# 22nd Annual International Conference on Comparative Cognition


## Sponsored by the Comparative Cognition Society

## April 15th to 18th, 2015

### Radisson Hotel

*Melbourne Beach, Florida*

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PROGRAM NOTE: Five minute talks are designated by a Talk Number with a grey background. They are five minutes in duration followed by two minutes for discussion. Ten and twenty minute talks are followed by four and five minutes for discussion, respectively. Spoken and poster presentation numbers enclosed in a box indicate participants in the **Ron Weisman Outstanding Student Presentation Award: Poster/Paper**.

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# Wednesday Afternoon

## 3:30 PM Welcome Reception and Check-In

## 7:00 PM Opening Remarks (Debbie Kelly)

## 7:05 PM Associative Processes (Chair: Ralph Miller)

7:05 PM

**1**

**An organization of conditioning procedures**

*Russell Church (Brown University)*

Textbooks in comparative cognition, and in learning and behavior, include the procedures, results, and explanations for many conditioning experiments. Currently, there is general agreement about most of the results of the procedures, but there are considerable differences in the explanation of these results. A proposed organization of conditioning procedures is based upon seven basic procedures that may be combined in ways that include most conditioning experiments described in current textbooks. The goal of this talk is to provide an organization of conditioning procedures that will facilitate the use of simple explanations of the results.

7:19 PM

**2**

**Mechanisms of midsession reversal performance: is timing the only factor?**

*Aaron P. Smith, Madison K. Sands, & Thomas R. Zentall (University of Kentucky)*

Reversal learning has been described as assessing behavioral flexibility. In the midsession reversal task, a simultaneous discrimination between two stimuli (S1 and S2) is presented in which S1 is always correct for the first half of the session. For the second half, the contingencies reverse and S2 is always correct. Previous research has shown strong evidence of temporal control in pigeons with this task, which leads to suboptimal performance. Pigeons appear to estimate the midpoint of the session and respond to S2 too early and continue choosing S1 after the reversal. The present research sought to assess an alternative explanation for these errors, loss of memory of the last response and its consequence. In Phase 1, during the 5-s intertrial interval, the experimental group received a house–light cue meant to "remind" the pigeons of its previous choice, while a hopper light indicated if it had been correct. In Phase 2, every fourth session, the intertrial interval was either doubled (10-s) or halved (2.5-s). Results in the first phase indicated that the cues significantly improved accuracy relative to the control group and in the second phase they reduced the disruption in performance due to the changing intertrial intervals.

7:26 PM

**3**

**Conditioned inhibition on Pavlovian-to-instrumental transfer**

*Daniel Alarcon, & Charlotte Bonardi (University of Nottingham)*

In the specific transfer effect, a conditioned stimulus (CS) selectively increases a response that was reinforced with the same outcome (O). In three experiments, we assessed the effect of a conditioned inhibitor (CI) in a Pavlovian-to-instrumental transfer (PIT) design with human participants. Two CSs were paired with two outcomes (A->O1, B->O2) and a CI that signalled the absence of one outcome was established (e.g. A->O1, AX->nothing). Subsequently, two responses were reinforced with those outcomes (R1->O1, R2->O2). At test, the CSs were presented in compound with a pre-exposed control stimulus or with the CI, and instrumental performance was measured. The specific transfer effect was found in the presence of the CSs in compound with the control stimuli, but it was significantly reduced when the CSs were together with the CI. These results support the stimulus-outcome-response (S-O-R) mechanism, in which the CS activates a representation of the outcome, which increases the performance (e.g. A->O1->R1). This representation would be suppressed by the CI, thus decreasing the transfer effect. However, these results are not predicted by the stimulus-response (S-R) account, according to which the CS increases the response by a direct link formed during training, without mediation of the outcome representation.

7:33 PM

**4**

**Time and contextual changes lead to relapse after counterconditioning in human predictive learning**

*R. Alexander Sauer, & Martha Escobar (Auburn University)*

In predictive learning, a cue is repeatedly paired with the occurrence of an outcome (O) such that the cue becomes a predictor of O. Counterconditioning involves training of a single cue with two different outcomes (i.e.,cue-O1 then cue-O2), usually of opposite valence (e.g., appetitive and aversive). As a result of such training, behavior reflects the cue-O2 association; however, cue-O1 responding is likely to return after time elapses (i.e., spontaneous recovery) or the physical context changes between counterconditioning and testing (i.e., renewal). Two experiments using a human predictive learning task assessed spontaneous recovery and renewal after both aversive-to-appetitive and appetitive-to-aversive counterconditioning. In Experiment 1, cue-O1 responding was assessed one week after counterconditioning (cue-O2) training. Spontaneous recovery was observed after both aversive-to-appetitive and appetitive-to-aversive training, and the effect was of equivalent magnitude. In Experiment 2, cue-O1 training, cue-O2 training, and testing occurred in one of two distinct contexts. Renewal was observed after both aversive-to-appetitive and appetitive-to-aversive training; however, this effect was more robust after aversive-to-appetitive training than after appetitive-to-aversive training. These findings suggest that aversive outcomes might be more relevant to the individual than appetitive outcomes. Consequently, the physical context appears to better retrieve aversive than appetitive memories.

**5**

7:40 PM **Combining preexposure and extinction as a treatment for conditioned fear**

*Elizabeth P. Dunaway, Whitney Kimble, & Martha Escobar (Auburn University)*

Both extinction (CS-US then CS-noUS) and latent inhibition (CS-noUS then CS-US) result in attenuated fear. However, combining these two treatments (e.g., Leung & Westbrook, 2010) appears to increase rather than decrease fear as compared to either treatment alone. Our laboratory has reported that providing extinction immediately after conditioning (Johnson et al., 2010) or CS preexposure immediately before conditioning (Powell et al., 2013) can increase the fear-reducing effect of these treatments. Two experiments assessed the effects of combining extinction and latent inhibition when either procedure was conducted in short proximity to conditioning. In Experiment 1, extinction occurred either 15-min or 24-h after conditioning, and produced equivalent responding in both delay conditions. In Experiment 2, CS preexposure occurred either 15 min or 24 h prior to conditioning. In this case, immediate preexposure enhanced the effectiveness of extinction and made it resistant to spontaneous recovery. This suggests that immediate latent inhibition may permanently affect the course of subsequently-acquired fear.

## 7:47 PM Tool Use and Problem Solving (Chair: David Brodbeck)

**6**

7:47 PM **Testing physical cognition in striped skunks with the slat-pulling task**

*Zoe Johnson-Ulrich, Jennifer Vonk, & Eric Hoffmaster (Oakland University)*

The striped skunk (*Mephitis mephitis*) is an omnivorous mammal with complex foraging habits. They have a diverse and flexible diet that is distributed in space and time and requires manipulation to obtain. These foraging habits are similar to those of other species that display intelligent abilities and are commonly included in tests of problem-solving cognition, such as primates, corvids, and parrots. Despite this, striped skunks are one of many species that are neglected in studies of cognitive ability. My goal is to examine physical problem-solving skills in the striped skunk in order to broaden the scope of species included in cognition tests, which will help elucidate the pressures that select for advanced cognitive abilities across species. I am assessing skunks' problem-solving abilities with a common and broadly used test of causal reasoning, the slat-pulling task. By contrasting skunk performance between versions of this task in which causal reasoning can and cannot be applied and by assessing transfer between conditions that share the same conceptual solution, I will determine whether they are capable of using causal reasoning about the physical concept of support on this task.

**7**

7:54 PM **Flexible problem solving by bumblebees**

*Caroline G. Strang, & David F. Sherry (University of Western Ontario)*

Foraging bumblebees engage in complex flower handing, requiring petals to be lifted and moved to reach nectar rewards. Flower handling is learned and there are individual differences in how successful bees are at handling flowers of different types. We developed a laboratory task comparable to flower handling in which bees encountered a barrier to nectar reward. The bees were required to lift the barrier, akin to lifting a petal, in order to reach the reward. Bees were given repeated trials and their behaviour was video recorded to quantify latency to success and the use of different behavioural strategies such as lifting, biting, and digging in the area of the barrier. All bees initially used the same repertoire of behaviours when they encountered the barrier. Results showed that the latency to success decreased with repeated trials as bees abandoned unsuccessful behaviours and converged on the only successful strategy, lifting. These results show that bees are capable of flexibly attempting a wide range of flower handling strategies but with experience converge on a single strategy shared by all individuals.

**8**

8:01 PM **Inhibition in Clark's nutcrackers (*Nucifraga columbiana*): results of a detour-reaching test**

*Alizée Vernouillet, & Debbie Kelly (University of Manitoba)*

Inhibition, the ability to restrain ineffective responses to a given stimulus, has been used as a measure of complex cognitive abilities in non-human animals and is argued to be an important component for social interactions. The ability to inhibit has been shown by great apes, dogs, and humans for instance; yet, this has not been tested in corvids (e.g., jays and ravens), a family of birds well known for their complex cognitive abilities. In this study, we measured the accuracy of Clark's nutcrackers (*Nucifraga columbiana*), a solitary corvid species, during a detour-reaching test. Individuals had to retrieve a pine nut which was located at one end of a transparent tube, and in doing so, refrain from pecking directly at transparent barrier. Overall, nutcrackers were able to inhibit responses directed towards the pine nut but at transparent barrier (i.e. prepotent response) but rather detoured to one side of the tube to directly retrieve the reward. Moreover, their accuracy increased during testing trials, suggesting that nutcrackers were able to learn from their errors. During future studies, we propose to compare several corvid species that differ in degree of sociality for further investigations on the importance of sociality in complex cognitive abilities.

## 8:08 PM *Break*

## 8:18 PM Canine Symposium (Chair: Anna Wilkinson)

**9** 8:18 PM **Self control in dogs**

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

The strength model of self-control suggests that like training a muscle, systematic practice enhances self-control. Dogs were tested for self-control strength using a design analogous to memory tasks used with human participants. Practice on unrelated tasks increased dogs' self-control strength but some of the gains from self-control practice were lost over time. We investigated the nature of this decline and the practical applications of self-control practice in the realm of dog training.

**10** 8:25 PM **Effect of odor pre-exposure on detection sensitivity**

*Nathaniel Hall, David Smith (University of Florida), & Clive Wynne (Arizona State University)*

In this study we assess how odor exposure influences a dog's threshold detection for that odor. Using a custom built 7-channel liquid dilution olfactometer, dogs are trained on a go/no-go olfactory discrimination that is under computer control. To assess a dog's sensitivity to an odor, dogs are presented with successively lower concentrations of the target odor until the dog's performance drops to 60% accuracy or less. Dogs first receive a baseline threshold assessment for two odorants (isoamyl acetate and phenylethanol). Half of the dogs then receive Pavlovian conditioning to one odor while the other odor is an unexposed control odor. The remaining half of dogs receive repeated daily exposures to one of the odors, while the other odor remains an unexposed control. All dogs then receive a post-test assessment of threshold to both the control and exposed odors to test whether dogs show a greater change in sensitivity to the exposed odor compared to the control odor.

**11** 8:32 PM **Odor categorization in dogs**

*Anna Wilkinson, Hannah F. Wright, Deanna K. Graham, Rebecca C. Harding, Hayley L. Hodkinson, Benjamin Keep (University of Lincoln), Nina R. Cracknell (Defense Science and Technology Laboratory), Ruth S. Croxton, & Helen E. Zulch (University of Lincoln)*

The ability to identify a novel stimulus as a member of a known category allows an organism to respond towards it in an appropriate way. Categorization can thus be considered a fundamental component of cognition and an essential tool for processing and responding to unknown stimuli. As this process is considered essential for interpreting and responding to stimuli in nature, it is likely to hold across species and sensory domains. Thus investigating the principles of categorization in an applied setting may aid in the training and hence performance of working animals, such as explosive detection dogs. The aim of this study was to examine whether dogs were able to categorize odors. Dogs were trained to make the discrimination using a line up containing 10 different odors in each run, 5 of which were positive and 5 negative. The dogs in the experimental group were rewarded for responding to pyrolysis products that were burned with accelerants and compared to the same products burned without accelerants (S+ counterbalanced). The control group were trained on the same stimuli but without the categorical rule. The differences in performance between the groups will be discussed.

