10, 1/5, 2/10, 1/10 and 2/20) were presented to fifteen starlings in a series of fifteen choice treatments (each symbol in a discrimination task with each other symbol). Preference was measured in three ways: relative choice, latency to respond in both single symbol and simultaneous presentation trials, and resistance to extinction. The three measures showed the same ordinal preferences across treatments, with latencies and extinction ratios being extremely similar. None of the extant models of amount and delay provide an accurate quantitative prediction of preferences. Alternative models of perception of variation in amount and delay, and of partial preference are presented with an assessment of the sensitivity of these measures of preference.

11:30-11:35 (26-5)
Squirrel Monkeys' Choices in Food
Tammy L.B. McKenzie, William A. Roberts, & Leanne R. Bird (University of Western Ontario)
The effects of food preference and quantity of food on food choice in two squirrel monkeys (Jake and Elwood) were examined. Each monkey was tested with two foods with one food being more preferred than the other food. Results from both monkeys suggest that preference may be a more important factor than quantity of food in determining food choice. In addition, results from Jake, but not from Elwood, suggest that when a preferred food is available in different quantities, the larger quantity is preferred.

11:35-11:40 (27-5)
The Effects of Food Preference on Hoarding and Retrieval Behavior in Rats
Leanne R. Bird & William A. Roberts (University of Western Ontario)
A series of experiments were conducted to examine whether rats possess memory for both where and what food has been cached on the arms of a radial maze. This was investigated by looking at the effects of food preference on hoarding and retrieval behavior. In Experiment 1 rats were allowed to choose the order that the preferred and less preferred foods were hoarded in, and were later returned to the maze and allowed to retrieve the foods. In Experiment 2 the order rats hoarded food in was controlled to examine the possibility that hoarding order affects retrieval order. In both experiments, rats visited arms containing the preferred food before arms containing the nonpreferred food. Results suggest that rats do remember both the location and type of food cached.

Thursday March 14 (Afternoon Sessions 2:00 - 7:00)

Drugs and Genes 2:00 - 2:55

Ralph Miller, Chair

2:00-2:20 (28-20)
Cannabidiol, a non-psychoactive component of cannabis, interferes with lithium-induced conditioned gaping, but not conditioned taste avoidance in rats.
Linda A. Parker (Wilfrid Laurier University) & Raphael Mechoulam (Hebrew University of Jerusalem)
Rats display conditioned gaping during an oral infusion of a flavor previously paired with an emetic drug; considerable evidence indicates that these rejection reactions reflect nausea. Here we report that cannabidiol (CBD), a major non-psychoactive cannabinoid found in marijuana and its synthetic dimethylheptyl homolog (CBD-DMH)interfere with the establishment and the expression of conditioned gaping elicited by a flavor paired with lithium chloride. As has been shown with other anti-emetic drugs, these agents did not interfere with the establishment or the expression of conditioned taste avoidance. These results support our previously reported dissociation between conditioned rejection and conditioned taste avoidance and suggest that cannabinoids without psychoactive side-effects may have therapeutic value in the treatment of chemotherapy-induced nausea.

2:25-2:35 (29-10)
Screening for mice that remember incorrectly first
C.R. Gallistel (Rutgers University), A.P. King (Fairfield University), & R.V. McDonald (Rutgers University)
Identifying the cellular and molecular mechanisms involved in memory is one of the great problems of contemporary neuroscience. We present here a behavioral screen for 'memory mutant' mice that can identify subjects with abnormal memory function, and that provides a basis for further genetic/molecular investigations into the mechanisms of memory. This screen involves a modification of the peak procedure used to test memory for temporal intervals. Data obtained using this preparation also have implications for current models of temporal cognition (Scalar Expectancy Theory, Behavioral Theory of Timing).

2:40-2:45 (30-5)
Morphine Onset Cue-Induced Hyperalgesia: Sensitization or Conditional Compensatory Response?
Marta Sokolowska & Shepard Siegel (McMaster University)
We have suggested that, within each drug administration, early drug onset cues (DOCs) may become associated with the later, larger drug effect. These DOCs elicit conditional compensatory responses that contribute to tolerance. For example, when morphine is administered the early effect of the drug comes to elicit a conditional hyperalgesic response that attenuates the unconditional analgesic effect of the opiate. Such DOC-elicited conditional responding is revealed by presenting a small dose of the drug to rats with a history of administration of larger dose of the drug. It is possible that the hyperalgesia seen in these experiments represents a nonassociative sensitized response, rather a DOC-elicited conditional response. We report the results of an experiment demonstrating DOC-elicited hyperalgesia in morphine-experienced rats in a preparation not subject to an alternative nonassociative interpretation.

2:45-2:50 (31-5)
Conditioned Compensatory Responses Elicited by Interoceptive Ethanol-Onset Cues
Amy B. Young & Shepard Siegel (McMaster University)
There is evidence that exteroceptive cues paired with drug administration come to elicit conditional compensatory responding (e.g., hyperalgesia in organisms with a history of morphine administration). Recently it has become apparent that, within each administration, interoceptive early drug onset cues may become associated with the later, larger drug effect (intra-administration associations). Research evaluating intra-administration associations has been conducted with morphine. We describe the results of research evaluating such associations with ethanol.

Number Discrimination 3:10 - 4:30

Jonathon Crystal, Chair

3:10-3:30 (32-20)
Representation of Arbitrary & Numerical Sequences by Rhesus Macaques
Herbert S. Terrace (Columbia University)
The serial expertise of monkeys defines a rich area of inquiry whose complexity falls beyond the scope of conditioning theory but below that needed to account for natural languages. A variety of experiments have shown that monkeys can learn lists composed of arbitrarily selected photographs and that they can apply an ascending or a descending rule when responding to lists composed of numerical stimuli. The manner in which each type of list is represented was assessed on subset tests in which subjects were presented with all possible pairs that could be derived from 7-item arbitrary lists and/or 9-item numerical lists. Almost perfect first trial accuracies on subset tests rule out procedural memory as an explanation of subjects' serial knowledge. Distance and magnitude effects, similar to those obtained from human subjects tested on their knowledge of positions of the letters of the alphabet or on the relative magnitude of Arabic numbers, suggest that some form of declarative memory is needed to account for a monkey's serial expertise.

