

Wednesday

3:30 PM Welcome

7:00 PM Opening Remarks (Jon Crystal)

7:05 PM Discrimination Learning (Chair: Jon Crystal)

7:05 PM **Near-Win Density in a Pigeon Slot Machine Analogue**

Nathaniel Rice, & Elizabeth Kyonka (West Virginia University)

In slot machine play, near wins are stimuli that approximate winning stimuli but deliver no reinforcer (e.g., two winning symbols and a losing symbol). Pigeons pecked lighted side keys on a fixed ratio 3 schedule. Across 4 trial types, the side key was lighted red or green, or changed from red to green after a specified number of pecks, simulating a slot machine reel. Winning trials involved 3 red presentations. Clear-loss trials involved 3 green presentations. Intermediate, near-win trials involved 2 red presentations before the key turned green. After the fixed ratio was completed, the side key was darkened and the center 'collect' key was lighted white for 5 s. Food was delivered on a winning trial so long as the pigeon pecked the collect key at least once during the 5-s interval. Non-winning trials were not reinforced with food. Throughout several conditions, trial-type density was manipulated and responding on the collect key was recorded. Rates of collect-key pecking were higher for trial types with more red presentations. Differences in rates at different trial-type densities may clarify the discriminative and conditioned reinforcing properties of near wins.

1

7:12 PM **Adaptive Experimentation: Using Genetic Algorithms to Analyze Stimulus Control**

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

During most experiments, a number of stimulus properties are determined by experimenter intuition or convention. Using digitally generated stimuli in a computerized design, however, experiments can be finely tuned to optimize subject performance. In this experiment, adaptive techniques are used to vary multiple aspects of a visual discrimination. Over time, the pigeon's responses to the display cause the stimuli to evolve and cluster into an optimal configuration. The final configuration of the stimuli and the evolution of the display will be discussed.

2

7:19 PM **Gradually increasing duration of incorrect comparison in MTS reduces errors.**

James MacDonall, Peter Sanneman, & Jaime Tanner (Fordham University)

These experiments demonstrate a procedure for reducing errors as pigeons learn identity matching-to-sample using colors. In Experiment 1, a fixed ratio 10 to the sample produced the comparisons and pecks to the matching comparison were reinforced; the intertrial interval was 30 s. In the experimental condition, FR 10 to the sample produced both comparisons but the incorrect comparison disappeared after 0.1 s, and that interval gradually increased over sessions. Two pigeons started in the experimental and two in the control condition. After two sessions of no errors pigeons were moved to the other condition using different colors. Again, after two sessions of no errors pigeons were moved to their initial condition using different colors. Pigeons made fewer errors in experimental conditions (3-50) than in control conditions (53-208). Experiment 2 replicated Experiment 1 but used a 10 s ITI to increase errors in the control condition. There were fewer errors in experimental conditions and a modest increase in errors in control conditions. Experiment 3 used a 5 s ITI and naïve pigeons. Pigeons made fewer errors in experimental conditions (6-96) than in control conditions (97-1052). In each experiment within-subject comparisons showed large differences in errors between conditions.

3

7:33 PM **Choice (Chair: Suzanne MacDonald)**

7:33 PM **Chimpanzees make equitable offers in an ultimatum game**

Darby Proctor (Georgia State University), Frans de Waal (Emory University), & Sarah Brosnan (Georgia State University)

Is what is fair to a human fair to a chimpanzee? This question has spurred much debate in the literature and has yet to be definitely answered. Here, we use a limited-form ultimatum game to explore whether chimpanzees will make fair or self-interested offers to a partner chimpanzee. The ultimatum game is a traditional human behavioral economic task in which one individual is given some amount of money and asked to split that amount with a partner. The partner can either accept the offer, which results in both individuals leaving with the proposed split, or can reject the offer, in which case neither individual is rewarded. Humans in this task typically offer 40-50% of the reward to their partner, indicating that humans do not act in purely self-interested ways. In the limited-form ultimatum game with chimpanzees, we find that proposers choose the equitable offer significantly more than the offer that is self-interested (more for the proposer than respondent). Thus, it seems likely that humans and chimpanzees share a sense of fairness that was present in our last common ancestor.

4

5

7:40 PM

Pigeons Prefer Discriminative Stimuli Independently of the Frequency with Which They Signal Reinforcement*Jessica P. Stagner, Jennifer R. Laude, & Thomas R. Zentall (University of Kentucky)*

Pigeons prefer an alternative that provides discriminative stimuli (an S+ on 20% of the trials that always predicts reinforcement and an S- on 80% of the trials that never predicts reinforcement) over one that provides nondiscriminative stimuli (one of two stimuli that both predict reinforcement 50% of the time), even though the nondiscriminative stimulus alternative is associated with 2.5 times more food. We hypothesized that pigeons evaluate the conditioned reinforcer associated with each alternative and ignore the conditioned inhibitor (i.e., by judging the stimulus associated with 100% reinforcement relative to the stimulus associated with 50% reinforcement). To test this, we gave pigeons a choice between an alternative associated with an S+ on 20% of the trials and an S- on 80% of the trials (20% reinforcement) versus an alternative associated with an S+ and an S- each on 50% of the trials (50% reinforcement) and found indifference between the two alternatives. Both alternatives were then associated with nondiscriminative stimuli resulting in a strong preference for 50% reinforcement, demonstrating the pigeons' ability to detect the difference between 20% and 50% reinforcement. Thus, pigeons appeared to judge the conditioned reinforcer's predictive value and ignore its frequency as well as the conditioned inhibitor's.

6

7:47 PM

Mid-Session Reversal in Pigeons on Visual and Spatial Discrimination Tasks*Neil McMillan, & William A. Roberts (University of Western Ontario)*

We trained pigeons on a red vs. green visual discrimination in which both colors appeared on each sidekey equally often. When the correct key color was reversed half-way through each session, pigeons consistently made anticipatory and perseverative errors. When the duration of the inter-trial interval was manipulated on probe sessions, the resulting shifts in errors supported the hypothesis that pigeons used the interval time from session onset to estimate the expected reversal point, and not the number of trials or reinforcers obtained. These pigeons then were trained with red and green always appearing on the same side (confounded visual/spatial discrimination), and markedly fewer errors were found around the reversal point. When the inter-trial interval was manipulated, no shifts in errors occurred. Pigeons appear to use interval timing as a strategy to predict a mid-session reversal when a visual discrimination is learned but use a win-stay, lose-shift strategy when a visual/spatial discrimination is learned.

7:54 PM

Break

7:59 PM

Auditory Discrimination (Chair: Marcia Spetch)

7:59 PM

Auditory object constancy: Recognition of objects from multiple orientations by human listeners using dolphin echoes*Caroline M. DeLong (Rochester Institute of Technology), Heidi E. Harley (New College of Florida), Amanda L. Heberle (Rochester Institute of Technology), & Whitlow W.L. Au (University of Hawaii)*

People recognize objects visually despite changes in object orientation. This ability is called object constancy and has not been well studied in the auditory modality. Dolphins use echolocation for object recognition, and objects ensounded by dolphins produce echoes that vary significantly as a function of orientation (e.g., fish). In this study, human listeners had to classify echoes from three objects ensounded with dolphin signals. The objects varied in material, size, and shape. Object echoes were collected from multiple lateral aspect angles (-30 to +30 degrees, 0 degrees is broadside). In Experiment 1, participants were trained to classify the objects using echoes from -5 to +5 degrees, and then were tested on novel aspect angles. Participants successfully classified objects at all angles ($M = 77%$). In Experiment 2, 5 groups of participants were trained on 5 different aspect angles and tested on novel angles. Participants trained on angles faraway from broadside could not identify one or more objects at broadside on the test. An analogous study with a dolphin subject is currently underway using the same object echoes. The aim of this comparative approach is to discover the mechanisms underlying auditory object constancy.

7

8:13 PM

Timbre alters how black-capped chickadees but not humans perceive chords*Marisa Hoeschele (University of Alberta), Robert G. Cook (Tufts University), Lauren M. Guillette, & Christopher B. Sturdy (University of Alberta)*

We previously trained humans and chickadees to respond to a C major triadic (three-note) chord and not to respond to semitone variations of this chord. Both species showed a similar pattern of responding across chords, but showed subtle differences when transferring this discrimination to a new key (i.e., novel pitches). In the current study we looked at whether changing timbre instead of key would have a similar effect on responding in both species. Timbre is the quality of a sound that differentiates its source (e.g., a flute compared to a clarinet) that is based on the relative powers of frequencies within the spectrum. We found that, while timbre had little effect on how humans responded to the different chords types, timbre had a large influence on the pattern of responding in chickadees. Further, we also presented each species with single notes and dyads (2 note chords) of the training timbre. While humans responded most to dyads that contained 2/3 of the notes from the major chord, chickadees responded more to individual notes. While humans appear to use the fundamental frequency of the component notes, we suspect chickadees are using a different set of spectral features to classify the chords.

8

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8:20 PM

Discrimination and generalization of musical consonance/dissonance in humans*Lee M. Vitinsky, Marisa Hoeschele, Ann-Marie Przyslupski, & Christopher B. Sturdy (University of Alberta)*

Musical consonance/dissonance is an attribute of sound that, although typically not found in nature, can elicit preferential responding in tasks using musical stimuli. Here, we examine the extent to which humans can use consonance/dissonance as a cue to discriminate and generalize musical intervals (i.e. two notes, played simultaneously) in a go/no-go task. After reinforcement contingencies to the intervals of octave (consonant) and tri-tone (dissonant) were established with response feedback, human subjects successfully generalized to the same intervals composed of different notes. During a subsequent test phase, subjects were presented with novel intervals major seventh (dissonant, one semi-tone below an octave) and perfect fifth (consonant, one semi-tone above a tri-tone) along with training stimuli, without feedback. Thus, the novel intervals that are more similar in pitch height to training intervals are less similar in terms of consonance/dissonance. Stimulus control for novel intervals was governed by consonance/dissonance for subjects initially reinforced for consonance during training and generalization but not for subjects initially reinforced for dissonance. Overall, our findings suggest that individual differences facilitate the use of either consonance/dissonance or pitch height as a cue for discrimination and categorization.

8:27 PM

Song & Communication (Chair: W. David Stahlman)

8:27 PM

Geographic song discrimination by black-capped chickadees*Allison H. Hahn, Marisa Hoeschele, Lauren M. Guillette (University of Alberta), Daniel Mennill (University of Windsor), Ken Otter, Thibault Grava (University of Northern British Columbia), & Christopher B. Sturdy (University of Alberta)*

The songs of many songbird species consist of complex vocalizations with multiple note types and a varied repertoire. However, the fee-bee song of the black-capped chickadee appears to be a relatively simple acoustic signal, containing only two whistled notes. The structure of the fee-bee song has been considered highly stereotypic across the species' range, with some exceptions in isolated populations. Previous discriminant function analyses using acoustic features of fee-bee songs produced by birds in Ontario and British Columbia suggest that songs can be accurately classified based on the location of origin of the singer. In the current experiment, we examined the perceptual abilities of black-capped chickadees in an operant discrimination task of fee-bee songs produced by birds from these two locations. Using a true category/pseudo category paradigm, we found that birds in the true category had an easier time discriminating songs based on the geographic location of the singer compared to birds discriminating the same songs based on random assignment (pseudo category). This discrimination also transfers to novel songs not heard during initial acquisition. These results suggest that black-capped chickadees perceive differences among songs produced by birds from different locations, which supports the previous statistical classification by discriminant function analysis.