**12** 8:46 PM **Domestic dogs can discriminate personal identities and emotional expressions of human faces**

*Ludwig Huber, Kira Schmitt, Anjuli Barber, & Corsin A. Müller (Messerli Research Institute – University of Veterinary Medicine Vienna – Austria)*

Recent evidence suggests that dogs can extract relevant information from the human face. They can not only discriminate between familiar people who present only their heads, but can also do so on the basis of pictures showing either the whole faces or only the inner parts of the faces (Huber et al. 2013). Using an advanced touch-screen technology (Steurer et al. 2012) we also proved the dogs' ability to discriminate only face parts (eyes, nose, mouth; Pitteri et al., 2014). In a recent experiment we addressed the dog's ability to discriminate emotional expressions of human faces. To date no study has convincingly shown that animals discriminate between emotional expressions of heterospecifics, excluding the possibility that they respond to simple cues, like the visibility of teeth (Nagasawa et al, 2011). Here we show that dogs can transfer the training contingency (happy versus angry) to novel stimuli that shared with the training set only the emotional expression as a distinguishing feature. We conclude that the dogs used their memories of real emotional human faces to accomplish this task. Overall, it seems as if domestic dogs have developed, either during phylogeny (domestication) or ontogeny, special skills to discriminate and memorize human faces.

**13** 9:00 PM **In the dog-house? Insights into the impact of kennelling on canine welfare.**

*Lisa Collins (University of Lincoln UK), Cherie Part (Queen's University Belfast UK), Jenna Kiddie (Anglia Ruskin University UK), & Daniel Mills (University of Lincoln UK)*

Domestic dogs (*Canis familiaris*) housed in kennelling establishments are considered at risk of suffering poor welfare, whether this stay is relatively short term, such as in a boarding kennel establishment, or longer term, such as in a rehoming center. Previous research supporting this hypothesis has typically used a physiological marker, cortisol:creatinine ratio (C/Cr), to measure acute and chronic stress in kennelled dogs. However, the value of C/Cr as a welfare indicator has been questioned. Through a series of epidemiological trials, we have tested the validity of a range of physiological, physical and behavioural welfare indicators and to establish baseline values reflecting good dog welfare. Through these studies, we were able to determine that the emotional valence of canine responses was ambiguous. No definitive evidence was found to suggest that dogs were negatively stressed by kenneling in the short term, and there appeared to be very little change within an individual over the longer term. Furthermore, it was possible to conclude that a number of physiological variables are robust indicators of psychological arousal in dogs. These results will be discussed in the wider context of inter-individual differences and similarities and the implications for canine welfare studies.

## 9:14 PM Metacognition (Chair: Victoria Templer)

**Do chimpanzees know what's real? Results from two new appearance-reality tests**

9:14 PM *Carla Krachun (Grenfell Campus Memorial University of Newfoundland), Robert Lurz (Brooklyn College CUNY), Jamie Russell, Jennifer Schaeffer, Daniel Wilson (Georgia State University and Yerkes National Primate Research Center), McLennon Wilson (Grenfell Campus Memorial University of Newfoundland), & William Hopkins (Georgia State University and Yerkes National Primate Research Center)*

**14**

Appearance-reality (AR) discrimination is an important cognitive ability that has only recently begun to be investigated in our nearest primate relatives. In two previous studies, chimpanzees passed tests in which the smaller of two items was made to look like the larger one (Karg, Schmelz & Tomasello, 2014; Krachun, Call & Tomasello, 2009). To investigate whether chimpanzees' AR-discrimination abilities extend beyond size illusions, we tested them with two new classes of illusory stimuli. In one test, we used a mirror to make the number of items in a group appear greater than it actually was; in another test, we used tinted filters to make an object appear a different color. In both tests, the chimpanzees needed to base their choice responses on the real, rather than apparent, properties of the stimuli. One of six subjects passed the mirror test, and two of seven passed the color test. The results indicate that while chimpanzees are challenged by our tests, making a variety of AR discriminations is within this species' cognitive capacity. Furthermore, there are reasons to think the animals employ metacognitive mechanisms in making these discriminations. This research was approved by the ethics committees for animal experimentation at all participating institutions.

## 12:00 PM Ron Weisman Outstanding Student Presentation Competition: Paper (Chair: Chris Sturdy)

**15**

12:00 PM **Defining reward value by cross-modal scaling**

*Anna H. Casey, Alan Silberberg (American University), Annika Paukner, & Stephen J. Suomi (Eunice Kennedy Shriver National Institute of Child Health and Human Development)*

Researchers in comparative psychology use different food rewards, with food values defined by a pre-experimental preference test. While this technique rank orders food values, it provides limited information about value differences because preferences may reflect the degree to which one good may "substitute" for another (e.g., one food may substitute well for another food, but not for water). We propose scaling the value of food pairs by a third food that is less substitutable for either food offered in preference tests (cross-modal scaling). Here, Cebus monkeys chose between four pairwise alternatives: fruits A versus B; cereal amount X versus fruit A and cereal amount Y versus fruit B where X and Y were adjusted to produce indifference between each cereal amount and each fruit; and cereal amounts X versus Y. When choice was between perfect substitutes (different cereal amounts), preferences were nearly absolute; so too when choice was between close substitutes (fruits); however, when choice was between fruits and cereal amounts, preferences were more modest and less likely due to substitutability. These results suggest that scaling between-good value differences in terms of a third, less-substitutable good may be better than simple preference tests in defining between-good value differences.

**16**

12:07 PM **Neural response to conspecific call notes varies with experience in chickadees**

*Allison H. Hahn (University of Alberta), Lauren M. Guillette (University of St Andrews), Daniel Lee, Neil McMillan, John Hoang, & Christopher B. Sturdy (University of Alberta)*

The chick-a-dee call of black-capped chickadees contains four note types (A, B, C, and D notes). Previous research suggests that D notes identify flock, species, food availability, and predator threat level. Recently, we found similar levels of immediate early gene (IEG) expression in two auditory areas (caudomedial mesopallium, CMM, and caudomedial nidopallium, NCM) of wild-caught black-capped chickadees following presentation of vocalizations with acoustic structure similar to D notes. Here we examine how rearing environment affects IEG response to conspecific D notes. We hand-reared black-capped chickadees: (1) with adult black-capped chickadees, (2) with adult mountain chickadees or (3) without adults. We presented hand-reared birds and a group of wild-caught adult black-capped chickadees (i.e., field-reared) with conspecific D notes and quantified IEG expression in CMM and NCM. We found the lowest expression in birds that were reared in the absence of adults. Our results suggest that for black-capped chickadees, experience with adult conspecifics or closely-related heterospecifics is an important prerequisite for species-typical IEG activation in CMM and NCM.

**17**

12:14 PM **Mirror mirror on the wall, who is the riskiest nutcracker of them all?**

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

The mark test has long been the standard for assessing self-recognition in non-human animals. This procedure has shown that a variety of primate species and other large-brained mammals are able to self-recognize in this context. European magpies have also been shown to pass the mark test provoking the controversial possibility that a mammalian neocortex is not needed for the seemingly complex ability to recognize one's self. However, methodological concerns and differences in species' motivation to respond to and detect the mark have limited the conclusiveness of the mark test. In the current study, we developed an alternative to the mark test by pairing a mirror with an ecologically relevant task. Clark's nutcrackers cached food when alone, with an observer, and with either a clear mirror or a blurry mirror. When compared to caching alone the nutcrackers suppressed their caching in the presence of a conspecific, as well as when in front of a mirror, suggesting no self-recognition. However, the nutcrackers did not suppress their caching with the blurry mirror, indicating that the broad psychological concept of mirror recognition may consist of two componential abilities, use of contingent motion and use of identity information, which may vary across species.

## 12:21 PM Spatial Cognition (Chair: Jonathan Crystal)

**18**

12:21 PM **The influence of familiar panoramic views in mid-scale navigation by pigeons**

*Sebastian Schwarz, & Debbie M Kelly (University of Manitoba)*

Birds are known to rely on terrestrial landmarks for navigation. Landmarks are used to pinpoint goal locations or chart familiar routes. The information from familiar panoramic views, which are usually composed of more than one landmark, is often thought not to be involved in directional guidance but to act as associative cue that triggers the memory of the landmarks. We trained pigeons to a food location that was characterised by a close prominent landmark (beacon) and other distinct and more distant visual objects in a large experimental room. We investigated whether pigeons rely solely on this prominent beacon as visual guidance or whether they also rely on the whole panoramic view. Experimental conditions such as the displacement or removal of the beacon affected the foraging routes of the birds. Certain behaviours appear to be inconsistent with guidance based on the beacon alone and suggest that pigeons may also rely on panoramic views or large parts of their visual field that include both the prominent beacon and the other more distant visual objects.

12:35 PM

**19**

**Interactions between object and location sequence learning in pigeons**

*Julia Schroeder, Dennis Garlick, & Aaron Blaisdell (UCLA)*

Pigeons were trained on an object-location task in which four different objects appeared in four different locations. In group Both (n=3), the objects and locations occurred in a consistent sequence. In group Object (n=3), the objects occurred in a consistent sequence but the locations were randomized. In group Location (n=3), the location sequence was consistent but object order was randomized. In group Neither (n=3), both location and object orders were randomized. During non-reinforced probe trials the object, location, or both were randomized. The Location group had an increase in response time when the sequence of locations was disrupted, while the Object group had minimal disruption. Surprisingly, birds in group Both had large response time costs to disruptions of either object or location sequences, but a smaller cost when both were disrupted concurrently with object-location binding intact. When object-location binding was disrupted, randomizing object and location sequences together increased response times. These results suggest that pigeons encode sequential information and that co-varying object and location information facilitated their perceptual binding.

12:42 PM

**20**

**The influence of landmark number and configuration on spatial search by Clark's nutcrackers (*Nucifraga columbiana*)**

*Debbie M. Kelly (University of Manitoba)*

Clark's nutcrackers use objects within their environment as landmarks to accurately locate previously hidden food-caches. Previous research has shown that nutcrackers have long lasting memories for spatial locations, with individuals recovering thousands of food-caches hidden several months earlier. Our research aims to understand how these birds use landmarks to accurately relocate to goal positions. During the current experiment, four groups of nutcrackers were trained to find food hidden in a large laboratory arena. The food was consistently hidden in relation to a one, two or three landmark array, depending on experimental group. In addition, the shape of the array differed among the four groups. This procedure allowed us to examine whether the number and/or the spatial arrangement of landmarks influenced search accuracy during training. Furthermore, upon completion of training we administered non-rewarded tests in which only one landmark was present, or one of the landmarks in the array was systematically shifted. These tests allowed us to examine whether the birds in each group relied on individual landmarks to a similar degree.

12:49 PM

**21**

**The effect of experience on the reorientation strategies of aged C57BL/6 mice**

*Kevin Leonard, & Debbie M. Kelly (University of Manitoba)*

Geometric (e.g., distance and direction) and featural cues (e.g., colour and texture) within an environment can be used by mobile animals to guide reorientation. Many species studied to date have shown an implicit encoding of geometric cues, even within a feature-rich environment. However, previous research has shown that such encoding can be modulated by age and experience. During the present study, three month old C57BL/6 mice (*Mus musculus*) were trained to search for a hidden platform in one corner of a feature-rich rectangular water maze. After training, transformation tests which manipulated specific properties of the environment were conducted to examine strength of encoding and preference for geometric and featural cues. The same mice were then trained and tested at 15 months to evaluate their retention of spatial knowledge and their ability to recuperate previously learned associations. A matched same-sex sibling was chosen for each of the above mice; these individuals received the same training and testing, only at the age of 15 months. Results show that the presence of uninformative features strongly facilitated reorientation based on geometric cues. Results from between- and within-subject analyses show the relative effects of age and experience on the encoding of environmental cues.

12:56 PM

**22**

**Sex differences in spatial memory in brown-headed cowbirds**

*David F. Sherry, Mélanie F. Guigueno, Danielle A. Snow, & Scott A. MacDougall-Shackleton (University of Western Ontario)*

Brown-headed cowbirds (*Molothrus ater*) are brood parasites. Females, but not males, search for potential host nests in which to lay their eggs. Females have a larger hippocampus, relative to the size of the forebrain, than males do. We tested male and female cowbirds on a spatial working memory task that required birds to remember which of 25 locations in a 1.8 m square array had been most recently baited. Birds were tested with 1 h and 24 h retention intervals in breeding and non-breeding conditions. Both sexes performed better than chance but females made significantly fewer errors than males and took more direct paths to the correct location. There was no effect of retention interval or breeding condition. These results show that female brown-headed cowbirds have better spatial working memory than males when required to return to previously encountered spatial locations – as they do when parasitizing host nests - and that their memory is as accurate after 24 h as after 1 h. Such memory may assist female cowbirds in revisiting nests to determine the stage of host clutch completion, remove host eggs, and lay their own eggs.

