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Radisson Hotel

Melbourne Beach, Florida

Note: PowerPoint versions of some presentations are available – links from the presentation title lead to these posted PowerPoint versions (they are best viewed using Microsoft Internet Explorer V4.0 or later)

Start Time

3:30 PM Welcome Reception & Light Snacks

Wednesday Evening

6:50 PM Opening Remarks - Tom Zentall

7:00 PM Spatial Learning and Memory (Chair - Mike Brown)

7:00 PM Michael F. Brown & Gary Giumetti (Villanova University)

Spatial Pattern Learning in the Radial-arm Maze

Two experiments will be described that provide evidence that rats can learn a spatial pattern of baited and unbaited arms on the radial-arm maze. In particular, baited and unbaited arms occurred in a spatially alternating pattern on each trial. However, the identity of the baited and unbaited arms was unpredictable over trials. Thus, it was the abstracted spatial pattern itself, rather than the spatial relations among particular locations, that controlled choices. The implications of these results for theories of spatial representation will be discussed.

7:14 PM William Timberlake, Susan A. Sinning, & Joseph Leffel (Indiana University

Beacon Training in a Water Maze Can Facilitate as well as Block Room Cue Learning

In Stage 1 of a water maze blocking procedure, rats were trained with a Beacon predicting the location of a submerged escape platform. In Stage 2 both Beacon rats and added controls were trained with a predictive compound of Beacon and Room Cues (Landmarks plus Background Cues). The effect of Stage 1 training was evaluated relative to controls in a Room Test without the Beacon. In Experiment 1, Stage 1 Pole Beacon training blocked Stage 2 learning of Room Cues. In Experiment 2, Stage 1 Hanging Beacon training had no effect or facilitated Room Cue Learning in Stage 2. In Experiment 3, Stage 1 Hanging Beacon training with irrelevant Room Cues showed no effect, and neither did an overshadowing control in Stage 2. In Experiment 4 Displaced Beacon training showed facilitation. Apparently Stage 1 Pole Beacon training contributes to blocking, and a stable framework to facilitation.

7:28 PM Ken Cheng, Ajay Narendra (Macquarie University), & Rüdiger Wehner (University of Zurich)

Navigation in the Central Australian Desert Ant Melophorus bagoti: Some Initial Results

The highly thermophilic red honey ant Melophorus bagoti forages in the heat of the day. We provided ants a feeder sunk in the ground. Ants arriving there the first time were displaced, with their food, to a distant test field and allowed to home. Ants headed off in the feeder-to-home direction, indicating a directional sense based on sky-compass cues. These ants ran on average, however, less than half the homebound distance before initiating search behavior. The search was biased, drifting farther and farther from the start of the homebound run. With repeated runs to and from a food source, ants established stereotypic routes. Ants trained and tested in channels that blocked most landmark cues estimated the correct distance home, indicating an odometric ability. Preliminary evidence also suggests that nest-associated cues, possibly panoramic cues, are used for homing. This suite of strategies suits an environment filled with tussocks interspersed with trees.

7:42 PM John B. Phillips, R Muheim (Virginia Tech), NM Edgar (New York Medical College), & KS Sloan (Virginia Tech)

Auditory and Magnetic Compass Orientation in C57BL/6 mice

We report the development of behavioral assays of magnetic and auditory compass orientation in C57BL/6 mice. We show that C57BL/6 mice can be trained to position their nests in a learned relationship to directional auditory or magnetic cues in a visually symmetrical arena. Initial findings from the magnetic compass assay suggest that mice may perceive the magnetic field as a complex three-dimensional "visual" pattern, consistent with the light-dependent, photoreceptor-based magnetoreception mechanism proposed by Ritz et al. (2000). Development of these assays in C57BL/6 mice will make it possible to investigate the biophysical and molecular mechanisms involved in magnetoreception, as well as the neural pathways and processing mechanisms involved in auditory and magnetic compass orientation. C57BL/6 mice also perform well in variety of spatial tasks in radial arm and water mazes, so this strain of mice can be used to investigate the interaction of spatial (e.g., visual landmark arrays) and magnetic compass cues in the orientation behavior of rodents.

7:56 PM Eric L.G. Legge & Marcia L. Spetch (University of Alberta)

Do Differential Outcomes Enhance Spatial Localization?

Numerous studies have shown that differential outcomes (DO) enhance discrimination and retention accuracy in matching-to-sample tasks. The present study tested whether DO would also promote faster learning and more accurate searching in a landmark-based spatial task. That is, would DO expectancies help an organism remember where a goal is hidden? Pigeons were trained to find a hidden goal that was either south-west of a green landmark or north of a red landmark in a spatial arena. Only a single landmark was presented on each trial. For the DO group, each landmark corresponded to a specific type of hidden food, whereas for the control group, the relation between food type and landmark was random across trials. If pigeons in the DO group show faster acquisition and more accurate searching than pigeons in the control group, this would indicate that outcome expectancies not only enhance discriminatory behavior but also spatial localization.

8:05 PM Causal Reasoning (Chair - Bill Whitlow)

8:05 PM Bill Whitlow (Rutgers University)

Causal Scenarios and Configural Learning

Learning psychologists typically approach causal learning with a focus on stimulus conditions and ask what is learned about the causal roles of the events involved in a given problem? Social psychologists typically adopt a focus on causal scenarios and ask what explanatory framework do people use to reach a causal interpretation of a given problem? Our research has tried to integrate these two approaches by asking how the role of configural cues in causal reasoning depends on the causal scenario invoked by different tasks. The present studies compare positive and negative patterning results in a social reasoning task and in a consummatory reasoning task.

8:19 PM Kenneth J. Leising & Aaron P. Blaisdell (University of California, Los Angeles)

Causal Reasoning from Interventions in Rats is Not Explained by Interference

Blaisdell, Sawa, and Waldmann (in press) found evidence that rats are capable of deriving predictions of the outcomes of interventions after observational learning of a casual model. This capacity is consistent with causal Bayes net theories, but alternatively, may be the result of interference between antecedent events that share a common outcome. To test this competing hypothesis, rats received sensory preconditioning training consisting of A->X pairings in Phase 1 and A->sucrose pairings in Phase 2. At test, one group of rats received outcome X contingent upon lever pressing. Nose poking into the feeding niche in this group was compared, using a yoking procedure, to two groups that merely observed outcome X, and one group that received an antecedent cue B prior to X (i.e., B->X). Cue B did not attenuate nose poking to X the way a lever press did, supporting causal Bayes nets and not an associative interference interpretation of intervention effects.

8:26 PM Seth R. Wilhelmsen, V. Leah Bray, W. Travis Suits, & Martha Escobar (Auburn University)

Overestimation of Contingencies Following Predictive but not Diagnostic Training

Contingency estimation (specifically, causality judgments) can be made as a prediction (cause-to-effect) or as a diagnosis (effect-to-cause). Most investigations trying to determine whether the two directionalities of learning involve identical or different processes have used designs with multiple causes or multiple effects (i.e., stimulus competition), but the results have been contradictory: Although causality learning occurs in both directions, competition in diagnostic training/testing situations has not been obtained in all preparations. To determine whether there are basic differences in contingency estimation depending on the directionality of training/testing, participants were trained with pairings of a single cause and a single effect (DP for both directions = 0.50). Training and testing were either predictive or diagnostic (i.e., a 2x2 design). Participants correctly estimated the contingencies when training was diagnostic, whereas they overestimated the contingency when training was predictive, both effects regardless of testing direction.

8:35 PM Communication, Song, and Auditory Discrimination (Chair -Ron Weisman)

8:35 PM Ronald Schusterman, Colleen Reichmuth Kastak (University of California Santa Cruz), & Debbie Quihuis (Six Flags Marine World)

Contingency Learning Can Modify Sound Production in Pinnipeds

Classical ideas about acoustic communication in nonhuman mammals are based on the notion that vocalizations are non-modifiable, with emotional constraints, anatomical limitations, and genetic predispositions being the most significant features in mammalian communication systems. Recently, several studies have shown that the vocalizations of some birds can be modified by food and social reinforcement contingencies. The current study examines whether contingency learning can also modify the context and structure of sounds emitted by mammals. Sounds produced by one captive harbor seal and four captive walruses were modified using food reinforcement to 1) alter in contextual control, 2) change in structure through selective shaping, or 3) vary in structure through the application of novelty or “difference” reinforcement criteria. The results of these investigations with pinnipeds reveal a degree of vocal plasticity previously unreported for non-human mammals and suggest that contingency learning is relevant to the evolution of communication systems including human speech.

8:59 PM Henrike Hultsch (Freie Universität Berlin) & Katharina Riebel (Leiden University)

The Serial Position Effect in the Song Acquisition of Birds

The 'serial position effect' is well known in short-term serial item learning (U-shaped recall probability) in humans. We asked whether analogous phenomena occur in a very different, long-term process, the song learning in nightingales (Luscinia megarhynchos). Young males heard strings of model song-types and were tested for song imitation as adults. Each song in a tutored string was a different song-type, thus imitations could be examined for the serial position of models from which they had been copied. We found no relation between serial position and probability of acquisition, but a significant effect on performance frequency. Models heard at the beginning or the end of a string were sung more frequently than 'central items'. Such U-shaped function implies that the beginning and the end of a string of learning stimuli signify a particular quality during perceptual learning in nightingales that does not express itself in acquisition success.

9:13 PM Christopher B. Sturdy, Michael R.W. Dawson and Isabelle Charrier (University of Alberta)

Artificial neural network and statistical approaches to understanding natural vocal categories

The ‘chick-a-dee’ call of the black-capped chickadee is composed of four note types, perceived by chickadees as open-ended categories. Here we describe the spectrograms from a sample of notes as a set of 9 summary features. An artificial neural network was trained to identify note type on the basis of these features, and obtained high (> 98%) accuracy. An internal analysis of the

network revealed a distributed code in which different hidden units generated high activities to different note types. By combining these different sensitivities, the network could discriminate all three types of notes. Network performance was compared to a discriminant analysis of the same data. This latter analysis also achieved a high level of performance (95%). Comparing the two approaches revealed some similarities, but also intriguing differences. We discuss our results in terms of developing both a tool for note classification and a theory of how birds classify notes.

9:27 PM Laurie L. Bloomfield & Christopher B. Sturdy (University of Alberta)

Mechanisms for Species Discrimination in Sympatric and Non-Sympatric Chickadees

Previous experiments (Bloomfield & Sturdy, in prep.) provide sound empirical evidence that both black-capped chickadees (Poecile atricapillus) and mountain chickadees (P. gambeli) treat their own and the other species' chick-a-dee calls as separate, open-ended categories. Further, there is no species-specific advantage for individual recognition of 30 different calls and prior experience of black-capped chickadees with mountain chickadees neither hinders nor aides in classification and recognition of chick-a-dee calls. Here we explore the mechanisms used by black-capped and mountain chickadees in discriminating among the chick-a-dee calls and whether experienced and non-experienced black-capped chickadees utilize different features of the chick-a-dee calls for accurate species discrimination. Preliminary data suggest that the terminal 'dee' portion of the calls guides species' recognition and discrimination, the ecological factors of which will be discussed.

9:34 PM Chris Harshaw & Robert Lickliter (Florida International University)

The Influence of Stimulus Contingency and Stimulus Enhancement on Auditory Preferences in Bobwhite Quail Neonates

This study explored the effects of both stimulus contingency and stimulus enhancement on the development of auditory preferences in bobwhite quail neonates. Subjects were given individual exposures to one of two variants of a bobwhite maternal call (A or B) at 24 hours of age and were subsequently tested at 48 hours of age in a simultaneous choice test between the familiar and novel calls. Exposure during training was either contingent (upon chick distress vocalizations), vicarious (exposure to both conspecific distress vocalizations as well as maternal calls sequenced to sound as if contingent upon those vocalizations), or non-contingent. The only condition (both A and B data) to show significant deviations from chance responding during testing was the contingent condition. Evidence of a significant preference, likely due to stimulus enhancement, was however seen in chicks given vicarious exposure to Call A. Additional data exploring this finding will be presented as well.

9:41 PM Daniel I. Brooks (University of Iowa) & Robert G. Cook (Tufts University)

The Discrimination of Complex Auditory Stimuli by Pigeons

In order to better understand the categorization of complex auditory stimuli, three pigeons were trained in a go/no-go task that examined the discrimination of a major chord (S+) from four alternative chord types (S-). The four chord types were chosen for their perceptual distance (one note) from the major chord (C Major). Two chords were chosen for one note manipulations of the third (Minor Chord, Sus4), and two were chosen for one note manipulations of the fifth (Augmented, Flat 5th). Results indicate that pigeons can discriminate these complex stimuli, and do so on the basis of both relational and absolute factors. The data also provide evidence for enhanced discrimination of manipulations of the fifth, suggesting accordance with human research on perceptual similarity within musical structure.

Thursday Afternoon

12:00 PM Category and Concept Learning (Chair - Roger Thompson)

12:00 PM Michael E. Young (Southern Illinois University at Carbondale) & Edward A. Wasserman (University of Iowa)

A Theory of Variability Discrimination: Finding Differences

Visual variability discrimination requires an observer to categorize visual collections of items based on the variability in the collection. We present a theory of visual variability discrimination that aggregates localized differences between nearby items to mediate the discrimination. This Finding Differences Model was compared to a previously posited Positional Entropy Model across various data sets involving people and pigeons. Previously published data sets were supplemented with three new experiments, two of which involved arrays comprising items with systematic, quantitative differences. Although both theories provide strong and similar fits for the published data sets, only the Finding Differences Model is applicable to investigations involving quantitative item differences, providing equally good fits in these new studies.

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12:24 PM Yasuo Nagasaka & Edward A. Wasserman (University of Iowa)

Concept Discrimination with the Reassignment Paradigm in Pigeons

Lea (1984) proposed a series of empirical tests for divulging concept discrimination in animals. We studied pigeons' concept discrimination using Lea's reassignment paradigm. In the training phase, pigeons were taught to peck one of four diagonally placed keys in response to five depth orientations of four geons. In the reassignment phase, one view of each geon was reassigned to four new keys. In the testing phase, both reassigned and nonreassigned stimuli were shown with the keys used in the reassignment phase. The results disclosed no transfer of the discrimination to the nonreassigned stimuli. Because this outcome may have been peculiar to our use of geometric stimuli, we are now conducting a companion experiment with more naturalistic

stimuli—photos of people, flowers, cars, and chairs. We will compare and contrast the results with both kinds of stimuli and relate these findings to Lea's proposed methods of revealing concept discrimination in animals.

12:38 PM Robert G. Cook (Tufts Univ.) & J. David Smith (St.Univ. of New York at Buffalo)

Stages of Abstraction and Exemplar Memorization in Pigeon Category Learning

We examined category learning in pigeons and humans across acquisition. Five birds and eight humans learned six-dimensional perceptual categories constructed to include prototypes, typical items, and exceptions. Early on in both species, prototype performance improved and exception performance correspondingly worsened, indicating an initial mastery of the categories' general structure. Later on, exception performance improved selectively, indicating exception-item resolution and exemplar memorization. The results suggest a psychological transition in pigeon category learning from abstraction- to exemplar-based processing similar to that previously found in humans.