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8:34 PM

Vocal signaling among male northern elephant seals: behavioral field studies of honesty vs. associative learning*Colleen Reichmuth, Caroline Casey (University of California - Santa Cruz), Isabelle Charrier (Centre Neurosciences Paris Sud), Nicolas Mathevon (Universite Jean Monnet), & Brandon Southall (University of California- Santa Cruz and SEA)*

Northern elephant seals (*Mirounga angustirostris*) are large, highly polygynous mammals that have a breeding system based on the defense of female harems by dominant males. The species provides a unique opportunity for the study of vocal recognition and communication. Acoustic signaling plays an important role in settling otherwise costly interactions between competing males, as stereotyped vocal displays often elicit appropriate behavioral responses from spatially separated individuals without physical contact. We recorded the vocalizations of adult male elephant seals during two breeding seasons to characterize their individual signatures. To determine whether these calls were sufficient to control the behavior of receivers, we conducted a series of playback experiments using calls recorded from individuals of known size, rank, and familiarity. The results show strong and predictable differential phonotaxis and calling behavior based on hierarchical status of the receiver relative to the playback. Call qualities reflecting duration, level, and frequency were evaluated for dependence on body size and rank to determine whether the vocalizations were honest indicators of resource holding potential. The absence of significant correlations supports the notion that these unique signals may not be honest signals but rather serve to convey information about individuals that is managed through associative learning.

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8:48 PM

Whisper-like Behavior in a Non-human Primate*Rachel Morrison (Biopsychology and Behavioral Neuroscience Subprogram in Psychology The Graduate Center of CUNY), & Diana Reiss (Department of Psychology Hunter College of CUNY Biopsychology and Behavioral Neuroscience Subprogram in Psychology The Graduate Center of CUNY)*

In humans, whispering has evolved as a counteractive strategy against eavesdropping. Evidence for whisper-like behavior exists in a few other species, but has not been reported in non-human primates. We discovered evidence of whisper-like behavior in cotton-top tamarins (*Saguinus oedipus*) in the course of investigating their use of human-directed mobbing calls. We exposed a family of captive cotton-top tamarins to a supervisor who previously elicited a strong mobbing response. Simultaneous audio-video recordings documented the animals' responses in the supervisor's presence and absence. Rather than exhibiting a full mobbing response and producing loud human-directed mobbing calls, the tamarins exhibited a partial mobbing response and produced low amplitude vocalizations that initially eluded our detection. A post hoc analysis was conducted to determine if the tamarins were reducing the amplitude of their vocalizations in the context of exposure to a potential threat. Consistent with whisper-like behavior, the amplitude of the tamarins' vocalizations was significantly reduced only in the presence of the supervisor. Due to its subtle properties, this phenomenon may have eluded detection in this species. Increasing evidence of whisper-like behavior in non-human species, suggests that low amplitude signaling may represent a convergence in a communication strategy amongst highly cooperative species.

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8:55 PM

Break

9:00 PM **Cognitive Processes I (Chair: Stephen Fountain)**

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9:00 PM

Face Recognition in Orangutans

Catherine F. Talbot (Department of Psychology Georgia State University), Laura Mayo, Tara Stoinski (Zoo Atlanta), & Sarah F. Brosnan (Department of Psychology and Neuroscience Institute Georgia State University)

Faces provide group-living species with information on the age, sex, identity, and emotions of others. In this study, we tested a less gregarious species, the orangutan, to determine if they exhibit similar face recognition skills. Using a match-to-sample paradigm, we first confirmed that orangutans can match two identical photographs of unfamiliar conspecifics. In the second task, subjects matched two different photographs of the same individual from different viewpoints. During testing, probe trials of the experimental question, which were always rewarded, were inserted among training trials. All three subjects successfully transferred to familiar novel stimuli with their first exposure to these individuals ($z=3.1$, $p=0.001$) but not unfamiliar novel stimuli ($z=0.15$, $p=0.878$), despite being trained with the same unfamiliar individuals. Results for all trials (not just initial trials) indicated the same pattern in (Familiar: $z=3.16$, $p=0.001$; Unfamiliar: $z=0.64$, $p=0.520$). Thus orangutans outperformed rhesus monkeys, but not as well as chimpanzees on similar tasks. Further examination is needed of social organization and other social factors which were important in the evolution of face-processing skills.

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9:07 PM

Clark's nutcrackers (*Nucifraga columbiana*) use informed, but not uninformed, knowledge states to guide choices during an object-choice task

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

Corvids have been shown to be adept at inferring the intentions of other individuals when tested in ecologically relevant food-caching paradigms. Rarely however, have the social cognition abilities of corvids been tested in contexts outside of food caching, thus the flexibility of their social cognition is yet unknown. The present study utilized the object-choice task to examine whether Clark's nutcrackers are able to discriminate the knowledge states of human experimenters. The nutcrackers were first trained to follow an experimenter's gesture to find a hidden food reward, and subsequently tested with two experimenters: one informed, the other uninformed of the reward's location. The nutcrackers preferentially chose the gesture of the experimenter informed of the hidden food reward's location over the simultaneously presented gesture of the uninformed experimenter. However, if the uninformed experimenter gestured alone, the birds continued to follow the gesture. Overall, these results suggest that nutcrackers are sensitive to when an experimenter is knowledgeable of the food reward's location, yet were not able to use an experimenter's lack of knowledge to guide choice behaviour.

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9:14 PM

The Behavior of Asian Elephants (*Elephas maximus*) during mirror exposure

Nicole Daurio, & Dr. Diana Reiss (Hunter College of the City University of New York)

There is controversy surrounding the topic of mirror-self recognition (MSR) that centers on the use of different methodologies and different criteria used to determine whether an individual shows this ability. Most studies have described mirror-oriented behaviors as exploratory, social, contingency testing, and self-directed. The standard objective test for MSR has been the mark test. Passing rates for the mark test vary greatly within species and between individuals. In a published study, three Asian elephants (*Elephas maximus*) were exposed to a mirror and tested using standard mark test procedures. Only one elephant passed the mark test. We conducted a subsequent quantitative and qualitative analysis of the behaviors these elephants exhibited during mirror exposure, to determine whether behavioral differences were evident. We categorized behavior as exploratory, social, contingency testing, and self-directed. Our results showed that the individual that passed the mark test spent significantly less time at the mirror over the course of the study. All three elephants showed many behavioral similarities. We conclude that although only one elephant passed the mark test, all three elephants exhibited contingency testing and self-directed behavior at the mirror, evidence for mirror self-recognition.

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9:21 PM

The Kakariki Model: comparing exploratory learning strategies in parrots and children

Zoe Demery, & Jackie Chappell (University of Birmingham)

The majority of comparative cognition has focussed on establishing what the cognitive capacities of different species are, rather than how animals acquire and structure information, specifically through exploration. We believe exploration is not random; but structured, selective and sensitive to categorical features of the environment. We exploited the neophilic tendencies and distinctive sensorimotor apparatus of parrots and human children by designing a series of comparative experiments. We measured the interaction between parrot visual fields and their bill tip organ to understand a sensory basis for exploration. We then linked this to increasingly complex behavioural tasks involving different novel objects and physical problems, to examine in detail the exploration process in different contexts. Although from quite different ecological niches, we argue kakariki (*Cyanoramphus novaezelandiae*) and children (4-7 yo) have common strategies. For instance, we found both explore more with functional changes in an object (e.g. weight), than with non-functional changes (e.g. colour). They also focus on certain object properties (e.g. corners or moveable parts) more than others (e.g. smooth surfaces or rigid features), which provide clues about objects' affordances. We discuss the implications of our findings for other animals from a computational, information-processing perspective.

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9:28 PM

What's all the bias about? Learning effects contribute to cognitive bias in nonhuman primates

Bonnie M. Perdue, Theodore A. Evans, & Michael J. Beran (Language Research Center - Georgia State University)

Cognitive bias refers to the influence of an individual's affective state on cognitive processes. Cognitive bias tasks typically involve training an animal on a conditional discrimination task in which one response results in a more positive outcome than the other. Then the subject is presented with intermediate stimuli and the response indicates whether the subject interprets these ambiguous stimuli as positive or negative. Manipulations of an animal's affective state have been reported to result in changes in the perception of the ambiguous stimuli in a variety of species; however, some recent research suggests that other learning effects may be influencing performance. We trained monkeys on a 40-step psychophysical discrimination task in which opposing responses made at opposite ends of the discrimination spectrum resulted in one (level 1) or four (level 40) pellets. Once at criterion, intermediate levels were introduced. Initially, subjects' classification approximated a true psychophysical discrimination. However, with continued exposure (and no manipulation of affective state), subjects began to classify the majority of intermediate stimuli as less positive. Our findings suggest that learning, independent of affective state, may also result in biased responding, and this potential confound should be considered and controlled for in future studies.

Thursday

9:30 AM-10:30AM **Behavioural Processes Workshop – Meet the Publisher & Editors**
Everyone is welcome to attend!

12:00 PM **Spatial Cognition (Chair: Russell Church)**

12:00 PM **Rats' encoding and retrieval of spatial and non-spatial features of a missing object in a foraging task.**

Corrine Keshen, & Jerome Cohen (University of Windsor)

After obtaining food from three of four baited objects in a study array rats had to find the remaining fourth baited object in the test array of a trial. For some rats the array configuration, its location within the foraging area, the position and orientation of objects within the array remained fixed over trials during training (stable group) while for others these cues varied over trials (unstable group). Rats' ability to flexibly use these cues to find the missing object in test arrays was assessed in post-acquisition probe tests where these cues were either dissociated from each other or were systematically eliminated. Rats were less able to use each of these cues accurately after being trained under stable than unstable conditions. These results suggest that a missing object's features were simultaneously encoded and retrieved under stable conditions but separately encoded and retrieved under unstable conditions.

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12:07 PM **The dynamics of visual orientation in foraging rats**

Tamara Carolina (Indiana University)

Animals collecting renewable resources are faced with complex spatial problems. In a familiar terrain, most species can return to those resources by using self-motion cues or environmental landmarks. In an effort to understand how rats can exploit visual landmarks, I have analyzed the areas of the visual scene that are salient to them from a sensory perspective, and have tracked the position of the animal's head as a proxy to measure their orientation to regions of their visual panorama, as they learn foraging tasks. Analyses of the head movements indicate scanning at regular locations in the arena, particularly prior to establishing a moving direction. In these experiments, visual scanning in the rats may arise for several relevant reasons, including the increase in visual field (from 320 to 360 degrees), motion parallax, or as an error detection signal.

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12:14 PM **Pigeons (*Columba livia*) establish and maintain consistent strategies for efficient route-finding in an open field Traveling Salesman Problem task**

Danielle Lubyk (University of Alberta Department of Psychology), Alejandro Sanabria, Vadim Bulitko (University of Alberta Department of Computing Science), & Marcia Spetch. (University of Alberta Department of Psychology.)

The Traveling Salesman Problem (TSP) is a computational task which requires a subject to "visit" multiple locations then return to the starting point via the shortest route. Most studies examining pigeon performance on the TSP have used operant paradigms in which subjects peck at nodes on a screen. The current study tested pigeons in an open field TSP task using a novel design. Pigeons were trained to establish consistent routes among several arrays of goal locations then tested with both easier and more difficult array configurations to determine whether their strategies transferred to novel situations. This procedure was carried out in several stages, which gradually increased the number of goal locations from three to six. In all stages, birds were able to establish consistent routes in training and subsequently transfer their strategies to both the easier and more difficult testing arrays. Birds were more likely to use an advanced Convex Hull strategy when three and four goal locations were present and a more primitive Nearest Neighbor strategy for five and six goals. These results suggest that while pigeons can establish consistent routes and generalize to novel arrays, the strategies employed may become less sophisticated as the number of goals increases.