**23**

1:10 PM

**Bottlenose dolphin (*Tursiops truncatus*) responses to a novel stimulus**

*Melissa M. Lopes (Rosenstiel School of Marine and Atmospheric Science/Dolphins Plus Oceanside), Jill L. Richardson (Rosenstiel School of Marine and Atmospheric Science/Dolphins Plus Oceanside/Dolphins Plus Bayside), Holli C. Eskelinen (Dolphins Plus Oceanside/Dolphins Plus Bayside), & Stan A. Kuczaj (University of Southern Mississippi)*

Responses to novelty differ among individuals and may be influenced by age, sex, and/or the presence of offspring. In this study, 20 captive Atlantic bottlenose dolphins (*Tursiops truncatus*) were exposed to a large novel object, consisting of PVC pipes and either a matte or reflective surface. The variation and changes in responses to these stimuli were recorded during 10 exposure trials. Adult females were most likely to interact with the object, and females with dependent calves tended to involve their calves in these interactions. Both adults and calves displayed significantly more interactions and more aggressive behaviors when exposed to the reflective surface, demonstrating that the characteristics of the apparatus influenced the response. Although the number of interactions did not change across repeated exposures, there were significantly more aggressive interactions during later exposures. There was no evidence of habituation over time for any of the subjects. These results suggest that marine mammal responses to novel stimuli are affected by the demographics of the population as well as the characteristics of the stimulus, which may contribute to habitation, sensitization, and/or tolerance.

**24**

1:17 PM

**The interaction between working and reference spatial memories in rats on a radial maze**

*Nicole A. Guitar, & William A. Roberts (University of Western Ontario)*

The interaction of reference and working memory was studied in rats through a two-phase procedure. Rats were forced to enter four arms on an eight arm radial maze in a study phase, before choosing among all eight arms in a test phase, with only the previously unvisited arms rewarded. For each rat, two arms on the maze were reference memory arms because they were always rewarded in the test phase, and two arms were randomly varying working memory arms. Rats showed equivalent preference for entering the reference and working memory arms in their first four choices of the test phase. Next, performances at 5-s, 1-hr, and 24-hr retention intervals were compared when reference memory and working memory were congruent and incongruent. Higher accuracy for choice of reference memory arms appeared at the 1-hr and 24-hr retention intervals on congruent tests. A process dissociation procedure indicated that only working memory declined over the 24-hr retention interval. Superior choice of reference memory arms on congruent tests at 1-hr and 24-hr retention intervals, but not at the 5-s retention interval, suggest that working and reference memory are interacting, independent systems that can facilitate and compete with one another.

1:24 PM *Break*

1:29 PM Perception and Attention (Chair: Kimberly Kirkpatrick)

**25**

1:29 PM

**Using audience effect to explore mirror-mediated behavior in chickens**

*Alexis Garland (Ruhr University Bochum), Inga Tiemann, Mareike Fellmin (Bruno-Dürigen Institute), & Onur Güntürkün (Ruhr University Bochum)*

Some bird and mammalian species display an 'audience effect' in the context of either alarm or food calls, where an individual will only make a call if an audience (typically conspecifics) is present. For roosters (male Gallus gallus), this appears to be the case when making alarm calls warning of aerial predators. We discuss evidence gathered from 30 roosters of three different breeds (Breda, Bergischer Kräher, and Rheinländer) that demonstrates a clear audience effect, where individuals are much more likely to alarm call in the presence of either a male or female conspecific (of a same or different breed) rather than when the neighboring arena is empty, or when faced with a mirror. This evidence adds to the recently growing discussion beyond the simple dichotomous interpretation of mirror-mediated behavior, and and begs the question of whether a potential basic 'self-other' distinction exists even in chickens, as they are significantly less likely to alarm call in the visual presence of their reflection as opposed to other conspecifics.

**26**

1:36 PM

**Intra- and inter-octave tests of human and black-capped chickadee octave perception**

*John Hoang, Allison H. Hahn (University of Alberta), Marisa Hoeschele (University of Vienna), Diana Cervantes, Neil McMillan, Jenna V. Congdon, Kimberly A. Campbell (University of Alberta), Ronald G. Weisman (Queen's University), & Christopher B. Sturdy (University of Alberta)*

Pitch perception is mediated by two attributes: pitch height and pitch chroma. These two attributes can be pitted against one another during an octave equivalence task in order to clarify the dominant perceptual mechanism. Pitch chroma mediates the perceptual phenomenon of octave equivalence, which occurs when two acoustic events are perceived as similar because they share the same chroma. Pitch height perception is the perception that a larger difference in frequency leads to a larger difference in perceived pitch. Previous research tested chickadees on a standardized octave equivalence task and suggested that pitch height use by chickadees may have overshadowed their ability to use pitch chroma. To disambiguate this possibility, we presented humans and chickadees with two novel discrimination tasks. Humans and chickadees were trained to discriminate three pairs of notes. After training, both humans and chickadees were presented with novel note pairs with either the same or different pitch chroma. Humans were able to transfer discrimination performance to stimuli with the same pitch chroma whereas preliminary results suggest that chickadees are unable to generalize or transfer the discrimination and suggest that chickadees relied mainly on pitch height to learn the tasks.

27

1:43 PM **Posterior entopallium lesions impair pigeon recognition of static poses and dynamic actions**

*Gabriel R. Rothman, Muhammad A. Qadri, Ashlynn M. Keller, Daniel I. Brooks (Tufts University), Toru Shimizu (University of South Florida), & Robert G. Cook (Tufts University)*

Previous research has suggested a functional division between portions of the pigeon entopallium, with the posterior portion focusing on motion information and the anterior portion focusing on static information. We sought to learn how this functional separation might contribute to the perception of complex actions. We taught six pigeons a conditional go/no-go task in which they learned to identify both static poses and dynamic actions taken from two human behaviors: Indian dance and martial arts. Reinforcement was conditional upon whether a behavior was presented as a static pose or as a dynamic action, requiring the pigeons to attend to both pose and action cues. After learning this conditional discrimination, three pigeons received lesions to the posterior entopallium and three received lesions to the anterior entopallium. The posterior lesion impaired discrimination in both pose and action conditions, and the anterior lesion had little effect on any performance. These results suggest that the functional division in the entopallium is not absolute, and whereas the anterior entopallium may focus primarily on static information, the posterior entopallium likely integrates static information as an inherent component of motion.

28

1:50 PM **An analysis of the Ebbinghaus-Titchener illusion in starlings**

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

Perceptual illusions reflect the contribution of the brain's processing to the final percept of the veridical world. Thus, the comparison of illusory perception across species is an informative method for revealing shared or divergent cognitive processing rules across evolutionary groups. Previous investigations in humans have shown that an irrelevant context of large surrounding inducers reduces the perceived size of a centrally located target, while small context inducers cause the central target to appear larger (the Ebbinghaus-Titchener illusion). Investigations with pigeons and bantams have reported a reversal of this effect in these birds. We replicated the methods of these avian investigations by training five starlings to judge the size of a centrally located circle while ignoring a surrounding inducer context. While the starlings' responses accord well with the previous pigeon and bantam work, further experiments reducing the numbers of inducers and varying inducer distance suggested that the birds may not have been responding exclusively to the size of the central target. This limits the implication of such results on any illusory perception of such stimuli by birds.

29

1:57 PM **Change blindness in pigeons (*Columba livia*): The effects of change salience and timing**

*Walter T Herbranson (Whitman College)*

Change blindness is a well-established phenomenon in humans, in which plainly visible changes may go unnoticed. For example, the difference between two non-identical displays is likely to go unnoticed if separated by a short inter-stimulus interval (ISI). Several factors have consistent effects on change blindness, including the duration of the ISI, and the salience of the change. Recently a parallel change blindness phenomenon has been demonstrated in pigeons. Two experiments follow up on this finding by investigating some of the factors previously demonstrated to influence change blindness in humans. Birds viewed alternating displays of randomly generated lines, with one or more line features differing between consecutive displays. Pecks to the location of the difference were reinforced at the completion of each trial. Change salience was manipulated by varying the number of line features that changed. In a separate experiment, durations of line displays and ISIs were systematically manipulated. Results indicated that change blindness is reduced if a change is made more salient, and / or if the ISI is shorter. These findings indicate that the change blindness effects seen in pigeons and humans are at this point strikingly parallel.

2:11 PM *Snack Break*

2:45 PM Communication (Chair: Stan Kuczaj)

30

2:45 PM **Vocal and neural responses of chickadees to conspecific and heterospecific calls**

*Christopher B. Sturdy, Allison H. Hahn, Daniel Lee, Neil McMillan, & John Hoang (University of Alberta)*

Black-capped and mountain chickadees are closely-related songbird species that both produce the namesake chick-a-dee call. The call is comprised of high-frequency A, A/B, B, or C notes (termed the chick-a portion) and broadband D or D-hybrid notes (termed the dee portion). The dee portion of the chick-a-dee call contains more species-typical information compared to the introductory chick-a portion; however, birds can identify the species of the producer using any of these note-types. We examined how phylogenetic relatedness affects vocal and neural responses (i.e., immediate early gene activation). We presented black-capped and mountain chickadees with the chick-a portion of calls produced by three chickadee species (black-capped, mountain, or boreal) or calls produced by gray-crowned rosy-finches (a more distantly-related songbird species) such that the vocalizations heard during playback varied by phylogenetic relatedness. Birds vocalized more in response to playback of calls produced by closely-related species, with the most vocalizations produced in response to conspecific calls. Our results add to a growing number of studies contrasting the effects of phylogeny versus acoustic structure on songbird behavioral and neural responses.

2:59 PM **Getting the baby: How a dolphin mother calls her wandering calf**

*Kelly Jaakkola, Loriel Keaton, Linda Erb, & Emily Guarino (Dolphin Research Center)*

**31**

Dolphin signature whistles (i.e., individually-distinctive whistles with unique frequency contours) allow mothers and calves to keep in acoustic contact and find each other after a separation. But exactly how this system works is not yet clear. In this study, we repeatedly asked a dolphin mother to Go Get (i.e., retrieve) her 3-month-old baby or Go Get another object, while we recorded any sounds. Results showed: (1) significantly more whistles overall in the Get-the-Baby condition, and (2) one particular distinctive whistle contour was made significantly more often than any other whistle contour in the Get-the-Baby condition. This suggests the mother was producing a signature whistle, but was it her contour or her calf's? Further testing revealed that she produced this same whistle contour when asked to whistle on signal, as well as spontaneously after completing a requested behavior correctly. This study represents a first of its kind in that it: (a) experimentally introduced a context that reliably elicited a signature whistle in a free-swimming dolphin, and (b) showed that a mother dolphin produces her own signature whistle when intending to reunite with a wandering calf.

3:13 PM **Chickadee behavioural response to varying threat levels of predator and conspecific calls**

*Jenna V. Congdon, Allison H. Hahn, Neil McMillan, Marc T. Avey, & Christopher B. Sturdy (University of Alberta)*

**32**

Chickadees produce many vocalizations, including the chick-a-dee call that they use as a mobbing call in the presence of predators. Previous research has shown that chickadees produce more D notes in their mobbing calls in response to high-threat predators compared to low-threat predators, and may perceive predator and corresponding mobbing vocalizations as similar. We presented black-capped chickadees with playback of high- and low-threat predator calls and conspecific mobbing calls to examine vocal and movement behaviours. Our preliminary results suggest that movement decreased in response to high-threat predator calls, but movement increased in response to high-threat mobbing calls. Food and water visits decreased during playback of both high-threat predator and high-threat mobbing calls. Preliminary data suggests that chickadees vocalized less in response to a high-threat predator compared to baseline, and vocalized more in response to mobbing calls compared to baseline, regardless of threat level. Chickadees also produced more D notes in response to high-threat mobbing calls compared to low-threat mobbing calls. Our results suggest that chickadees may vocalize less as a way of avoiding attention from a potential predator, while they may be vocalizing more to help initiate mobbing with conspecifics.