3:35-3:55 (33-20)
Numerical discrimination in salamanders
Claudia Uller & Robert Jaeger (University of Louisiana, Lafayette)
Animals are capable of computing number in various ways. One such ability is the discrimination of numerosities found in rats and pigeons through training techniques. An experiment using a forced-choice discrimination method found that a species of amphibians, red-backed salamanders (*Plethodon cinereus*), spontaneously discriminate between
2 and 3 fruit flies. This is a ground-breaking finding, as never before have researchers investigated and found a spontaneous rudimentary capacity for numerical discrimination in animals that date back at least to the Lower Miocene, 28 million years ago.

4:00-4:10 (34-10)
Relative Numerosity Discrimination in Pigeons
Richard Keen (Brown University)
Pigeons were exposed to a frequency discrimination task in which two colored keys were illuminated serially and for a varying number of times (sampling period). Then, in a choice period, both keys were illuminated simultaneously and the pigeons obtained food for choosing the key that occurred the least number of times during the sampling period. At issue was how performance varies with (a) the interval between each stimulus (interstimulus interval), (b) the interval between the two blocked-stimulus sets (interblock interval), and (c) the interval between the end of the sample and the beginning of the choice period (retention interval). Results showed that increasing the interstimulus and interblock intervals reduced the probability of choosing the last stimulus of the sample as the least?frequent one. Increasing the retention interval reduced accuracy without inducing any stimulus bias. A simple mathematical model of the discrimination process accounted well for the major trends in the data.

4:15-4:25 (35-10)
Nonverbal Counting in Humans and Animals
William A. Roberts (University of Western Ontario), Michael J. Boisvert (University of Western Ontario), & Benjamin D. Abroms (University of Kentucky)
Experiments using the peak procedure have shown that pigeons can accurately estimate a fixed number of light flashes and thus suggest that these animals may use a nonverbal accumulator to keep track of number. Comparative data were taken on nonverbal counting by human subjects. People observed a rapidly presented sequence of colored geometric patterns and were prevented from counting them verbally by having the subjects name both the shape and color of the pattern. Subjects then estimated the number of patterns seen both verbally and manually by tapping a key as another set of patterns was shown. Both verbal estimates and peak numbers showed accurate nonverbal counting. A matching-to-sample procedure was used to obtain verbal and manual estimates on

individual trials and revealed consistent positive correlation between verbal and manual estimates of the number of patterns. These findings show nonverbal counting in people and indicate ready translation between verbal and nonverbal representations of number.

Visual Discrimination and Perception I 4:45 - 6:00

Joel Fagot, Chair

4:45-4:55 (36-10)
Underwater Visual Acuity of the Florida Manatee (*Trichechus manatus latirostris*)
Gordon B. Bauer (New College of Florida, Mote Marine Laboratory) & Debborah E. Colbert (Mote Marine Laboratory)
Two male Florida manatees were trained on a two-choice simultaneous discrimination procedure to select between grating stimuli, black and white striped targets. The black and white stripes were of equal width to control for brightness differences. One target with 1mm stripes, the standard, appeared on all trials. The comparison target had stripes with widths that varied across trials. A method of constant stimuli was employed. The threshold, calculated as the minimum angle of resolution (MAR) at 1 meter, was determined at the interpolated 75% correct point. The MAR for one manatee was 23' for vertically oriented gratings and 21' for horizontally oriented gratings. The second subject's MAR was also better for horizontal gratings, but threshold was over 1º. Results are interpreted in terms of retinal morphology and naturally occurring vascularization of the manatee cornea.

5:00-5:10 (37-10)
Reverse lateralization of discriminative abilities in the brain of a passerine, the European Starling
Jennifer Templeton (Knox College) & Diana Gonzalez (Franklin & Marshall College)
Previous experiments using visual feature discrimination tasks have shown a right eye / left hemisphere lateralization in pigeons and domestic chicks. However, the potential lateralization of discriminative abilities in ground foraging passerines (songbirds) has not yet been investigated. In the first experiment, starlings were tested on a simultaneous visual discrimination task in three conditions: binocular, left monocular, and right monocular. Subjects in the left eye and binocular conditions achieved significantly higher performance scores than birds in the right eye condition. A second experiment found similar results; birds in the left eye condition learned the discrimination task over twice as quickly as those in the right eye condition. Subsequent tests with the alternative eye for both groups indicated no inter-ocular transfer. The possibility that this reverse lateralization may be correlated with the presence of the song control region in the left hemisphere of the passerine brain is discussed

5:15-5:25 (38-10)
Does visibility influence owl peering behavior? Studies with Short-eared owls (*Asio flammeus*) and Northern Saw-whet owls (*Aegolius acadicus*).
Debbie M. Kelly (Ruhr Universität Bochum) & Walter F. Bischof (University of Alberta)
Eye movements as well as head and body movements are used by many animals to actively select and control the visual input to the central nervous system. Active vision, in which sensory information is continually controlled by the observer, has been shown to be superior to passive sensing. Research suggests that owls may use a specialized form of active vision. Owls engage in peering, in which the head is moved systematically side to side, prior to a predatory attack. Motion parallax generated from this movement may be used to enhance binocular depth cues. This investigation examined the influence of lighting and prey movement on the frequency and duration of peering by two owl species. Results suggest that low-visibility may differentially influence peering in the two species, with Short-eared owls (a crepuscular hunter) showing an increase in peer frequency. These results suggest that peering may be used as a compensatory mechanism during degraded conditions.

5:30-5:40 (39-10)
Structure from Motion Effects in Pigeons
Robert Cook (Tufts University), Miranda Mockrin (Tufts University), Aaron Blaisdell (UCLA), & Phil Kellman (UCLA)

Do birds see and experience the world as being composed of objects? Does motion contribute to this perception? Six White Carneaux pigeons were tested in a go/no-go discrimination in which they were required to discriminate between wire-frame triangular stimuli that varied only in the angle of their intersection (95° vs. 165°). On each trial, a stimulus was randomly oriented at one of 360 orientations in both X and Z axes and then presented in one of three presentation conditions. In the motion condition, stimuli were presented as continuously rotating in the X-axis. In the static condition, the stimuli remained at only one orientation throughout the presentation interval. In the random condition, the stimulus randomly changed its X-axis orientation throughout the interval at the same rate as in the motion condition. Transfer tests with different types of featural transformations suggested the pigeons may have used a 3D representation of the shapes as their primary means of performing the discrimination and that their motion contributed to this perception.