12:52 PM Tamo Nakamura, Anthony A. Wright (University of Texas Health Science Center at Houston), & Jeffrey S. Katz (Auburn University)

Same/Different Abstract-Concept Learning by Pigeons: Relational Learning, Item-Specific Learning, and the Generalization Hypothesis

Pigeons were trained in a two-item same/different task with either 8 or 32 picture items. The generalization-from-item-pairs hypothesis predicts that pigeons trained with 32 items would take 16 times longer to learn the task compared to those trained with 8 items because the correct response needs to be learned for each pair of items (1024 pairs vs. 64 pairs). Contrary to this prediction, the numbers of trials required to reach the criterion for the 32-item group was the same as the 8-item group. The reason that the 32-item group learned as rapidly as the 8-item group must be that they were basing their decision (in part) on the relationship between the two items presented in each trial – the same/different abstract concept. This conclusion was supported by better transfer for the 32-item group than the 8-item group. This rapid learning and partial concept learning by the 32-item group is evidence against the generalization-from-item-pairs hypothesis.

1:06 PM Andrea J. Frank & Edward A. Wasserman (University of Iowa)

Pigeons Process Both Items and Relations in Multi-Element Visual Arrays

Stimulus control can be quite specific and limited to the particular items that are presented, or, in the case of two or more items, stimulus control can be more general and involve the relations between or among the items. Here, we gave pigeons either icon set (Set 1 versus Set 2) or relation (Same versus Different) report keys after showing them a display containing 12 visual icons that were either the same as or different from one another. This method forced the pigeons to attend to both icon set and relation on every trial. After the pigeons attained 80% correct on both tasks, we showed them displays containing 2, 4, 6, 8, 10, 14, 16, 18, 20, 22, and 24 icons followed by the "set" or "relation" report keys. Pigeons' ability to flexibly report set or relation with smaller and larger numbers of items will be discussed.

1:13 PM Jeffrey S. Katz (Auburn University), Anthony A. Wright, (University of Texas Health Science Center at Houston), & Bradley R. Sturz (Auburn University)

Same/Different Concept Learning: Familiarity and Emergent Features

Pigeons initially learned a simultaneous two-item same/different concept by responding to a sample picture before selecting same or different to another picture. This procedure has been argued to have a familiarity component that controlled performance (e.g., Premack, 1983). Familiarity of the sample item was manipulated by decreasing the observing response to zero and retesting for concept learning. Pigeons again showed full abstract-concept learning (transfer = baseline). This simultaneous procedure has been argued to have low-level emergent features that controlled performance (e.g., Mackintosh, 2000). Such features were eliminated by changing the procedure to a 1-item list memory task with delays up to 30 seconds. Pigeons again showed full abstract-concept learning. Taken together, these findings indicated pigeons learned the same/different abstract concept based on relational processing between the pictures.

1:27 PM Anthony A. Wright, Tamo Nakamura, Jacquelyne J. Rivera (University of Texas Health Science Center at Houston), & Jeffrey S. Katz (Auburn University)

The hypothesis that generalization from the training stimuli accounts for transfer and concept learning in the same/different task was tested using human similarity ratings. Similarity was rated on a five point scale in terms of shared features for each of the unique 90 transfer stimuli tested with monkeys and pigeons following successive acquisitions with sets of 8, 32, 64, and 128 stimuli. The generalization hypothesis predicts that transfer will vary as a function of the degree of similarity between the transfer and training stimuli. Contrary to the generalization hypothesis, pigeon and monkey transfer was unrelated to the degree of similarity as rated by humans.

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1:41 PM NSF Grant Writing (Chair - Bob Cook)

1:41 PM Jerry O. Wolff (National Science Foundation)

Competitive Grant Writing for NSF

I will provide an outline and discuss the critical content and approach for writing a competitive grant proposal for NSF. Those areas that are the most critical in making a grant competitive are the theoretical construct, testing alternative hypotheses, providing

an explanation for interpretation of results, be truly integrative, and apply to the broadest audience in the field. Common problems encountered in proposals that preclude receiving an award are application of the model species to theory and other taxa, "unnaturalness" of the test arena, too proximate without ultimate (evolutionary) consideration, avoiding the "so what" question, and narrowness of the question with regard to appeal to the greater field of animal behavior. Successful proposals must have a "wow" factor, be original and creative, reject alternative hypotheses, have an "endpoint" (reach a conclusion), advance the field, be integrative, and contribute significantly to the broadest field of behaviorists.

1:55 PM

Snack Break

2:40 PM

Associative and Memorial Processes (Chair - Jeff Katz)

2:40 PM Mark E. Bouton, Ceyhun Sunsay, Ana Garcia-Gutierrez, & Michael C. Hendrix (University of Vermont)

Understanding Intertrial Interval Effects

A series of experiments isolated at least three mechanisms explaining why Pavlovian learning is better with spaced trials than with massed trials: (1.) recent presentations of the conditioning events "primes" them in short-term memory, making them less surprising (e.g., Wagner, 1981); (2.) contextual conditioning that blocks learning with massed trials is extinguished with longer intertrial intervals; and (3.) spaced trials engage a third process (the "X Factor") that allows better conditioning even when the other two factors are controlled. Recent experiments in which ITI signaled whether or not the next CS would be reinforced uncovered surprising asymmetries in how rats discriminated short from long ITIs that are consistent with the idea that time is coded as a series of hypothetical stimuli (A-B-C-D). If early cues (e.g., A) are more salient than later cues (e.g., C), then other aspects of the results, including the "X Factor," may be explained.

3:04 PM Nina Tarner (Sacred Heart University) & Zoe Warwick (University of Maryland, Baltimore County)

Environmental Cues That Signal a High Calorie Meal Enhance Satiety
An arbitrary stimulus (CS) that reliably precedes food presentation can come to elicit feeding. Arbitrary stimuli have also been shown to activate cephalic responses (e.g., gastric acid secretion, increased insulin levels, etc.) The magnitude of postprandial satiety is influenced by a variety of factors such as the macronutrient profile of the meal and the flavor-cued expectancies of the meal's satiating effects. What is not clear is whether the satiety effect of the food is affected by the conditioned response. The present experiment investigated the impact of environmental cues on the magnitude of satiety produced by a nutritive preload. Both oral and IG preloads were evaluated.

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3:18 PM Gonzalo P. Urcelay & Ralph R. Miller (SUNY-Binghamton)

Spacing Extinction Trials Attenuates Renewal and Spontaneous Recovery.

Two experiments investigated the effect of varying the intertrial interval among extinction trials while keeping the session duration constant. In the first experiment we used an ABA renewal preparation and observed that massed trials resulted in renewal of responding whereas spaced trials attenuated renewal. In the second experiment we used a similar approach but instead of changing the physical context at the time of testing, we interposed a retention interval (change in temporal context). Results showed that responding after massed extinction trials was recovered after a retention interval and this effect was reduced if extinction trials were spaced. These results suggest that extinction is more effective when the extinction trials are spaced in time rather than massed. While the benefits of spaced trials are small when there is no contextual change from extinction to testing, a change in context following extinction has detrimental consequences for extinction when the trials are massed rather than spaced.

3:25 PM Ana Martins & E.J.Capaldi (Purdue University)

Rapid Reacquisition in Pavlovian Learning: The role of memory

Rapid reacquisition following extinction in prior Pavlovian studies has been attributed to the CS retaining its excitatory capacity. In the instrumental area, the Sequential Model attributes rapid reacquisition to memories of reward and nonreward events retaining excitatory capacity despite extinction. Two Pavlovian investigations are reported, in which rapid reacquisition occurred, that could only be attributed to reward produced memories retaining excitatory capacity in extinction. In these experiments the CS was presented in every trial and what changed was the delivery, or not, of the UCS. This is not to suggest that the original interpretation applied to the earlier Pavlovian studies is incorrect. The CS may indeed retain excitatory capacity in extinction, as suggested, but this has yet to be demonstrated under conditions that cannot be explained by the memory view.

3:37 PM

Timing (Chair - Jon Crystal)

3:37 PM Angelo Santi, Dwayne Keough & Patrick Van Rooyen (Wilfrid Laurier University)

Differences in the Perception of Empty and Filled Time Intervals by Pigeons

Pigeons were trained in a within-subjects design to discriminate empty intervals (2-s and 8-s bound by two 1-s visual markers) and filled intervals (2-s and 8-s of a continuous visual signal). The two types of intervals were signaled by different visual stimuli and they required responses to different sets of comparison stimuli. Empty intervals were judged longer than filled intervals. The difference was not a result of pigeons timing the empty interval markers. This timing difference reliably occurs when there is no

ambient illumination present during test sessions, but it can be eliminated if ambient illumination is present. Different explanations of the timing difference between empty and filled intervals will be discussed.

4:01 PM Catalin V. Buhusi & Warren H. Meck (Duke University)

Time Sharing in Rats

The Time-Sharing and Instructional-Ambiguity hypotheses were evaluated in a peak-interval procedure with gaps and distracters. The Instructional-Ambiguity hypothesis predicts that subjects time through distracters and delay responding after gaps. The Time-Sharing hypothesis assumes that the timer shares attentional/memory resources with other processes. According to the Time-Sharing hypothesis both gaps and distracters delay timing by decreasing the attentional and memory resources allocated for timing, thus reducing the ability of the timer to maintain the pre-gap duration in working memory. Response functions were displaced by both gaps and distracters in accord with the Time-Sharing hypothesis. Computer simulations with a Time-Sharing model successfully matched these data and related results.

4:25 PM Marcelo Caetano (Brown University)

Training Temporal Discriminations in Rats: Memorization or Relearning?

Rats can be trained to discriminate between time intervals when different intervals are signaled by different stimuli. This study paired three intervals (30, 60 and 120 s) with a single stimulus or with three different stimuli. The stimulus-interval combinations were trained either simultaneously (different combinations presented in the same session) or in blocks (one combination per session). When the stimulus-interval combinations were trained simultaneously with different stimuli signaling different intervals, the rats memorized the stimulus-interval combinations; when the stimulus-interval combinations were trained in blocks, even after extensive training, the rats relearned the stimulus-interval combinations on each session. An evaluation of possible cues used for prediction of food availability indicated the possibility that daily relearning of the interval was the default strategy, and memorization of the stimulus-interval combination occurred only when the default strategy was ineffective.

4:32 PM Paulo Guilhardi (Brown University)

Maintenance of Learning During Extensive Extinction

The memory of rats for interval durations is maintained after extensive extinction when the conditions of original acquisition and extinction are the same. The goal was to determine whether the memory for interval durations is also preserved when the conditions during extinction are different from those of original acquisition. Twenty-four rats were trained on fixed-intervals 30-, 60-, and 120-s signaled by noise, light, and clicker. The stimulus-interval combinations (A) during acquisition were either maintained for 12 rats or changed (B) for the other 12 rats during extensive extinction. Following extinction, half of each group had reacquisition of the combinations A, and the other half B. The rats learned new stimulus-interval combinations during extinction, but the new learning did not eliminate the memory of the original combinations shown in the reacquisition transfer test. The restoration of the original context revealed the preservation of the original learning.

4:46 PM Linlin Yi (Brown University)

Pattern and Rate of Responding: An Explicit Solution

A three-phase experiment (acquisition, extinction and reacquisition) with three fixed intervals (FI 30, 60 and 120 s) was conducted to explore the effects of extinction on response pattern and response rate in rats. The response rate in extinction was much lower than the rate in acquisition and reacquisition, but the response patterns in the three phases were very similar. This suggests that extinction affects response rate, not response pattern. The separation of pattern and rate is well demonstrated by the explicit solution of packet theory, which contains two independent memories that corresponds to pattern and rate separately.

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4:53 PM Mika Macinnis (Brown University)

Automatic Identification of Adjunctive Behaviors in Rats

In a standard operant chamber a rat exhibits a wide range of behaviors, although only a few are automatically recorded for analysis (e.g. lever press, head entry). Other methods of measurement, including digital video analysis, have been used to record gross measures such as distance traveled or trajectory. Additional behaviors the rats exhibit, sometimes referred to as adjunctive behaviors, must be hand coded by an observer (e.g. exploring, grooming). An automatic method for behavior identification would make it possible to develop a model of behavior that encompasses the full repertoire of the rats' behavior. This project proposes a method for the automatic identification of adjunctive behaviors in rats, in a simple operant environment.

5:00 PM Sara Cordes (Duke University), Adam King (Fairfield Unversity), & C. R. Gallistel (Rutgers University)

Subtraction in the Mouse: Time Left Revisited

Evidence suggests that both rats and pigeons can respond according to the difference in two temporal durations (Time Left: Gibbon & Church, 1981) and two numerical values (Number Left: Brannon, Wusthoff, Gallistel, & Gibbon, 2001). The neural basis for these nonverbal computations is an open question although it has been suggested that genetics may provide an answer. Using a modified Time left procedure, the current study provides the first investigation into temporal subtraction in the mouse, a species in which the genetic code is available. Results of two experiments reveal that mice responded as a function of the difference between two standard latencies, suggesting that like rats and pigeons, mice can perform online subtraction. These results open the door for investigations of the cellular and molecular basis of nonverbal computations.

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

8:00 PM See Poster Abstracts Starting on Page 22

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

Friday Afternoon

12:00 PM Visual Processing - Pigeon Models (Chair - Robert Cook)

12:00 PM Donald Blough (Brown University)

Do Hard Decisions Take Longer, and If So, Why?

A red spot appeared on each trial of a go/no-go discrimination with pigeons. A particular shade of red was the S+, and a different shade of red was the S-. If during a block of sessions the S- was quite similar to the S+, responding was slower to the S+ than it was when, in other blocks of sessions, the S- was less similar to the S+. This result is consistent with a simple signal detection model that includes plausible assumptions about response speed and response bias. But harder to account for are the findings that responses to S+ fastest of all when the S- and the S+ were identical, and also that a difficult red discrimination also slowed responses to a green S+ that appeared in the same sessions.

12:14 PM Kevin Beale, Angie Koban, & Robert Cook (Tufts University)

Rate Classification by Pigeons

This research examined whether pigeons can learn motion categories, and more specifically, whether they can classify speed of motion. Pigeons (n=5) were trained to classify forty left and right rotating objects by their fast or slow rate of movement. Subjects easily learned this rate discrimination and transferred this property to novel objects, rotations and type of movements. These findings suggest pigeons may be able utilize abstract categorization in defining some types of motion.

12:21 PM Angie Koban & Robert Cook (Tufts University)

Tests of Motion and Identity Discrimination with Dynamic Object Stimuli.

Four pigeons were tested in a motion and identity categorization task. Object stimuli were composed of 40 different objects. In phase 1, the right versus left rotation of the objects had to be categorized by the pigeons in a go/no-go procedure. After extended training and several procedural changes, all pigeons failed to learn this motion categorization task. In phase 2, the pigeons were found to be able to learn this left/right discrimination with a single object. In phase 3, the 40 objects had to classified by their identity with half of the 40 objects being reinforced and the other half not reinforced in a go/no-go procedure. The pigeons were successful with this multiple object task. The results showed that pigeons can discriminate rotation with a single object and can learn to recognize up to 40 objects, but the number of objects interferes with discriminating directional rotation as a class. Implications of these results for our understanding of motion perception, classification and object recognition will be discussed.