3:20 PM **Disambiguating the ambiguous: Do chimpanzees use perspective-taking to resolve referential ambiguity?**

*R. W. Lurz (Brooklyn College (CUNY)), C. Krachun (Memorial University), J. L. Russell, & W. D. Hopkins (Georgia State University/ Yerkes National Primate Research Center)*

**33**

Recent studies show that adults (Hanna & Brennan, 2007) and children (Nadig & Sedivy, 2002) use perspective-taking to resolve referential ambiguity. Little is known about the evolutionary origins of this strategy to settle ambiguity in communicative contexts. To investigate this question, we tested a lexigram-trained chimpanzee on a modified 'director task.' The subject initially learned to identify objects in an array that a director requested by name (e.g., "point to the straw"). In the experimental test, two of the objects in the array were duplicates (e.g., two straws), and one of them was hidden from the director's line of sight behind an opaque occluder. In the control test, a transparent occluder replaced the opaque occluder. In both tests, the director asked the subject to point to the duplicate object (e.g., "point to the straw"). The subject pointed to the non-occluded object significantly more than chance in the experimental test but not in the control test, suggesting it used what the director could see in the experimental test to determine the referent of the ambiguous request. We are currently carrying out the study with additional apes. This research was approved by the ethics committees for animal experimentation at participating institutions.

## 3:34 PM Numerosity (Chair: Tammy McKenzie)

3:34 PM **Tests of quantity discrimination by the Clark's nutcracker (*Nucifraga columbiana*) using computer generated displays of items.**

*Rikki Miller, Lindsay Michaud, & Brett Gibson (University of New Hampshire)*

**34**

We examined number discrimination in the Clark's nutcracker (*Nucifraga columbiana*), a corvid bird with a strong dependence upon caching and recovering nuts. We presented the birds with two sets of virtual nuts on a computer screen; the birds were required to peck one of two sets on the display that had the larger number of nuts. We initially compared the ability of the birds to discriminate two sets of nuts with up to 10 items per set (e.g., Set 1: 8 nuts vs. Set 2: 10 nuts). The birds rapidly acquired these discriminations and sustained at high level of performance. In a subsequent study we present the birds with the same task except that each set could contain up to 30 items (e.g., Set 1: 22 nuts vs. Set 2 : 28 nuts). Like other animals tested previously, the nutcrackers' performance decreased somewhat as the ratio of the two quantities approached one. The volume or surface area of the display did not appear to account for their discriminative ability. These birds may have developed a keen ability to discriminate quantity as an adaptive specialization to cope with their unique ecological pressures.

3:41 PM **The influence of representational format on quantity discrimination in apes and new world monkeys**

*Regina Paxton Gazes (Bucknell University Zoo Atlanta), Vanessa Schmitt (Zoo Heidelberg and the Center for Organismal Studies at University of Heidelberg Zoo Atlanta), Alison R. Billas (Bucknell University), Julia Fischer (Cognitive Ethology Lab at the German Primate Center), & Tara S. Stoinski (Dian Fossey Gorilla Fund International Zoo Atlanta)*

**35** Non-human primates regularly solve quantity discrimination tasks, but performance differs across species as well as within species across studies. These discrepancies may indicate differences in ability between species or populations, or may stem from subtle methodological differences in stimulus presentation. For example, old world monkeys perform more poorly when discriminating between quantities of food than when discriminating between inedible items that stand in for quantities of food (Schmitt & Fischer, 2011). We determined the effects of the representational format of choice stimuli on performance in a two choice quantity discrimination task by members of two ape (Pongo & Gorilla) and two new world monkey (Cebus & Saimiri) genera. Primates chose between quantities of items presented in three formats: Edible (choice between quantities of food), Inedible (choice between quantities of pebbles that stood in for quantities of food), and Edible-Replacement (choice between quantities of food that stood in for a different set of identical food items). We determined the contributions of both stimulus type (food vs. non-food) and format (directly received vs. stand in for food) to performance by each of the four species. The implications of the results for comparative studies of quantitative abilities across primate will be discussed.

3:55 PM **Representation of number by a spider-eating spider**

*Fiona Cross, & Robert Jackson (University of Canterbury)*

**36** Observations in the field suggest that *Portia africana*, a salticid spider, often follows a pre-planned detouring path while attending to the number, locations and identities of other spiders in a web. These observations are the rationale for new experiments by which we investigate the capacity of Portia to represent number as part of a specialised predatory strategy. In these experiments, Portia first views a scene consisting of a particular number of prey items, and the only way Portia can reach these prey is by taking a detour. While detouring, the scene goes out of view and then, when Portia reaches the top of a viewing tower, the scene is in view again. When the number of prey seen from the top of the viewing tower differs from the number initially seen (e.g. if Portia sees 4 prey before initiating a detour but sees 2 at the end), Portia hesitates longer before completing the final leg of the path to the prey. However, there was no significant hesitation when it was prey size or arrangement, but not number, that changed.

4:09 PM *Break*

4:14 PM Temporal Processing (Chair: Heather Hill)

4:14 PM **Interval timing and overshadowing in domestic dogs**

*Krista Macpherson, & William A. Roberts (University of Western Ontario)*

**37** Interval timing is an important skill that allows animals to approximate how much time has elapsed since a given event. Little, however, is known about interval timing in domestic dogs. A bi-section task was used in which dogs had to learn to approach one feeder when given an 8 second signal, and another feeder when given a 2 second signal. The signal had both visual (white light) and auditory (a tone) properties. Dogs were then tested with probe trials of intermediate duration (3s-7s). The light-tone compound was ultimately dissociated, such that the dogs received only the light or the tone stimulus. Psychophysical curves were obtained which showed control of discriminative responding by the tone, but not by the light. Thus, the tone stimulus overshadowed the light stimulus.

4:21 PM **Testing preference for rhythmic vs. arrhythmic stimuli in humans and budgerigars**

*Marisa Hoeschele, & Daniel L Bowling (University of Vienna)*

**38** Rhythm is a fundamental aspect of music at the core of all musical systems. Recently it has been shown that some members of the parrot family have the ability to entrain to a musical beat. But do these species prefer stimuli with a clear beat-like structure? We built two-sided place preference environments for humans and budgerigars and presented rhythmic stimuli on one side and arrhythmic stimuli on the other. While humans consistently preferred rhythmic stimuli, budgerigars did not show similar preferences. Our goal is to examine these differences with respect to the biological relevance of rhythmic and arrhythmic patterns for each species in order to further our understanding of the biological origins of rhythm.

4:35 PM **Temporal structure is key to midsession reversal performance in pigeons and chickadees**

*Neil McMillan, Marcia L. Spetch, Jeffrey M. Pisklak, Allison H. Hahn, John Hoang, Jenna V. Congdon, Kimberly A. Campbell, & Christopher B. Sturdy (University of Alberta)*

**39** It has been shown previously that some animals make surprising anticipatory errors on tasks in which contingencies of reinforcement reverse midway through each session. We trained pigeons (*Columba livia*) on a variant of the midsession reversal procedure with the first-correct stimulus for each session varied randomly across sessions. We also trained black-capped chickadees (*Poecile atricapillus*) with constant back-to-back midsession reversal sessions. Even though both procedures maintained the basic temporal regularities of previous midsession reversal tasks, the subjects did not show anticipatory responding in either of these procedures. The overarching temporal structure of the session appears to be an important determinant for animals' use of time on these reversal tasks.

4:49 PM **And keeps on ticking: internal and external cue use by pigeons in midsession reversal learning**
*Rebecca M. Rayburn-Reeves, Daniel I. Brooks, Muhammad A. Qadri, Ashlynn M. Keller, & Robert G. Cook (Tufts University)*

**40**

In a midsession reversal task, subjects choose between two stimuli, with one stimulus reinforced for the first half of a session and the other for the second half. In this paradigm, subjects can use two reliable sources of information: internal cues, such as time-based estimation, and external cues, such as the presence or absence of reinforcement. Interestingly, pigeons sub-optimally use time estimation, foregoing the more efficient reinforcement cue. To test another type of external cue, we first trained pigeons on a midsession reversal task, then introduced alternating sessions in which different color cues during the inter-trial intervals were presented before (blue) and after (yellow) the reversal point. Results showed that pigeons used both color and timing cues when available. We then introduced non-differentially reinforced probe trials around the reversal point where we either removed the cue in otherwise cued sessions or added the cue in otherwise un-cued sessions. Tests revealed that the color cues overshadowed the timing cues when in conflict, but did not reset or alter the clock time. These results suggest that, regardless of whether external cues are used as a basis of behavioral control in midsession reversals, the pigeons' clock continuously, and independently, updates.

5:03 PM **Temporal integration requires continuous influence**
*Matthew Matell, Thomas Kerrigan, & Benjamin DeCorte (Villanova University)*

**41**

Previous research in our lab has demonstrated that rats simultaneously presented with two different cues, signaling two different intervals until reinforcement availability, will respond in a scalar manner at an intermediate duration. In order to examine whether this temporal memory integration occurred at trial onset or required ongoing influence of the two cues, in the present study we included cut-off trials in which the simultaneous compound stimulus abruptly changed to one of the component stimuli after two seconds. Replicating past work, rats (n=10) trained that tone and light signal reinforcement availability at 4s and 12s, respectively, responded in a roughly scalar manner at 8.8s to the simultaneous compound presented in extinction. In contrast, on light cut-off trials in which the compound stimulus switched to a tone after 2s, the rats responded two seconds earlier, peaking at 6.9s. On tone cut-off trials, in which the compound stimulus switched to a light after 2s, the rats responded three seconds later, peaking at 11.6s. These data suggest that the process used by rats to respond on compound trials requires a continuous influence of the two stimuli, rather than the fixed formation of an integrated temporal expectation.

5:17 PM **Exploration of joint stimulus control on a timing task**
*Carlos Pinto, & Armando Machado (University of Minho)*

**42**

Pigeons were trained on a temporal discrimination task: On each trial, in a dark box a white key light (sample) was presented and pigeons were trained to choose a red key after a 2-s light and a green key after a 6-s or an 18-s light. Between trials, there was an intertrial interval (ITI) illuminated with a houselight. Although the pigeons only needed to attend to the sample (white key light) duration to learn the task, the ITI (houselight) could also have been used to distinguish between trials: If the houselight was presented very recently choose red; otherwise choose green. To evaluate the individual influences of the white key light and the houselight, we conducted two tests. Firstly, the ITI was darkened; secondly, no sample was presented. Results of both tests suggest that the pigeons' responses were under control of both the houselight (ITI) and the white key light (sample). These results stress the importance of taking into account all discriminative stimuli available to an animal when trying to understand its behavior.

## 8:00 PM Ron Weisman Memorial Celebration

Ron Weisman (September 14, 1937 - January 27, 2015) is recognized as cofounder of the Conference on Comparative Cognition as well as cofounder and co-editor of our organization's journal, *Comparative Cognition & Behavioral Reviews*. Ron loved the beach and a good party, so we will honor Ron's memory by a social gathering at the Radisson pool and on the beach just below. A few friends and colleagues will say a few words in Ron's honor.

Both the inside bar and the pool bar will be available for purchasing refreshments. In the event of bad weather, the memorial celebration will be held in the Manatee Room.

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

See Poster Abstracts Starting on Page 23

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

# Friday Morning

## 10:30 AM CO3 Mentoring Program II: Post-graduate Prep (Chair: Ken Leising)

Do you have questions about the process of obtaining a post-doc or full-time position in an academic or other setting (e.g., zoo)? An informal meet and greet will be held in the Manatee room to provide undergraduate and graduate students with an opportunity to chat with recent Ph.D. graduates that have obtained post-graduate positions. One post-graduate mentor will be seated at each of six tables. You are encouraged to come and go from table to table to get to know different mentors. Feel free to ask the mentors questions about the dissertation process, searching for post-graduate positions, the interview process, or post-doc or faculty life. A poster identifying each mentor and pertinent academic information will be displayed at the entrance to the Manatee room. This session will end promptly at 11:30.