5:50-5:55 (6-5)
Handling time as a measure of 14- to 19-month-old human infants understanding of identity relations.
Tewlyn Underwood, Lauren Howanski, Mary Jo Rattermann, & Roger K.R. Thompson (Franklin & Marshall College)
In an effort to find a methodology to compare human infants' understanding of identity and non-identity with that of non-human primates, we examined 14- to 19-month-olds' abilities using object handling time as our measure. Infants were first allowed to handle a pair of identical (or non-identical) brightly colored wooden objects attached to a piece of plastic (AA) until habituated. For half the infants these objects, and those at test, were rich and complex while for the other half the objects were simple and sparse. During test, the infants were presented with a new set of identical stimuli (BB) and a set of non-identical stimuli (CD). Handling time for each set was recorded. We found that the infants were sensitive to the identity relation--handling the objects that instantiated the new relationship longer than those that instantiated the familiar relationship. Object richness, however, did not seem to have an effect.

Visual Discrimination and Perception II 6:15 - 6:55

Ron Weisman, Chair

6:15-6:20 (40-5)
Making Explicit What Monkeys Implicitly Discriminate
Kristen C. Totonelly, Hulya T. Israfil, & Roger K. R. Thompson (Franklin & Marshall College)
To what physical and relational stimulus properties do different species spontaneously attend? Progress in the comparative analysis of implicit perception & discrimination across taxa has been hampered by the lack of a common methodology. Habituation/dishabituation & preferential gaze procedures used with human and nonhuman primates, for example, apparently cannot be adapted easily for use with birds. We report here preliminary results from monkeys tested with a procedure adapted from that recently developed by E. Wasserman to measure implicit perception and discrimination in pigeons. Response latencies of macaque monkeys were recorded when they were rewarded for responding to each of four patterns, and then, subsequently, when they were rewarded for responding to only one of the four patterns. Results speak not only to the potential cross-taxa generality of the procedure, but also to its value in identifying differences and similarities in implicit attention to stimulus properties between species and individuals.

6:20-6:25 (41-5)
Corridor illusion in baboons (*Papio papio*)
Isabelle Barbet & Joel Fagot (Center for Research in Cognitive Neurosciences)
When two identical objects are presented to a human observer at different heights in a corridor-perspective picture, the farthest one (i.e., higher) looks much larger than the other one. That size illusion, called "corridor illusion", is induced by pictorial depth cues. We will present here a series of experiments on baboons' sensitivity to that illusion. Results show that pictorial depth backgrounds affected baboons' size-judgments of two identical persons, and that both linear perspectives or texture gradients cues induced that illusion.

6:30-6:35 (42-5)
Turnover of Information in Exemplar Memory
Sheila Chase (Hunter College of The City University of New York)
Pigeons were trained on an absolute identification task to identify nine luminances by pecking the appropriate key in a row of nine. The key choice associated with the dimmest and brightest luminances were then reversed. The changes in key choice as the new task was acquired provided evidence for a model of exemplar memory.

6:35-6:40 (43-5)
Mechanisms of Associative Memory in the Pigeon
Sarah Gillett & Robert Cook (Tufts University)
New experiments on the mechanisms of associative memory in pigeons will be reported. Building on an already extensive memory of over 1000 pictures for each bird, two pigeons learned a right-left discrimination for various picture-like images: randomized blocks of four colors, images made from pictures into blocks of averaged colors, scrambled pictures, and grayscale pictures. Acquisition times were examined to identify the mechanisms of memorization. Only the scrambled images were learned at the same rate as picture controls, suggesting that color is important, and fine detail is of greater importance than the global image. Implications for structure and coding of animal associative memory will be discussed.

6:45-6:50 (44-5)
Blue Jays use Sequential and Symbolic Priming when Searching for Cryptic Prey Stimuli
Mira Belik, Al Kamil, & Alan Bond (SBS, University of Nebraska at Lincoln)
In human literature, priming has been identified as an important mechanism facilitating complex visual search tasks. Animal visual predators may also use priming to increase the efficiency of search for cryptic prey. Two types of priming may have important roles in increasing efficiency of foraging for these predators; sequential and symbolic priming. We have previously demonstrated that each of these primes is effective in facilitating visual search in our lab using blue jays searching for cryptic prey stimuli. The focus of this experiment was to determine if these two priming types represent two different cognitive processes or if they are part of one cognitive process primed differently. We therefore provided jays either one or both primes during the searching task, predicting that if they are different processes the birds will perform more accurately when both primes are available. Our results provided evidence in support of two processes with the type of priming being used depending on the difficulty level of the task.

Funding Opportunities for Comparative Cognition 6:55 - 7:15

Ron Weisman, Chair

6:55-7:05 (45-10)
Opportunities at the National Science Foundation
Fred Stollnitz (National Science Foundation)
The National Science Foundation (www.nsf.gov) supports research and education in comparative cognition as it does in nearly all fields of science that are not disease-oriented. Research projects may be small, single-investigator projects or large, collaborative, cross-disciplinary projects in such areas as biocomplexity or information technology. Education projects may involve course, curriculum and laboratory improvement, teacher enhancement, or informal education of the general public through films or TV programs, museum or zoo exhibits, etc. Projects that integrate research and education are especially welcome, as in Research Experiences for Undergraduates, Undergraduate Mentoring in Environmental Biology (defined broadly enough to include comparative cognition!), Faculty Early Career Development, Research in Undergraduate Institutions, and Research on Learning and Education. Opportunities are available in many NSF programs to serve as a reviewer or as a program officer.