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12:21 PM **Can zebrafish solve a spatial learning task**

Robert Gerlai (University of Toronto Mississauga)

Mammals can solve spatial tasks. Fish, despite the lack of mammalian hippocampal structure in their brain, have also been shown to acquire spatial tasks. However, investigators almost never check whether the "good" spatial learning performance actually reflects acquisition of the dynamic relationships among spatial cues. For example, subjects may solve a spatial task by picking out a salient extra-maze cue from their environment and thus turn the task into a simple CS-US associative paradigm, without the knowledge of the experimenter. The mammalian literature, however, also shows that the ability to focus on a salient "background" cue is practically abolished if the experimenter provides a highly predictive, temporally contiguous and salient associative cue in addition to the spatial cues. We utilized this procedure and investigated whether the excellent spatial learning performance we found in zebrafish indeed reflects spatial learning or whether it may be due to simple two-stimulus, i.e. CS-US associative processes. Here we show that zebrafish can learn a CS-US association, can perform well in a spatial task and, importantly, can learn both the CS-US association and the location-US association at the same time, suggesting that fish are able to learn spatial tasks.

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12:35 PM **Vertebrate pollinators: a time-dependent generalized traveling-salesman problem**

York Winter (Humboldt Universitaet - Berlin), Magnus Jungsbluth (Universitaet Oldenburg), Johannes Thiele (Universitaet Muenchen), & Alexander Hartmann (Universitaet Oldenburg)

Nectar-feeding animals exploit resource landscapes with flowers at fixed locations but with time-dependent nectar content. Vertebrate flower visitors with cognitive abilities may have evolved behavioral mechanisms to optimize the exploitation of such dynamic resources. We present a theoretical approach for this foraging problem (determining minimum-effort harvesting optima in multiple individual and time-dynamic resource landscapes). We introduce a model for the global optimization problem of nectar harvesting by nectar-feeding flower bats as a generalization of the (multiple) traveling-salesman problem. We numerically studied optimum harvesting using genetic algorithms. We investigated experimentally the resource use by freely visiting flower bats. For this we caught bats in the Costa Rican rainforest and equipped them with RFID tags. Free-ranging bats could then visit fully automated computer controlled artificial flowers with ID readers on a 100 by 100 m experimental area in the rainforest. A bat on visiting an artificial flower was identified in real-time and received a nectar reward according to its individually specific schedule. We found that both temporal and spatial patterns of resource exploitation were in the directions as predicted by the theoretical optimization model. Surprisingly, individual differences in foraging efficiency (kJ per km flight effort) were more than twofold.

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12:49 PM

Discrimination Learning of Geometric Angles by Humans Differs as a Function of Angle Size

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

Geometric angles, such as those found at corners of enclosed spaces, represent one specific type of geometric spatial cue used by human and non-human animals to establish environmental position. The current research examined how adult humans learn to discriminate between different sized angles. During Experiment 1, participants learned to discriminate between two real-world objects shaped as geometric angles; one object projected a 50° angle and the other projected a 75° angle and participants were divided into groups based upon training angle size. During testing each respective training angle was individually paired with one of a series of novel test angles that was either smaller or larger than the training angle. The results showed more absolute encoding of the smaller training angle compared to the larger training angle. During Experiment 2, a third angle (25°) was included during training; participants now learned to discriminate between three angles during training but, during testing, were provided with a choice between their training angle and one of a series of novel test angles. Once again, the resulting response patterns showed smaller angles being associated with absolute learning and larger angles associated with relative, rule-based learning.

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1:03 PM

Associative Processes (Chair: Ralph Miller)

1:03 PM

Preventing recovery from CS preexposure

Mario A. Laborda, Cody W. Polack, & Ralph R. Miller (SUNY Binghamton)

The effects of manipulations known to reduce recovery from CS postexposure (a.k.a. extinction) were evaluated in their effectiveness in reducing recovery from CS preexposure (a.k.a. latent inhibition), in two lick suppression experiments with rats as subjects. In Experiment 1, the effects of massive nonreinforced training and of nonreinforced training in multiple contexts were evaluated in their effectiveness to reduce recovery from CS preexposure, as well as the conjoint effect of these manipulations. In Experiment 2, the effects of spacing the nonreinforced trials and of spacing the nonreinforced sessions were evaluated in their effectiveness to reduce recovery from CS preexposure, as well as the conjoint effect of these manipulations. Our results suggest that, as in the case of CS postexposure, these techniques are effective plots in reducing recovery from CS preexposure.

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1:10 PM

Exploring the Temporal Nature of Conditioned Response During the Over-expectation Treatment

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

Over-expectation (ox), in Pavlovian conditioning, is the finding that following a compound phase of two pre-trained, asymptotic elements (e.g., stimulus A + X), less conditioned responding is found during tests of either element in isolation. Numerous studies have bolstered the notion that the temporal relationship between a target stimulus and a US not only strengthen but modulate the nature and magnitude of the conditioned response (Catania, 1970; Roberts 1981). In this experiment, we used a conditioned magazine approach paradigm to evaluate the role of timing in the overexpectation effect. In Phase 1, rats were trained with two elements of separate duration; a long element A (40 sec) and short element X (10 Sec), both of which were simultaneously paired with the delivery of the U.S. In Phase 2, we embedded X either early (onset 10 sec) or late (onset 25 sec) within element A (Leising, Sawa, & Blaisdell, 2007). Subjects showed widespread decrements in conditioned responding during testing with A. The results are discussed in terms of how simple conditioned response measures may provide different information about what is learned than evaluation of the distribution of responses.

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1:17 PM

Within-session shifts in reward probability and behavioral variability in pigeons

W. David Stahlman (UCLA), Chad M. Ruprecht, & Kenneth J. Leising (Texas Christian University)

Recent research has indicated that pigeons use within-session temporal cues to govern decision-making behavior in discrimination tasks (Cook & Rosen, 2010; Rayburn-Reeves, Molet, & Zentall, 2011). Even after extensive training, pigeons make both anticipatory and perseverative errors in a two-choice discrimination task when the reinforced response is reversed midway through training sessions. We were interested to know whether variability in behavior shows a similar topography. We report results from a single experiment in which pigeons were rewarded with grain for pecking to a single disc on a touchscreen. Three pigeons (Group Stable) received alternating daily sessions of trials that were rewarded at either High (13%) or Low (4%) probability; the other three (Group Switch) received alternating sessions where the probability of reinforcement was changed midway through the session (i.e., 13%→4%, 4%→13%). We find little evidence for anticipatory shifts in the variability of pecks, but do find evidence for a delayed adjustment in response variability to the reduction in reward probability.

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1:24 PM

Analogies between forward blocking and proactive cue interference in context dependency

Gonzalo Miguez, Henry X. Cham, & Ralph R. Miller (State University of New York at Binghamton)

Blocking (i.e., A-US pairings in Phase 1 and AX-US pairings in Phase 2) has been one of the signature phenomena in Pavlovian conditioning. Its discovery promoted the development of several associative models, most of which posed blocking as an instance of cue competition phenomena (i.e., a decrease in responding due to training two conditioned stimuli conjointly). In one experiment using rats in a fear conditioning paradigm, we found that forward-blocking can be influenced, due to the nature of the design, by proactive interference (i.e., a decrease in responding without a within-compound association) as well as cue competition. Specifically, we show that renewal of backward-blocking parallels the renewal of retroactive interference, while renewal of forward-blocking parallels that of proactive interference

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1:31 PM

Inhibition and Facilitation Using Espinet Pretraining

Cody W. Polack, & Ralph R. Miller (State University of New York at Binghamton)

Espinet pretraining (XB / AB; Espinet, Iraola, Bennett, & Mackintosh, 1995) has been used to create inhibitory relationships between neutral stimuli. Subjects seemingly learn that Stimuli X and A are mutually exclusive in the presence of Stimulus B. Specifically, if Stimulus A is subsequently paired with an aversive stimulus (i.e., footshock), then X will also function as a conditioned inhibitor for that aversive stimulus. Using rats in a barpress preparation, we replicated the finding that many XB /AB discrimination trials result in X-A conditioned inhibition, whereas few discrimination trials do not (Experiment 1). Considering that, given Pavlovian conditioned inhibition treatments (A+ / AX-), one can observe either conditioned inhibition or second-order conditioning depending on the number of training trials, we sought to determine whether a similar distinction would occur using Espinet pretraining. In Experiment 2, we found that giving few Espinet pretraining trials resulted in a facilitative X-footshock relationship. Experiment 3 investigated the role of within-compound associations with Stimulus B in this facilitated responding to X. This series provides further support for the view that, as the number of training trials increases, within-compound associations shift from serving a facilitative role to serving in an inhibitory-like fashion.

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1:38 PM

MEG study of associative learning using a streamed-trial procedure

Susana Maia (Universidade do Minho), Jeremie Jozefowicz (Université Charles de Gaulle-Lille3), & Gary Green (University of York)

We used magnetoencephalographic recording techniques to investigate brain areas involved in associative learning. Participants were exposed to a variant of Crump et al. (2007)'s streamed trial procedure: They were presented with 100-ms stimuli and had to judge the contingency between a target cue and an outcome, while their brain activity was recorded. The contingency between the cue and the outcome was manipulated by changing the probability between them while keeping constant the probability between a companion cue and the outcome. Behavioral results show that despite the difficulty of the task and the short duration of the stimuli, subjects' ratings were sensitive to the contingencies. Preliminary analysis of the MEG data revealed brain areas specifically sensitive to the manipulation of the contingency between the cue and the outcome. Keywords: Associative learning; Contingency judgments; Streamed-trial procedure; Magnetoencephalography;

1:45 PM

Break

1:50 PM

Memory (Chair: Olga Lazareva)

1:50 PM

Effect of generalization gradients, relational disparity, and familiarity in motion-based transposition

Olga Lazareva, Kaitlyn Kandray, & Emily Leiker (Drake University)

Pigeons demonstrate robust relational learning after multiple-pair transposition training (Lazareva, Young, & Wasserman, 2005; Lazareva, Miner, Young, & Wasserman, 2008). These studies, however, employed the stimuli varying along the same dimension (i.e., size), raising concerns about generality of the findings. We trained pigeons to select the faster (or the slower) of the two stimuli moving vertically with different speed. The first group of pigeons was trained to discriminate S1 vs. S2 (where digits denote the speed of movement). The two-pair training group discriminated S1 vs. S2 and S2 vs. S3. Finally, three-pair training group discriminated S1 vs. S2, S2 vs. S3, and S3 vs. S4. As in our earlier studies, we found an overall increase in relational learning from one-pair to two-pair to three-pair training. We also applied our model of relational responding in transposition task that uses the difference in generalized associative strength between the stimuli in the testing pair, the dissimilarity between the testing stimuli, and the Euclidean distance from the training pair to the testing pair as predictors of relational choice in a novel testing pair (Lazareva, Young, & Wasserman, in preparation). The preliminary results of simulations will be presented.

2:04 PM

Lateral and Frontal Long-Term Memory in Pigeons (*Columba livia*)

Matthew S. Murphy & Robert G. Cook (Tufts University)

Birds as laterally-eyed animals have specialized retinal areas for frontal and lateral vision, which have unique perceptual, anatomical, and cognitive properties. The visual fields largely follow different visual pathways in the brain. There is an additional difficulty in transferring information learned in one field to the other. However, prior research has not thoroughly investigated this area and has suggested that there is a separate long-term memory store for lateral and frontal information. Using a behavioral targeting procedure with pigeons, we are able to test visual transfer of pictures between the fields in a variety of ways. We found the first strong evidence of frontal-to-lateral intraocular transfer in pigeons, and further results will be discussed.