# Friday Afternoon

## 12:00 PM Social Learning (Chair: Suzanne MacDonald)

12:00 PM **Social learning in nest building zebra finches**

*Lauren M. Guillette (University of St Andrews), Alice C. Y. Scott, & Susan D. Healy (University of St Andrews)*

**43**

Recent research from our laboratory suggests that decisions made by birds when nest building are more flexible and experience dependent than is typically thought. To date, this work has been addressed at elucidating the role of individual learning in nest building. It is not clear, however, whether social learning plays a role in nest building. We will describe an experiment in which we tested whether zebra finches learn about nest material from conspecifics. We first assessed the preferences of pair-bonded zebra finches (the observers) without experience of nest building for building material of one colour or another. These birds then observed a second pair (the demonstrators) building a partial nest using the observers' least-preferred colour. To assess whether the social demonstration of nest building with the observers' least-preferred colour altered the observers' preference for material of that colour, we tested the observers' material preference a second time. We found that some of the observers did, indeed, switch their nest material preference to the material they had not preferred initially. It appears, then, that naive birds can use social information when learning what material they should use to build their nest.

12:14 PM **I am plastic: Zebrafish behavioral flexibility as a function of social context**

*Noam Miller (Wilfrid Laurier University), Olivia Guayasamin (Princeton University), & Iain Couzin (Princeton University)*

**44**

Recently there has been a lot of interest in animal 'personalities' (also called behavioral syndromes), individual differences in behavior that are consistent across multiple contexts. For group-living species, the key context is the social one which, in species that form fission-fusion groups, is constantly changing. Members of such groups might therefore benefit from being able to adapt their 'personality' to their current social context. We demonstrate several features of such behavioral flexibility across social contexts using pairs of zebrafish exploring a large novel tank. We show that there are individual differences in plasticity which correlate with 'personality' such that more exploratory fish are less plastic. We suggest that, from an adaptive perspective, creating and maintaining a stable, dynamic social context, robust to frequent changes in group membership, is what plasticity in personality is for.

12:28 PM **Investigating the neural basis of emotional reactivity to familiar human faces in working dogs using fMRI**

*Andie Thompkins, Lucia Lazarowski, Tuo Shi, John Paul Anglin, Sinan Zhao, Pradyumna Lanka, Paul Waggoner, Ronald Beyers (Auburn University), Lizzie Benecke (iK9 LLC), Thomas S. Denney, Gopikrishna Deshpande, & Jeffrey Katz (Auburn University)*

**45**

The bond between humans and dogs is one of rich history and ever-increasing investigation in the comparative cognition literature. Given the unique co-evolutionary relationship between dogs and humans, we sought to investigate the neural underpinnings of the emotional reactivity to familiar human faces in working dogs using functional magnetic resonance imaging (fMRI). In this experiment, domestic working dogs were trained, using reinforcement learning, to lie motionless and awake during fMRI (Jia et al., 2014). The dogs were trained to attend to projected images and videos of faces that varied in emotional valence and familiarity. In the still images task, dogs were presented with human and dog faces with corresponding scrambled images serving as a control condition. The human faces presented were counterbalanced across familiarity (familiar trainers and unfamiliar individuals) and emotion (angry, neutral, and happy). In the videos task, dogs were presented with human faces expressing commands related to anger, neutral affect, and happiness. The fMRI activation results indicate that the amygdala showed increased response to familiar compared to unfamiliar faces, as well as higher activation for angry/happy faces compared to neutral faces.

12:35 PM **Experimental evidence of contagious yawning in budgerigars (Melopsittacus undulatus)**

*Andrew C. Gallup, Janine Militello, Serena Sackett, & Lexington Swartwood (State University of New York at Oneonta)*

**46** Unlike spontaneous yawning, which has been observed across vertebrates, contagious yawning has only been documented in a few selected mammalian species. Since contagious yawning has been linked with empathy, experimentally demonstrating the presence of this behavior in a laboratory animal could be important for exploring basic questions related to this capacity. Here we report on an experiment testing whether yawning is contagious in a social parrot, the budgerigar (*Melopsittacus undulatus*). A total of 16 captive birds were tested in this study using a repeated measures design. Based on previous research on great apes, pairs of familiar and unfamiliar birds were tested together to also assess whether there was an ingroup bias in this response. Results show that yawning was indeed socially contagious, with individual birds being significantly more likely to yawn after witnessing a yawn in the matched pair. There was no evidence for an ingroup bias, however, as contagious yawns were equally common for familiar and unfamiliar pairings. This is the first experimental evidence of contagious yawning in a non-mammalian species, and future research will begin to utilize these birds as a model for studying basic forms of empathic processing.

12:49 PM **Behavioral correlates of personality in Asian (*Elephas maximus*) elephants**

*Radhika N. Makecha (Eastern Kentucky University), Lauren Highfill (Eckerd College), Otto Fad (Busch Gardens (Tampa), & Stan A. Kuczaj II (FL))*

**47** Animal personality continues to piqué the interest of researchers, and it appears that such individual differences affect cognitive performance, exploratory behavior, play and group dynamics. We report on the personality and behavior of six Asian elephants housed at Busch Gardens in Tampa, Florida. Personality was assessed using human ratings designed in accordance with the five-factor model of personality (OCEAN) and each elephant's behavioral profile was compared to its personality profile. The results revealed that the behaviors that each elephant tended to engage in the most related to the personality traits they were rated highest on.

1:03 PM *Break*

1:13 PM Auditory Discrimination (Chair: David Stahlman)

1:13 PM **Recognition of frequency modulated whistle-like sounds by human listeners and a bottlenose dolphin (*Tursiops truncatus*)**

*Caroline M. DeLong, Brandon Dziedzic (Rochester Institute of Technology), Brian Branstetter, Amy Black, & Kimberly Bakhtiari (National Marine Mammal Foundation)*

**48** Bottlenose dolphins use the frequency contour of whistles produced by conspecifics for individual recognition. A bottlenose dolphin and 30 human participants performed an object discrimination task to investigate the ability to recognize whistle-like sounds that have been transformed in amplitude, duration, and frequency. The dolphin was first trained to match three objects to three different whistle-like sounds. In the test, the sounds were transformed by amplitude, duration, or frequency transposition while still preserving the frequency contour of each sound. The human participants completed the same task using the same sounds, objects, and training and testing procedures. The dolphin's ability to correctly match objects to sounds was robust to changes in amplitude with only a minor decrement in performance for short durations. The dolphin failed to recognize sounds that were frequency transposed by plus or minus one-half octave. Human listeners demonstrated robust recognition with all acoustic transformations. The results indicate that this dolphin's acoustic recognition of whistle like sounds was constrained by absolute pitch. Unlike human speech, which varies considerably in average frequency, signature whistles are relatively stable in frequency, which may have selected for a whistle recognition system invariant to frequency transposition.

1:27 PM **Attention to acoustic features in a spatial task**

*Madeleine Brodbeck, & Laurie Bloomfield (Algoma University)*

**49** Many species can use geometric information to find a target. The 4 corners in a rectangular environment provide geometric information (e.g., location of short wall vs. long wall) which birds have been shown to utilize to find a baited corner. Visual features, if attended to, can provide supplemental information regarding target location. In the current study, we asked whether black-capped chickadees could learn to associate not a visual feature, but rather an acoustic feature, with a geometrically correct corner. Chick-a-dee call A was presented during 4-perch training when corner 1 (or geometrically correct corner 3) was baited and chick-a-dee call B was presented when corner 2 (or 4) was baited. Following training, birds were presented with 1 of 10 different test stimuli each day to determine whether birds attend to the note-type repetitions or to the specific voice when attending to the call. Preliminary results will be discussed.

1:34 PM **Auditory object perception in a sequential auditory same-different discrimination in pigeons**

*Ashlynn M. Keller, Muhammad A.J. Qadri, Daniel I. Brooks, & Robert G. Cook (Tufts University)*

**50**

Auditory scene analysis suggests that humans identify sounds and separate them from background noise to form perceptual auditory "objects." Previous studies suggest that pigeons also create these auditory objects when making similarity judgments about sequences of tones, chords, and various complex sounds. One useful test of object perception is scrambling, in which equivalent local features are reorganized to disrupt the global object. To understand the global organization present in each perceived auditory object, we divided each of the well-trained complex sounds into six temporally equivalent elements, which were then re-ordered to create a set of scrambled sounds. When we tested same and different sequences using various combinations of these scrambled sounds, we found no effect of temporal reorganization at the object level, revealing little attention to the global auditory objects and more attention paid to the local auditory elements. These data suggest a fundamental difference between the way pigeons and humans perceive the psychological structure of auditory units.

1:48 PM *Break*

1:53 PM Memory (Chair: Jeff Katz)

1:53 PM **Animal models of episodic memory**

*Jonathon D. Crystal (Indiana University)*

**51**

The proposal that nonhumans and humans have similar episodic-memory systems has long been controversial. Alternative explanations of putative episodic-memory performance is a significant threat to the hypothesis that nonhumans remember episodes. Converging lines of evidence are needed to evaluate an animal model of episodic memory because any one approach is likely characterized by strengths and weaknesses. Several lines of evidence permit evaluation of the suitability of rats as an animal model of episodic memory. I review four lines of evidence, including studies which suggest that: Rats remember the time at which an earlier event occurred (what-where-when memory); rats remember the source by which they acquired information about an event (what-where-source memory); rats bind multiple features of similar events to disambiguate multiple episodic memories (context-what-where-source memory); and rats use memory of an event to answer an unexpected question. These four lines of behavioral evidence, together with studies that temporarily inactivated the hippocampus, suggest that rats represent a promising animal model of episodic memory. This research suggests that rats have detailed memories of earlier events, episodic memory is evolutionarily quite old, and rats may be used to model fundamental aspects of human memory.

2:18 PM **Validation of pharmacotherapies with limited cognitive side effects**

*Alexandra E. Smith, Yvonne Y. Lai (Indiana University), Ganesh Thakur (Northeastern University), Andrea G. Hohmann, & Jonathon D. Crystal (Indiana University)*

**52**

A major barrier to deployment of pharmacotherapies includes debilitating cognitive impairments. For example, NMDARs are largely considered therapeutically untargetable because blockade of these receptors produces both motor and memory impairment. Consequently, drug discovery efforts have been directed toward the development of small molecules that impact the signaling cascade downstream of these receptor sites by targeting protein-protein interactions. We developed IC87201, the first inhibitor of the protein-protein interactions between the enzyme neuronal nitric oxide synthase and the scaffolding protein postsynaptic density 95 kDA (PSD95) that tethers nNOS to the NMDAR signaling complex. Here, we used a source-memory preparation to assess potential cognitive impairments on spatial memory and source memory associated with blockade of NMDAR (using MK801) and blockade of nNOS-PSD95 protein-protein interactions (using IC87201). MK801, at doses that did not impair motor function, preferentially impaired source memory over spatial memory. These observations suggest that source memory is more vulnerable than spatial memory to impairment. IC87201, at doses that are effective in suppressing pain behavior, spared source memory, spatial memory, and motor function. These results lend support to the translational value of animal models of episodic memory for validation of pharmacotherapies with limited cognitive side effects.

2:25 PM **Lateral and frontal long-term memory for simple and complex visual stimuli**

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

**53**

Birds have two foveae in each eye, which creates separate frontal and lateral visual fields. Previous research only found transfer from the lateral to the frontal fields, and none from the frontal to the lateral. Our research has found the first evidence of frontal-to-lateral transfer, using an item-memorization task with picture stimuli. In the current study, we replicated a previous intraocular transfer study using simple color stimuli to test whether our results were due to a difference in methodology, or whether transfer depends on the level of processing.

2:32 PM **Influence of oxytocin on cognitive bias in rats**

*Molly McGuire, Jennifer Vonk, Keith Williams, & Lisa Welling (Oakland University)*

**54** Previous research has suggested that the affective states of animals induced by exposure to different external manipulations influences the way they judge ambiguous stimuli – known as cognitive bias. We investigated the effects of oxytocin, on cognitive bias in rats in a modified CPP paradigm. 15 male rats were trained to discriminate between two different cue combinations, one rewarded with palatable foods - the other with unpalatable food. Their reactions to two ambiguous cue combinations were then evaluated, and their latency to contact the goal pot recorded. Rats were injected with either oxytocin, or saline with the prediction that the rats in the oxytocin treatment group would display a shorter average latency to approach on ambiguous trials. There was no significant difference between latencies to approach on ambiguous trials compared to reward trials but the rats approached significantly more slowly on the aversive compared to the ambiguous conditions. There was no effect of OT on approach time, and no interaction with cue type; however, it was unclear, after follow-up testing, whether the oxytocin dosages tested were sufficient to produce the desired effects on cognitive bias.