Friday March 15 (Afternoon Sessions 1:00 - 7:00)

Spatial Learning and Attention 1:00 - 2:20

Aaron Blaisdell, Chair

1:00-1:20 (46-20)
Dissociation of recollection and familiarity in Rhesus monkeys?
Robert R. Hampton (NIMH)
Rhesus monkeys were trained to report the presence or absence of a sample stimulus on some trials, while also reporting the identity of the sample on randomly intermixed trials in a delayed matching to sample task. When tested with stimuli seen only once daily, performance on identity tests was good at long delays, while performance on the detection task dropped off steeply as the delay interval increased. Performance on identity tests was much worse when monkeys were repeatedly tested with the same few stimuli, and performance matched that found for the detection task more closely. These results suggest that accurate performance on the identity tests is supported by both familiarity and recollection, and the relative contribution of recollection to successful identification is greater when stimuli are highly familiar. Monkeys with perirhinal cortex damage are impaired on the detection task, suggesting a role for this brain region in recollection in monkeys.

1:25-1:45 (47-20)
Measuring the search image: The attention band differs from the generalization gradient.
Donald S. Blough (Brown University)
Pigeons searched computer screens for a grating target that varied, from trial to trial, in spatial frequency and orientation. In one experiment a cue signaled that one particular target would appear. The cue speeded search to this target; probes with the other targets tested the generalization of this priming effect. In a second experiment, pecks to the same single target were reinforced and pecks to other targets were extinguished, producing generalization gradients. These generalization gradients differed from the priming gradients in a manner suggesting that the search image is not tied directly to similarity among the targets.

1:50-1:55 (48-5)
Modulation of learning flights in honey bees, *Apis mellifera*
Cynthia A. Wei, Shawna L. Rafalko, & Fred C. Dyer (Michigan State University)
Honey bees and other insects actively learn visual landmarks that enable them to return to a goal by performing learning flights. The durations of these flights are greatest during initial visits and subsequently decline, which suggests that investment in learning is modulated by a bee's accumulating experience. We investigated a variety of factors that may influence the probability of performing learning flights and their duration at a food source. Our results show that learning flight duration is influenced by: 1) past experience, 2) increasing delays between a bee's arrival at a food source and receipt of the sucrose reward, 3) complexity of the visual environment, 4) stability of landmarks, and 5) sucrose concentration of the food source. These results suggest that the mechanisms by which learning flights are modulated allow bees to adjust their learning efforts in response to changing needs for visual information.

1:55-2:00 (49-5)
How goal-landmark distance affects search accuracy of Clark's nutcrackers
Aleida J Goodyear & Alan C. Kamil (University of Nebraska)

Previous experiments with Clark's nutcrackers have shown that as goal-landmark distance decreases, search accuracy increases. This may be due to increases in the accuracy of the birds' ability to judge distance and direction with greater proximity to a landmark. Alternatively, the most p roximal landmark in an array may be the most salient, over shadowing other landmarks. The current experiment was designed to distinguish between the two theories by presenting the same goal-landmark distances in different arrays so that, for example, the 70cm landmark was the closest to the goal in one array, but not in the others. If effects of goal-landmark distance are due to proximity, performance should not vary across groups. If due to overshadowing, performance should vary across groups. Results indicate that overshadowing accounts for increases in search accuracy only at very close (30cm) landmark distances.

2:05-2:10 (50-5)
Food deprivation and spatial memory in coal tits and great tits
Sue Healy & Jeni Cleland (University of Edinburgh)
In comparisons of spatial memory ability between food storers and nonstoring species, differences have not found consistently. One possible explanation stems from the fact that the food storers are invariably considerably smaller than the nonstorers. As testing proceeds after food deprivation of varying intervals with correct choices in the tests being rewarded by food, performance on these tasks may be affected if deprivation duration differentially affects the costs of making errors for birds of differing body size. Spatial memory in food-storing coal tits (8-10g) and nonstoring great tits (17-20g) was compared after three food deprivation durations (0hrs, 2hrs, 4hrs). Birds completed more trials with increasing deprivation duration. Coal tits reached a significantly longer retention interval than did great tits. But differences in deprivation duration were not correlated with differences in spatial memory performance in either species.

2:10-2:15 (51-5)
An automated system for measuring spatial choices and presenting spatial cues
Kelly DiGian & Michael Brown (Villanova University)
Brown and Terrinoni (1996) developed a spatial learning apparatus in which food items are always hidden in a particular spatial pattern. Rats can potentially use this pattern to find the food items more efficiently. In these experiments, the rats' behavior is typically recorded by the experimenter. A Microsoft VisualBasic (Version 6) program was designed to automate the measurement of choices in this experimental paradigm by using changes in the amount of light that is reflected above a pole when a rat makes a choice. The VisualBasic program also controls visual cues that can be projected from above the apparatus. The rats can potentially use these cues to avoid revisits to poles. The efficacy of this technology will be discussed in the context of an experiment conducted using visual cues controlled by the program.

Conditioning II 2:30 - 4:05

Tom Zentall, Chair

2:30-2:50 (52-20)
A Turing Test of a Theory of Conditioning and Timing
Russell M. Church (Brown University)
The observed data from a conditioning or timing experiment consist of the time of onset and termination of stimuli, the time of each response, and the time of delivery of each reinforcer. The simulated data from quantitative theories of conditioning or timing may also consist of the times of stimuli, responses, and reinforcers. In an informal Turing test, the analyst selects the procedures to be used and the behavioral measures to be examined, and attempts to distinguish between observed and simulated data. A formal Turing test requires a principled selection of procedures and behavioral measures, and a principled basis for distinguishing between observed and simulated

data. The application of Turing tests to a packet theory of conditioning and timing reveals both strengths and weaknesses of this theory.

2:55-3:05 (53-10)
Postconditioning Inflation of the Elements of Taste + Odor Compound
Bob Batsell (Kalamazoo College) & John Batson (Furman University)
Taste + odor compound conditioning experiments are often unique because they can produce synergistic conditioning. One explanation for these synergistic conditioning effects is the formation of within-compound associations between taste, odor, and illness. One means of testing for within-compound associations is via postconditioning inflation. Two experiments will be described in which taste + odor compound conditioning (AX+) was followed by postconditioning inflation of one of the elements (A+), before testing Stimulus X. Taste was Stimulus A in Experiment 1 and odor was Stimulus A in Experiment 2. In both experiments, AX+/A+ training produced significantly stronger aversions to X compared to AX+ or X+ conditioning. Furthermore, AX+/A+ conditioning was equivalent to A+/AX+ conditioning in both studies. In sum, the results of these experiments are consistent with the within-compound association approach.