2:11 PM

Mid-session Reversal Task in Pigeons: Effect of ITI Duration

Jennifer R. Laude, Becky Rayburn-Reeves, & Thomas R. Zentall (University of Kentucky)

Pigeons trained for many sessions on a simple, simultaneous spatial discrimination with one response correct for half of the 80-trial session (left key) and the other response correct for the remainder of the session (right key) anticipate the reversal well before it occurred and perseverate well after it occurred. We tested the hypothesis that one reason for the difficulty that pigeons have with this task is the relatively long (5 s) intertrial interval (ITI) because pigeons need to remember not only whether they were fed on the last trial or not but which alternative they had selected. Thus, the task may be not unlike biconditional matching with a 5 s delay. To test this hypothesis, we manipulated the ITI (1.5, 5, and 10 s) and found that pigeons' accuracy was much improved. They made almost no anticipatory errors and made many fewer perseverative errors. Thus, their inability to develop something close to a

2:18 PM

Rhythmic Entrainment in a California Sea Lion (*Zalophus californianus*)

Peter Cook, Andrew Rouse, Margaret Wilson (University of California Santa Cruz), & Colleen Reichmuth (Institute of Marine Sciences)

Motoric entrainment to an isochronous rhythmic auditory stimulus is a behavioral capability once thought to be unique to humans. Recently, this ability has been identified in a few other species, most notably the sulfur-crested cockatoo (*Cacatua galerita leonora*). Because the most convincing demonstrations have come from animals that demonstrate vocal mimicry, it has been theorized that entrainment is an evolutionary byproduct of vocal mimicry and related adaptations in the basal ganglia. Anecdotal evidence suggests that, when present, entrainment may be innate rather than acquired. To further explore whether 1) entrainment to specific auditory tempos can be acquired through explicit training, and 2) whether such an ability would generalize to novel tempos, we are studying rhythmic entrainment in an easily trained but vocally stereotypic mammal: the California sea lion. After more than 20 sessions of operant training, the sea lion subject has learned to reliably synchronize a continuous head bob to two similar auditory stimuli with different rates (80 and 120 beats/minute). This finding confirms that a vocally stereotypic animal can learn to entrain, and will serve as a jumping off point to assess transfer of rhythmic entrainment to novel tempos.

2:25 PM

Is it really all noise? Beyond unitary comparisons of visual working memory across species.

John F. Magnotti, Jeffrey S. Katz (Auburn University), L. Caitlin Elmore, & Anthony A. Wright (University of Texas Medical School at Houston)

Current theories of visual working memory (VWM) fall into two broad classes: discrete and continuous. Discrete models suggest that VWM is best viewed as filling a few fixed-resolution slots with whole objects, while continuous models suggest that VWM is best described as the allocation of a continuous resource, with no stipulation on storing whole or parts of objects. We have recently suggested that both human and nonhuman data favor the continuous view, and that the quantitative differences across species are best summarized by the amount of "noise" in the VWM system. The current study was designed to fractionate this single noise parameter into variability at encoding, storage, and retrieval/decision time. Three pigeons were trained in a color change detection task in which we manipulated several factors relevant to both encoding (view time, display eccentricity) and retrieval (color similarity) demands. These results were compared to humans in an analogous task. Results indicate that rather than a single measure of noise (e.g., the slope parameter of an exponential function), comparisons across species are better understood in terms of relative noisiness at each phase (i.e., encoding, storage, retrieval/decision) of the task. Our conclusions generalize to considerations of discrete models of VWM as well.

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2:32 PM

Operant Analogs of Episodic-Like Memory in Western Scrub Jays

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

We have employed two different operant procedures to test the what-where-when (WWW) memory of Western scrub jays, the species studied by Clayton and Dickinson in their studies of episodic-like memory during cache recovery. In one procedure, intended as a direct simulation of the Clayton & Dickinson methodology, jays were shown a trial-unique sample stimulus followed by either a 2-s or 7-s retention interval. The retention interval was followed by a two-choice test between the sample in the original location and another trial-unique stimulus in a different location. The birds were required to match after one retention interval and nonmatch after the other. The second procedure was modeled on the work of Skov-Rackette et al. with pigeons. We trained jays to respond to what, where, and when tests presented on separate trials in random order. They were then given probe trials during which they were presented with two tests. Results from both procedures demonstrate very good WWW learning and memory but provide no evidence for the integrated WWW memories posited to be characteristic of episodic memory.

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2:46 PM

Prospective memory in a language-trained chimpanzee

Theodore A. Evans, Jessica Bramlett, Bonnie M. Perdue, & Michael J. Beran (Georgia State University Language Research Center)

Prospective memory is remembering to execute an intended action at an appropriate future time. We assessed this capacity in a language-trained chimpanzee, Panzee. Panzee chose between two food options from her indoor enclosure: the chosen option was distributed in her outdoor yard and the non-chosen option was sealed in an opaque container near the indoor enclosure (not visible from the outdoor yard). She then could access the outdoor enclosure for 30 minutes, which also contained eight face-down lexigram tokens. A naive experimenter remained indoors, available to exchange the food in the container for the appropriate token. Panzee searched the tokens in the yard after foraging for her chosen food in 91% of trials, discontinuing her search when she found the token that matched the food contained indoors in 71% of trials. Panzee remembered to bring a token indoors in 89% of trials (an appropriate token in 67% of trials), and she came indoors without any external prompt 81% of the time. This indicates that Panzee may be using prospective memory to store, retrieve, and execute an intended action at a future time of her choosing within the context of other ongoing activity.

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3:00 PM

Educated Predators

Christina Halpin (Newcastle University), John Skelhorn (University of Exeter), & Candy Rowe (Newcastle University)

Aposematic insects use conspicuous colours and/or markings to advertise the fact that they are defended in some way. Educated predators are those that have learned about the nutritional value and defence levels of prey in their environment, and are able to make informed decisions about whether or not to eat prey that they encounter. Although we know that the toxin content in aposematic prey is important for the degree to which they are avoided, we don't know how the nutritional content of aposematic prey affects predators' foraging decisions. In an experiment using wild-caught starlings (*Sturnus vulgaris*) feeding on defended and undefended mealworms (*Tenebrio molitor*) of different nutritional values, we found that the asymptotic attack rates on defended prey were not absolute, but differed depending on the protein content of the defended and undefended prey. Our findings offer an insight into how educated predators integrate information about toxins and nutrients to make adaptive foraging decisions, and how their decision-making can impact on the evolution of aposematism and prey defences.

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Snack Break

3:54 PM

Serial & Temporal Processing (Chair: York Winter)

3:54 PM

Similarities and Differences in Orangutans' and Human Children's Serial Recall of Lists with Different Content and Spatial Cues

Elizabeth Renner (The George Washington University), Elizabeth Price (Smithsonian National Zoological Park), & Francys Subiaul (The George Washington University)

Comparisons between human and non-human primate serial memory have used arbitrarily related items. Here, we explored whether apes and young children spontaneously attend to cues that predict order. We used two paradigms in which pictures appearing on a touch-sensitive screen must be touched in a specific serial order. In the simultaneous chaining paradigm (SCP), three different items (A->B->C) appear in different spatial arrangements from trial to trial. In the spatial sequencing task (SST), three items (A->A->A) appear in the same spatial arrangement from trial to trial (e.g., Top->Bottom->Right). Experiment 1 predicted that spatial cues in the SST would enhance performance compared to the SCP. Results confirmed that both children and apes learned better in the SST than in the SCP. Experiment 2 manipulated the content of pictures in the SCP by size, color, and number, and compared performance to lists of arbitrary pictures. Size cues enhanced performance in children but not in apes, while color cues enhanced performance in one ape but depressed it in children. These results indicate that apes and children are able to use spatial cues to learn a list more rapidly and may be able to use certain content cues to improve serial recall.

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Starlings do not always average temporal memories

Marco Vasconcelos, Tiago Monteiro, & Alex Kacelnik (University of Oxford)

Recent reports (e.g., Swanton et al., 2009) suggest that rats trained with signals for two different times of reward respond to the two signals' joint presence by averaging their values. Most current models of timing predict either independent responding to each time or sub-arithmetic averaging. We present two experiments with starlings. Experiment 1 replicated the original report. Birds were trained with two stimuli signalling a 10 and a 20 s delay to food. Single signal trials showed peaks close to 10 and 20 s, respectively. Compound peak trials (with both stimuli present) showed peaks roughly intermediate between the trained reward times. Experiment 2 tested the effect of increasing the difference between the intervals: one delay was kept at 10 s to reward but the other moved to 50 s. In compound presentations, there were now two distinct peaks in response rate. This finding challenges the temporal averaging hypothesis and suggests that both delays are timed in parallel.

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Stimulus Onset and Key-Peck Response as Time Markers for Pigeons

Adam E. Fox, & Elizabeth G. E. Kyonka (West Virginia University)

The onset of an external stimulus (e.g., auditory signal) and engagement in a physical response (e.g., nose poke) have been reported as being comparable time markers for rats. The present experiment compared the onset of a key light and a peck to a lit key as time markers in pigeons. Four pigeons pecked in fixed-interval (FI) and response-initiated fixed-interval (RIFI) schedules of food reinforcement. RIFI schedules are tandem fixed-ratio (FR) 1 and FI schedules. Pigeons were exposed to FI- and RIFI-15 s, 30 s, 60 s, 120 s, 240 s schedules of reinforcement. Post-reinforcement pauses were a function of the interval duration for both FI and RIFI schedules. However, post-reinforcement pauses were more variable and included more long pauses in RIFI than in FI conditions. Response rates, temporal discrimination ratios and ogive model parameters indicated that temporal discrimination was greater in FI than in RIFI conditions for all pigeons. External stimuli and physical responses may not serve as equally salient time markers for pigeons, in contrast to previous research with rats.

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When Does Integration of Independent Temporal Maps Take Place?

Ralph R. Miller, Gonzalo Miguez, Henry X. Cham, Cara Burney (SUNY-Binghamton), & Mikael Molet (University of Lille (France))

Prior research has demonstrated that when two independent temporal relationships with a common element are sequentially encoded (e.g., A-B followed by B-Outcome), subjects behave as if A and the Outcome have a unique temporal relationship despite that they have never been paired. We will describe a series of experiments conducted to determine when this integration of temporal maps occurs: at the time of acquisition of the second temporal map containing the common element, or at the time of testing. This question was assessed by extinguishing the common (i.e., mediating) element (B) between acquisition of the second temporal relationship and testing. If this manipulation failed to disrupt the temporal relationship between A and the Outcome, this would suggest that temporal integration of the two maps occurred at the time of acquisition of the second temporal relationship. However, using both sensory preconditioning and second-order conditioning procedures, we found that the extinction manipulation disrupted the A-Outcome temporal relationship. Thus, temporal integration appears to have occurred at the time of testing.

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Turning Points: Clocks and Samples are linked in MTS reversals

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

We examined temporally controlled switching behavior with matching and oddity conditional discriminations. In four pigeons, we tested the hypotheses that the internal clock controlling a behavioral transition was either linked with samples or independent from them. First they were trained to switch conditional behavior (matching-to-oddity or oddity-to-matching) at the midway point of a session with two stimulus sets. We then trained the birds to shift earlier or later in a session with one set of samples and intermittently tested them with the unshifted samples. Results suggest internal clocks and sample sets are linked.

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Age-related changes in speed and accuracy of rats on a temporal task

Russell Church, & David Freestone (Brown University)

The purpose of this experiment was to identify fundamental age-related behavior in the rat that could be used to investigate the relationship between cognitive and brain aging. Thirty-six male Fischer 344/Brown-Norway rats at ages of 3, 12, 20, and 30 months were trained in standard lever boxes on a 64-s fixed interval of reinforcement schedule in which food was delivered following the first response after 64 s had elapsed. The primary data were the times of lever responses and food delivery; the summary measures of performance reflected the speed of responding and the relative precision of the times of responding. The results showed that there was a decrease in the speed of responding, but an increase in accuracy as a function of age. The response speed was relatively fast and constant between 3 and 12 months, and relatively slow and constant between 20 and 30 months, with a large decrease in speed between 12 and 20 months. There was a similar (but slightly earlier) abrupt change in the age trajectory of the accumulation of amyloid in the brain. The conclusion was that there is a close relationship between some measures of brain aging and some measures of cognitive aging.