2:39 PM **Task complexity elicits stronger lateralization in spider monkeys (*Ateles fusciceps rufiventris*)**

*Emily R. Boeving, & Eliza L. Nelson (Florida International University)*

**55** The coordinated bimanual TUBE task is used to measure handedness in nonhuman primates and involves holding a tube with one hand while removing food with the other hand. The TUBE task is thought to elicit manual asymmetries because subjects often use a single digit to perform the task. The spider monkey is a unique model for examining this hypothesis because the hand has been described as hook-like. Previously, we found spider monkeys could perform the TUBE task with a large diameter tube by inserting multiple fingers. We predicted that decreasing the tube diameter would increase the expression of handedness. Contrary to traditional views of limited dexterity in the spider monkey, preliminary analyses found that monkeys use a single digit 89.6% (SD=0.13) of the time on the smaller diameter tube. We computed individual preference scores and compared the two diameters. Six monkeys who were strongly lateralized on the large diameter tube remained strongly lateralized on the small diameter tube with a mean change score of 0.01 (SD=0.04). Three monkeys who exhibited weak to moderate preferences on the large diameter tube were strongly lateralized on the small diameter tube with a mean change score of 0.52 (SD=0.14), supporting our prediction.

2:46 PM **Implications of retrospective revaluation for models of learning and memory; Contributions by Wasserman and others**

*Ralph R. Miller (SUNY - Binghamton)*

**56** Students of animal learning and behavioral neuroscience (in contrast to students of cognition) have long focused almost exclusively on acquisition during training, and minimized the roles of retrieval and response generation at test. The discovery and later confirmation of retrospective revaluation (Kaufman & Bolles, 1981) across many tasks and species eventually forced reconsideration of this blind spot. Different accounts of retrospective revaluation, including that of E.A. Wasserman, will be presented, categorized by the different roles played by retrieval in producing the phenomenon, and assessed in light of existing data. Proper explanation of retrospective revaluation has important implications going far beyond retrospective revaluation per se, as it helps us differentiate between conventional models of learning that assume animals encode only summary statistics (i.e., current values of associations) and instance theories (i.e., memories of large numbers of specific prior events). How these two broad positions map into modern thinking in neuroscience and human/animal cognition will be reviewed, with an emphasis on their implications for learning mechanisms dependent on total error reduction (e.g., Rescorla & Wagner; Sutton & Barto) as opposed to older Hebbian (e.g., Bush & Mosteller) mechanisms.

3:11 PM *Snack Break*

4:00 PM In Honor of the Contributions of Ed Wasserman (Chair: Mike Young)

4:00 PM **Selective attention and attentional shifts in pigeons' categorization learning**

*Leyre Castro (University of Iowa)*

**57** Attention has conventionally been *inferred* after learning has occurred rather than *measured while* learning is taking place. Here, we gave pigeons a categorization task during which we monitored their choice accuracy as well as the location of their pecks to both relevant and irrelevant attributes of the training stimuli (Experiment 1). As categorization accuracy rose, pigeons increasingly pecked the relevant attributes of the stimuli, suggesting that the birds were tracking the relevant information to solve the task. In Experiment 2, the relevant features could be either perfect or imperfect predictors of the category. Results disclosed an attentional preference for the perfect rather than the imperfect relevant features, as well as higher accuracy when the perfect relevant features were attended. Overall, our findings are best explained by theories which propose that attention is learned and deployed to those features that prove to be reliable predictors of the correct categorization response (e.g., George & Pearce, 2012; Kruschke, 2001; Mackintosh, 1975).

4:15 PM **What do animals see in invisible areas?**

*Yasuo Nagasaka (Eli Lilly Japan)*

**58** Our visual world is filled with objects that are partly obscured by other objects. However, we can easily recognize the occluded objects by integrating visible parts and interpolating invisible areas. This visual function called 'amodal completion' was studied in several nonhuman animal species as well as in humans. In this talk, the animal studies for amodal completion, especially our several attempts in pigeons, monkeys, and bonobos will be discussed. The procedures used in our studies were broad; the same procedure was used between pigeons and bonobos, and some procedures was responsive to amodal completion in our pigeons, but others were not. Comparing and exploring these results will discuss our understanding of visual perception as well as amodal completion in pigeons.

4:30 PM **Categorical learning by Clark's nutcrackers (*Nucifraga columbiana*): The role of display variability.**

*Brett Gibson (University of New Hampshire)*

**59** Wasserman and colleagues have examined a variety of non-human animals and people on tests of abstract conceptualization involving displays of 16 items on a computer monitor (e.g., Wasserman, Hugart, & Kirkpatrick-Steger, 1995). Participants (human and non-human) are required to discriminate displays of 16 items that are all identical (Same) from displays that have mixtures of items (Different). Past work has indicated that pigeons and people are both proficient in classifying these displays, but may spontaneously do so using different information. Most people make the discrimination categorically; that is, when any of the 16 items is dissimilar from the others they classify the display as being different (Young and Wasserman, 2001). In contrast, pigeons tend to make more "different" classifications as the variability in the Different displays increases (Young and Wasserman, 1997, but see Young & Wasserman, 2002). Corvid birds have displayed an impressive array of cognitive abilities that have been compared to those of non-human primates (e.g., Emery & Clayton, 2004). In the current study we examined whether Clark's nutcrackers discriminate Same-Different displays of 16 items categorically (like people) or primarily using display variability (like pigeons).

4:45 PM **Mechanisms of impulsive choice: III. The role of reward processes**

*Kimberly Kirkpatrick, & Andrew T. Marshall (Kansas State University)*

**60** Two experiments examined the relationship between reward magnitude sensitivity and impulsive choice. In Experiment 1, rats chose between a smaller-sooner (SS) reward (1 pellet, 10s) and a larger-later (LL) reward (1, 2, and 4 pellets, 30s). They then experienced concurrent random-interval 30-s schedules with variations in reward magnitude to evaluate reward magnitude sensitivity, followed by a satiety-specific devaluation task. LL choice behavior positively correlated with reward magnitude sensitivity, which was positively correlated with differential reward devaluation. In Experiment 2, rats chose between an SS reward (1 pellet, 10s) and an LL reward (2 and 4 pellets, 30s). Rats then received either concurrent fixed-ratio schedules associated with different magnitudes to attempt to improve reward magnitude sensitivity, or a control task. All rats then experienced a post-intervention impulsive choice task followed by a reward magnitude challenge task. The rats that received the intervention behaved more optimally in the reward magnitude challenge task, suggesting that the intervention heightened sensitivities to changing reward magnitudes. The results suggest that reward magnitude sensitivity may play a key role in individual differences in impulsive choice, and that improving reward sensitivity may optimize behavior within dynamic choice environments.

5:00 PM **Change detection in pigeons: Entropy instead of binding**

*Olga F. Lazareva (Drake University)*

**61** We trained pigeons to discriminate whether two successive displays containing four differently colored bars at four different orientations were same or different. Different-trial displays were always distinguished by change along three dimensions (color, orientation, and location) in all four items. Pigeons learned this change-no change discrimination to high levels of accuracy. In the first series of tests, one attribute (color, orientation, or location) or two attributes (color and location, color and orientation, or location and orientation) were changed in the second display. The results of these two tests indicated that location was the most salient feature and that orientation was the least salient feature; moreover, changes in two features produced more "different" responses than changes in single features. In the second series of tests, we conducted a series of tests where different-trial displays did not contain new values of the three attributes; instead, the values of the attributes were swapped among the objects. The results disclosed no evidence of feature binding. Finally, in the third series of tests we manipulated the number of bars on the display. Pigeons' behavior again showed no evidence of binding and revealed control by overall entropy of the display.

5:15 PM **The problem with categorical thinking by psychologists**

*Michael E. Young (Kansas State University)*

**62** When designing experiments, psychologists often sample two values along a continuum (e.g., low/high, short/long, slow/fast). This approach has multiple benefits – simplicity in implementation, conformity to analysis by ANOVA, high power when linearity is assumed, and ease of interpretation. However, the approach also has a significant drawback because it assumes that the relationship is linear and thus cannot identify nonlinearities between a predictor and an outcome. I will examine data in which sampling along a continuum provided key insights, from understanding stimulus entropy to causal delays and discounting.

5:55 PM Introduction - Olga Lazareva

6:00 PM Master Lecture - Categorization in pigeons: The evolution of a paradigm - Ed Wasserman

7:30 PM Banquet

- Includes announcement of the Ron Weisman Outstanding Student Presentation Award: Poster/Paper.

# Saturday Afternoon

## 12:00 PM Business Meeting of the Comparative Cognition Society

## 1:10 PM Group Photo Shoot

## 1:30 PM Choice (Chair: Debbie Kelly)

1:30 PM **63**

**Mechanisms of impulsive choice: IV. Individual differences in timing and reward processes**

*Catherine C. Hill, & Kimberly Kirkpatrick (Kansas State University)*

The present experiment investigated how individual differences in timing and reward processing influence impulsive choice. Rats received two sets of tests, one focused on interval timing and the other focused on reward processing, to determine the relationship between behavior in these tasks and impulsive choice behavior. For assessing temporal processing, rats were tested on an impulsive choice task that manipulated the smaller-sooner (SS) delay. They were then tested on a bisection task in which they were trained to discriminate between a 4s and 12s light stimulus, and then tested with intermediate durations. For assessing reward processing, rats were tested on an impulsive choice task that manipulated the larger-later (LL) reward magnitude. They were then tested on a reward sensitivity task that consisted of concurrent variable-interval 30 schedules of reinforcement where the reward magnitude for one lever was manipulated. Both reward sensitivity and interval timing were associated with impulsive choice behavior, but the order of delivery of the procedures affected the inter-task correlations. The results suggest that interval timing and reward processing are critical factors driving impulsive choice behavior, but that carryover between procedures may influence the relationship between these phenomena.

1:37 PM **64**

**When is less better than more?**

*Jacob Case, Jasmine Luong, & Thomas Zentall (University of Kentucky)*

Recent research has tested the ability of animals to acquire what appears to be a relatively simple discrimination. Animals are presented with two disks, for example, one black the other white. On each disk is a similar piece of food. The animals are allowed to choose between them. If they choose the food on the black disc, for example, they can also have the food on the white disk. But if they choose the food on the white disk, the black disk and its food are removed. Thus, it would be optimal to choose the black disk. Others have found that adult wrasse fish and grey parrots quickly learn to choose optimally but several species of primates do not. Surprisingly, pigeons tend to choose suboptimally (significantly below chance).

1:44 PM **65**

**A time-based intervention to promote self-control in middle-aged rats**

*Jennifer R. Peterson, & Kimberly Kirkpatrick (Kansas State University)*

Impulsive choice has been posited as a trait behavior due to the expression of stability over time. Stable levels of impulsive choice have been found in rats, and individual differences that were evident in a young sample of rats were stable at middle-age. It has also been suggested that older rats become more self-controlled, but less flexible in choice behavior. Time-based interventions have been implemented in young rats that show improvements in impulsive choice and timing after treatment. The current study examined the effectiveness of a time-based intervention on impulsive choice and timing in experienced, middle-aged rats (15 months). Rats were evaluated using an impulsive choice procedure pre- and post- intervention. The treatment group underwent a variable interval (VI) procedure, while the control group experienced an equivalent environmental context. Both groups then completed a temporal bisection test to examine response timing. Middle-aged rats were more likely to make larger-later choices after the VI intervention compared to no treatment controls of the same age and also compared to the pre-intervention choices. In addition, the most impulsive rats benefited most from treatment. These findings suggest that time-based intervention strategies can be successful in middle-aged rats.