12:28 PM Marcia Spetch & Alinda Friedman (University of Alberta)

Pigeons See Correspondence Between Objects and Pictures

Pictorial stimuli are used extensively in studies of avian cognition, yet attempts to show that birds recognize the correspondence between static pictures and the objects they depict have produced mixed results. We trained pigeons to discriminate between two identically-colored but differently shaped 3-D objects seen directly or as pictures and we found clear transfer of learning in both directions between the actual objects and their pictures. Transfer was also seen when pigeons were trained with multiple views of the 3-D objects and transferred to novel views seen in pictures. Because the transfer could not be based on two-dimensional cues such as color, we believe that our results provide the clearest evidence yet that pigeons can recognize the correspondence between objects and pictures.

12:35 PM A. Kieres, T.B. Patton, J. VandenBosche, T. Shimizu, & R.G Cook (Tufts Univ. & USF)

Functional Segregation Within the Entopallium in Pigeons

The avian visual pathway is thought to be organized anatomically, physiologically and functionally in a parallel fashion. Here we aimed to determine if there is functional specificity between the anterior and posterior entopallium, by employing a variety of visual discrimination tasks. Bilateral lesions showed a clear distinction between the function of these two areas. Lesions to the anterior entopallium produced selective impairment in the birds' ability to perform a color/shape discrimination task, while posterior lesions selectively impaired performance on a motion discrimination task. These results point to possible similarities in visual processing in pigeons and primates, namely through parallel processing visual channels.

12:42 PM #REF!

12:45 PM Social, Symbolic, and Cognitive Processes (Chair - Karen Hollis)

12:45 PM Jennifer Vonk (University of Southern Mississippi), Daniel J. Povinelli (University of Louisiana at Lafayette) & Joan B. Silk (University of California, Los Angeles)

Chimpanzees do not Donate Food to Unrelated Group Members

Humans exhibit a wide range of prosocial behaviors, even under conditions in which their kind acts can not be reciprocated. It is possible that these other-regarding preferences are unique to humans. If they are not, we might expect evidence for similar sentiments in our closest living relatives, the other great apes. Chimpanzees in particular might be expected to show concern for the welfare of others given their proclivity towards forming strong social bonds and engaging in cooperative behaviors such as hunting. In two experiments using slightly different methodologies, seven unrelated chimpanzees that have been part of a stable social group for more than 15 years did not opt to deliver food rewards to group members when they could do so at no cost to themselves. Instead, they were just as likely to choose an option that delivered food rewards only to themselves and not to their group-mates.

12:59 PM Francys Subiaul, Jennifer Vonk, Jochen Barth, Sanae Okamoto-Barth, & Daniel Povinelli (University of Louisiana at Lafayette)

Chimpanzees Infer the Reputation of Strangers

Several studies in the economics of information and social psychology have demonstrated that humans habitually attribute specific characteristics to unknown individuals. Assigning reputations to others appears to be an important feature of cooperative endeavors and necessary to solve the "tragedy of the commons." While various studies have reported how humans make reputational judgments, none have explored whether non-humans make similar judgments based entirely on observations of third party interactions. Here we present data which demonstrates that, when presented with two strangers, chimpanzees prefer to beg from an individual who gave food, versus an individual who refused to give food, to a third party [$t(3) = 5.25$, $p < .01$, one-tailed]. Though cooperation among strangers is rare in the primate order, the result reported here suggests that as with humans, reputation may be an available mechanism for mediating pro-social behaviors among chimpanzees.

1:13 PM Thomas Bugnyar (University of Vienna) & Bernd Heinrich (University of Vermont)

Knower-Guesser Differentiation in Ravens

Human social behavior is influenced by attributing mental states to others. It is debated whether such skills play a role in the behavior of non-human animals. We here used the mutually antagonistic interactions occurring between food-storing ravens and conspecific pilferers to test for the possibility of knowledge attribution in birds. Since pilfer success in ravens depends on memory of observed caches, we manipulated the view of birds at caching, thereby designing competitors who were either knowledgeable or ignorant of cache location, and then tested the responses of both storers and pilferers to those competitors at recovery. We show that ravens modify their cache protection and pilfer tactics not simply in response to the behavior of competitors but on the recognition of individuals that could or could not see the caching. Our results suggest that ravens know that obstacles can obstruct the view of others and that this affects pilfering.

1:27 PM Wendi Fellner (The Living Seas, Epcot) & Heidi E. Harley (New College of Florida & The Living Seas, Epcot)

Dolphin Vocal Responses to Acoustic Stimuli

Each dolphin produces a stereotyped whistle, a signature whistle, with a unique frequency contour. The frequency contour is stable, but the whistles vary in terms of absolute frequency, duration, and amplitude. It is not clear what influences those changes. In this study, the vocalizations of an adult male bottlenose dolphin at Epcot's Living Seas were recorded during a behavioral audiogram. For the audiogram, the dolphin was trained to whistle in response to a pulsed tone and to remain silent in its absence. Although any whistle was acceptable, the dolphin produced a stereotyped whistle to the pulsed tone stimuli used in the audiogram. The mean peak frequency of the stereotyped whistle increased when the frequency of the acoustic stimuli increased. The dolphin also produced a different category of vocalization after the flat-frequency-contour whistle used as the secondary reinforcer. These data suggest that dolphins vary their signature whistles based on their acoustic environment.

1:34 PM Ellen E. Furlong & Sarah T. Boysen (The Ohio State University)

The Effects of Enculturation on Chimpanzees' Understanding of Visual Attention

Visual attention has been the focus of many recent studies of non-human primate theory of mind. Povinelli and colleagues (1996) conducted a task examining 7 non-enculturated chimpanzees' understanding of the importance of posture, the face and the eyes in visual attention. Povinelli's chimpanzees failed most of this task, passing only posture conditions. We found that our group of 9 enculturated chimpanzees at The Ohio State University performed as if they understood visual attention when presented with the same task, passing all three conditions (posture, face and eyes). In order to determine whether this discrepancy was due to the effects of enculturation, we tested a third group of semi-enculturated subjects using the same paradigm. The semi-enculturated chimpanzees performed intermediately between the two other groups, succeeding on the posture and face conditions, but failing the eyes condition. Our results indicate that enculturation may affect the extent to which chimpanzees understand visual attention.

1:41 PM Anna M. Yocom, Ellen E. Furlong, & Sarah T. Boysen (The Ohio State University)

Discrimination of Relevant and Irrelevant Problem-Solving Features by Capuchin Monkeys

We tested three capuchin monkeys on a "means-end" problem solving task first used by Hauser and colleagues (1999) to determine whether tamarin monkeys generalize a learned solution to the task across functionally irrelevant changes. The task required the monkeys to pull one of two cloths; one with a piece of food on the surface or one with a piece of food next to the cloth surface. The capuchins showed evidence of generalizing their knowledge across such irrelevant variations as reward size, color and

location, as well as cloth shape and color, indicating that the capuchins based their responses on the functionality of the cloth as the means to access the food. These results are in contrast to a similar task used by Povinelli and colleagues (2000) with seven chimpanzees who failed most of the conditions presented to them.

1:50 PM Spatial Geometrics and Search (Chair -Jerry Cohen)

1:50 PM Debbie M. Kelly (University of Saskatchewan) & Walter F. Bischof (University of Alberta)

Influence of Features and Geometry on Goal-Directed Search Behavior in Virtual Environments

Successful navigation may be achieved using many different mechanisms including guidance based on featural and geometric information. In this study, we investigated how the environmental shape and the featural properties influenced goal-directed search behavior by adults. Groups of participants were presented with distinctive featural cues, as either discrete objects or as surface properties, in a virtual environment. Furthermore, these featural cues could either be contiguous with the geometric information or not. Transformation tests showed that contiguity of the two cues led to higher accuracy in the localization of a hidden target position. However, for women, the featural cues could overshadow the geometric cues, if the features were presented as discrete objects. Our results suggest that adults use a flexible strategy for encoding spatial information.

2:04 PM Sylvain Fiset (Université de Moncton in Edmundston) & Martine Perreault (University of Ottawa)

Do Domestic Dogs Understand Invisible Displacement of Object in an Opaque Tunnel?

We tested whether dogs understand invisible displacement of objects through an opaque tunnel. In Experiment 1 to 3, a tunnel was fixed horizontally over six opaque boxes and in Experiment 4, it was placed diagonally. On control trials, the tunnel was transparent and connected with a box. On testing trials, the tunnel was transparent at one end and opaque at the other end where it connected with a box. A ball was pushed through the tunnel and the dog's task was to open one box to find the object. On control trials, the dogs easily succeeded the task. On testing trials, the dogs mostly failed in all four experiments and predominantly tended to search inside the box adjacent to the disappearing location of the object inside the opaque tunnel. These results suggest that dogs do not understand that an object can move through an opaque tunnel.

2:18 PM Steven W. Badelt, Michael A. Parenteau, Kenneth J. Leising, & Aaron P. Blaisdell (UCLA)

ARENA: Automated Remote Environmental Navigation Apparatus

We have developed a wireless device which automates open field experiments. The system eliminates the time required for manual setup of each trial and reduces experimenter inconsistencies between trials. Our new open field is composed of independently-addressable, remotely-controlled units (up to 240) which can be arbitrarily arranged on any surface within a 25+ m. radius. Each of these units may be configured to serve one of two functions. As a navigational beacon, a unit is configured to illuminate one of several shapes in any of 16 million combinations of luminance and color. Each unit can alternatively serve as a response device by providing a key that is illuminated at one of 256 levels. Units of either type are linked to a coordinating computer, which can establish arbitrary links between devices to test simple forms of learning or complex cognition in either pigeons or rats.

2:25 PM Emily Gray & Marcia Spetch (University of Alberta)

Pigeons Encode Absolute Distance but Relational Direction from Landmarks and Walls

Many recent studies have examined animals' abilities to use absolute or relational distances to find a hidden goal. In general, when trained with an array of landmarks, expansion tests reveal that the default strategy of most animals is to search at an absolute distance from one or more landmarks. In contrast, when trained in enclosures that block external cues, animals often search on the basis of the relationship between walls of the enclosure. In the present study, pigeons were trained to find the center of either an array of landmarks or a set of short walls that did not block external cues. Expansion tests showed that both groups of pigeons tended to use an absolute distance strategy. However, on rotational tests, pigeons continued to search in the center of the array, suggesting that direction was learned in relation to array.

2:32 PM W. David Stahlman (UCLA), Seth Roberts (UC-Berkeley), & Aaron P. Blaisdell (UCLA)

Response Rate and Behavioral Variability of Operant Screen-Pecking in Pigeons Over a Continuum of Reward Probability

Gharib, Gade, and Roberts (2004) demonstrated a direct relationship between reward probability and variability in bar press duration in an operant task in rats. We investigated the relationship between reinforcement likelihood and operant variability in the spatial domain. Pigeons were trained to peck at a set of colored discriminative stimuli; each stimulus signaled a different probability of reward. We found that spatial variability of responses increased with decreasing probability of reward, but only for pecks outside the discriminative stimulus. Furthermore, peck rates within the stimulus did not differ across stimuli, but higher rates were observed to stimuli signaling a higher likelihood of reward. It is difficult to reconcile these results with the law of effect.

2:39 PM Verner P. Bingman & Daniele Nardi (Bowling Green State University)

The Avian Hippocampus: Space or Spatial Salience?
The avian hippocampus has been proposed to play a crucial role in memory representations of space that guide goal recognition and navigation, including the geometric coding of space. However, a growing body of evidence suggests that the geometric coding of space in homing pigeons is not blocked by hippocampal lesions, but rather re-assigned a subordinate role with respect to other goal recognition strategies such as the use of feature properties. A shift in the salience of spatial cues is also seen in lateralization studies when damage to the hippocampus of one hemisphere influences the relative salience but not capacity for representing space. As such, many previous findings on impaired spatial behavior in hippocampal lesioned pigeons may actually reflect more a shift in the salience of spatial information rather than lost spatial ability.

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2:53 PM Izabela Szelest & Debbie M. Kelly (University of Saskatchewan)

Pseudo-neglect in Clark's Nutcrackers?
Humans routinely show a slight left-sided visuospatial bias, over-selecting for objects on their left in comparison to their right, when engaging in cancellation tasks. This asymmetry has been explained by reference to the superiority of the right hemisphere for spatially guided tasks. Recent research has suggested that birds, like humans, may show a similar left-sided visuospatial bias. This finding has put into question the role of the corpus callosum in the emergence of spatial asymmetries. Our study examines whether a left-sided visuospatial bias is also evident in the food-storing Clark's nutcracker.

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3:00 PM Snack Break

4:15 PM In Honor of the Contributions of Russell M. Church

4:15 PM Introduction - Jon Crystal

4:20 PM Kimberly Kirkpatrick & Rona Russell (University of York)

The Role off Temporal Generalization and Categorical Learning in the Bisection Task in Rats

Two experiments were conducted in which rats were trained to discriminate two or three stimulus durations using a bisection task. When trained to discriminate short vs. long signals, rats demonstrated a standard peak shift effect. Conditions where training involved three signals (short, medium, and long) revealed that rats: (a) discriminated three durations (short, medium, and long) if three distinct responses were available; (b) learned to respond to short and medium signals as a category vs. a long signal; and (c) were unable to learn to respond to short and long signals as a category vs. a medium signal. The results suggest that generalization plays a major role in determining discriminability, but that categorical learning may also contribute.

4:35 PM Peter R. Killeen & Federico Sanabria (Arizona State University)

Wrinkles in Time

One of the procedures most commonly used to evaluate time production is the "Peak Procedure", a Fixed Interval schedule in which some of the trials are replaced by extended non-reinforced trials. Unless precautions are taking to prevent it, responding will often resurge at the end of the extended trials. This feature may be used to test alternate models of the internal clock. Relevant data and theory are assembled for this talk.

4:50 PM Jonathon D. Crystal (University of Georgia)

Endogenous Oscillations in Short Interval Timing

A defining feature of a circadian oscillator is that periodic output from the oscillator continues after the termination of periodic input. In contrast, a defining feature of a pacemaker-accumulator system is that elapsed time is measured with respect to the presentation of a stimulus; consequently, the output of a short-interval system is periodic if presented with periodic input. However, periodic output ceases if periodic input is discontinued. Groups of rats were trained to time short intervals (approximately 1-3 minutes); periodic delivery of food produced periodic behavior. Next, delivery of food was suspended. Behavior was periodic after termination of periodic input. The period in extinction increased as a function of the period in training. These data suggest that short-interval timing is based on a self-sustaining, endogenous oscillator.