3:10-3:20 (54-10)
Trial Number and Temporal Contiguity as Determinants of Cue Mediation
Steven Stout & Ralph Miller (SUNY--Binghamton)
A conditioned lick suppression experiment with rats examined the role of number of compound stimulus presentations in determining the type of cue interaction seen. Treatment consisting of interspersed A-->US, AX-->noUS pairings found second-order conditioning to decline as the number of AX compound trials was increased and, further, to decline more rapidly if A and X were presented simultaneously, as opposed to serially. Conditioned inhibition, as assessed by a summation test, increased with the number of AX trials.

3:25-3:35 (55-10)
A within-subject comparison of avoidance with yoked contingency effects on conditioned eyelid closures in the rabbit.
Susan E. Brandon (American Psychological Association and Yale University)
Brandon, Betts and Wagner (1994) reported that for rabbits, two CSs, contemporaneously paired with left vs. right paraorbital shock USs, produced discriminated, lateralized eyelid closure CRs. The experiment described here used this technique in an analysis of the effects of an avoidance contingency on eyelid closure CRs. For 8 rabbits, one eye was trained on an avoidance contingency and the other eye provided the yoked control. A third, nonreinforced CS also was used. The three 1,050-ms CSs were a tone, flashing light, and vibratory stimulus, differentially assigned as an avoidance, yoked, or nonreinforced CS. The USs were 50-ms shock pulses delivered with a 1,000-ms CS-US interval. After 8 training sessions, the asymptotic level of responding to the avoidance CS was greater than to the yoked CS on the eye ipsilateral to US locus for each cue, and there was little responding to the nonreinforced CS on either eye.

3:40-3:50 (56-10)
Effect of Magnitude of Extinction Treatment on Spontaneous Recovery
James C. Denniston & Christy D. Hawley (Appalachian State University)
Thirsty rats received Pavlovian training intended to condition a fear to two separate audiovisual stimuli (CSs X and Y) through pairings with an aversive footshock. Following acquisition training, subjects received either extensive or moderate extinction treatment with CS X. Initial testing revealed equivalent responding to CS X (attenuated fear), whereas a subsequent test (following a 21 day retention interval) revealed greater spontaneous recovery in Group Extensive. Results will be discussed in terms of contemporary theories of extinction and stimulus processing.

3:55-4:00 (57-5)
Backward Blocking with Humans in a Nonverbal Task
Jeffrey C. Amundson, Martha Escobar, & Ralph R. Miller (SUNY-Binghamton)
Traditionally, blocking takes the form of A-outcome followed by AX-outcome training. Shanks (1985) demonstrated that [backward] blocking could occur if the A-outcome trials follow (rather than precede) the AX-

outcome trials. However, Larkin, Aitken, and Dickinson (1998) have suggested that backward blocking is not a real phenomenon, but a phenomenon dependent upon the use of inappropriate control groups. Often the control group used for backward blocking receives AX-outcome followed by A-. This control group has the problem that the A- treatment can result in revaluation of X (i.e., a retrospective deflation effect); consequently responding to X is increased in the control group rather than decreased in the blocking group. Our experiment demonstrates behavioral (i.e., nonverbal) backward blocking in humans using an appropriate control (i.e., AX-outcome followed by C-outcome, in which C differs from A).

Social Learning and Social Effects on Learning 4:15 - 5:50

Karyl Swartz, Chair

4:15-4:35 (58-20)
The Effects of Social Dominance on Access to Reaching Tools in 12-18 month-old Children and Capuchin Monkeys (*Cebus apella*)
Mary Jo Rattermann, Roger K.R. Thompson, Theresa Franz, & Andrei Cimpian (Franklin & Marshall College)
The effects of social dominance on access to resources is well documented in non-human primates, with animals higher in the social hierarchy having access to more resources (Tomasello & Call, 1997) of tool-use, is access to tools also affected by social status? Twelve- to eighteen-month-old children and Capuchin monkeys (cebus apella) were given access to tools that could be used to reach food. Each population was tested as a group, in their usual environments. Position within the social
hierarchy affected access to tools for both children and capuchins, with more dominant animals handling the tools more. However, in the children, the effects of dominance were mitigated by other pro-social behaviors, such as sharing. These behaviors may be an effect of the children being enculturated by parents and daycare staff.

4:40-4:50 (59-10)
Perception of pictorial eye-gaze by baboons (*Papio Papio*)
J. Fagot & C. Deruelle (CNRS-Center for Research in Cognitive Neurosciences, Marseille)
This study assessed the processing of oriented eye-gaze by nonhuman primates. Pictorial faces looking left or right were presented to baboons prior to the display of a target letter in the left or right hemi-field of the monitor screen. Baboons had to provide go or no-go responses considering the identity of the target letter. The first six experiments showed no reliable effect of eye-gaze on discrimination speed, using either schematic gazes or pictures of real gazes. The last experiment showed that eye-gazes facilitated target processing when eye-cues were perfect predictors of target location. Findings suggest that baboons do not spontaneously process eye-gaze direction, but can learn to do so if the eye-gaze has sx_e predictive values.

4:55-5:00 (60-5)
Playing into Awareness: Does a dog have a theory of mind?
Alexandra Horowitz (University of California, San Diego)
I present preliminary results from a novel study of play in animals: as a behavior which may reveal the degree to which the participants have a rudimentary "theory of mind." A study of domestic dogs (*Canis familiaris*) engaged in paired play-fighting indicates that dogs may differentially signal their play intentions to their partners based on the perceived attention of that partner. When a play signal is not seen, the signaler re-indicates his intentions in the view of the partner. Appreciation of the importance of attention in this communication leads to the hypothesis of an "implicit" (Gómez, 1996) theory of mind in dogs.