4:50 PM

Break

4:55 PM **Perception & Song (Chair: Anna Wilkinson)**

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Underwater hearing in spotted seals

Jillian M. Vitacco, Colleen Reichmuth, Asila Ghoul (University of California - Santa Cruz), & Brandon L. Southall (SEA Inc. and University of California - Santa Cruz)

The characterization of species-typical hearing in arctic seals is important in terms of understanding both their perception of the acoustic environment and their susceptibility to anthropogenic noise. In this study, two 1-year-old male spotted seals (*Phoca largha*) were tested in a go/no-go procedure using the method of constants to measure their underwater hearing sensitivity. Detection thresholds, defined as the stimulus levels resulting in 50% detection probability, were measured for 10% bandwidth linear frequency-modulated sweeps at frequencies between 0.1 – 72.4 kHz. The resulting audiograms exhibited the typical mammalian U-shape, with a wide range of best sensitivity between 3.2 – 25.6 kHz. Moreover, these audiograms were similar to those previously described for related species, strengthening the notion that functional hearing groups may exist among the true seals. The study of acoustic ecology—including measurements of basic hearing capabilities—is relevant to the protection of vulnerable species, especially animals such as arctic seals that often utilize auditory cues to orient and communicate in relative darkness. This work represents the first reported data concerning hearing in spotted seals and provides the foundation for future studies examining noise-induced temporary threshold shifts and masking effects.

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Effect of lesion of nucleus subpretectalis on visual discrimination in pigeons

Martin Acerbo (University of Iowa), & Olga Lazareva (Drake University)

Our earlier research has shown that nucleus rotundus, a thalamic nucleus processing visual information in pigeons, together with its inhibitory complex, is differentially activated in birds performing figure-ground discrimination, color discrimination, and shape discrimination (Acerbo, McInerney, et al., in preparation). In this study, we conducted bilateral chemical lesions of nucleus subpretectalis, a major inhibitory nucleus that regulates activity of nucleus rotundus. We trained pigeons to simultaneously perform three visual discriminations (figure-ground, color, and shape) using the same displays. When birds learned to perform all three tasks at high levels of accuracy, we conducted bilateral lesions of n. subpretectalis using ibotenic acid. After a period of recovery, the birds were retrained on the same tasks to evaluate the effect of lesion on maintenance of discriminations. Preliminary results indicate that lesion of nucleus subpretectalis has no effect on color discrimination, and impairs both shape and figure-ground discrimination. These results suggest that figure-ground segregation in avian brain may occur at the level of thalamus, rather than at the cortical level as it does in primates.

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46

Perception of emergent configurations in capuchin monkeys and pigeons

Kazuhiro Goto (Kyoto University), Shigeru Watanabe (Keio University), & Kazuo Fujita (Kyoto University)

We examined the perceptions of emergent configurations in capuchin monkeys and pigeons using a matching-to-sample task. A target and distractors were presented either solely, within congruent contexts which salient configurations emerge, or within incongruent contexts in which salient configurations do not emerge. We found that congruent contexts facilitated the discrimination for capuchins, whereas it disrupted the discrimination for pigeons. The incongruent contexts disrupted the discrimination for both species. These results suggest that capuchin monkeys perceive emergent configurations when targets and distractors are presented within certain congruent contexts but pigeons do not perceive such emergent configurations.

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Phylogenetic relatedness and immediate early gene expression in black-capped chickadees

Christopher B. Sturdy, Marc T. Avey (University of Alberta), Laurie L. Bloomfield (Algoma University), Julie E. Elie (University of California Berkeley), Todd M. Freeberg, Lauren M. Guillette, Marisa Hoeschele, Homan Lee, Michele Moscicki, & Jessica L. Owens (University of Tennessee Knoxville)

We assessed immediate early gene (IEG) expression in secondary auditory areas of black-capped chickadees to understand their involvement in vocal recognition of conspecific and heterospecific vocalizations. In Experiment 1, playback stimuli were whole “chick-a-dee” calls produced by black-capped and mountain chickadees (sister species), along with “chick-a-dee” calls produced by closely-related boreal chickadees and calls produced by the more distantly-related gray-crowned rosy-finch. We found no significant differences in the amount of IEG expression in response to the three chickadee calls, but IEG expression was significantly greater to all chickadee species compared to gray-crowned rosy-finch calls and silence controls. In Experiment 2, we tested if acoustic structure was driving the IEG response, regardless of phylogenetic relatedness. We compared the IEG response to D notes from the “chick-a-dee” call to the IEG response elicited by acoustically-similar stimuli from species of varying phylogenetic relatedness to black-capped chickadees. All vocalizations, independent of phylogenetic relatedness, led to significant IEG expression, with the exception of reversed black-capped chickadee D notes. These results, along with previous studies from our lab, suggest that IEG expression in the chickadee brain is not a simple conspecific/heterospecific dichotomy, but rather, is best described as a complex interplay between representation/function and perception/acoustics.

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In the eye of the beholder: visual mate choice lateralization in a songbird

Jennifer Templeton, D. James Mountjoy (Knox College), Simon Griffith, & Sarah Pryke (Macquarie University)

Birds choose mates on the basis of color, song, and body size, but little is known about the cognitive mechanisms underlying these mating decisions. Recent reports that immediate early gene expression associated with courtship behavior is lateralized in the left optic tectum of Zebra Finches suggest that visual mate choice itself may be lateralized. To evaluate this hypothesis, we used Gouldian Finches, which exhibit strong, adaptive preferences for mates of their own head-color (red or black). We tested finches in a mate-choice apparatus under each of three eye conditions: left, right, and binocular. We discovered that preference for females of the same head color is so strongly lateralized that if the right eye is unavailable, males are unable to discriminate not only between males and females of the same head color, but between the strikingly different female morphs. Song was consistent with these lateralized mate preferences; black-headed males sang significantly more to black-headed females when using their right eye than when using their left. Thus, beauty is in the right eye of the beholder for these colorful songbirds. This is the first clear demonstration of visual mate choice lateralization in any animal.

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

See Poster Abstracts Starting on Page ##

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

12:00 PM **Canine Cognition (Chair: Stephen Lea)**

12:00 PM

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Discrete-trials Training Procedure for an Odor Discrimination in Domestic Dogs (*Canis lupus familiaris*)*Nathaniel J. Hall, & Clive D.L. Wynne (University of Florida)*

A dog's nose remains one of the most reliable and accurate tools for detecting odors (Furton and Myers, 2001). The intensive procedure required to train these dogs, however, limits their availability and the ability of scientists to study factors that influence performance. In Experiment 1 we trained a group of 20 naïve dogs on an odor detection task with 24 scheduled trials. In Experiment 2, we assessed if dogs learned an odor cue more rapidly than a visual (black vs. white) cue. Exp 2 also assessed if placing accessible food directly in the target bin and inaccessible food in the non-target bin enhanced discrimination training, compared to a procedure in which the experimenter delivered the food shortly after a correct response. Dogs learned faster on the odor task when food was delivered after a response. When the experimenter delivered food, dogs performed better on the odor task than the visual task. Across dogs, important individual differences were noted. A select group of dogs consistently performed with a high level of accuracy while other dogs performed with greater variability. This procedure may be useful to select dogs that will perform well as odor detectors.

12:07 PM

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Social play as an attention-seeking behavior in captive canid populations.*Lindsay R. Mehrkam, & Clive D.L. Wynne (University of Florida)*

The benefits of environmental enrichment for captive animals are widely documented in the scientific literature. However, few studies have examined the relationship between enrichment and social interactions among conspecifics housed together. We provide empirical support for human interaction as enrichment across several canid species, including wolves, wolfdog hybrids, and coyotes. In addition, we suggest that social play, a behavior observed frequently when human interaction was provided, may partially be an interspecific attention-seeking behavior in socialized canids as a result of extensive experience with human caretakers. As play is considered an indicator of positive welfare, further investigation into the function of play behavior may have applied significance for captive populations of animals.

12:14 PM

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The effects of social training and other factors on adoption rates of shelter dogs.*Sasha Protopopova, & Clive Wynne (University of Florida)*

The aim of the present study was to identify factors that may influence and predict adoption rates. Previous research suggested that friendly and sociable dogs are sought out and are perceived as more adoptable. Therefore, we hypothesized that dogs trained to gaze into potential adopters' eyes will be more attractive and thus more likely to be adopted. In addition, we investigated which other individual factors predicted adoption rates. One hundred and seventy-six dogs were randomly assigned into one of three conditions: training, feeding, or control. In order to determine which factors predict adoption, we tracked the outcomes for each dog in addition to their scores on a weekly sociability test as well as their morphological traits and their mode of intake. These findings suggest that other factors besides behavior may be more important to adopters when considering a dog.

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Gestural Communication from the Canine Perspective*Monique Udell (Flagler College), Nicole Dorey, Nathaniel Hall, & Clive Wynne (University of Florida)*

What do domestic dogs really understand about human gestural communication? Research has tackled this question by looking at canine responsiveness to human pointing, gaze, and a myriad of other gestures that vary in degree of stimulus complexity, orientation, and movement. In a series of recent studies we have demonstrated that dogs are proficient at behaving in ways that maximize their chances of reinforcement in the presence of human social stimuli, choosing to preferentially beg for food from those looking at them and following a point to a target location. However there is increasing evidence that sensitivity to these stimuli varies based on the environment, population and experience level of canine subjects. The results of several studies will be discussed that shed light on this debate, demonstrating the context specific nature of canine responsiveness to human stimuli.

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Tool Use & Problem Solving (Chair: Sara Shettleworth)

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Insightful Problem Solving in an Asian Elephant*Preston Foerder (Biopsychology and Behavioral Neuroscience Subprogram in Psychology of the Graduate Center of The City University of New York), Marie Galloway, Tony Barthel, Donald E. Moore III (Smithsonian National Zoological Park Washington D.C.), & Diana Reiss (Department of Psychology of Hunter College of The City University of New York and Biopsychology and Behavioral Neuroscience Subprogram in Psychology of The Graduate Center of The City University of New York)*

Spontaneous problem solving without evident trial and error behavior in humans and other animals has been referred to as insight. Surprisingly, elephants, thought to be highly intelligent, have failed to exhibit insightful problem solving in previous cognitive studies. We tested whether three Asian elephants (*Elephas maximus*) would use sticks or other objects to obtain food placed out-of-reach, overhead. Without prior trial and error behavior, a 7-year-old male Asian elephant showed spontaneous problem solving by moving a large plastic cube and standing on it to acquire the food. In further testing he showed behavioral flexibility, using this technique to reach other items and retrieving the cube from various locations to use as a tool to acquire food. In the cube's absence, he generalized this tool utilization technique to other objects and, when given smaller objects, stacked them in an attempt to reach food. The elephant's overall behavior was consistent with the definition of insightful problem solving. Previous failures to demonstrate this ability in elephants may have resulted not from a lack of cognitive ability but from the presentation of tasks requiring trunk-held sticks as potential tools, thereby interfering with the trunk's use as a sensory organ to locate the targeted food.

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12:42 PM

String-pulling performance in two Australian parrot species: do ecological factors matter?*Anastasia Krasheninnikova, & Ralf Wanker (University of Hamburg Germany)*

Problem-solving tasks such as string-pulling tasks are often used to analyse the advanced cognitive abilities in animals, as it requires a large number of different motions in a precise order to solve a problem never previously encountered. In birds only corvids and parrots understand the logical structure in the task. However, inconsistent performances across parrot species suggest different socioecological factors driving success in such tests. We presented two closely related Australian parrot species, the Galah (*Eolophus roseicapillus*), and the cockatiel (*Nymphicus hollandicus*), with a set of string-pulling and string-choice tasks. While both species forage on the ground, only the Galah uses its feet while foraging which was suggested a requirement for the string pulling problem. The performance of the cockatiels demonstrated that for the fine coordinating motor skills it is not necessary to use the feet during foraging. However, galahs outperformed the cockatiels in 4 out of 5 choice tasks. Performance at the individual level suggests that some birds of both species were able to grasp the logical structure of the tasks, but only Galahs were able to inhibit their preference for a shorter string when it was not connected with the reward. Considerable individual and inter-specific differences are discussed.