5:05 PM Warren H. Meck (Duke University)

Amygdala Inactivation Reverses Fear's Ability to Make Time Stand Still

The magnitude of fear as a function of time from the onset of a signal paired with footshock can be assessed using a conditioned emotional response procedure (Libby & Church, 1975). By embedding 10-s auditory signals paired with shock within a peak-interval procedure using 50-s visual signals paired with food, one can study the effects of fear on simultaneous temporal processing (Meck & Church, 1984). Moreover, this hierarchical arrangement of signals allows for a double dissociation between sequential and parallel timing mechanisms as a function of the emotional valence of the 10-s signal (positive or negative) and inactivation of the amygdala or frontal cortex (Olton, Wenk, Church, & Meck, 1988). Results show that rats temporarily stop the timing of the 50-s signal when presented with a 10-s signal paired with shock (but not with food) and amygdala inactivation (in contrast to cortical lesions) restores the ability to time both signals simultaneously.

5:20 PM Mariam Naqshbandi & William A. Roberts (University of Western Ontario)

Anticipation of Future Events by Squirrel Monkeys and Rats: Tests of the Bischof-Kohler Hypothesis

The Bischof-Kohler hypothesis holds that to the extent animals may show behavior that anticipates a future need, this behavior will only appear when the future need is also experienced at the time the behavior is performed. In experiments with squirrel monkeys and rats, choice between two quantities of food led to differential satisfaction of a future need not experienced at the time of choice. Although the rat findings supported the Bischof-Kohler hypothesis, monkeys showed clear evidence of being able to anticipate a future need not currently experienced.

5:35 PM Lorraine G. Allan, Samuel Hannah, & Shepard Siegel (McMaster University)

The Consequences of Surrendering a Degree of Freedom to the Participant in a Contingency Assessment Task

Many studies of contingency judgments have used a task in which, on each trial, the participant is free either to respond or not to respond, and an outcome may, or may not, be presented. Although the experimenter specifies a nominal value for the contingency between responding and outcome, the actual values of a variety of variables experienced by a particular participant depend on that participant's frequency of responding. We will present experimental data and the outcomes of simulations which indicate that the same nominal contingency value will lead to considerable variability in the actual contingency experienced by participants. We will also show that nominal contingency manipulations are confounded with the probability that the participant experiences an outcome. We will discuss similar concerns in the animal learning literature, and we will suggest methods which allow the experimenter to reclaim the degree of freedom which typically has been yielded to the participant.

6:00 PM Master Lecture - Russell M. Church (Brown University)

The Predictability of Behavior

7:30 PM Banquet

Saturday

10:00 AM Business Meeting of the Comparative Cognition Society

All Invited to Attend - CCS Members May Vote on any Motions Made

11:10 AM (: Group Photo Shoot - SMILE :)

11:30 AM Tool Use (Chair - Chris Sturdy)

11:30 AM Alex A. S. Weir & Alex Kacelnik (University of Oxford)

Tool Shaping and 'Understanding' in New Caledonian Crows

The observation that a New Caledonian crow ("Betty") spontaneously discovered how to build a hook out of wire (Weir et al, 2002) raised the question as to what extent this was controlled by previous reinforcement learning of specific movements or by innovative responses to a novel problem. To examine this issue we presented Betty with complementary tasks requiring: (1) making hooks using a different material that required different modification techniques; (2) straightening a strip of metal in order to make it longer to reach food and (3) modifying a strip of metal to make it narrower. In all three cases Betty quickly succeeded in reaching the food, indicating that a simple process of reinforcement of random actions is unlikely to suffice as an explanation. However, the details of her acquisition process do not allow as yet for a full model of the cognitive process behind her rapid problem solving.

11:44 AM Joanna Wimpenny, Alex A. S. Weir & Alex Kacelnik (University of Oxford)

Sequential Tool Use in the New Caledonian Crow

New Caledonian crows show evidence of cognitive flexibility through their ability to produce tools of different shapes with new materials for specific purposes. To test the extent to which they can plan future actions and are sensitive to causal relations, we conducted experiments in which subjects had to use one tool to obtain a second, and sometimes a third tool, only the last of which was long enough to retrieve food. Three subjects consistently used two tools in a sequence from the first trial, and one spontaneously used a three-tool-sequence on all appropriate trials. Since sequential and composite tool use has only been seen in rudimentary form in apes, and is often considered to be evidence for advanced planning and understanding, this performance in a bird is striking and adds to the surprising level of sophistication that is apparently present in this species.

11:55 PM Serial Pattern Learning and Memory (Chair - Bill Roberts)

11:55 PM Stephen B. Fountain & Amber M. Chenoweth (Kent State University)

Central Cholinergic Systems are Necessary for Organized Responses to Cue Changes in Rat Serial Pattern Learning

In serial pattern learning, it is common to find that the transitions to new chunks of a serial pattern are more difficult to anticipate than elements within chunks. Providing "phrasing cues" at chunk boundaries can facilitate learning about these transitions in normal rats. Further, our lab has found evidence that atropine, a muscarinic cholinergic antagonist, impairs acquisition of chunk boundaries, regardless of the presence of phrasing cues. We examined the differences between two groups of rats given daily i.p. injections of either saline or atropine sulfate (50 mg/kg) and trained to press levers in a specific order (the serial pattern) for brain-stimulation reward in an octagonal operant chamber. Two phrasing cue removal probes revealed that both control and atropine-

exposed rats anticipated chunk boundaries. However, the results also showed that intact central cholinergic systems are necessary for rats to exhibit organized strategies for dealing with cue changes in transfer conditions.

12:09 AM Jerome Cohen, Sirad Mohamoud, Tammy Kani (University of Windsor) & Izabela Szelest (University of Saskatchewan)

Do Rats "Trial Travel" in a Serial Pattern Task?

Rats reduce their trial 2 runway speeds less within an RNR than within as RNN series when both occur in a fixed order in every session (Capaldi et al., 1983). Originally this differential trial 2 speeds effect was considered an example of rats' foresight for anticipating future trial outcomes (Capaldi, 1985). More recent assessments consider this effect an example of "trial confusions" between the last two trials in a series rather than a form of "time or trial travel" (Capaldi et al., 2004; Burns et al., 2000). To test these alternative accounts, we conducted three experiments in the T-maze with elongated, visually different side runways. In those experiments, we employed different methods to enhance rats' abilities to differentiate between the last two trials in each series. Under these conditions, the differential trial 2 speeds effect, is either diminished or eliminated, supporting the trial confusion over the trial travel hypothesis.

12:23 AM Kelly Jaakkola (Dolphin Research Center)

Can Dolphins Learn the Shell Game? A Test of Physical Reasoning in a Marine Mammal

A basic element of spatial cognition is the ability to reason about the location and movements of objects that are no longer directly visible (i.e., "object permanence"). In this study, dolphins (n=6) were first trained to "find the object" when part of the object remained visible. They were then tested in three conditions: single visible displacement, double visible displacement, and invisible displacement. Overall, they succeeded on single displacement, but not on double or invisible displacement. However, dolphins who received the single displacement condition first performed notably better than those who received the other conditions first, suggesting that one problem may have been too great a jump between the training situation and the more complicated testing conditions. Preliminary results of a second study addressing this possibility will also be presented.

12:37 AM Stephanie J. Babb & Jonathon D. Crystal (University of Georgia)

Evaluating the Selectivity of Discriminating What, When, and Where

Rats (n=12) visited four baited locations (randomly chosen on each trial; study phase), two of which were randomly selected to provide a distinctive flavor, either grape or raspberry. The distinctive arms provided three pellets per visit; the other arms provided one regular pellet per visit. After a short (1 hr; SRI) or long (6 hr; LRI) retention interval, all 8 locations were available and the four locations not available in the study phase provided food (test phase); the distinctive locations also provided food after LRI. More revisits to the distinctive locations occurred after LRI than after SRI, documenting that the rats discriminated what, when and where. Rats were then satiated to one of the two distinctive food types during LRI in order to selectively devalue that food type. One of the distinctive food types was also paired with LiCl during the LRI to selectively devalue that food type.

12:44 AM Rebecca Singer & Thomas Zentall (University of Kentucky)

The Use of an Unexpected Question to Assess Episodic Memory in Pigeons

It has been suggested that memory for personal events, or episodic memory, is unique to humans. In an attempt to show that animals too have episodic-like memory, we first trained pigeons to respond to the question "Where did you just peck, left or right?" A red comparison was correct if they had pecked left. A green comparison was correct if they had pecked right. In Phase 2, vertical lines were correct following blue samples and horizontal lines were correct following yellow samples (sometimes the correct line orientation was on the left, sometimes on the right). In the test phase, after the pigeons had pecked the line orientation, we unexpectedly asked "Where did you just peck"? Pigeons chose the correct comparison (that depended upon the location just pecked) 72% of the time, demonstrating that they had the capacity to unexpectedly recall specific details about their past experiences, an ability consistent with episodic memory.

12:55 PM Developmental Learning (Chair - Bill Roberts)

12:55 PM Susan M. Schneider & Robert Lickliter (Florida International University)

Generalization in Early Development: Evidence from Bobwhite Quail

A longstanding controversy concerns the degree to which generalization skills are a function of experience/learning. This study investigated whether standard generalization gradient phenomena would be present in precocial avian chicks in the days immediately following hatching. 24-hr old bobwhite quail were autoshaped to peck a touchscreen target on a variable ratio (VR) heat reinforcement schedule. When the target was present, a high-pitched beep repeated at a constant rate. We obtained individual generalization gradients over seven beep rates in extinction from chicks at 3 to 5 days of age. In Experiment 1, the training stimulus continued to be presented during succeeding VR sessions. Experiment 2 utilized differential training with an S+ and an S- at different beep rates. Gradients were excitatory or inhibitory depending in an orderly way on response rate and number of training sessions. Even at this young age, generalization phenomena appear similar to those seen at older ages.

1:09 PM Chuck Locurto (College of the Holy Cross)

Growing Old Doesn't Entirely Suck - at Least Cognitively

A group of mice (n = 40) were run through a battery of cognitive tasks at age 3 months and again at age 18 months. The battery of four cognitive tasks included a detour task, an olfactory foraging problem, a Hebb-Williams maze, and a working memory radial maze problem. Each task was run under a different motivational system and in a different arena. Subjects also received control procedures to assess activity, exploration,and anxiety. Decrements in performance as a function of age were noted only in the working memory task. Positive correlations were observed across the four tasks both during initial testing and retesting, indicating that subjects that performed well on one task performed well on the others at a given age. The intra-task correlations between test and retest were, however, quite modest, suggesting that subjects that performed well as young animals did not necessarily retain their rank in retesting.

Snack Break

2:30 PM Discrimination Learning (Chair - Ken Cheng)

2:30 PM Olga F. Lazareva (University of Iowa), Michelle Miner (University of Iowa), Edward A. Wasserman (University of Iowa) & Michael E. Young (Southern Illinois University at Carbondale)

Transposition in Pigeons: Multiple-Pair Training Facilitates Relational Responding

We studied transposition in pigeons by training them to select the smaller (or the larger) circle. In training, different groups of pigeons were exposed to a single training pair, to two training pairs, or to three training pairs along the size dimension. Testing included two stimulus pairs for which, according to theoretical postdiscrimination generalization gradients, relational responding should decrease from one-pair to two-pair to three-pair training. Based on the results of our earlier study (Lazareva, Young, & Wasserman, 2005), we predicted that relational responding should increase from one-pair to two-pair to three-pair training, contrary to Spence's (1937) predictions. We found that multiple-pair discrimination training enhanced relational responding which, on average, rose from 46.8% (one-pair training) to 52.3% (two-pair training) to 64.1% (three-pair training). These results provide strong evidence against Spence's theory as an explanation of relational responding in two-alternative discrimination tasks.

2:44 PM Karen L. Hollis, Amber Hayden, & Margaret McDermott (Mount Holyoke College)

Learning in Antlions: Anticipating a Long Wait

Antlions, the larvae of an adult winged insect, capture food by digging pits in sand and then lying in wait, buried at the vertex, for prey to fall inside. The sedentary nature of antlions' sit-and-wait predatory behavior and, especially, their innate ability to detect prey arrival, do not fit the profile of invertebrates that possess learning capabilities. However, we show that learning can play an important, heretofore unrecognized, role in this insect's predatory behavior. Once each day for 16 days, individual antlions received either a brief vibrational cue presented immediately before the arrival of food or that same cue presented independently of food arrival. Signaling of food enabled antlions not only to extract food faster, but also dig more efficient pits and molt sooner than antlions for which food was not signaled.

2:58 PM Paula Roy, Carrie Blakeslee, & Jean Geary Boal (Millersville University)

Conditional Discrimination Learning in Octopuses

Conditional discrimination, the ability to selectively respond to a stimulus based on a contextual cue, would be of clear utility for animals that use learning to navigate. Demonstrations of conditional discrimination in cephalopods have suffered from the difficulties of obtaining unambiguous behavior from subjects. Clear evidence for conditional discrimination in octopuses was obtained by providing prolonged (18h) exposure to two alternate maze configurations. Each maze configuration included two potential burrow sites, one open and one closed, and a variety of landmarks. No aversive conditions, other than the open maze itself, were provided. Within five exposures to each maze, each octopus (n=6) traveled directly to the open burrow upon entry to each maze, providing clear evidence for conditional discrimination. (Presented by Jean Boal)

3:05 PM Kristy Lindemann, Colleen Reichmuth Kastak, & Ronald J. Schusterman (University of California, Santa Cruz)

Exclusion Procedures Can Be Used to Assess Emergent Cross-Modal Matching in a California Sea Lion

The process of exclusion is demonstrated when a subject, in the presence of an undefined sample, chooses an undefined comparison as opposed to a familiar defined comparison. In the field of psycholinguistics the term fast-mapping is used to describe the same phenomenon and is often used to study early word learning in small children. Exclusion can be demonstrated both within and across the sensory modalities. Our current research with a California sea lion (Zalophus californianus), investigates cross-modal exclusion by using an auditory-visual matching-to-sample procedure. Following acquisition of auditory-visual associations using exclusion procedures, the presence of spontaneous learning outcomes were evaluated. The subject's transfer performance was significantly higher than expected by chance and generally not different from performance on familiar trials. This finding illustrates that training associations with an auditory-visual exclusion procedure can lead to successful and spontaneous cross modal transfer performances.

3:12 PM Sarah A. Michalek, Marco Vasconcelos, & Peter J. Urcuioli (Purdue University)

The Effects of Partial Reinforcement on the Ambiguous Cue Effect

The ambiguous cue effect refers to low accuracy on a two-choice simultaneous discrimination in which the S- in one task appears as the S+ in another, concurrently run simultaneous discrimination task. When selection of the S+ in the former task was partially reinforced, the ambiguous cue effect was enhanced to the point that pigeons' accuracy dropped below chance. By contrast, when selection of the S+ in the latter task was partially reinforced, it virtually eliminated the effect by producing high accuracy on the other simultaneous discrimination. These findings support the notion that value transfer from the S+ to the S- in simultaneous discriminations also plays a role in the ambiguous cue effect.

3:21 PM Withdrawn

3:28 PM Marco Vasconcelos, Sarah A. Michalek, & Peter J. Urcuioli (Purdue University)

"Work Ethic" and the Anticipation of Effort

Pigeons reportedly prefer stimuli preceded by greater effort. This "work ethic" effect has been attributed to a greater hedonic improvement in the shift from high effort to the stimulus that follows it, a contrast that can supposedly also arise from the anticipation of high effort. We tested the latter hypothesis by training pigeons on different simultaneous discriminations following high-effort (80 pecks) and low-effort (1 peck) work links that, in turn, were signaled by different stimuli. Differential effort expectations were evident in substantially longer latencies to peck the stimulus signaling high effort than to peck the stimulus signaling low effort. However, when given a choice between the S+ following the high-effort link and the S+ following the low-effort link, pigeons did not show a preference for the former. Likewise, no work ethic effect was evident in a group for which the high- and low-effort links were unsignaled.