5:00-5:05 (61-5)
Social Learning Processes Involved in the Diet Development of Young Drills (*Mandrillus leucophaeus*) and Gorillas (*Gorilla gorilla gorilla*).
Elizabeth Johnson & Shannon Thompson (Oglethorpe University)
We are quick to assume social learning plays a central role in the development of behavior, such as feeding, for social living primates. However data, when available, does not always support this claim. King (1994) observed

baboon infants actively seek information from adults about food (information acquisition), but did not see adults intervene in infants' foraging activities in a meaningful way (information donation). To test for the presence of these two types of information transfer, we observed social interactions during feeding in a group of drill baboons and a group of Western lowland gorillas. The data support predictions consistent with information acquisition more often than predictions consistent with an information donation or individual learning explanation of diet development in these species. We argue that in addition to testing non-human primates' ability to engage in social learning processes, primatologists need to consider which processes are expressed in a species' normal behavioral repertoire.

5:10-5:15 (62-5)
Imitation in pigeons using the bidirectional control procedure.
Emily Klein and Thomas Zentall (University of Kentucky)
In research using the two-action method, in which either of two behaviors lead to the same outcome, pigeons have been found to imitate (Zentall, Sherburne, & Sutton, 1996). In the bi-directional control procedure, a variation on the two-action method, a manipulandum can be moved in one of two directions and the correlation between observed and performed behavior indicates the degree to which imitation has occurred (Heyes & Dawson, 1990). We find that pigeons show evidence of imitation relative to social-facilitation/affordance and odor/trial-and-error controls.

5:15-5:20 (63-5)
Solving the syntax of the Carolina chickadee social call.
Laurie Bloomfield (Queen's University), Chris Sturdy (University of Alberta), Leslie Phillmore (Queen's University), & Ron Weisman (Queen's University)
Black-capped and Carolina chickadees are closely related species which share a similar learned social call. The chick-a-dee calls of both species consist of an ordered sequence of notes, called A, B, C, and D. These notes are always sung in the same order, but often including only some of the notes, e.g., AD, BCD. Carolina calls can include some further number of notes (at least 3 or 4 different note types). Here, we identify these notes and identify their position in the syntax of Carolina chick-a-dee calls.

5:25-5:35 (64-10)
Anti-Predator Behavior in a Captive-bred Endangered Species
Melissa Burns (Texas Christian University)
Recent attempts to increase population size with the release of captive-bred Attwater’s Prairie Chicken (APC) on a protected refuge have been ineffective, primarily due to excessively high rates of raptorial predation on newly released birds. Innate fear responses in 6-20 day old APC chicks that were reared either by a broody domestic hen or in the absence of an adult were assessed with three different fear tests. Fear behaviors were then correlated with survival after release into wild populations. Data showed that hen-reared chicks were more fearful than chicks reared only with cohorts. Several fear behaviors present in young chicks significantly correlated with survival in the wild. Social learning of anti-predator behavior may enhance responses to raptorial predators and prolong survival in the wild.

5:40-5:45 (65-5)
Does predation pressure affect learning and memory?
Victoria Braithwaite (Edinburgh University, UK) Several lines of research have recently been addressing the role of the environment in shaping animal learning and memory. Here I present an experiment that investigated the role of predation pressure on rate of learning a spatial task. The study compared populations of the tropical freshwater fish, Brachraphis episcopali, (a close relative of the guppy) sampled from high and low predation sites. The fish were trained to solve a T-maze. Fish from the high predation site were able to learn the maze almost twice as fast as the low predation site fish. The cues that the fish used, however, did not vary between sites.

6:00 - 7:00 - Featured Speaker
Howard Eichenbaum (Boston University)
Introduced by Robert Cook

The Cognitive Neurobiology of Declarative Memory

In humans, the hippocampal system mediates a capacity for declarative memory. A major obstacle in neurobiological analyses of declarative memory is the development of behavioral assays that reflect defining features of declarative memory, including memory for unique episodes, conscious recollection, and "flexible" memory expression. This presentation will
survey recent evidence suggesting the hippocampus encodes sequences of places and events that compose episodic memories, and links them together to create a memory network that supports inferential memory expression. A combination of neuropsychological and physiological findings supports the notion that the hippcampus plays a critical role in processes fundamental to declarative memory in animals as well as humans.

Saturday March 16 (Afternoon Sessions 1:20 - 6:20)
1:20 - 2:20 - CCS Business Meeting

Serial Learning 2:35 - 3:30
Herb Terrace, Chair

2:35-2:55 (66-20)
Examining rule-flexibility in serial pattern learning in rats: Transfer to reversed and interleaved patterns.
James D. Rowan (Chowan College), Shannon M.A. Kundey (Yale University), Christina L. Miner (Wesleyan College), & P. Taylor Johnson (Wesleyan College)
Three experiments examined rats' abilities to modify serial pattern rule-representations. In the three experiments, rats learned either a 24-element, 3-elements per chunk pattern (3E) or a 16-element, 4-elements per chunk pattern (4E). In Experiment 1, half were then transferred to a reversed 3E (3E-R), and the remaining were transferred to a reversed 4E (4E-R). In Experiment 2, half were transferred to a 3E with an interleaved pattern (3E-I), and the remaining were transferred to a 4E with an interleaved pattern (4E-I). In Experiment 3, half were transferred to a reversed and interleaved E3 (3E-RI), and the remaining rats were transferred to a reversed and interleaved 4E (4E-RI). The results support the idea that rats form a flexible representation of the rules and can modify this representation to learn a novel but similar pattern.

3:00-3:10 (68-10)
Control of choices by a serial pattern of spatial pattern exemplars
Michael F. Brown, Kelly A. DiGian, & William M. Smith (Villanova University)
Rats were exposed to a spatial pattern learning task in which one row of locations in a 5 X 5 matrix of locations was baited on each trial. For each of two experimental groups, only 3 of the five rows ever served as the baited

row. For one group, the baited row (spatial pattern exemplar) could be predicted prior to the trial, because the baited row followed a serial sequence over the three trials of each daily session. For the other (control) group, the baited row was randomly selected from among the three pattern exemplars. There was clear evidence that both groups came to be controlled by the spatial pattern. Both groups also directed most choices to the three rows that served as pattern exemplars. The evidence for control by the serial pattern of spatial pattern exemplars was mixed.