12:49 PM Break

12:54 PM **Concept Learning (Chair: Christopher Sturdy)****Effects of spatial configuration in a same/different task with pigeons***Adam Goodman, Jeff Katz (Auburn University), & Anthony Wright (University of Texas Medical School at Houston)*

Four pigeons were trained in an abstract-concept same/different (S/D) reversal task in which the sample and test stimuli were aligned vertically (sample item located directly above the test item with a white rectangle to the right) and then subsequently trained with sample aligned midway between choice stimuli (test item and white rectangle). When trained in the S/D task with contingency reversals using a vertically aligned configuration, pigeons display response-location preferences that spike and then diminish for each reversal. These patterns of responding may influence relational learning. We hypothesized that increasing the distance between response locations in our S/D task would reduce these preferences. Performance was assessed for the effects of the two different spatial configurations on spatial preferences during reversal learning. Our findings indicated that although pigeons responded based on relational rules in both conditions, location-preferences subsequent to a reversal diminished more rapidly with the sample midway-aligned configuration than with the vertically aligned configuration. Research in human category learning has shown that increased choice-item spacing decreases choice response times, suggesting that forming distinct categorical representations is easier when responses are correspondingly distinct in physical space. The current findings suggest that the choice-item facilitation extends to non-human abstract-concept learning.

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1:01 PM

Is your subject ready? Exploring the correlation between training criteria and cognitive task success using inferential and Bayesian statistics*Marie Trone & Stan Kuczaj (Valencia College University of Southern Mississippi)*

Many cognitive studies involve subjects becoming proficient at a specific conceptual task through training. These conceptual tasks are designed to provide information about a species' mental capacities in areas such as perceptual discrimination, memory, numerosity, communication, etc. This analysis investigates the correlation between task proficiency during training (i.e. training criteria) and subsequent success during testing under novel conditions, using both inferential and Bayesian statistics. Inferential statistics have been traditionally employed in comparative psychology, although statistical assumptions are often violated given the small sample sizes in such studies. Advances in computing technology facilitate the use of Bayesian statistics, consequently avoiding such violations. Results from this study demonstrate that more stringent training criteria are correlated with greater testing success. Implications from this analysis suggest that some species may have tested negatively for specific cognitive tasks due to insufficient preparation. A true comparison of the mental abilities among various species should take into consideration the training criteria employed in the respective studies.

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1:08 PM

Same/Different Discrimination in Bumblebee Colonies*Michael F. Brown, & Justin S. Sayde (Villanova University)*

Four colonies of bumblebees (*Bombus impatiens*) were trained to respond differentially to visual displays consisting of either two identical stimuli or two different stimuli. The stimuli were either two colors (two colonies) or two line orientations (two colonies). Discriminative responses were defined by flying to an area on either the left vs. right side of the stimulus display, with one side being correct during a "same" display and the other correct during a "different" display. A correct choice resulted in access to sucrose solution. Following training, the colonies were tested with the alternative (novel) stimulus set, under conditions of non-differential reinforcement. All four colonies showed transfer of the discrimination in a manner consistent with use of a same/different concept.

57

1:22 PM

Sequence learning in pigeons: Behavior can reflect an abstract rule*Dennis Garlick (UCLA), Stephen B. Fountain (Kent State University), & Aaron P. Blaisdell (UCLA)*

At the 2011 CO3 conference, we reported how, in contrast to rats, pigeons perform better on a violation element than a run element on a sequence learning task. Pigeons were presented with 8 disks arranged in a circular array on a touchscreen. On each trial, two of the disks were illuminated. Correct responding consisted of serial patterns involving run chunks (e.g., 123 234, etc.) Each chunk was also signified by a different color, which served as a phrasing cue. For the Run group, the final chunk of 812 also conformed to the pattern. For the Violation group, the final chunk of 818 violated the pattern. It was found that, unlike rats, pigeons made fewer errors on the final trial in the Violation than the Run condition. This was attributed to pigeons learning a configuration of color and positional cues independent to the sequence. To reconcile this inconsistency, we used a different procedure where, rather than being rewarded after each correct response, the pigeons were only rewarded after each complete chunk. With this new procedure, pigeon results corresponded closely with those found with rats and suggest that pigeons can also be influenced by an underlying abstract structure.

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1:29 PM **Discrimination Learning & Numerosity (Chair: Roger Thompson)**

1:29 PM **Motion Matters: Discrimination of Complex Action Categories by Pigeons**

Justin M. Sayde, Muhammad A. Qadri, & Robert G. Cook (Tufts University)

Pigeons are skilled at discriminating noun-based categories, but few studies have examined their ability to distinguish stimuli on the basis of action categories. Previous work in our lab has shown that pigeons can discriminate computer-generated models of animals based on gait (i.e., walking vs. running), but given the cyclic nature of these stimuli, it is possible that they accomplished the task by tending to low-level features inherent in these repetitive movements. The current study employed more intricate motion sequences (i.e., a computer-generated human figure engaging in dance or martial arts) to examine how pigeons process and conceptualize action categories. Using a go/no-go procedure tied to each type of action, pigeons were presented with either a 20-second video of each action or randomly-selected frames. The pigeons reliably discriminated the behaviors within ten sessions, and learning was more pronounced for the dynamic condition compared to the static condition. A different group of pigeons trained in just the static condition failed to learn the discrimination over the same period. These results suggest that the dynamic stimuli contain valuable information that can be used to facilitate the perception of action and contribute to the discrimination of static poses.

59

1:36 PM **Can pigeons and humans transfer information between the local and global level in exemplar- and rule-based discrimination tasks?**

Ulrike Aust, & Elisabeth Braunöder (University of Vienna)

Pigeons and humans were presented with an exemplar-based discrimination task (category membership of each picture had to be learned individually) and with a rule-based task (category membership was defined by a perceptual rule). Each subject was trained in one of three presentation modes, namely, with intact pictures (providing both local and global information), with scrambled pictures (impairing global information), or with blurred pictures (impairing local information). While humans readily learned both tasks irrespective of presentation mode, pigeons took much longer to learn blurred than intact or scrambled stimuli, and this was particularly evident in the exemplar-based task. When subsequently presented with the two stimulus versions not shown during training, pigeons showed good transfer only between intact and scrambled pictures, while transfer from and to blurred stimuli was poor in both tasks. Humans readily transferred between any two presentation modes in both tasks. The results confirm the notion of a local preference in pigeons and reveal some limitations in their ability to directly generalize from one processing level to the other. Humans did not show a preference for either level, and transfer between levels was excellent in both tasks.

60

1:50 PM **Quantity estimation in animal collective movement**

Eran Shiffman (Konrad Lorenz Institute for Evolution and Cognition Research)

Collective movement (CM) is an instance of collective decision making, in which a group of individuals begins to move for purposes such as foraging or migration. There are many different manifestations of CM across various taxa, and these offer a glimpse at the mechanisms allowing for the coordination and trade-off between knowledge and motivation from both the individual and the group levels. Initiation of CM can be centralized (by a leader) or distributed (any individual can lead) and recruitment can rely on thresholds or it could be more precise and require a certain number of specific followers. In this talk I argue that we can find evidence for an increase in the complexity of the employment of quantity estimation (QE) in the various fashions different species behave in the context of CM. I review field data documenting the contextual use of various QE aptitudes, beginning with the rudimentary utilization of thresholds and culminating in counting. This test case provides yet another example for the socioecological impetus for the evolution of the cognitive attribute of QE.

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2:04 PM **Evolutionary foundations of numerical abilities: Evidence for similar numerical systems in humans and fish**

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

Humans and non-human animals share an approximate system for representing numerosities that has no upper limit and for which accuracy is ratio-dependent. Current evidence indicates that humans possess also a numerical system for small numbers (up to 3-4 items) called 'subitizing', insensitive to numerical ratio. There is, however, growing controversy as to whether two separate number systems are present in other species. We directly compared numerical abilities of fish and humans. Two different methods were adopted with fish: in the former the natural tendency to join the larger shoal was used to investigate their limits of quantity discrimination; in the latter fish were trained to discriminate between sets of dots differing in numerosity. Humans were required to discriminate sets of dots differing in numerosity. The same numerical ratios, both within and beyond the subitizing range, were presented to both species. Interestingly, in both students and fish the performance was ratio-independent for numbers 1-4, while it steadily increased with numerical distance when larger numbers were presented. Our results suggest that two systems underlie quantity discrimination in both humans and fish, implying that the building blocks of uniquely human mathematical abilities may be more ancient than we have previously thought.

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2:18 PM **Break**

2:23 PM **Cognitive Processes II & Development (Chair: Angie Koban)**

Self-Directed Behavior at a Mirror by a 14-month-old Bottlenose Dolphin

Diana Reiss (Department of Psychology Hunter College CUNY Biopsychology Behavioral Neuroscience Sub-program in Psychology at The Graduate Center CUNY), & Rachel Morrison (Biopsychology Behavioral Neuroscience Sub-program in Psychology at The Graduate Center)

Dolphins, like humans, apes, elephants, and magpies demonstrate mirror self-recognition (MSR). MSR emerges in children between 18-24 months and in chimpanzees between 2.5-4.5 years. We conducted a study with a social group of nine bottlenose dolphins (*Tursiops truncatus*) at the National Aquarium to determine the age of onset of self-directed behaviors and MSR. A 14-month-old male dolphin was exposed to a two-way mirror within a social context and his responses were videotaped and analyzed. The young dolphin demonstrated a high level of interest in the mirror, measured by his total time spent at the mirror (35.6 min). Throughout the study, little social behavior was observed ($f=20$, 3%) and the majority of the dolphin's behavior was categorized as self-directed ($f=501$, 62%) followed by contingency-testing ($f=115$, 14%), ambiguous ($f=98$, 12%), and stationing ($f=77$, 10%). A significant number of behavioral events were exhibited when he was alone at the mirror ($f=646$, 79%). Dolphins are precocious at birth and exceed human and non-human primates in motor skills and coordination. Our findings suggest, that young dolphins may show advanced cognition at an earlier age with respect to mirror self-directed behavior as compared to humans and chimpanzees.

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2:37 PM **Testing the limits of optimality: The effect of base rates on pigeons' performance in the Monty Hall dilemma**

Walter Herbranson (Whitman College)

Pigeons have previously been shown to respond optimally in a task analogous to the "Monty Hall dilemma" (Herbranson & Schroeder, 2010). On each trial, reinforcement was available for pecking a randomly determined response key from among three options. After an initial choice from among all three keys, birds made a second choice from among two keys, always including the key that had just been pecked and the key that could produce reinforcement. Birds performed optimally by switching keys on virtually all trials. While a bird's initial choice had no influence on the probability of gaining reinforcement, most birds nevertheless adopted a preferred key for their initial choice. Two experiments replicated this procedure, but with the availability of reinforcement unequally distributed across keys. With this asymmetry, the initial choice is no longer irrelevant. The best possible rate of reinforcement is attained by choosing the key with the lowest likelihood of reinforcement and then switching. Pigeons approximated this optimal strategy in both respects. By doing so, they earned close to the maximum possible payoff, despite the fact that the initial choices were necessarily on the key that produced the fewest reinforcers.

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2:51 PM **The role of attentional control in analogical reasoning for baboons**

Timothy M. Flemming (Georgia Gwinnett College), & Joel Fagot (CNRS)

The judgment of relational information and ability to reason analogically has proven difficult for several nonhuman animal species. In recent years, the role of diminished executive control and attention, specifically sustained attention, has been implicated as a contributing factor to these difficulties in maintenance of abstract concepts. The relational matching-to-sample (RMTS) task used commonly to assess ability to reason analogically requires not only the maintenance of abstract relations but also is very highly demanding of attention for monkeys. It may be the case that demonstrations of failure of this task are due to attentional deficits rather than a lack of ability to reason by analogy per se. In the present study, we examined the supposed link between observed behaviors demonstrative of attentional control in individuals from a large social group of baboons and their ability to complete a computerized RMTS task. Those individuals sustaining behavioral activity in one concentrated bout for longer periods of time tended to outperform individuals on an RMTS task which engaged in shorter bouts of focused behavioral activity. These results have implications for attentional control and perhaps even model of ADHD as they affect one's ability to reason analogically.