3:35 PM **Intelligence** (Chair - Tom Zentall)

3:35 PM Withdrawn

3:35 PM Patrice Marie Miller (Salem State College) & Michael Lamport Commons (Harvard Medical School)

Using Hierarchical Complexity to Determine How Smart Animals Are

A problem in comparative psychology is the lack of a good way to compare "how smart" different animals are. Here, we set forth a general and powerful means. The Model of Hierarchical Complexity (MHC) posits that tasks can be ordered by their hierarchical complexity. The Model also may measure the stages of animal behavior on this absolute scale. It does so by taking the actions that animals and humans engage in, and ordering them. Stage of performance has the same number and name as the corresponding order of hierarchical complexity of the task it correctly completes. An animal species is characterized by the highest stage of performance observed with any amount of training on it best task series. Animals perform up to the concrete stage, about what 8 to 10-year-old children do. Examples show how MHC can be used to compare how smart different animals are.

3:49 PM Michael Lamport Commons (Harvard Medical School)

Measuring an Approximate g in Animals

A science of comparative cognition ultimately needs a measurement theory, allowing the comparison of performances of different species of animals. Current theories are often based on human performances and may not easily apply to other species. We propose that such a theory include three-indexes: an index of the stage of development based on the order of hierarchical complexity of the tasks the species can perform; an index of horizontal complexity; and a measure of g. Here we propose a way to conceive of g in animals. Geary has argued that domain-general mechanisms are essential for evolutionary psychologists. We use existing research to enumerate domains, such as problem solving behavior in pursuit of food, or behaviors in pursuit of mates and/or reproduction. We then illustrate how to construct two forms of g, one across domains and one within domains.

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4:05 PM Closing Remarks - Mike Brown

Poster Session II (8:00 - 10:00)

8:00 PM See Poster Abstracts Starting on Page 28

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

CO3 2006 Posters

Posters

Poster Session 1 - Thursday Evening

P1 Gin Morgan (Columbia University)
Numerical Matching to Sample in Rhesus Macaques (Macaca mulatta)
Past research with rhesus macaques has shown ordinal competence with numerical stimuli, though it is unclear exactly how numerical values are represented and if different values are represented in different ways. This experiment uses a computerized delayed matching to sample paradigm with all values 1-9 and stimuli varied across multiple dimensions. This experiment aims to determine the extent of rhesus numerical competence and which mechanism or mechanisms are used to form a mental representation of, and compare, numerical stimuli.

P2 Anna Wilkinson & Kimberly Kirkpatrick (University of York, UK)

Complex Catching and Tracking Behavior in Pigeons

Pigeons have been shown to track moving objects using a complex tracking strategy; however, the underlying mechanisms are still unknown. Four pigeons were trained in a customized operant chamber in which one side was made up of a touch screen and video monitor. They were presented with a stimulus that could start from any side of the screen and travel horizontally or vertically to the other side. Test trials were randomly intermixed with training trials; in these the stimulus made a sudden 90 deg turn. Additional tests were given where the object disappeared and then reappeared on its original trajectory or on the turn trajectory. The pigeons adapted to the test motions, with their performance improving over sessions. Examination of their peck errors revealed that on normal turn trials, their initial strategy persisted beyond the turn. However the brief disappearance of the object prior to the turn resulted in an improvement in adaptation to the post-turn motion.

P3 Steven W. Badelt, Jack W. Judy, Aaron P. Blaisdell (UCLA)

A Behavioral Model for Testing Reliable Brain Computer Interfaces in Rat

Brain-computer interfaces (BCIs) are designed to decode patterns of neural behavior and rehabilitate patients by substituting machine function for incurred disabilities. However, this technology has not enabled patients to reliably interact with the environment. Here, we propose a two-lever operant task which supports the testing and design of reliable BCIs in a rat model. The operant schedule first requires rats to reliably produce a pattern of lever pressing. Later, use of the BCI will be substituted for lever-pressing activity. The schedule allows the behavioral definition of the rat's intent to subsequently lever-press, or activate the BCI. Our preliminary data indicate that rats can be conditioned to correctly produce the lever-pressing pattern in >99% of trials. The method used herein provides a mechanism for developing reliable BCIs in a rat model, with eventual applications to primate research and for human patients.

P4 Jochen Barth (Maastricht University) & Josep Call (Max Planck Institute for Evolutionary Anthropology)

Tracking the Displacement of Objects: A Series of Tasks with Great Apes and Young Children

We administered a series of object displacement tasks to twenty-four great apes and twenty-four 30-month-old children. Objects were placed under one or two of three cups by visible or invisible displacements. The series included six tasks: Delayed response, inhibition test, A-not-B, rotations, transpositions, and object permanence. Apes and children solved most tasks performing at comparable levels except in the transposition task, in which apes performed better than children. Ape species performed at comparable levels in all tasks except in single transpositions, in which chimpanzees and bonobos performed better than gorillas and orangutans. All species found non-adjacent trials and rotations especially difficult. The number of elements that changed locations, the type of displacement, and having to inhibit predominant reaching responses were factors that negatively affected the subjects' performance.

P5 Benjamin M. Basile & Robert R. Hampton (National Institute of Mental Health, now at Emory University), Stephen J. Suomi (National Institute of Child Health and Human Development) & Elisabeth A. Murray (National Institute of Mental Health)

Assessment of Memory Awareness in Capuchin Monkeys (Cebus apella)

Humans, apes, and rhesus monkeys demonstrate memory awareness by collecting information when ignorant and acting immediately when informed. In the current study, five capuchin monkeys searched for food after either watching the experimenter bait one of four opaque tubes (seen trials), or not watching (unseen trials). Monkeys with memory awareness should look into the tubes before making a selection only on unseen trials because on seen trials they already know the location of the food. In Experiment 1 one capuchin looked more often on unseen trials. In Experiment 2 we ensured that the monkeys attended to the baiting by interleaving training and test sessions. Three monkeys looked more often on unseen trials. In Experiment 3 we increased the effort required to look, predicting a larger difference between seen and unseen trials. No monkeys looked more often on unseen trials. These findings provide equivocal evidence for memory awareness in capuchin monkeys.

P6 Toyomi Matsuno (Kyoto University, JSPS) & Masaki Tomonaga (Kyoto University)

Stream/Bounce Perception in Chimpanzees (Pan troglodytes)

The stream/bounce stimulus is an ambiguous motion event; identical visual objects move directly toward and the two objects overlapped completely before they past one another. They appear either to stream past one another or to bounce off each other. Previous studies have shown that the stimulus is dominantly perceived as "stream" by human observers and that attention-capturing stimuli (such as sounds, flashes, and bounce event) synchronously presented with the overlap of the objects turn the perception into "bounce". In this study, behavioral experiments using an object-tracking task revealed characteristics of stream/bounce perception in chimpanzees (n=5). First, chimpanzees did not show a tendency of dominant "stream" perception of the stream/bounce stimulus. Second, chimpanzees significantly increased "bounce" responses depending on the addition of a synchronous bounce event to the display as humans did. These results suggest both similarity and difference between chimpanzees and humans in perceptually organizing movement of multiple objects.

P7 Joshua S. Beckmann & Michael E. Young (Southern Illinois University at Carbondale)

Novelty as a Feature in the Feature Positive Effect in Humans

We investigated the role of the relative salience of present and absent cues in Feature Positive (FP) and Feature Negative (FN) tasks. Past literature has shown, across various methods and species, that FP tasks are learned more easily than FN tasks, giving rise to what is known as the Feature Positive Effect (FPE). Experiment 1 was devised to investigate the role of presence/absence salience in the FPE through manipulation of the context (constant versus varied) that was paired with the feature. The results suggest that novel contextual elements may be salient enough to eliminate the FPE, creating a Feature Negative Effect (FNE) under certain conditions. Experiment 2 replicated the FNE and the addition of a testing phase confirmed that participants in the FN task judged novel stimuli to be strong positive predictors whereas participants in the FP task did not. These results are problematic for contemporary associative learning models.

P8 Miranda C. Feeney & William A. Roberts (University of Western Ontario)

Studies of Impulsivity versus Self-control in Rats on the Radial Maze

Traditional assessments of “impulsivity” versus “self-control” in animals have studied choice in an operant chamber; findings have indicated a lack of ability to foresee future consequences and a discounting of delayed rewards. The current studies examined impulsivity in the context of foraging on the radial maze. Rats chose between arms yielding a delayed large reward and arms yielding a more immediate small reward. In Experiment 1, rats showed a preference for arms providing 1 reward pellet after a 1-s delay over arms providing 1 pellet after a 10-s delay; this preference continued as the reward after 10-s was increased to 5 pellets. In Experiment 2, however, reward magnitude differences were present from trial 1, and results differed from the typical operant finding, with rats visiting delayed-large-reward arms before immediate-small-reward arms. Experiment 3 explored the possibility that differential secondary reinforcement experiences on maze arms during delays facilitated self-control.

P9 Tiffany Galtress & Kimberly Kirkpatrick (University of York, UK)

Reward Value and Reward Timing are Not Independent.

Rats were initially trained on an instrumental FI60-s peak procedure. Increasing the value of the reward by increasing the number of food pellets led to a leftward shift in the peak function during non-reinforced probe trials, whilst reducing the value of the reward by pairing the food pellets with lithium chloride led to a rightward shift in the peak function during non-reinforced probe trials. These findings suggest that changing the motivational value of the reward affected the perceived delay to reward.

P10 Chris Harshaw, Susan Schneider, & Robert Lickliter (Florida International University)

Superstition in the One-Day-Old? Inter-Call-Interval and Auditory Preference in Bobwhite Quail Neonates

The interaction of species-typical patterns of behavior with arbitrarily chosen schedules of stimulus presentation is a topic of interest to a wide range of researchers. This study presents data demonstrating a near linear relationship between length of inter-call-interval (ICI) and naïve preferences for variants of bobwhite maternal calls in 24-hour-old bobwhite quail chicks. Naïve chicks were given 5-minute simultaneous choice tests between two variants of the same maternal call, differing only in length of ICI. Calls with shorter ICIs were found to be significantly preferred over calls with longer ICIs, the degree of preference being proportional to the difference in ICI between the two calls. It seems likely that this phenomenon is the result of chance contiguities between specific behaviors of the chick (e.g. distress vocalizations) and specific features of the maternal call being played during testing. Sequential analyses exploring this hypothesis will be presented.

P11 Brooke Poerstel, Carol Dwan, Bridgette Byrd, Nick Hahn, Patrick McKinney, Jessie Ramsey, Rebecca M. Rayburn-Reeves & Mark Galizio (University of North Carolina Wilmington)

The Importance of Response Topography in Olfactory Discrimination in Rats

Using a two-choice repeated discrimination learning procedure with olfactory stimuli, we have found rapid, single-session, learning in rats when the response involved digging in scented sand to produce food pellets. Experiment 1 attempted to replicate these findings using a nose-poke response with three discriminative stimuli, but rapid learning was not obtained. Discrepancies between Experiment 1 and our earlier findings might have been due to increasing the number stimulus choices from two to three in Experiment 1 or to differences in response topography: nose-poke vs. digging. To examine the importance of response topography, Experiment 2 tested repeated discrimination learning with three choices and a more active response requirement. Rapid learning in this study suggests that response topography is a major influence on olfactory discrimination learning.

P12 Elizabeth J. Rahn (University of Georgia), Tyson L. Platt, Daniel Bradford & Martha Escobar (Auburn University)

Inhibition of Delay in Appetitive Conditioning: Retardation Test

Inhibition of delay refers to the observation that conditioned responding to a long conditioned stimulus (CS) tends to be delayed until the final segments of the CS, which are contiguous with the unconditioned stimulus (US; Pavlov, 1927). Rescorla (1967), using dog subjects in an aversive preparation, conducted summation and retardation tests for the initial segments of a long CS, and reported that the initial segments of the long CS became inhibitory. A previous experiment from our laboratory, using an appetitive paradigm with rat subjects, failed to obtain evidence of conditioned inhibition to the initial segments of a CS trained with an inhibition of delay paradigm, when assessed via a summation test. Using the same appetitive preparation, the current study revealed retarded acquisition of a conditioned response to the initial segments of the CS.

P13 John Townsend-Mehler (Michigan State University)

Bumblebees and Honeybees: A Comparison of Foraging Decisions in a Changing Environment

When a food source becomes non-rewarding, all foragers must decide if and how often to revisit that site, when to look elsewhere, and for many insects, when to return to the nest. In this experiment we compared the foraging behavior of honeybees and bumblebees. Foragers were given permanent access to a constant low reward feeder, and then a limited amount of experience (either long or short) at a variable feeder, offering first a high payoff and then no payoff. Once the variable feeder ceased to be rewarding, both feeders and the hive were monitored. I observed strong species differences in sampling rates at the variable high-reward site, willingness to reinitiate foraging at the low reward site, as well as subsequent return visits to the nest. These results suggest that there are fundamental differences between species in terms how each utilizes information from past experience to make foraging decisions.

P14 Tania J. Bettis & Lucia F. Jacobs (University of California at Berkeley)
Sex Differences in Spatial Cognition in Mice
Sex differences can be an important tool for comparative cognition. Females and males may utilize different cognitive solutions to solve similar problems such as encoding spatial cues. We addressed this question in the laboratory mouse in experiments using cohorts of 10 mice per sex. These experiments included novel object recognition which has never been shown to be sexually dimorphic. This task is mediated by a subfield of the hippocampus (CA1). The mice were habituated to two identical objects in a 5 min session 24 hours before the

test session. During the test session the mice were presented with a novel object paired with a familiar object. Females spent significantly more time with the novel object than the familiar object while males did not show this bias. These results will be presented along with the results from ongoing studies of sex differences in cue use in various mazes.

P15 Kent D. Bodily, Bradley R. Sturz, & Jeffrey S. Katz, (Auburn University)

Generalization of Spatial Rules Instead of Integration of Spatial Maps in a Virtual Open-Field

A 3-D virtual-environment open-field analogue of Blaisdell & Cook's (2005) pigeon foraging task was constructed to determine if humans, like pigeons, were capable of integrating separately learned spatial maps. Participants searched for a goal among 16 raised cups arranged in a 4 x 4 grid. During separate training phases, participants learned to locate the goal between two landmarks (Phase 1: blue T and red L) and down and left of a single landmark (Phase 2: blue T). During test trials, participants made 6 unrewarded choices in the presence of the red L alone. Cup choices during testing were analyzed to assess participants' strategies: generalization (Phase 2), association (Phase 1), or integration (combination of Phases 1 and 2). Results suggested participants used a generalization strategy which was confirmed by two control groups. Comparative implications of the data are discussed.