3:15-3:20 (69-5)
The Impact of Prior Experience on the Planning Abilities of Capuchin Monkeys (*Cebus apella*)
Carrie R. Rosengart & Dorothy M. Fragaszy (University of Georgia)
Previous research on children has revealed three strategies used to combine nesting cups into stable seriated structures. These techniques may differ in cognitive complexity with the putatively most advanced of these emerging as the dominant strategy only at about three years of age, after the development of language skills. Two capuchin monkeys' (*Cebus apella*) combinatorial strategies for the same tasks presented to children were evaluated. The current study examined if strategy selection can be altered by specific training history. After a brief training period, both monkeys changed their preferred strategy to the one that has been associated with hierarchical planning abilities and they reduced the total number of moves required to correctly seriate a set of nesting cups. It might be that in learning to use this technique, the monkeys also learned to better plan their actions.

3:20-3:25 (70-5)
Serial learning of spatial lists by Clark's nutcrackers (*Nucifraga columbiana*)
Jody L. Lewis & Alan C. Kamil (University of Nebraska -Lincoln)
Clark's nutcrackers survive harsh winters by recovering stored pine seeds in as many as 5,000-6,000 different cache sites. Memory for such a large number of locations is remarkable considering the possibility of high levels of interference and forgetting. In food storing birds, memory for spatial items has been used to examine traditional effects found in list learning such as serial position effects, proactive, and retroactive interference. Such experiments yield inconsistent results, which could be due to differences in the number of available locations and the amount of control over item placement. We are examining serial learning of locations in Clark's nutcrackers using unique item lists and lists that vary in the number of reused items between lists, to control the amount of interference. This may help us to understand what strategies food storing birds could use to increase cache retrieval by decreasing the chances of forgetting by decay or interference.

Auditory Discrimination Learning 3:45 - 5:00

Bill Roberts, Chair

3:45-3:55 (71-10)
Belated Ode to Stewart Hulse: Dolphins Got Rhythm
Heidi E. Harley (New College of Florida & Epcot's Living Seas), Kim Odell (Epcot's Living Seas), Erika A. Putman; Cathy Goonen, & Caroline M. DeLong (University of Hawaii)
A bottlenose dolphin's ability to discriminate among six different acoustic temporal patterns (rhythms) was explored. Each 4-sec rhythm was comprised of silences and 14 kHz tones of varied lengths. The dolphin was rewarded for performing a different behavior to each of the six rhythms, e.g., a spin to Rhythm 1, ball toss to Rhythm 2, etc. Performance accuracy on the final ten 18-trial sessions averaged 93%. In two 6-session transfer test blocks in which three rhythms each were presented at semi-tone intervals from 7 - 14 kHz and from 3.5 - 7 kHz, performance accuracy was 90% and 96%, respectively. In six 5-session test blocks in which three rhythms each were presented at different tempos, the dolphin's performance accuracy varied. When the original stimuli were multiplied by .8 and 1.3, performance accuracy was 91% and 68%, respectively, but accuracy was lower with more extreme tempo changes. Overall performance suggests dolphins got rhythm.

4:00-4:10 (72-10)
Visual and echoic simple discrimination reversal learning in bottlenose dolphins

David Kastak & Ronald Schusterman (University of California, Santa Cruz)
We tested two bottlenose dolphins in a two-choice discrimination reversal task using two modalities, vision and echolocation. We used a differential outcome procedure in which conditioned reinforcers and primary reinforcers were segregated between the two stimuli comprising a discrimination problem. After several hundred training trials, both animals showed strong evidence of win-stay/lose-shift behavior, and consistently solved discrimination problems after only a single information trial. This is the first report of learning set in visual discriminations by the bottlenose dolphin, supporting the view that conceptual behavior is not limited to acoustic tasks. This work is part of a longer-term study using the principle of stimulus equivalence to analyze object representation by echolocating dolphins.

4:15-4:25 (73-10)
Human-Baboon discrimination and representation by humans and baboons (*Papio papio*)
Julie Martin-Malivel, Michael Mangini, Irving Biederman (University of Southern California), & Joël Fagot (Centre de Recherche en Neurosciences Cognitives, CNRS)
Baboons were trained to discriminate vocalizations of baboons vs. humans. When primed by a picture (human or baboon) briefly presented prior to the target sound, response times were shortened if the picture was consistent with the vocalization, suggesting that these discriminations were made at a conceptual level. To assess the representation of faces that baboons and humans use to distinguish one species from another, these baboons discriminated a human-baboon morph with superimposed random noise. Sometimes the noise rendered the image human-like, sometimes baboon-like. Using a method of reverse correlation, the noise was sorted according to the subjects' responses allowing the calculation of a "classification image" which specifies the information that the subjects are using. When superimposed over the morph, the average noise on trials when the subjects responded "baboon", produced a good picture of a baboon; the noise on trials where the subjects responded "human" produced a picture of a human. Human subjects produced classification images that were highly similar to those produced by the baboons.

4:30-4:40 (74-10)
Do black-capped chickadees treat their calls and those of Carolina chickadees as different categories?
Ronald G. Weisman, Laurie Bloomfield, Christopher Sturdy, & Leslie Phillmore (Queen's University)
We compared discriminations between and within species-defined of sets of exemplars of black-capped and Carolina
chickadee social calls. Black-capped chickadees discriminated call exemplars between species more rapidly than call
exemplars within species. Chickadees transferred their discriminations to novel exemplars in a reversal of the between
category discrimination and, in a later test, the change propagated back to the original exemplars. The results support the hypothesis that songbirds classify their learned vocalizations into open-ended auditory categories.