1:58 PM **66**

**The role of "bad news" in suboptimal choice in pigeons**

*Inês Fortes, Marco Vasconcelos, & Armando Machado (University of Minho)*

When choosing between delayed rewards, pigeons prefer an option that immediately signals whether food will be delivered ("good news") or not ("bad news") over an option that does not signal whether or not food will be delivered (noninformative option). Moreover, this preference occurs even when the probability of reinforcement in the "bad/good news" option is substantially lower than that in the noninformative option. In two experiments, we tested the hypothesis that suboptimal choice occurs because, when computing the reinforcement rate associated with the "bad/good news" option, pigeons ignore the time spent in the presence of "bad news". In the first experiment we varied systematically the probability of the "bad news" stimulus. In the second experiment, the duration of the "bad news" stimuli increased with every choice of the "bad/good news" option (titration procedure). The results show that pigeons are relatively insensitive to the probability and duration of a discriminative stimulus for no food.

2:05 PM

**67**

**Investigating the effects of applied learning principles on the "create" response in Atlantic bottlenose dolphins (*Tursiops truncatus*)**

*Mary K. Lawrence (Rosenstiel School of Marine and Atmospheric Science/Dolphins Plus Oceanside), Jill L. Borger-Turner (Rosenstiel School of Marine and Atmospheric Science/Dolphins Plus Oceanside/Dolphins Plus Bayside), Holli C. Eskelinen (Dolphins Plus Oceanside/Dolphins Plus Bayside), & Ted N. Turner (Rosenstiel School of Marine and Atmospheric Science/Dolphins Plus Bayside)*

The create SD elicits the performance of any behavior in a non-specific, non-repeat contingency and, as such, involves a choice response on the part of the animal. The goal of this study was to identify the influence of Reinforcement Theory, response class, and primacy and recency on the create responses of three Atlantic bottlenose dolphins (*Tursiops truncatus*). Two-months of training sessions (i.e. "Pre-Assessment", PA), followed by create requests (i.e. "Create Assessment", CA, n=119), were recorded in double blind trials, and each behavior was identified by reinforcement frequency, type, magnitude, and response class. When asked to produce a behavior of their choice, the dolphins elected to produce behaviors predominantly associated with the CA context versus the PA, which demonstrates the effect of primacy versus recency on the choice response. Additionally, since a repeat was the only "incorrect" response in a series of repeated cues, the CA was associated with reinforcement on a high frequency and high magnitude, fixed, low ratio schedule (i.e. FR1), supporting the influence of Reinforcement Theory on the responses of the three subjects. Thus, the create response was, in part, explained by the learning theories examined, indicating that the animals' choices were not arbitrary but influenced by learning.

2:12 PM

**68**

**Acquisition of categorization of light-sound compounds by pigeons**

*Sheila Chase (Hunter College)*

Generalization tests show that pigeons optimize the use of information provided by compounds of light and sound intensities. Pigeons were trained from the start of acquisition with pairs of light-sound intensities that varied across an 8 X 8 matrix in which the softer and dimmer stimuli were correct for one response and the louder and brighter stimuli for the other. Computer simulations showed performance to represent a gradual approach to optimal use of the information--division of the decision space by a diagonal line that maximized the probability of the making the correct choice.

2:19 PM

**69**

**Midsession shifts in reward probability and the control of behavioral variability**

*W. David Stahlman (University of Mary Washington), & Kenneth J. Leising (Texas Christian University)*

Pigeons engage in suboptimal choice in a two-choice task when the rewarded behavioral option predictably shifts at the midpoint of experimental sessions. Pigeons both prematurely anticipate the response shift and to perseverate on a no-longer rewarded response. We conducted two experiments to examine whether the spatial variability with which pigeons respond in an operant task shows similar patterns. In Experiment 1, we trained six pigeons to peck at a disc on a touchscreen to obtain grain; three of the animals received alternating sessions of high and low reward probability, while the other birds received alternating sessions in which reward probability was shifted at the midpoint of the session. In Experiment 2, we trained six pigeons on a similar task, but with the addition of a discriminative color cue that indicated reinforcement probabilities. We found little evidence for anticipatory errors in either experiment. We found that the birds exhibited perseveration of variability only when no discrete discriminative cue was available. For most birds, color exhibited control of spatiotemporal behavioral variability when it reliably signaled reward probability. We discuss results with respect to a comparative perspective and outline future avenues for research in this domain.

2:33 PM *Break*

## 2:38 PM Cognitive Processes (Chair: Matthew Matell)

2:38 PM

**70**

**Effects of variation of inter-signal-intervals (ISI) on 3-choice serial reaction time (SRT) performance in rats: Deliberative vs automated pattern processing**

*Kaitlyn Iannicello,, Janice Burgers, & Jerry Cohen (University of Windsor)*

Previous research from our laboratory presented earlier showed that rats incidentally acquired response patterns in a 3-choice serial reaction time (SRT) task. In the current experiment we examine the effect of varying the inter-signal intervals within each successively presented lit key on such incidental response pattern performance. One group of rats acquired this task with fixed 250ms inter-signal intervals (Fixed ISI group) while the other group was exposed to inter-signal intervals that varied between 50ms and 500ms (Varied ISI group). We examine data to determine if acquisition of the fixed pattern of 3-choicie SRT differed between groups and if each group showed different effects on occasional probe sequences that violated the trained pattern that continued to occur over regular sequences. Findings from these differences suggest that the Fixed ISI group developed an automated process of responding while the Varied ISI group used a more deliberative process.

2:45 PM **The influence of object familiarity and discriminability on echoic effort**

*Katherine T. Newton, Heidi E. Harley (New College of Florida), Wendi Fellner (Disney's Epcot's The Seas), Diana Ward (New College of Florida), & Barbara Losch (Disney's Epcot's The Seas)*

**71** Dolphins gain information through echolocation, an active sensory system in which they produce clicks to investigate objects. Hence, we can record and analyze clicks to determine the echoic effort dolphins expend to recognize objects. Here we studied a dolphin's echoic investigations across object familiarity and discriminability by recording clicks of a blindfolded dolphin investigating a sample object in an MTS task in which objects were unfamiliar in the first session but familiar by the fifth session. In addition, performance accuracy across object sets varied (44% to 100%) suggesting differences in discriminability of sets. The dolphin produced significantly fewer clicks in fifth sessions with easy objects (M=162.81, SD=68.01) versus in first sessions with the same objects (M=214.78, SD=74.84). Similarly, he spent less time echolocating under these conditions (session 5: M=4.31s, SD=1.6s; session 1: M=5.13s, SD=1.84s). In contrast, click production (session 5: M=236.94, SD=76.11; session 1: M=225.37, SD=142.74) and echolocation time (session 5: M=5.13s, SD=1.57s; session 1: M=4.65s, SD=3.14s) did not change significantly across sessions with difficult objects. Overall, these data suggest dolphins reduce echoic effort when they recognize objects and use both working (within trials) and reference (across sessions) memory to perform these tasks.

2:59 PM **Serial reversal learning in grey squirrels (*Sciurus carolinensis*): learning efficiency as a function of learning, flexible tactic use, and memory retention.**

*Pizza K. Y. Chow (University of Exeter), Lisa A. Leaver (University of Exeter), Ming Wang (Penn State College of Medicine), & Stephen E. G. Lea (University of Exeter)*

**72** Learning, particularly learning to be flexible, allows animals to adapt the changing environment and to tackle the same change more efficiently with experience. Although learning process unavoidably leads to time and energy costs, learning to use a relevant tactic may increase learning efficiency. We examined this relationship in a serial spatial reversal task with five grey squirrels. Squirrels completed 11 reversal phases with a poke box in which two out of four possible reward locations were baited diagonally. Instead of searching food locations in clockwise or anti-clockwise direction (sequential search tactic), an efficient tactic is to associate locations that are in a particular spatial relationship (an integrative search tactic) and apply this rule under varying reinforcement contingencies. Results showed that all the squirrels formed a learning set. Four out of five individuals gradually employed fewer sequential and more integrative search tactics in relocating the hidden food within and between phases, though sequential tactic was used in the first trial of each phase. GEE models showed that learning efficiency required learning and less proactive interference. Tactic changes across phases improved memory retention, which in turn improved learning efficiency. These results provide evidence for the advantages of learning to be flexible.

3:06 PM **Cognitive processes in a stop-signal paradigm**

*Christina Meier, Stephen Lea, & Ian McLaren (University of Exeter)*

**73** To respond flexibly to a changing environment, individuals sometimes have to inhibit the execution of an anticipated behaviour, which requires cognitive control. In humans, this inhibition is investigated in stop paradigms, and results in worse performance on trials in which the sudden appearance of a 'stop signal' orders participants to inhibit the behaviour they initially prepared to give in response to a presented stimulus compared to trials in which no signal appears and participants respond normally to the stimulus. But does performance in a stop paradigm indeed rely on cognitive control, or can it be explained by associative processes? To investigate this, we developed a stop task for pigeons, who presumably do not possess cognitive control. In Study 1, the sudden appearance of a signal ordered subjects to withhold the response to a stimulus (stop-signal paradigm), while in Study 2, the signal indicated that a different behaviour had to be performed (stop-change paradigm). Humans generally face more performance costs in the latter paradigm, presumably because humans have to firstly inhibit a response and then prepare the alternative behaviour. We find that pigeons have difficulties in suppressing a response entirely, but show similar performance patterns to humans when changing their behaviour.

3:13 PM *Snack Break*

## 4:00 PM Concept Learning (Chair: Olga Lazareva)

4:00 PM **Methodology matters in comparative psychology**

*Heidi Lyn (University of Southern Mississippi)*

**74** The comparative method is particularly vulnerable to methodological and interpretive flaws. Although many of the species studied are morphologically and/or cognitively similar to humans, they are often tested with distinctly different methodologies, even when not compelled by morphological differences (see Lyn et al., 2013, for discussion). We know from studies of both human children and nonhumans that even minor changes in physical context can lead to large changes in response characteristics (e.g. Leavens, Bard, & Hopkins, 2010; Lyn et al., 2013). Although it may seem that these problems are self-correcting, they can lead to many years and many dollars wasted on incorrect interpretations of differences between species that will not further our understanding of the evolution of cognition or language. Examples from our data suggest that: with a minor methodological re-design, apes can indicate absent objects - a finding directly in conflict with a recent paper, but more in line with over 40 years of experimental work on ape communication. Similarly, in the case of the dogs, extremely minor methodological changes again result in distinct responses, but it is highly unlikely that any of these differences point to differential cognitive abilities of the species.

4:14 PM

**Pigeons' selective attention to spatial frequency bands: Effects of category vs. single stimulus training and of chromaticity of stimuli**

*Stephen E. G. Lea, Chloe Angwin, Thomas D. S. Seaman, & Sophie C. Edwards (University of Exeter)*

**75**

In several situations, pigeons are more likely than humans to respond to the details of a visual stimulus rather than its overall shape. A possible explanation is that pigeons' visual systems are more sensitive than humans' to higher spatial frequencies. However, in direct tests of this hypothesis using generalisation to band-pass spatial-frequency filtered and hybrid stimuli following training in a category discrimination between cat and dog faces, we found the reverse effect (Lea et al., 2013, JEPABP). Two experiments tested the generality of this result. First, we compared generalisation to band-pass and hybrid stimuli following either category or single-stimulus discrimination training. We expected that category training would favour holistic stimulus processing and hence preferential attention to low spatial frequencies, but if anything control by low spatial frequencies was stronger following single stimulus training. Secondly, we compared generalisation following training with coloured and monochrome stimuli. Colour is better preserved by low- than high-pass filtering, and accordingly we found that the preferential attention to low spatial frequencies was less following monochrome training. However, when pigeons initially trained with coloured stimuli were retrained with monochrome stimuli, they retained their preferential attention to low spatial frequencies.

4:28 PM

**Information seeking in non-human primates and pre-school children: Domain-specific metacognition?**

*Heidi L. Marsh, & William A. Roberts (University of Western Ontario)*

**76**

A popular method in metacognitive research is to examine whether individuals actively control their knowledge states by seeking information selectively, rather than indiscriminately, when faced with a problem. In the present research lion-tailed macaques, capuchins, and pre-school aged children were tested with a task in which a reward was hidden in one of several objects. Sometimes the location of the reward was shown to subjects, sometimes its location could be inferred using exclusion, and sometimes no information was given. In all cases, subjects could peek inside the objects to gather information about the reward's location before making a response. The results suggest that rudimentary forms of metacognition may exist in monkeys and 3-4-year-old children, in which metacognitive access is available for some forms of information (i.e., perceptual) but not others (i.e., cognitively derived). These results differ from behaviour seen in 5-year-old children as well as in great apes, and dovetail with other evidence in young children that shows they attribute sources of knowledge differently depending on whether the information is gathered visually or derived cognitively. Thus, these results suggest metacognition may emerge in a domain-specific fashion, and may also represent a possible divergence within the primate order.