P16 Mona Buhusi (University of North Carolina at Chapel Hill), Richard Chu (Duke University), Melitta Schachner (University of Hamburg), Patricia Maness (University of North Carolina at Chapel Hill) & Catalin V. Buhusi (Duke University)
Impaired Working Memory in a Spatial Task in CHL1 KO Mice
Cell adhesion molecules play important roles during development including axonal growth, pathfinding, and neural plasticity. The "Close Homolog of L1" (CHL1) gene is associated with human mental retardation and schizophrenia. We assessed spatial navigation in male CHL1 null mutants, heterozygotes, and wildtype littermate controls (C57BL/6) in a modified radial arm maze. The results suggest a reduced working memory capacity during spatial navigation in CHL1-KO mice relative to controls.

P17 Xiaoqian J. Chai & Lucia F. Jacobs (University of California Berkeley)

Sex differences in the Construction of the Cognitive Map: A Spatial Navigation Study in Virtual Environments

Sex differences in spatial strategy have been reported in multiple species. In humans, comprehensive cue use has not been studied in previous experiments. The present study uses computer generated virtual environments to investigate human sex differences in the construction of the cognitive map. We hypothesize that females rely more on topology-like maps constructed mainly from local positional cues, whereas males rely more on bearing maps based on directional cues such as distal objects, geometric and gradient information. Subjects are asked to navigate in a computerized open field and locate a hidden object. Each subject is trained with an environment where all cues are present, then tested on modified environments where some cues are removed, displaced or rotated. We predict males should be less affected by manipulations of positional cues and females should be less affected by manipulations of directional cues.

P18 Fred Dyer (Michigan State University

Multiple Representations of Sun-Compass Information in Honey Bees

To use the sun as a compass, honey bees compensate for its movement relative to earth-bound landmarks. This study examined whether bees that have learned the sun's course relative to one foraging route can transfer this knowledge to a different foraging route. Bees were trained to fly to food in narrow channels, which served as the reference frame for learning the sun's course. Covering the channels forced bees to rely upon memory of the sun's position. Waggle dances, which signal flight directions relative to the sun, revealed where the bees estimated the sun to be. When bees that had already learned the sun were made to fly in a different direction, they quickly learned the angle of this new tunnel relative to the sun. However, this angle was not compensated for the sun's subsequent movement. This suggests that bees can encode the sun's position in both time-compensated and non-compensated formats.

P19 Sylvain Fiset (Université de Moncton in Edmundston)

Searching in the Center : Do Guinea-Pigs Encode Relative Distance?

This study was aimed at determining whether guinea-pigs encode absolute or relative distance to locate the center of a configuration of landmarks. The guinea-pigs' task was to locate a hidden platform surrounded by landmarks placed inside a pool. In Experiment 1, the

platform was centrally placed between two landmarks. In Experiment 2 and 3, it was surrounded by four landmarks forming a square. On control test, the landmark array remained the same as in training. On expansion tests, the size of the array was double along one dimension (Experiments 1 and 2) or along both dimensions (Experiment 3). On control tests, the guinea-pigs searched at the center of the landmark array. On expansion tests, the guinea-pigs tended to search either at the training distance from one of the landmarks or at the center of the array, suggesting that guinea-pigs encode and use both relative and absolute distances from the landmarks.

P20 Michelle Hernández & Jeffrey S. Katz (Auburn University)

Pigeons Can Use Optimal Paths in a Computerized Task

Pigeons that learned to move a target toward a goal on a computer screen by responding to arrows representing distinct directions (i.e., left, right, down, up) were transfer tested with a barrier placed between the start and goal locations. The target could not be moved through the barrier. Optimal path use was analyzed in relation to the effects of distance and angle of the configurations (i.e., specific relationship among target-barrier-goal). Pigeons successfully avoided the barrier but when the barrier blocked the goal at the shortest distance, the pigeons incorrectly selected the arrow that would move the target through the barrier toward the goal. Next, after training with the barrier, the pigeons were again tested with the same configurations but in novel angles. Movement toward the barrier decreased and good transfer was found for some configuration types indicating pigeons can learn optimal paths.

P21 Edward Lorek & Michael F. Brown (Villanova University)

Sex Differences in Human Spatial Pattern Learning

The present study was focused on the extent to which men and women demonstrate spatial abilities that correspond to the predictions made by the theory that human sex differences in spatial abilities are based on our evolutionary history as hunter-gatherers (Silverman & Eals, 1992). To investigate this hypothesis, we used a version of the human analog pole-box task developed by Upton (2004) and based on the spatial pattern learning task for rats introduced by Brown and Terrinoni (1996). The task requires subjects to locate a consistent spatial arrangement of correct buttons within a 6 x 6 matrix of blank buttons over the course of 60 trials that is either consistently located across trials (Location Condition) or randomly located across trials (Pattern Condition). The hunter-gatherer hypothesis predicts that females will outperform males in the Location Condition and males will outperform females in the Pattern Condition. Little, if any, support for this prediction was obtained.

P22 Tomas Pickering, Erica H. Kennedy, Bettina von Ammon, Nicole Scott, Dorothy Fragaszy, & Josh Wintje (University of Georgia)

Capuchin Monkeys (Cebus apella) Complete Two-Dimensional Mazes More Efficiently Following Practice With Numerous Exemplars

Can monkeys navigate mazes that require attention to multiple features more efficiently following practice with numerous exemplars? We presented three capuchin monkeys with 192 two-dimensional digital mazes that they encountered four to seven times in replicates. Mazes contained one to five binary choices including zero to three “non-obvious” choices (where the incorrect path was in the Euclidean direction of the goal). After each replicate, we presented a subset of twenty-four mazes to assess variables that we hypothesize reflect the monkey’s attention to the relevant spatial relations in this task. With continuing experience at solving the mazes, monkeys a) made fewer errors, particularly on non-obvious choices, b) self-corrected their errors before striking the end of path proportionally more often, c) and looped the cursor 360º less frequently. These findings indicate that monkeys can learn to manage attention in a task involving sequential and concurrent decisions about travel.

P23 Cynthia Wei (University of Nebraska)

A Test of the Social Complexity Hypothesis: Transitive Inference in Clark's Nutcrackers and Azure-winged Magpies

According to the social complexity hypothesis, life in large, stable social groups demands sophisticated cognitive abilities. Comparing two closely related species, Bond et al. (2003) showed that the highly social pinyon jay (Gymnorhinus cyanocephalus) outperforms the relatively nonsocial western scrub jay (Aphelocoma californica) in dyadic tracking and transitive inference tasks. While the pinyon jay’s superior performance might be attributed to the demands of social life, it might also be the result of their superior spatial abilities. To investigate this possibility, we compared a relatively social bird that does not cache, the Azure-winged magpies (Cyanopica cyanus), to a relatively nonsocial species known for their excellent spatial abilities, Clark’s nutcrackers (Nucifraga columbiana) on dyadic tracking and transitive inference tasks. Our preliminary results indicate that magpies and nutcrackers do not differ in acquisition rates or accuracy in dyadic tracking, and neither species appears to perform as well as pinyon jays in these tasks.

P24 Anna Waisman & Lucia F. Jacobs(University of California, Berkeley)

Flexible Spatial Cue Use in a Food-storing Mammal

Although most animal studies on the use of spatial cues in place location tasks have concentrated on the use of rigid hierarchical strategies, new data suggests that these strategies do not adequately explain animal behavior. We plan to explore the ability of a food-storing mammal, Sciuridae (squirrel), to adopt different heuristics depending on the availability and stability of cues in the environment. We will first demonstrate that squirrels use cues in the same hierarchical manner as other food-storing animals and that this hierarchy is then disrupted in cue conflict situations when two subordinate cue types are put in conflict with the single dominant cue type. We will also establish how cue stability interacts with cue use. Preliminary results show: that squirrels are comparable to other animals in their use of spatial cues, that cue majority overrides cue hierarchy, and that cue stability is a main predictor of cue use.

P25 Carrie R. Rosengart (California University of Pennsylvania) & Dorothy M. Fragaszy (University of Georgia)

Spatial Search Accuracy on Probe and Non-Probe Trials in Capuchin Monkeys (Cebus apella)

In spatial search tasks probe trials are frequently used to assess search accuracy without the confound of a reward. Capuchin monkeys were tested on a search task where they were required to find a raisin (after 0-120 second delays) that they had observed being hidden in a sandbox. Accuracy was determined on non-probe trials based on the distance of the first search attempt from the actual hiding location. On probe trials, the raisin was removed prior to the search attempt. The monkeys were then allowed to search for 30 seconds. Multiple searches were allowed. On the non-probe trials, the delay impaired search accuracy. However, on the probe trials, the monkeys showed similar search patterns regardless of the length of the delay period. These findings indicate that though initial searches were impaired by a delay period, the monkeys were able to accurately focus their searches if given additional search opportunities.

P26 Nicole M. Scott, Dorothy Fragaszy (University of Georgia), & Charles Menzel (Georgia State University)

Chimpanzee Strategies to Solving Spatial Relation Problems: Managing Concurrent and Asymmetric Relations

Solving spatial problems requires managing relations between objects and surfaces. We predicted that managing concurrent relations between an object and a surface would be more difficult than managing a single relation. Four adult chimpanzees placed a rigid stick into a groove on a circular tray and then returned the tray to the experimenter. The sticks changed progressively from straight, to a cross, to a tomahawk shape. In this manner, the number of concurrent relations required to insert the stick increased. Subjects completed ten trials of each shape before progressing to the next. All subjects completed the series, but in a manner distinct from a human approach (i.e. direct placement into the groove). Chimpanzees used several strategies including sliding the stick over the surface and bimanual guidance. The asymmetric conditions were more difficult for them than the simple straight stick conditions as evidenced in more attempts and longer trials.

P27 Sarah A. Stamper & Gordon B. Bauer (New College of Florida)

Landmark Navigation in Honeybees (Apis mellifera): Snapshot Memory and Relative Position

Honeybees have the ability to use landmarks to navigate. Two models proposed to explain landmark navigation by honeybees have been frequently suggested: snapshot memory and compass navigation. An alternative model more commonly used to describe vertebrate landmark navigation is relative position. This study consisted of two experiments. The first had a single landmark array and manipulated the size and distance to the goal of the landmark. The honeybees made predicable errors in search location and search time consistent with the snapshot model. The second study had a two-landmark array and made the same manipulations but for either one or both of the landmarks. When both landmarks were manipulated the honeybees did not make search location errors, although they did have increased search times. Results for the second study suggest the possibility that the honeybees could use a strategy of relative position under conditions of a constrained environment.

P28 Bradley R. Sturz, Kent D. Bodily, & Jeffrey S. Katz (Auburn University)

Evidence for Spatial Integration in Humans

A sensory preconditioning procedure similar to that used by Sawa, Leising, and Blaisdell (2005) with pigeons was implemented for humans to test for spatial integration. Two separate groups searched a 3-D virtual environment for a goal in a 4 x 4 grid. First, both groups learned to locate a goal down and left of a single blue landmark. Next, participants were presented with five successive three-trial blocks consisting of two blue landmark trials followed by one preconditioning trial. Preconditioning trials lasted 30 seconds and consisted of the

blue landmark paired consistently (Consistent group) or inconsistently (Inconsistent group) with a red landmark. Choice responses could not occur during preconditioning trials. Next, a single test trial occurred in which participants made choices in the presence of the red landmark alone. Results suggested only the Consistent group utilized an integration strategy and were consistent with those obtained with pigeons.

P28A Daniel I. Brooks & Edward A. Wasserman (University of Iowa)

Same/Different Concept Learning with Trial-Unique Stimuli in Pigeons

A longstanding issue in same/different concept learning is the repeated use of stimuli across training trials, because such a procedure encourages individual or configural stimulus learning. This issue prompted us to devise a means for generating trial-unique stimuli with which to investigate same/different concept learning. Four pigeons were given a Two-Alternative Forced-Choice Same/Different task using trial-unique stimuli, which meant that every discrimination training trial was also a generalization testing trial. These stimulus arrays were arranged in a 4 x 4 grid containing 16 cubes; each cube itself contained a 16-item array whose cells were filled with one of 16 levels of luminance. Creating stimuli in this way afforded us a virtually endless set of unique patterns and allowed the controlled manipulation of the degree of similarity between individual stimuli in the task.

P29 Aaron P. Blaisdell (UCLA), Kosuke Sawa (Japan Society for the Promotion of Science—Nagoya University), W. David Stahlman, Kenneth J. Leising, Dana Gant (UCLA), & Michael S. Waldmann (University of Göttingen)

Causal Reasoning in Rats

Empirical research with nonhuman primates appears to support the view that causal reasoning is a key cognitive faculty that divides humans from animals. The claim is that animals approximate causal learning using associative processes. The present results cast doubt on this conclusion. Rats made causal inferences in a more basic task which taps into core features of causal reasoning without requiring complex physical knowledge. They derived predictions of the outcomes of interventions after passive observational learning of different kinds of causal models. These competencies cannot be explained by current associative theories but are consistent with causal Bayes net theories.

P30 Erica Hoy Kennedy & Dorothy M. Fragaszy (University of Georgia)

Examining the Analogical Reasoning Capacity of Capuchin Monkeys (Cebus apella) using a Three-Dimensional Search Task

Analogical reasoning involves recognizing similarities among object relations when the objects themselves are dissimilar. It has been argued that apes, but not monkeys, are capable of analogical reasoning. This study investigates whether capuchin monkeys can use analogical reasoning in order to solve a three-dimensional search task that was modeled from a paradigm used in the developmental literature (i.e, Goswami, 1992). The task involves hiding food under one of two opaque cups of different sizes and allowing the subject to search for food under the cup of analogous size in their own set of cups. Monkeys are first learning basic MTS. Next they will be exposed to two pairs of cups and required to search for food based on physical or relational similarity. It is expected that the monkeys will have more difficulty solving the analogical search task in comparison to the task based on physical similarity.

P31 Michael Lamport Commons (Harvard Medical School)

Horizontal Complexity and How Smart Animals Are

There are three major forms of task difficulty that should be taken into consideration in determining how smart animals are: Hierarchical complexity, g, and Horizontal complexity. Classical information theory describes the number of “yes-no” questions it takes to do a task. Each yes-no question is a bit. The measure of Horizontal complexity, then, is the sum of bits required by doing a task correctly. Horizontal complexity is exemplified by short term memory span and length of behavioral chains that may be assembled in a stable manner. There have been many studies of these across a wide variety of species done in a number of ways. Some examples will be reviewed.

P32 Patricia Wilson (Columbia University)

Order Information Task Comparing Monkeys and Humans

Three rhesus monkeys performed a Serial List Recognition (SLR) task containing 4 arbitrary photographs against varying numbers of distracters (2, 3, or 4). Responses were reinforced for selecting all the items in the list, regardless of presentation order, without selecting any distracters. A strong recency effect was found without any evidence of a primacy effect. Human subjects were then asked to perform the same task to compare behavioral responses with an increase in the number of distracters (6, 7, or 8). On the identical task humans

showed both primacy and recency effects. When the arbitrary photographs were changed to black and white fractals, human performance decreased and output order shifted to more closely mirror that found in monkeys. A third Human condition that decreased the reaction time to match that of the monkey subjects resulted in further modification of the output order and accuracy away from primacy toward recency. A fourth Human condition was intended to completely eliminate the participant's ability to verbalize the stimuli. Participants were asked to say "the" repeatedly throughout the session. This condition is expected to result in further modification of human output order to mirror that of the monkey subjects.