65

2:58 PM **Joint Attention and Cooperation Develop in Chimpanzee and Human Infants**

K.A. Bard (University of Portsmouth), R. Bakeman (Georgia State University), S.T. Boysen (The Ohio State University), & D.A. Leavens (University of Sussex)

Joint attention, triadic engagement with social partners and objects, marks the onset of shared intentionality, and may be a precursor to 'theory of mind'. Tomasello's Shared Intentionality hypothesis proposed an inextricable link between Joint Attention and Cooperation, demarcating a human-unique evolutionary pathway. Here we compare the social cognition of human infants with chimpanzee infants assessed during a standardized test. We found that laboratory-reared, 5- to 12-month-old chimpanzees develop joint attention and exhibit cooperation similar to typically-developing, 5- to 12-month humans. Enriched experiences increased joint attention, cooperation, and cognition in chimpanzee infants. Notably, once emotional engagement was statistically controlled, the spurious correlation between Cooperation and Joint Attention disappeared. Social cognition outcomes, at least in chimpanzees, change as a function of emotionally meaningful social interactions. These data support an alternative Lived Experiences hypothesis, highlighting evolutionary continuity in those developmental processes that underpin the emergence of social cognition.

66

3:12 PM **What's in a Face? Orangutans' and Human Children's Recall of Lists Comprised of Conspecifics and Arbitrary Images**

Francys Subiaul, Elizabeth Renner (The George Washington University), & Elizabeth Price (Smithsonian National Zoological Park)

Are images of conspecifics recalled more accurately than arbitrary images in a serial task? Here, we explored that question using the simultaneous chaining paradigm (SCP). In the SCP, pictures appear on a touch-sensitive screen and must be touched in a specific serial order. From trial to trial, pictures randomly change spatial position. In Experiment 1, children and orangutans were presented with pictures of three humans or orangutans, respectively. Neither apes nor children learned lists of conspecifics significantly better than lists of arbitrary pictures. In Experiment 2, orangutans were presented with 2 types of lists. One list comprised arbitrary images that had to be touched in a specific order (as in Experiment 1), the other comprised different photographic representations of the same familiar individual (zookeeper). The goal was to respond to the individuals in the same order while ignoring differences in the photographic representation. There was no evidence of learning from List 1 to 30 for either list type. Results suggest that while certain attention biases improve the recognition of individual faces relative to arbitrary images, these biases may not extend to serial recall.

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3:26 PM

Development and application of a new method to investigate cognition in newborn guppies*Maria Elena Miletto Petrazzini, Christian Agrillo, Laura Piffer, Marco Dadda, & Angelo Bisazza (University of Padova (Italy))*

Assessment of cognitive abilities often involves individual training requiring that subjects are maintained in social isolation for prolonged periods. This raises ethical problems, especially when newborns and young individuals are the target of research. The aim of the current study was designing a procedure to investigate cognition in newborn guppies. To achieve our goal we initially observed the development of social behavior in newborn guppies. Spontaneous shoal choices were observed in two different experiments: newborn guppies spent more time near social companions than near an empty compartment (exp. 1), showing an increasing gregarious tendency from birth for two weeks. However they did not exhibit any preference between social companions and their own mirror image (exp. 2), suggesting the possibility of using mirrors as a substitute of social companions to reduce social isolation of single individuals. We accordingly set up a novel training procedure which included the presence of mirrors in the experimental tank. Newborn guppies were required to discriminate between two geometrical figures (circle vs. triangle) to get a food reward (exp. 3): 9 day-old fish successfully discriminated the two stimuli after 20 trials, thus providing the first evidence of operant conditioning in newborn guppies.

3:33 PM

Snack Break

4:33 PM

In Honor of Tony Wright (Chair: Jeff Katz)

4:33 PM

Source memory in the rat*Jonathon D. Crystal, & Wesley T. Alford (Indiana University)*

Source memory includes a representation of the origin—source—of information and is related to episodic memory. We developed an animal model of external source monitoring by asking if rats can discriminate self-generated (walking along a runway, encountering food) and experimenter-generated (placement at a food site without walking) events. Placement feeding of chocolate- or chow-flavored food occurred at a randomly selected location on an eight-arm radial maze; chow was encountered at other locations. Chocolate replenished at its study location in a subsequent test if the chocolate event was self-generated but did not replenish if the event was experimenter generated. Rats revisited the chocolate location at a higher rate in replenishment than non-replenishment conditions. A transfer test to a novel room suggests that the rats had not memorized a series of spatial contingencies. Manipulation of the retention interval suggests that memory for source information decays with intact flavor-location information, thereby providing a dissociation between source and other memories. These experiments add to recent evidence that rats have a detailed representation of earlier episodes including the external source, what-where-and-when it occurred, and the ability to answer an unexpected question after incidental encoding.

4:48 PM

Role of the dentate gyrus in mediating interference as measured by a pattern separation process*Raymond Kesner (University of Utah)*

In order to understand the neural mechanism associated with specific forms of interference, this presentation will concentrate on the role of the dorsal and ventral dentate gyrus subregions of the hippocampus in rats. The computational modelers have suggested that the dentate gyrus can provide a neural mechanism that can operate to reduce interference between highly processed similar spatial, contextual or odor inputs to generate pattern separation functions. This is based on the large number of inputs into granule cells of the dentate gyrus and sparse output to the next subregion the CA3 in combination with a competitive inhibition network associated with the granule cells of the dentate gyrus. Based on episodic memory paradigms, such as matching to sample and recognition memory using novelty detection, it can be shown that the dorsal dentate gyrus plays an important role in mediating spatial and context pattern separation and the ventral dentate gyrus plays an important role in mediating odor pattern separation.

5:03 PM

Perceptual Load in Pigeons and Humans*Jeffrey Katz, John Magnotti, Adam Goodman, Thomas A. Daniel (Auburn University), & Anthony Wright (University of Texas Medical School at Houston)*

Perceptual load can influence estimates of visual working memory (VWM) capacity as assessed via change detection. Using the same stimuli in a visual search task, as in change detection, one can estimate perceptual load by varying the display size and determining search slopes. For the stimulus types tested (colored circles and white shapes), our results indicate flat search slopes for colors, but increasing search slopes for shapes for pigeons and humans. These results suggest that perceptual load is constant across display size for colors, but increases linearly when shape stimuli are used. Our findings are consistent with increased perceptual load leading to decreased VWM capacity estimates and strengthen previous demonstrations of the similarity of VWM across species.

5:18 PM

When Pigs Fly*Robert Cook (Tufts University)*

What kinds of information animals process from complex visual stimuli remains a challenging issue in the study of animal cognition. New data on this problem using various timeworn procedures will be presented. Within this context, Tony Wright's contributions to this topic will be highlighted.

5:33 PM

Animal Models of Temporal Lobe Amnesia*Jocelyne Bachevalier (Emory University)*

Our understanding of the nature of the human amnesic syndrome has expanded enormously in the last 60 years. This increased knowledge stems not only from the detailed description of memory disorders in patients with brain lesions and from recent neuroimaging studies in both patients with memory disorders and normal subjects, but also from a growing number of animal models of different species. These animal models have been used to refine our understanding of the specific brain regions involved in human amnesic syndromes and the critical memory processes mediated by each region. Although animals and humans differ greatly in many ways, the basic principles of brain organization and function are homologous. The use of selective methods of lesion production as well as the design of new memory paradigms have enabled neuroscientists to examine in rats and monkeys the contribution of specific structures implicated in human memory in a way that is rarely possible in human studies. This presentation will describe several categories of animal model that have advanced our understanding of the processes underlying normal human memory and in particular, the deficits observed in human amnesia.

5:48 PM Break

5:55 PM Introduction – Jeff Katz

6:00 PM Master Lecture – Tony Wright (University of Texas Medical School at Houston)

7:30 PM Banquet

Saturday

12:00 PM Business Meeting

1:10 PM Group Photo – Smile ☺

1:30 PM Timing Symposium: Valter Tucci (Chair: Valter Tucci)

1:30 PM **Timing by coincidence detection: What's all the noise about?**

Catalin V. Buhusi (Medical University of South Carolina), & Sorinel Oprisan (College of Charleston)

Interval timing is crucial for fundamental cognitive processes like decision making, rate calculation, and action planning. In the vast majority of species and behavioral and neurophysiological manipulations, interval timing is scale invariant: time-estimation errors are proportional to the estimated duration. Time-scale invariance is considered the fundamental property of interval timing, yet its origin and mechanisms are unknown, despite its ubiquity. How does such a specific property of supra-second timing emerge from neurons firing in the milliseconds range? Current behavioral models posit that time-scale invariance derives from convenient computations, rules, or coding schemes. In contrast, neurobiological models attempt to explain timing as a property of neurons and circuits. We discuss computational properties of a simple neurobiological building block in which time is coded by the pattern of coincidental activation of its inputs. Results suggest that scalar timing may not be a property of higher-order cognitive processes or computations such as timing or counting, but rather a general property naturally emerging in a massively-connected brain from the intrinsic noise of neurons and circuits. These findings provide the simplest, most general explanation for the ubiquity of time-scale invariance over virtually every species, behavioral, and neurophysiological investigation to date.

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1:45 PM **Circadian Timing and Interval Timing by Mice in a Fully-Automated System**

C.R. Gallistel, Joseph Negron, & Aaron Kheifets (Rutgers University)

Animals locate themselves in space and time. They know where they are, the direction and distance of interesting locations from their location, and the direction and distances between remote locations. They know the time of day, the times of day at which interesting events happen, e.g., meals, and the temporal distances between events, that is, durations. The neurobiological mechanisms by which they locate themselves in space and time may be amenable to investigation by means of forward genetics. The first step in such an investigation is behavioral screening for heritable malfunctions in these mechanisms. For that to be practical, we need highly automated behavioral testing systems that measure the performance of these mechanisms quantitatively. We present results from a fully-automated 24/7, live-in test environment in which we screen simultaneously for the ability to anticipate meal onsets and the ability to time elapsing intervals.

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2:00 PM **Sleep, circadian rhythms and interval timing: a genetic and epigenetic approach**

Valter Tucci, & Glenda Lassi (Department of Neuroscience and Brain Technologies - Istituto Italiano di Tecnologia – Italy)

Molecular genetics and epigenetics play an important role in sleep, circadian rhythms and interval timing. Thus, timing is a functional phenotype that is coded at a behavioral, physiological, genetic and epigenetic level. An integrated investigation of these mechanisms represents a powerful instrument to understand strategies that evolution has developed to timestamp information in daily life. Here we will present evidence that support the use of the mouse in understanding the biology of timing. In particular, by manipulating genetic and epigenetic variables, we were able to alter the ability to process time in mice. In one case we have evidence that circadian and interval timing share some common mechanism. In the second case we present sound evidence that loss of genomic imprinting affects timing and sleep homeostasis. Our results suggest that biallelic genetic expression is beneficial to high-level brain processes, even when evolution has maintained a specific monoallelic expression profile.

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2:15 PM **Unwinding the Molecular Basis of Interval and Circadian Timing**

Warren H. Meck (Duke University)

Studies investigating the interaction between interval and circadian timing implicate common dopaminergic and glutamatergic systems in the modulation of temporal processing. The impact of these systems will be discussed at the behavioral and molecular levels as a function of the obligatory entrainment of rhythmic neuronal ensembles functioning at different time scales – thus providing a potential bridge between interval and circadian timing.