4:45-4:55 (75-10)
Effect of Vocalization Type on ZENK Response in Black-capped Chickadees
Leslie Phillmore, Laurie Bloomfield and Ron Weisman (Queen's University)
It is well known that specific auditory forebrain regions in the songbird brain respond to playback of conspecific song with a rapid increase in the expression of the immediate early gene called ZENK. This study examines whether gene expression varies with vocalization type (i.e. learned songs vs. calls) in black-capped chickadees. Analyses revealed that song playback induces more ZENK expression than call playback in the auditory forebrain, that males show more ZENK expression to song than females, and that chickadees reared in isolation from adult conspecific vocalizations show reduced gene expression to song compared to normal chickadees.

Causal Judgement 5:15 - 6:30

Ed Wasserman, Chair

5:15-5:20 (76-5)
Cue-interaction effects in judgments of contingency I: The role of causal order and structure
Jason M. Tangen & Lorraine G. Allan (McMaster University)
In causal relationships, several events may precede an outcome and people must evaluate the strength of each event relative to that outcome and in relation to one another. Previous studies have demonstrated cue-interaction effects where judgments of contingency between two predictor variables and a single outcome vary systematically depending on the likelihood of one variable signalling the outcome relative to another. The Rescorla-Wagner model encodes the event that is presented first as an input cue regardless of whether it is represented as a cause or an effect. In contrast, causal-model theory is sensitive to the asymmetry of causal inference. Each model, therefore, makes opposing predictions about cue-interaction depending on the direction of the causal relationship and the structure of the causal model, i.e., multiple causes of a single effect vs. multiple effects of a single cause. To evaluate the predictions by each model, causal order and structure were tested independently.

5:20-5:40 (77-20)
Cue-interaction effects in judgments of contingency II: Investigating the result of discrete trial predictions
Jason M. Tangen & Lorraine G. Allan (McMaster University)
In one set of experiments, subjects passively observed a series of trials depicting a relationship between binary events. If two cues were represented as causes, each signalling a common effect, then subjects rated each cause relative to the other. This cue-interaction effect was demonstrated regardless of causal order. In additional experiments, subjects not only rated the overall contingency between each cue and the outcome, but were asked to predict the outcome on each trial. By using subjects' discrete trial predictions, we have obtained an indirect measure of their contingency estimates that we compared to their direct ratings. Our data suggest a dissociation between subjects' indirect contingency estimates from their trial data and their contingency ratings of the overall cue-outcome relationship. We will discuss the results in light of the predictions made by the Rescorla-Wagner model and causal-model theory. (Presented by L. Allan)

5:45-5:55 (78-10)
Causal Reasoning and Conditioning
J.W. (Bill) Whitlow (Rutgers University, Camden)
Associative learning models derived from studies of animal conditioning provide one approach to understanding human causal reasoning. These models provide an attractive means for integrating an important aspect of human cognition with the behavior of nonhuman animals. However, there are a variety of reasons to ask if these are appropriate models. This talk discusses data from human subjects that raises questions about a fundamental assumption of conditioning models of causal reasoning, namely, the degree to which associative strength is 'accumulated' in human causal reasoning tasks.

6:00-6:10 (79-10)
Pigeons Can Make Inferences Based on Exclusion
Thomas R. Zentall & Tricia S. Clement (University of Kentucky)
When humans and some other higher mammals (e.g., chimps and sea lions) are given a novel sample-comparison choice, they may choose by exclusion (i.e., they may reject one alternative and choose the other by default). We found that if pigeons are trained (matching-to-sample) to treat two stimuli differently (i.e., to associate Sample A with Comparison 1 and Sample B with Comparison 2) and they then are trained to associate one of those samples with a new comparison (e.g., to associate Sample A with Comparison 3 rather than Comparison 4) they will then show a significant tendency to choose Comparison 4 when presented with Sample B (i.e., if Comparison 3 is not correct, then it must be Comparison 4).

6:15-6:20 (80-5)
Like a puppy on a string - means-end tasks in dogs
Britta Osthaus, Alan M. Slater, & Stephen E.G. Lea (University of Exeter)

Means-end tasks have long been employed to test the problem-solving abilities of humans and various species of non-human animals. The research with dogs concerning their ability to understand means-end tasks started early (e.g. Fischel, 1933) but has not provided a coherent picture. Basically dogs are able to learn to manipulate one string to pull a piece of food into their reach. This study examines different set-ups with two strings and the conditions that enable dogs to make a correct choice between a baited and a non-baited string. There are two conditions: parallel or crossed strings. The distance between the parallel strings and the distance of the crossing point from the dog were varied. Pilot data show that dogs are able to learn to choose the baited string. So-called "clicker-trained" dogs were faster in learning the task than traditionally trained dogs.

6:20-6:25 (81-5)
Motion Discrimination in Pigeons
Shelly Roberts & Robert Cook (Tufts University)
Semi-realistic video sequences were used to examine pigeon's ability to discriminate between different motions. Pigeons were previously tested using a go/no-go procedure with video stimuli in which the point of view moved "around" or "through" approaching objects which pigeons were able to discriminate between. In experiment 2 pigeons in a within subjects design were exposed to the same videos, however they received two additional conditions. The videos were presented in either a coherent sequence, or a random one. The coherent sequence presumably maintains 3-D qualities of motion pictures, while random sequences destroy them. Results suggested that pigeons were better at the "around" and "through" motion discrimination when presented with the coherent video sequence compared to the random. However, a between subjects design is needed to support this initial finding.

Coauthors and Discussants

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Gordon Baurer (New College of Florida)	Suzanne MacDonald (York University)
John Batson (Furman University)	Michael Renner (West Chester University)
Laurie Bloomfield (Queens University)	Todd Schachtman (University of Missouri)
Marilyn Haldane	Ron Schusterman (University of California, Santa Cruz)
Heather Hass (Long Marine Lab)	
Erica Hoy (University of Georgia)	Sara Shettleworth (University of Toronto)
Taylor Johnson (Wesleyan College)	Shepard Siegel (McMaster University)
Shannon Kundey (Yale University)	Brian Smith (Ohio State University)
Christina Miner (Wesleyan College)	Denise Smith (Kent State University)
Katherine Leighty (University of Georgia)	Marta Sokolowska (McMaster University)
	Chris Sturdy (University of Alberta)
	Roger Thompson (Franklin & Marshall College)