Poster Session 2 - Saturday Evening

P33 Denise P.A. Smith & Stephen B. Fountain (Kent State University)

Medial Caudate Putamen Lesions and Rat Serial Pattern Learning

In prior research in our lab, MK-801, an NMDA receptor antagonist, disrupted serial pattern learning in rats when the serial pattern was a sequence of 24 response elements arranged in eight 3-element chunks. The final element of the sequence violated the overall pattern structure. MK-801 rats learned within-chunk elements as fast as controls, but showed permanent inability to learn the violation response and, to a lesser degree, chunk boundary responses. In the present study, 6 rats received medial caudate putamen excitotoxic lesions later confirmed by histological analysis. Rats were then trained on the same pattern as in previous studies. Medial caudate putamen lesions caused learning deficits for within-chunk elements and the violation element, but not for chunk-boundary elements. Deficits were generally less severe than those caused by MK-801. These results support the claim that serial pattern learning is subserved by multiple dissociable brain and cognitive systems.

P34 James D. Rowan (Wesleyan College), Amanda R. Willey, Eric P. Nolley, Brian M. Kelley (Bridgewater College), and Stephen B. Fountain (Kent State University)

Adolescence exposure to nicotine impairs adult serial-pattern learning in rats.

This experiment examines the effects of early exposure to Nicotine on adult higher cognitive function. Weanling rats were injected 5 days a week for 5 weeks with 3.0, 1.0, 0.3 mg/kg nicotine or saline based on body weight (1 ml/kg). After 5 weeks off, all subjects were trained on the perfect run pattern (123 234 345 456 567 678 781 812) for 28 days receiving 5 patterns a day. Analysis of the data found the performance of the 1.0mg/kg nicotine group was significantly impaired compared with all other groups. To our knowledge, this is the first evidence that long-term, low-level adolescent nicotine exposure significantly impairs higher cognitive functioning in adulthood.

P35 James D. Rowan (Wesleyan College), Barbara E. Rowan (James Madison University), Shannon M.A. Kundey (Yale University), and Nandini Sen (Wesleyan College)

The Effects of Pattern Dispersal on Acquisition of Alternation, Runs, and Perseveration Patterns on a Rat and Human Serial-Pattern Learning Task.

Theories of serial-pattern learning have discussed different types of rules but have little discussion whether all rules are learned with the same difficulty. In an experiment using rats and humans (different but analogous procedures), subjects were divided into groups and required to learn 1 of 5 simple patterns (run-plus, run-minus, preservation, double alternation, and disrupted pattern) interleaved with another perseveration pattern. Subjects, both humans and rats, in all groups learned to track their pattern. The data support the hypothesis that the perseveration rule is learned fastest even when overall effort is controlled for. The perseveration pattern allowed for the fastest acquisition and the plus, minus, and alternation patterns were acquired at approximately the same rate.

P36 Amber M. Chenoweth, Steven A. Wolfe, & Stephen B. Fountain (Kent State University)

"Extreme" Sequential Learning: Rats Learn 60-Element Interleaved Serial Patterns

Humans have the ability to chunk together information from nonadjacent serial positions in sequential patterns. For example, human subjects typically learn the pattern, A-M-B-N-C-O-D-P-E-Q, by cognitively sorting pattern elements into component interleaved subpatterns: A-B-C-D-E and M-N-O-P-Q. Our earlier studies demonstrating similar capacities in rats showed that patterns composed of two interleaved subpatterns were difficult to learn, but that subpattern difficulty was nonetheless determined by subpattern structure. In the present study, we investigated rats' ability to learn a 60-element interleaved pattern where one subpattern was one of two 30-element hierarchically organized patterns composed of either "runs" or "trills" chunks. The other subpattern was composed of a repeating element. Subpattern acquisition rates were correlated with the structural properties of component subpatterns. The results indicate that rats are sensitive to the patterning of nonadjacent elements even in extremely long serial patterns and that several factors contribute to pattern tracking in interleaved patterns.

P37 Stephen B. Fountain & Amber M. Chenoweth (Kent State University)

A Serial Reaction Time Task for Rats: Individual Differences in Sequence Encoding

The serial reaction time (SRT) task is a popular procedure for assessing sequential learning capacity in human neuropsychology and functional imaging studies. We developed an operant SRT procedure for rats that is a close analogue of the human SRT procedure. It encourages rats to respond as quickly as possible to the successive positions of a light that appears in one of four positions in a horizontal array. Rats press corresponding levers under the array of lights for brief pulses of hypothalamic brain-stimulation reward. "Reaction times" (RTs) are similar to those observed in human studies, averaging 1000 msec or less for 1000-trial sessions. Rats learned a simple repeating pattern in this task in a single session; RTs were shorter for repeating patterns than for random sequences presented in blocks in the same session. Rats showed individual differences in sequence encoding that appeared in their first session and remained consistent across sessions.

P38 Amber M. Chenoweth & Stephen B. Fountain (Kent State University)

Central cholinergic systems are necessary for learning and retaining "exceptions-to-the-rule" in rat serial pattern learning.

We examined the effects of atropine, a muscarinic cholinergic antagonist, on acquisition and retention of serial patterns. Rats were given daily i.p. injections of either saline or atropine sulfate (50 mg/kg) and trained to press levers in a specific order (the serial pattern) for brain-stimulation reward in an octagonal operant chamber. The two groups learned the following pattern: 123 234 345 456 567 678 781 818. Atropine exposure impaired acquisition for chunk boundary elements (the first element of chunks) and the violation element of the pattern, but did not impair acquisition for within-chunk elements. Performance was unchanged in a subsequent drug-free day. Similar deficits were observed in a retention test where saline-trained rats were exposed to atropine for one day. The results indicate that intact central cholinergic systems are necessary for learning and retaining appropriate responses at places in sequences where pattern structure changes.

P39 Sara Crowell (New College of Florida), Heidi E. Harley (New College of Florida, The Living Seas at Epcot), Wendi Fellner & Leslie Larsen-Plott (The Living Seas at Epcot)

Vocal Productions of Rhythms by the Bottlenose Dolphin

This study is an in-depth analysis of vocalizations produced by a dolphin participating in a rhythm production study. In the rhythm production study, the dolphin was shown one of six objects and reinforced for vocally producing a rhythm uniquely associated with that object. An analysis of the dolphin's vocal responses across eight months of the study revealed that the dolphin varied frequencies and durations across the rhythms while maintaining the structure of each rhythm. Stable characteristics of the vocalizations included incorporation of an upsweeping frequency contour into the long elements, and more broadband characteristics in the short elements. These results demonstrate that dolphins represent rhythms in terms of relative durations and frequencies versus absolute durations and frequencies. In addition, because the importance of contour in the dolphin's vocal repertoire was evident throughout this study, these data suggest that dolphins may categorize whistles by contour.

P40 Joseph Tremblay & William A. Roberts (University of Western Ontario)

Is the whole greater than the sum of its parts? Categorization of whole and partial geometric figures by pigeons

We report two studies that examined which properties of geometric figures pigeons attended to during discrimination training. In the first experiment, one group of pigeons was reinforced for pecking at different images of triangles and was nonreinforced for pecking at images of circles and ellipses. Another group saw only triangles and was reinforced for pecking at them. On test trials given after discrimination learning, both groups were shown novel whole and partial triangles, circles, and ellipses. The results indicated that any feature of a triangle was sufficient for it to be categorized as a triangle and that categorization of circle and ellipse test stimuli was dependent upon their similarity to the training stimuli. Similar procedures were used in a second experiment to find out if pigeons can learn the concepts of triangle and circle.

P41 Walter T. Herbranson (Whitman College)

Pigeons (Columba livia) learn visual categories based on angle of movement, but not angle of orientation

Pigeons can learn to categorize stimuli based on a wide variety of visual features. However, not all kinds of categories are equally easy to learn. Some can be learned with very little training, while others can only be acquired with extensive experience, if at all. In these experiments, pigeons learned to categorize visual stimuli presented on a computer monitor. When categorizing moving objects based on

their speed and angle of travel, pigeons divided attention across both stimulus dimensions and performed nearly optimally. When categorizing objects based on size and angle of orientation, pigeons selectively attended to size, even when attention to orientation was required for optimal performance. These results indicate that categories based on angle can be relatively easy or relatively difficult for pigeons, depending on whether angle represents an orientation or a direction of travel.

P42 Tammy L.B. McKenzie (Brandon University) & William A. Roberts (The University of Western Ontario).

Categorization by Pigeons: The Role of Category Variability and Perceptual Similarity

The influence of category variability and perceptual similarity on categorization judgments by pigeons was examined. Two groups of pigeons were trained with two categories of horizontal lines. Group 1 was trained with a low variability short line category (lines similar in length) and a high variability long line category (greater variability in length). Group 2 was trained with a high variability short line category and a low variability long line category. Then pigeons were tested with lines intermediate in length to the two training categories. If category variability is important then the majority of intermediate lines should be categorized into the more variable category, whereas if perceptual similarity is important each intermediate line should be categorized into the category that it most resembles. Pigeons categorized the intermediate test stimuli based on perceptual similarity.

P43 Matthew Murphy & Robert Cook (Tufts University)

Control by Absolute and Relational Properties in an Auditory Discrimination Task in Pigeons (Columba livia)

Many discrimination tasks typically separate stimuli by absolute or relational properties (i.e. same versus different). In this study, both sources of control were simultaneously available to examine when and how each property controlled behavior. Pigeons (n=4) were reinforced in a go / no-go successive auditory discrimination task for “different” tone stimuli from one stimulus set (octave 1), but not for “different” stimuli from the another set (octave 2) or “same” stimuli from either set. A second experiment tested the same task with two stimulus sets of alternating notes from within a single octave. The response pattern across conditions suggested strong absolute discrimination in the first task. Initial second task results showed relational factor utilization. This indicates that relational factors may spontaneously play a role in audition when absolute factors become less discriminable.

P44 Jennifer J. Pokorny & Frans B.M. de Waal (Living Links, Yerkes National Primate Research Center, Emory University)

Failure of Capuchin Monkeys to Generalize the Oddity Task Under Certain Conditions

Previous work has shown that brown capuchin monkeys (Cebus apella) are able to perform oddity tasks and successfully transfer to new stimuli. However, most of the studies used a WGTA with physical objects of a similar type. We trained 6 capuchin monkeys to perform the oddity task by selecting digital images on a touchscreen computer. Under certain conditions it appeared that the oddity concept was obtained (reached and maintained criterion for at least 2 sessions). However, after subsequent transfer to new digital stimuli types (e.g. clip art, faces), it was found that performance returned to chance level, suggesting that knowledge of the concept failed to generalize. Other strategies were employed to facilitate generalization to new stimulus types, which included providing luminance cues and small set sizes. We will present data on individual performance on each stimulus type as well as performance on subsequent transfer tasks.

P45 Deborah E. Racey, Michael E. Young (Southern Illinois University), & Edward A. Wasserman (University of Iowa)

Discriminating Continuous Variability: Evidence for the Finding Differences Model

A visual variability discrimination task using displays of items that varied along a continuous stimulus dimension, color or size, was presented to college students. Display items differed in their relative similarity and also in proximity of similar items, a manipulation included in order to study effects of display organization on variability discrimination. Stimulus displays were arranged in one of five conditions: same, similar-near, similar-far, dissimilar-near, and dissimilar-far. In near displays the most similar items were adjacent. The data generally followed a systematic ordering of more “different” responses and lower RTs for dissimilar-far displays to more “same” responses and higher RTs for similar-near displays. When similar items were more proximal, judged display variability decreased, an effect that increased with similarity. These findings provide strong support for a recently proposed model of variability discrimination, the Finding Differences Model (Young, Ellefson, & Wasserman, 2003).

P46 Matching and Non-matching to Sample in Rats with Olfactory Stimuli

Rebecca M. Rayburn-Reeves, Rhiannon Thomas, Laurence L. Miller & Mark Galizio (University of North Carolina at Wilmington)

Six rats were trained to dig in scented sand to obtain food pellets. Digging in a sample stimulus cup produced two comparison stimuli, one with a scent identical to the sample and the other with a different scent. Three rats were reinforced for digging in the comparison cup that matched the sample and three for digging in the non-matching cup with five different odor stimuli. After 25 sessions a new set of five stimuli was introduced with the same contingency in effect. After 15 sessions with the second stimulus set, a third set was introduced with the contingencies reversed so that rats trained with matching were switched to non-matching and vice versa. All six rats showed acquisition of the initial conditional discriminations, and transfer to the second stimulus set. In contrast, when rats were switched from a matching to a non-matching contingency, there was persistent control by the original contingency.

P47 Kristin E. Bonnie (Emory University) & Ryan L. Earley (Georgia State University)

Stop, Look and Listen: An Integrative Framework for Social Information Use in Animals

The field of social learning has been instrumental in shaping our understanding of how, when and why animals utilize the information provided by the behavior of others. Social eavesdropping and public information also have provided insights into social information use among diverse taxa. However, these concepts have not yet been integrated with social learning in any great capacity. We offer a novel, interdisciplinary approach to linking these three concepts, which have remained to date, remarkably distinct within the literature. We identify points of convergence and divergence including types of information gathered (about what versus whom), how information is packaged (signals versus cues) and relative payoffs to parties involved. Finally, we evaluate the benefits to broadening the scope of research on social information use.

P48 Jessica Crast, Robin Cooley, & Dorothy Fragaszy (University of Georgia)

Capuchin Monkeys Learn with Others

We investigated the extent to which social context influences skill acquisition in captive young capuchin monkeys. Social groups (adults and juveniles) were presented with an apparatus that could be operated to obtain juice. Concurrently, a matching apparatus was available to juveniles only in a crèche within the home enclosure. Several juveniles used the apparatus in both locations, often in the presence of adults and/or other juveniles. To determine which factors influenced their learning, we compared juveniles that first encountered the apparatus for 20 sessions in the crèche with juveniles that first encountered the apparatus together with proficient adults. We tracked the juveniles' activity at the apparatus prior to their first solution while alone and while with others. Encountering the apparatus in the presence of adults and other juveniles facilitated the juveniles' acquisition of the skill compared to prior experience in the crèche.

P49 Colin Ellard (University of Waterloo)

Gerbils Monitor the Behaviour of Conspecifics to Assess Risk.

Previous studies have shown that when gerbils respond to unexpected sensory stimuli by fleeing, their trajectories take into the account the probable behaviour of conspecifics, presumably to avoid competition for safe refuges. In the present study, gerbils were presented with simulated predators while in an arena that allowed them to view the behaviour of another gerbil. Responses to predator models depended on the behaviour of observed gerbils. Observed gerbils that fled from the stimulus facilitated the likelihood of flight in tested gerbils and lack of response in the observed gerbils depressed the likelihood of flight in the tested gerbils. A second study showed that this dependence was restricted to trials in which the observed gerbils were within visual range of the tested gerbils at stimulus onset. These findings suggest that gerbils select the appropriate response to unexpected stimuli, in part, by observing the responses of their neighbours.