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2:30 PM Break

2:35 PM Memory, Choice & Attention (Chair: Catalin Buhusi)

Visual Short-Term Memory Compared in Pigeons, Rhesus Monkeys, & Humans

Caitlin Elmore (The University of Texas Health Science Center at Houston), Wei Ji Ma (Baylor College of Medicine), John Magnotti (Auburn University), Kenneth Leising (Texas Christian University), Antony Passaro (The University of Texas Health Science Center at Houston), Jeffrey Katz (Auburn University), & Anthony A. Wright (The University of Texas Health Science Center at Houston)

The change detection task has been used extensively to study visual short-term memory (VSTM) in human subjects. In this study, we conducted the first comparison of change detection memory between humans, rhesus monkeys, and pigeons. All three species were tested with the same stimuli and nearly identical procedures. Results indicate that VSTM is qualitatively similar between all three species, but quantitatively different. In addition, two popular models of VSTM, the fixed-capacity model and the continuous-resource model, were evaluated using the results obtained from all three species. Converging evidence from all three species indicates that the continuous-resource model provides a more parsimonious account of VSTM.

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2:49 PM

Reduction of uncertainty and sub-optimal choice in starlings*Marco Vasconcelos, Tiago Monteiro, & Alex Kacelnik (University of Oxford)*

Pigeons have been shown to prefer options yielding reward less frequently than other available options provided that the lower payoff option provides explicit information about the outcome of each trial (i.e., food or no food). Because these observations conflict with predictions of rate-maximising models, they are interesting and important. We ran a series of experiments with starlings to investigate the conditions that elicit the effect and the possible mechanisms that control it. We found that the effect is stronger and develops faster in starlings than in pigeons and that the emergence of the effect depends crucially on the moment in which the outcome of each trial is disambiguated: when disambiguation occurs later in the trial, the maladaptive choice pattern is abolished. These findings suggest that it is not the removal of uncertainty per se that drives the effect but a reduction in the duration of uncertainty.

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2:56 PM

The single-mindedness of the pigeon: Attention to single dimensions in multidimensional stimuli*Stephen Lea, & Ruth Huckstep (University of Exeter)*

Pigeons were trained in discriminations between black-on-colour grating stimuli that varied in three stimulus dimensions, spatial frequency, orientation, and background hue. During training, one dimension in each stimulus took either a positive or negative value, while the other two took neutral, mid-point values. Multiple positive and negative stimuli were presented simultaneously, and the pigeons were trained to select the positive stimuli. The positive and negative values were adjusted until the three dimensions were equally salient, i.e. until the pigeons did not systematically respond to the stimuli that were positive on any one dimension before the others. In test sessions, stimuli in which all three stimuli took positive values were mixed with "one-away" stimuli in which two dimensions took their positive values and the other took its negative value. The pigeons tended to respond to such stimuli on the basis of only one of the dimensions. We conclude that although pigeons are capable of attending to many aspects of a stimulus, and of attending selectively to a dimension that gives useful information when others do not, they tend to attend to only a single dimension when many dimensions are giving apparently useful information.

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3:10 PM

Attention is neither limited nor evidenced by the absence of stimulus control*Sheila Chase (Hunter College)*

Although the Shelia, please contact Debbie Kelly to submit your full abstract.

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3:24 PM

Object-based Attention in Hill Mynas (*Gracula religiosa*) and Pigeons (*Columba livia*)*Tomokazu Ushitani (Chiba University)*

Hill mynas and pigeons were compared to determine if task-irrelevant objects controlled attentional processes in these Aves. On each trial, a green circle cue appeared at one end of two rectangles arranged in the horizontal, or vertical parallel. Responding to the cue extinguished it and displayed a yellow circle target that appeared either at the cued location (Valid condition), at the opposite side of the cued rectangle (Within condition), at the near side to the cue on the non-cued rectangle (Between condition), or at the far end of the non-cued rectangle (Far condition). Mynas and pigeons were rewarded for responding to the target, regardless of the arrangement of the rectangles, or the location of the target relative to the cue. Comparing the reaction times of mynas in the Within and Between conditions revealed that mynas responded faster to the target appearing on the cued rectangle than on the non-cued rectangle, suggesting that the attentional process of mynas was object-based. The same comparison with pigeons did not reveal any significant difference between the two conditions. Ecological differences between the two species may have produced divergent characteristics of visual attention within this class Aves.

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3:38 PM

Attentive spiders that eat mosquitoes*Fiona Cross, & Robert Jackson (University of Canterbury)*

Evarcha culicivora, a jumping spider from East Africa, is an unusual species because it specialises at feeding indirectly on vertebrate blood by choosing blood-carrying mosquitoes as preferred prey. It can identify this prey by vision alone and by odour alone, and it also uses search images (selective attention) for finding this prey. For example, when individuals are primed with the odour of blood-carrying mosquitoes, they find this particular prey by sight significantly more often than when they are primed with a different odour source. This is in spite of the fact that these spiders never encountered a mosquito before the experiment. Our results suggest that *E. culicivora*'s search images are innate rather than acquired by perceptual learning. In our ongoing research on *E. culicivora*'s biology, we are considering the role of selective attention in making complex behaviour possible, even for animals with small nervous systems.

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3:52 PM

Contextual Cueing in Visual Search Through Naturalistic Scenes by Primates*Daniel I. Brooks, Ji Dai, & David L. Sheinberg (Brown University)*

To investigate the role of attentional guidance during visual search, we trained rhesus monkeys to search through photographic visual scenes and report the identity of a transparent target object by classifying it into one of two arbitrary pseudocategories. In half of the visual scenes (non-predictive condition), targets appeared randomly in one of eight locations. In the other half of the scenes (predictive condition), scene identity cued the location of the target through consistent scene-location pairings. Along with manual reaction time, we also tracked the monkey's eye position in order to examine how the monkey searched through each scene. We also recorded from cells in the posterior parietal cortex that participate in the control of visuospatial attention and eye movements to learn how these areas are involved in visual search through more complex environments. This contextual cueing task allows us to investigate the extent to which these cells reflect the integration of bottom-up information from the presentation of the visual scene with top-down information through the learned association of particular scenes with particular target locations.

4:06 PM

Break

4:11 PM
4:11 PM

Cognitive Processes III (Chair: Jim Reichert)

Examining evidence for empathic-like abilities in bonobos, *Pan paniscus*

Zanna Clay, & Frans de Waal (Emory University)

Empathy refers to the capacity to be affected by and share another's emotional state, which may involve perspective taking (de Waal, 2008). Compared to the human literature, comparative studies exploring empathic-like abilities in our closest relatives, non-human primates, have received little attention. Here we explored how bonobos deal with others' distress and the extent to which they show empathic behaviours. We observed semi-free-ranging bonobos in DR Congo, (N = 36; mixed sex/ age). Specifically, we observed consolatory and reconciliatory behaviours occurring during post-conflict interactions using the Post-Conflict/ Matched-Control Method (de Waal & van Roosmalen 1979). Overall, bonobos actively consoled victims, using embracing, touching and sexual contacts. Females consoled more than males, especially towards female victims. The strongest predictor was bystander age, with juveniles more likely to console than adults or adolescents. Consolation became more selective with age, suggesting that empathic-like behaviours are modified by developments in other socio-emotional and cognitive skills, such as distinguishing socially-valuable partners. Reconciliation emerged comparatively later, indicating these two behaviours develop under different trajectories and may involve different underlying mechanisms. Overall, results indicate that bonobos possess empathic-like abilities that, with age, combine with other socio-cognitive skills enabling them to assess relative costs/benefits before providing consolation.

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4:25 PM

Transitions in search strategy may be mediated by environmental and task complexity

Kenneth J. Leising, Chad M. Ruprecht, C. Drew Taylor, & Steven Drawdy (Texas Christian University)

Animals make use of many different search strategies to arrive at familiar places and evade predators. Previous research indicates that rats use a place strategy to locate a hidden goal (e.g., a submerged platform) early in training, but shift their strategy with additional trials. The present study aimed to evaluate spatial-search behavior within an apparatus which provides easy access to extramaze cues and many routes to the goal. Rats were trained to approach a fixed goal location (i.e., buried fruit loop) within a 5x5 array. After rats learned to reliably search at the hidden goal, the open field could then be shifted along one axis. Rats employing a place strategy should search more often at a novel location relative to intramaze cues, whereas, rats using a directional strategy should search at the same location. In Experiment 1, probe tests with rats in the shift and control (no shift) conditions revealed a place strategy. In Experiment 2, all subjects were tested in the shift scenario, but one group (Late) was given an additional 18 training sessions. Surprisingly, probe tests from rats in Groups Early and Late again indicate a place strategy.

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4:39 PM

Social Learning & Metacognition (Chair: Michael Beran)

4:39 PM

Social learning by imitation in bearded dragons (*Pogona vitticeps*)

Anna Wilkinson (University of Lincoln), Anna Kis (Eötvös University), & Ludwig Huber (Messerli Research Institute Vienna)

It is frequently claimed that imitation only occurs in humans and great apes although some argue that other mammals and birds also imitate. In the present study we investigated whether a reptile species, the bearded dragon (*Pogona vitticeps*), is capable of this type of learning. To this end 12 bearded dragons were tested using a bidirectional control procedure. The experimental group (n=8) observed a video of a demonstrator accessing food by either moving a sliding door leftward or rightward. All of the experimental animals moved the door in the observed direction on their first attempt, all four control animals (who observed the door move but not as the result of the demonstrator's behavior) failed. We therefore show, for the first time, that a reptile species is capable of social learning that cannot be explained by simple mechanisms such as local enhancement or goal emulation. This suggests that learning by imitation is likely to be based on ancient evolutionary mechanisms.

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4:53 PM

Unsupervised Learning and Metacognition in Rhesus monkeys using Intuitive Tasks

Justin J. Couchman (Fredonia State University), Joseph Boomer (University at Buffalo), Michael J. Beran (Georgia State University), & J. David Smith (University at Buffalo)

Unsupervised learning is learning that does not rely on direct external or objective information about whether specific choices are correct. Humans generally rely on executive processes when there is no one-to-one relationship between specific decisions and outcomes. We asked rhesus monkeys to learn perceptual discrimination tasks without any direct trial-by-trial feedback. Direct feedback was absent even during the initial training phase when they learned the basic objectives of the task. They were presented with a stimulus, two primary responses, and an uncertainty response. They received only summary feedback every six trials (all rewards for correct choices, followed by all penalties). We found that they were able to learn the tasks and escape difficult trials in the face of limited information when the response layout was intuitive (e.g., responding to an icon on the left when the stimulus was on the left). Humans were able to learn comparable intuitive and non-intuitive tasks, though they learned faster in the intuitive task. These results will be discussed in terms of theories about the level of cognitive processing mediating uncertainty responding.

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5:00 PM

Executive-Attentional Uncertainty Responses by Rhesus Monkeys (*Macaca mulatta*)

Michael Beran (Georgia State University), Mariana Coutinho, Barbara Church, & J. David Smith (University at Buffalo)

Some animals use an uncertainty response appropriately by declining exactly those trials for which they are most likely to make errors of perception or memory. However, the interpretation of the uncertainty response is still sharply debated. We attempted to clarify this interpretation by imposing cognitive loads upon ongoing discrimination performance. Two monkeys performed a Sparse-Dense discrimination with an uncertainty response available to decline any trials if they chose. Identity or spatial memory tasks were periodically overlain on these ongoing discrimination tasks. Both concurrent tasks disrupted monkeys' uncertainty responses but not their Sparse/Dense discrimination responses. Two other monkeys were given the same Sparse/Dense task but with a Middle response to objectively classify stimuli in the middle region of the continuum. These monkeys showed less or no disruption when faced with concurrent task loads from the memory test, indicating that Middle responses were qualitatively different from uncertainty responses in their susceptibility to disruption. This dissociation suggests that the uncertainty response is a higher-level, decisional response that is particularly dependent on working memory and attentional resources. Therefore, the uncertainty response probably deserves to be interpreted as an elemental behavioral index of metacognition.

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5:14 PM Closing Remarks (Jeff Katz)

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

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