P50 Tephillah Jeyaraj (University of Georgia)

Response of Pair-housed Male Capuchin Monkeys (Cebus apella) to Inequity.

Brosnan and de Waal (2003) studied the response to unequal rewards of socially-housed female brown capuchin monkeys. The task was to return a token to the experimenter for a reward. Expanding on their study, I tested six male capuchins who have lived in fixed pairs for more than ten years. I used the same procedure with certain modifications to the experimental design and found that pair-housed males did not respond to unequal rewards in the same way as socially-housed females. They responded to inequity by significantly rejecting the low-value reward when both rewards were visible to them but not when they were hidden from view, regardless of whether the competitor received the high-value reward. However, the identity of the competitor did seem to influence rejection of the low-value reward. The monkeys showed significantly more rejection when the competitor receiving the high-value reward was a non-cage-mate rather than their cage-mate.

P51 Jeaniene Leis, Emily Ward, Meredith Bashaw, & Roger K. R. Thompson (Franklin & Marshall College)

Does What a Capuchin Monkey (Cebus apella) Receive Affect His Partner's Expectation of Reward?

Brosnan and de Waal (2003) reported that Capuchin monkeys (Cebus apella) respond negatively to unequal reward distributions. They interpreted their results as evidence for "an early evolutionary origin of inequity aversion" and a sense of fairness and injustice. They rejected the less anthropomorphic explanation of violated expectations, in which animals forgo a low-value reward if a high-value one is anticipated (i.e. negative contrast). However, Gant, Suri, Disla, & Thompson's (2004) within-subject finding that Capuchin monkeys valued a cucumber reward less if it was preceded by a grape than preceded by a cucumber supported this latter hypothesis, particularly in the presence of conspecifics. We tested whether or not parallel between-subject contrast effects would occur from one trial to the next if an animal observed a partner receive a grape or cucumber. Our results revealed striking individual differences. All four animals showed between-subject contrast effects, whereas only two showed within-subject contrast effects.

P52 Kandis Purnell, Ashley Jensen, & Martin Shapiro (California State University, Fresno)

Choice behavior is affected by both the amount and delay of reward. While most experiments use nutritional rewards, the present set of experiments tested how choice is affected by the amount and delay of a social reward in Siamese fighting fish (Betta splendens). Male Siamese fighting fish find the access to aggressive displays with another male rewarding. Using a specially designed plus maze, animals were run in four, 100-trial experiments (half choice and half no-choice trials), with the left and right arm associated with different amounts of time displaying to another male (experiment 1), different delays (experiment 2), and the interaction of amount and delay in self-control designs (experiments 3 and 4). The results were compared with the most often cited quantitative models dealing with the affects of amount and delay of reward on choice behavior in animals.

P53 Sanae Okamoto-Barth (Nagoya University and Maastricht University), Nobuyuki Kawai (Nagoya University), Masayuki Tanaka, & Masaki Tomonaga (Primate Research Institute, Kyoto University)

Looking compensates for the distance between mother and infant chimpanzee

The development of visual interaction between mother and infant has received much attention in developmental and comparative psychology. The present study focused on the question of whether the mother and infant chimpanzee replace physical contact with visual contact. To test this hypothesis, we measured non-synchronous looking ('looking') between mother and infant. A unique setting, in which the mother stayed in one location and the infant moved freely, allowed us to analyze the relation between the visual interaction and the distance of a mother-infant pair during the first year of life. Our results showed that 'looking' increased when body contact decreased or when the distance between mother and infant increased. We also show a typical "secure-base" behavior, which is characterized by the infant regularly returning to its mother when exploring the environment. These findings imply that attachment between mother and infant chimpanzee appears to develop in a similar fashion as in humans.

P54 Tadd B. Patton and Toru Shimizu (University of South Florida)

Which Features of Female Pigeons Elicit Courtship Display in Males?

Previous research has shown that male pigeons (Columba livia) respond with courtship displays to video images of a female pigeon. Courtship displays significantly decline when the head region of the female stimulus is occluded, suggesting that this region contains important visual information. However, the exact features necessary to elicit males' displays are still unknown. This study examined the courtship behavior of male pigeons when exposed to a digitally altered female pigeon. The alterations included size and spatial arrangement of facial features (eyes and beak) as well as the contour (outline) of the bird. The results showed that the presence of facial features was important only when the contour was not clear and that size and spatial arrangement was not essential to elicit courtship displays. These findings will be discussed in the context of conspecific recognition and mate selection.

P55 Regina Paxton & Peter Judge (Bucknell University)

Capuchin monkeys (Cebus apella) categorize images of familiar individuals but not unfamiliar individuals

Primates are highly social animals, yet few studies have used social stimuli to investigate their conceptual abilities. We explored the ability of capuchin monkeys to form a social concept by requiring them to categorize images of conspecifics into one of two sets, "familiar monkeys" (from the subjects' home group) or "unfamiliar monkeys" (previously unseen). Digital photographs of capuchins were presented in a match to sample design. Subjects were required to match the sample image to one of a different monkey from the same familiarity set. The monkeys were able to match images of familiar animals but not images of unfamiliar animals. Our findings are consistent with

previous studies showing that primates more easily categorize items into closed sets with a finite number of known elements, as would be the case with the members of their home group, than into open sets such as that defined by "unfamiliar monkeys."

P56 Daniel R. Saunders & Nikolaus F. Troje (Queen's University)

Animal courtship in many species is not only an evaluation process, but also a two-way communicative interaction. Although pigeon courtship has been extensively described, it is not known whether male and female pigeons coordinate their body movements as a form of communication. We used simultaneous motion capture recordings of both partners during courtship to examine correlations between kinematic measurements reflecting behaviors at several different time scales. The behaviors included head bobbing, movement speed, body orientation, and direction of turning. Each was modeled using semi-markov processes previously used for modeling parallel streams of human nonverbal behaviors during conversation. The analysis results in a quantitative ethogram of the choreography of pigeon courtship and elucidates the different levels of coordination, as well as the role of leading, following, and behavioral synchronization between the two partners.

P57 Kandis Purnell, Ashley Jensen, & Martin Shapiro (California State University, Fresno)
Choice behavior is affected by both the amount and delay of reward. While most experiments use nutritional rewards, the present set of experiments tested how choice is affected by the amount and delay of a social reward in Siamese fighting fish (Betta splendens). Male Siamese fighting fish find the access to aggressive displays with another male rewarding. Using a specially designed plus maze, animals were run in four, 100-trial experiments (half choice and half no-choice trials), with the left and right arm associated with different amounts of time displaying to another male (experiment 1), different delays (experiment 2), and the interaction of amount and delay in self-control designs (experiments 3 and 4). The results were compared with the most often cited quantitative models dealing with the affects of amount and delay of reward on choice behavior in animals.

P58 Dana J. Gant & Roger K. R. Thompson (Franklin & Marshall College)

Scratch & Match Revisited: A Test of Observational Learning in Pigeons (Columba livia)

Observational learning of a matching/oddity task by pigeons was tested using a gravel-digging procedure with which Wright and Delius (1994) reported significantly faster acquisition by birds as compared to those tested in traditional key-peck tasks. 16 birds were assigned to the following conditions: Observed or unobserved (acquisition-alone) during matching or oddity acquisition trials; observers of learners; observers of experts (i.e., acquisition-alone birds that had reached criterion); and observers of ghost trials (i.e., trials where rewards were revealed by gravel displaced with air-puffs). Although birds in all conditions reached a performance criterion of 75% or better within 16-32 trials, there was no evidence that acquisition of matching or oddity by birds was facilitated within any observational condition. However, consistent with Wright & Delius' (2005) results, oddity-learning birds made fewer errors across all conditions.

P59 Ruey K. Cheng, Christina L. Williams, & Warren H. Meck (Duke University)

Effects of prenatal choline supplementation and reinforcement density on temporal precision in peak-interval procedure.

Steady-state performance in the peak-interval (PI) procedure can be characterized by a low–high–low response rate function, which contributes to an approximate Gaussian-shaped mean function centered around the criterion time. Adult offspring of pregnant rats fed 4.5 times the choline in standard chow can show sharper PI functions than offspring of pregnant rats fed a control diet, indicating greater temporal precision for prenatal choline supplemented rats. The present study investigated when this precision-enhancing effect emerges by monitoring the temporal control of behavior from the initial acquisition of a fixed-interval (FI) 18-s procedure to acquiring the full Gaussian-shaped response function of the PI 18-s procedure. The data indicate that the density of reinforcement as determined by the percentage of FI and probe trial interacts with the availability of choline during prenatal development in order to determine the level of timing precision.

P60 Christopher J. MacDonald, Ruey K. Cheng, Elizabeth L. Clore, & Warren H. Meck (Duke Univeristy)

De Novo Protein Synthesis in the Ventral Striatum is Necessary for the Acquisition of a New Temporal Criterion

Rats were trained on the peak-interval procedure using a 20-s temporal criterion (PI-20 s). Following sufficient training, the rats were divided into two groups that differed with respect to whether bilateral cannulae were implanted in the dorsolateral striatum (DS) or ventral striatum (VS). Following surgery, both the DS and VS groups were further subdivided into two groups, which distinguished whether anisomycin (ANI- 62.5 µg/µl)—a protein synthesis inhibitor— or vehicle would be microinjected prior to sessions during a final

"transition phase". During this transition phase, all four groups were placed on a PI-50 s procedure so that the rats acquired a new temporal criterion. ANI differentially impaired acquisition with respect to the DS and VS. Although protein synthesis in the VS was necessary to make a transition to the new temporal criterion, it was not necessary to extinguish the S2 response threshold.

P61 Christopher J. MacDonald, Ruey K. Cheng, Antonia M. Laino, & Warren H. Meck (Duke University)

Dissociable Roles for De Novo Protein Synthesis in the Dorsal and Ventral Striatum for Learning When to "Start" and "Stop" Responding

In peak-interval (PI) procedures, animals make abrupt transitions both into and out of a high response state, during which a relatively constant rate of responding centered around the criterion time is observed. These transition times are called the S1 and S2 respectively. Because the S2 is acquired during the earliest PI training sessions in which unreinforced probe trials are first presented, we wondered whether S2 acquisition depends on de novo protein synthesis. Following FI 20-s training, bilateral cannulae were implanted in either the dorsolateral striatum (DS) or ventral striatum (VS) before being placed on the PI training. Anisomycin (ANI- 62.5 µg/µl) – a protein synthesis inhibitor— was microinjected before PI sessions in a sub-set of rats in the DS and VS groups whereas the remaining rats received vehicle solution. While protein synthesis inhibition impaired S2 acquisition in the VS group, temporal accuracy improved in the DS group by sharpening the S1.

P62 Matthew J. Pizzo (University of York) and Jonathon D. Crystal (University of Georgia)

Temporal discrimination of alternate days by rats

The goal of this study was to determine if rats could learn to time a 48-hr interval. Rats (n = 6) were continuously housed in operant chambers in constant darkness. The feeding cycle consisted of unlimited access to food for 6-hr followed by 42 hr without access to food (i.e., meals were available on alternate days). Response rate increased as a function of time prior to the meal; this increase was higher relative to the increase that occurred at the same time of day on alternate (i.e., non-food) days. These data suggest that rats discriminated alternate days. Next, two meals were omitted to test for the presence of a self-sustained endogenous rhythm. Response rate increased periodically every 24 hr. Implications for alternative mechanisms of time discrimination are discussed.

P63 Kristen E. Pleil, Sara Cordes, Warren H. Meck, & Christina L. Williams (Duke University)

Sex Differences in Counting and Timing: Possible Neuroendocrine Mechanisms

Gonadal hormones have been found to modulate behaviors dependent upon temporal and numerical integration, e.g., spatial navigation, working memory, and motor control. However, the organizational and activational effects of these hormones on timing and counting abilities have yet to be explored. In the current study, 2 groups of male (neonatal castrates and adult castrates) and 2 groups of female rats (neonatal estradiol and neonatal oil) were trained on a mixed counting and timing bisection task. During test sessions, rats were presented with probe trials consisting of intermediate stimulus values. Analyses examined differences in acquisition, precision, and accuracy for both temporal and numerical discriminations. Results speak to the modulating effects of sex hormones on counting and timing, both during development and in adulthood. This suggests that sexual dimorphism observed in related behaviors such as spatial navigation may be affected by underlying differences in the organization and activation of gonadal hormones.

P64 Robin L. Cooley, Colin Closek, Sarah Kilgore, & Dorothy Fragasy (University of Georgia)

Capuchins and chimpanzees combine objects and surfaces in manual exploration

Humans modify their manual actions in accord with the physical properties of objects and/or surfaces they explore, and they use objects to explore surfaces. These characteristics of action are thought to support the development of tool use. Do nonhuman animals do the same? We investigated activity in capuchin monkeys (Cebus apella) and chimpanzees (Pan troglodytes) presented with four surfaces (wood, sponge, water, and netting) and two cubes (sponge, wood). Like human children, (a) both species contacted the surfaces using the objects, and (b) both species differentiated actions combining cubes with different surfaces. Chimpanzees performed more actions overall and a greater variety of actions combining cubes with surfaces. The data suggest that both capuchins and chimpanzees spontaneously explore their world in ways supporting the development of goal-directed action with objects (i.e., tool use). Differences between the genera in exploration match known differences in manual behavior, including tool use, in wild individuals.

P65 Qing Liu & Dorothy Fragaszy (University of Georgia)

Vigilance in Nut Cracking by Bearded Capuchin Monkeys (Cebus libidinosus)

Visually scanning the environment (vigilance) requires interrupting visual attention for other activities. Capuchin males typically are more vigilant than females, but we know little about the development of vigilance in capuchins. Wild capuchins in our field site in Brazil crack nuts with stones, and they pay close attention to their actions during cycles of striking. They must also be vigilant, as this activity exposes them to predators, and they can be displaced by others. We predict that while cracking nuts, males are more vigilant than females, and adults are more vigilant than juveniles. Video samples of three adult females, three adult males, and four juveniles cracking nuts are coded for frequency and distribution of bouts and duration of time engaged in vigilance. Scoring is still in progress. We will discuss the developmental and ecological implications of our findings.

P67 Kelly A. Schmidtke (Auburn University), Bruce Overmier, & John Holden (University of Minnesota)

Differential Outcomes Procedure Effects on the Ability to Form Equivalent Classes by Pigeons

Humans can spontaneously form equivalent classes, but whether nonhumans can remains controversial. Five pigeons were taught a linear series of three symbolic matching-to-sample discriminations establishing the possibility for the emergence of two stimulus classes via differential reinforcement of each class. The first class (A->B, B->C, C->D) was reinforced with five seconds access to food and the second class (1->2, 2->3, 3->4) was reinforced with one second access to food. Non-reinforced transitivity tests for class formation included examination of two and three nodal distances. Evidence for transitivity in both tests was found. The experiment demonstrates the utility of the Differential Outcomes Procedure for establishing equivalence relations consistent with Sidman's (2000) speculation that reinforcers may become elements that form equivalence classes. Our explanation is based on mediation by conditioned expectancies within the discriminations as the cues for choices (Trapold & Overmier, 1972).