4:42 PM

**Analogical reasoning in juvenile amazons**

*Tatyana Obozova, Anna Smirnova, & Zoya Zorina (Lomonosov Moscow State University)*

**77**

Two juvenile orange-winged amazons (*Amazona amazonica*) were trained to match stimuli by color, shape, and number of items, but not size. They needed a total of 1152 and 1876 training trials before the testing began. After learning these various IMTS tasks, the parrots transferred discriminative responding to new stimuli from the same categories that were used in training (another colors, shapes and number of items) as well as to stimuli from an different category (stimuli varying in size). In the final testing, both parrots spontaneously exhibited relational matching-to-sample behavior: they were able to perceive the relationship between items in the sample stimulus pair and match this relation to that between items in the comparison stimulus pair (same size, same shape and same color between items). They made 70,8% and 80,2% correct choices (same size), 77,0% and 75,0% correct choices (same shape) and 71,9% and 69,8% correct choices (same color) over 96 relational trials.

4:49 PM

**Absence of abstract relational learning in a same/different discrimination with small number of training stimuli in rats**

*Makiko Kamijo, & Tohru Taniuchi (Kanazawa University)*

**78**

Four Long-Evans rats were trained to discriminate same/different relationships of stimulus sets of pictorial stimuli in a conditional place discrimination task. Same-sets consisted of two identical pictures (AA, BB, and so on), while different-sets consisted of two different pictures (AB, BA, so on). A rectangular discrimination box was divided into two compartments by a central partition with a guillotine door. LCD displays were attached on both sides of the box and presented identical stimulus sets. Staying either to the left or right side was assigned as a correct response for same- and different-sets. Rats could explore both sides of the compartments freely for 60 s. Food reward was presented if rats stayed in the correct side at the end of the trial. Training stimuli were increased gradually and transfer tests with novel stimuli were conducted each time rats attained the learning criterion. Rats could acquire the task consisting of up to four stimuli but showed chance performance to novel test sets. These results suggest that rats learn some kind of non-conceptual stimulus-specific cue after training with a small variation of stimuli. We will report the result of the transfer tests after training with a larger variety of stimuli.

4:56 PM **Configurations in a midsession reversal task are encoded with time**

*Thomas Daniel (Auburn University), Robert Cook (Tufts University), & Jeffrey Katz (Auburn University)*

**79**

In midsession reversal tasks that switch contingencies from matching to nonmatching, pigeon behavior is controlled by temporal factors. Specifically, discrimination behavior shifts gradually with time from matching to nonmatching. The current study examined whether pigeons could simultaneously learn matching and nonmatching and apply both concepts. Pigeons were trained on a match-to-sample (MTS) task featuring a midsession reversal to non-MTS halfway through the session. After reaching performance criterion, the training set was doubled from 3 to 6 to 12 items. Abstract-concept learning was tested with novel items at the beginning and end of a testing session. In addition, two groups were formed based on prior abstract-concept learning experience: matching and nonmatching concept groups. While there were initial differences in acquisition during the 3-item set, groups did not show a difference on later set-sizes. Prior experience affected transfer accuracy, and the matching concept group transferred to novel items in the first half of the session, whereas the nonmatching concept group transferred in the second half. Hence, when novel configurations were presented, pigeons relied on their prior learning (i.e., renewal; Bouton, 2004) because these configurations had not been encoded within the midsession reversal time-course.

5:03 PM **Same/different discrimination of dynamic dot fields by pigeons**

*Daniel I. Brooks, Muhammad A. Qadri, Kate B. Williams, & Robert G. Cook (Tufts University)*

**80**

In order to investigate temporal grouping and motion perception, we asked pigeons to extract conceptual same/different relationships from a sequence of dynamic dot fields that varied in the two dimensions of motion rate and motion direction. To do this, we used a go/no-go procedure in which "same" sequences were reinforced and "different" sequences were not. When we examined differential pecking behavior across the duration of each trial, we found that peck rates rapidly diverged for same and different sequences. Tests with sequences that varied along only one dimension demonstrated attention to both features, though birds showed generally more sensitivity to direction than to rate. When we progressively reduced the number of moving objects in each dot field, birds required more time to identify the conceptual relationships. The current experiment provides strong evidence that birds can make conceptual judgments about a sequence of dynamic features. This provides a useful paradigm with which we are able to investigate the perceptual similarities between the various kinds of motion information in dynamic stimuli.

5:17 PM **Determinants of abstract concept learning: Social complexity and cache reliance**

*John Magnotti (UT Medical School), Kevin Leonard, Alizée Vernouillet (University of Manitoba), Jeffrey Katz (Auburn University), Anthony Wright (UT Medical School), & Debbie Kelly (University of Manitoba)*

**81**

A wealth of research assessing same/different (S/D) abstract-concept learning has shown that the number of training exemplars is a critical variable controlling abstract concept learning. We have previously followed a general process approach to show qualitative similarities between a range of species, including rhesus monkeys, capuchin monkeys, pigeons, and Clark's nutcrackers. In this study, we examined 4 more closely related species—Clark's nutcrackers, magpies, pinyon jays, and scrub jays—to understand how adaptive specializations contribute to quantitative differences in the use of abstract concepts. These birds can be arranged according to both relative social complexity and relative reliance on caching for food (Bond, Wei, & Kamil, 2010), allowing us to independently assess these variables. All birds were trained using the same 8-item S/D procedure. We compared transfer performance on novel items across species and related it to sociality and cache reliance. We found that neither high caching reliance nor high social complexity was necessary for abstract concept learning. Within-species differences were also found, suggesting that a full understanding of abstract concept formation will require not only studying a larger number of species with specific specializations, but also a large number of members within each species.

5:31 PM Closing Remarks (Debbie Kelly)

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

See Poster Abstracts Starting on Page 30

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

# Posters

## Poster Session I - Thursday Evening

**Appetitive Pavlovian conditioning in Japanese fire belly newts**

*Tohru Taniuchi (Kanazawa University)*

**P1** The present study examined appetitive Pavlovian conditioning in Japanese fire belly newts. Male newts were housed individually in an alley-like water cage that had a middle dark place with an opaque ceiling and bright areas at both ends with transparent ceilings. An object stimulus was presented as the CS for 5 min in one end and then a food US was presented in the opposite end. One trial was given per day. 24 trials were conducted. The US was presented immediately after the CS in Experimental group whereas the Control group received the US the next day. Reliable sign tracking to the CS developed in the Experimental group but not in Control group. The goal tracking response, however, did not develop in either of these groups. In Experiment 2, CS pre-exposure effect (latent inhibition) was examined. In the Experimental group, the CS was presented 10 times per day without the US for seven days prior to conditioning. The control group did not receive CS pre-exposure. During conditioning trials, both groups significantly developed a sign-tracking response to the CS object but retardation of conditioning by CS pre-exposure was not observed.

**What can ball play tell us about dolphins' understanding of human attention?**

*Stan Kuczaj (University of Southern Mississippi), Deirdre Yeater (Sacred Heart University), & Lauren Highfill (Eckerd College)*

**P2** Understanding the perception of conspecifics can provide valuable information for social interactions. Some species may also use their understanding of others' attentional state to guide their interactions with members of other species. For example, dogs are more likely to disobey a command when their human owner is not looking at them or is engaged in a distracting activity. In the present study, we tested whether four captive dolphins would modify their ball tossing behavior depending on if a human playmate was facing toward or away from the subject. Two of the subjects were much more likely to toss the ball when the human was facing them. The attentional state of the human also affected how hard the dolphins threw the ball and the body part of the human at which the ball toss was directed. For example, one dolphin was more likely to gently toss the ball when the human was facing her, but more likely to throw the ball hard when the human was facing away. These results demonstrate that dolphin interactions are influenced by human attentional state. However, it is unclear what cues dolphins use to assess human attention.

**Sex-specific acoustic features contained in the black-capped chickadee (*Poecile atricapillus*) chick-a-dee call**

*Kimberley A. Campbell, Allison H. Hahn, Jenna V. Congdon, & Christopher B. Sturdy (University of Alberta)*

**P3** The chick-a-dee call of the black-capped chickadee (*Poecile atricapillus*), which is composed of four main note types (A, B, C, and D), contains information regarding individual identity, flock membership, and species of the caller. Acoustic features indicating sex of the caller have been identified in the chick-a-dee calls of other species, but not in black-capped chickadee calls. Here we investigated ten acoustic features in black-capped chickadee calls including frequency, duration, and amplitude measurements. Using permuted discriminant function analyses, these features were examined to determine which feature, or combination of features, could be used to identify the sex of the caller. Preliminary results indicate that duration measures in C notes vary by sex. In addition, while most descriptions of black-capped chickadee calls do not discuss D-hybrid notes, we found that the majority of birds in our sample produced D-hybrid notes and the total duration of D-hybrid notes varies by sex. Previous studies have indicated sex-specific acoustic features in other black-capped chickadee vocalizations and our results suggest that there are also acoustic features within chick-a-dee calls that birds could use to distinguish male and female callers.

**Turtle toys: Familiar and novel environmental enrichment for captive female adult loggerhead sea turtles (*Caretta caretta*)**

*Caitlin Golder (Drake University)*

**P4** Environmental enrichment can be extremely beneficial in that it provides mental and physical stimulation and reduces prevalence of stereotyped behaviors in captive animals. Such enrichment has been studied extensively for many different species of mammals and birds, but less is known about environmental enrichment for reptiles. The goal of this study was to test the effect of novel and familiar Environmental Enrichment Devices (EEDs) on the behavior of two female loggerhead captive sea turtles. The turtles were presented with two familiar EEDs and two novel EEDs, one of which was floating and one was sinking. Each EED was placed in the tank a total of two times, and behaviors were recorded once every minute for 30 minutes. The results indicated that turtles interacted more with novel EEDs on the first trial. On the second trial, turtles showed no preference for novel or familiar EEDs. Overall, this result indicates that captive loggerhead sea turtles can discriminate between and are more attracted to novel objects in comparison to familiar objects.

**The Near-Hit Effect in Pigeons**

*Amanda Duncan, Jacob Case, & Thomas Zentall (University of Kentucky)*

**P5** In most gambling tasks such as a lottery or slot machine, a near hit encourages further play by creating an illusion the player is close to winning. In a slot machine, all three slots must display the same image, indicating a win. During trial, the first two slots may display similar symbols indicating a potential win or near hit, creating a feeling of excitement until the third and final symbol differs, indicating a loss. When the near hit occurs, players often experience negative emotions such as anger or frustration. However, players may also feel encouraged to continue gambling, believing the chances of winning have increased because they came closer to winning. It is as though they have had an influence on the outcome of the game. When pigeons were given a similar gambling task with a choice between an alternative that contained near-hit outcomes and an alternative that did not, contrary to humans, the pigeons had a strong preference for the absence of near-hit outcomes. It appears that pigeons do not develop the same illusion of control as humans do and the near-hit outcome actually decreases the value of a win.

**The Effect of Dominance on Risky and Impulsive Choice**

*Jeremy R. Lott, Jennifer R. Peterson, & Kimberly Kirkpatrick (Kansas State University)*

**P6** Standard pair-housing conditions for male rats most likely produces alterations in behavior due to the emergence of social relationships. Research has shown that a dominant/subordinate relationship forms in paired-housing conditions, and dominant rats have increased risky decision making. In this experiment, the effects of dominant/subordinate relationships on impulsive and risky choice were explored. In the impulsive choice task, the rats chose between a smaller sooner (SS) reward and a larger later (LL) reward. In the risky choice task, the rats chose either a certain-smaller (C-S) reward or an uncertain-larger (U-L) reward. Dominance was assessed by a tube test by counting the number of times a rat was able to force the other rat backwards out of the tube. Dominance, as assessed by winning in the tube test, was a significant predictor of impulsive choice. If dominant behavior is magnified by housing conditions, and dominant behavior, impulsive, and risky choice are related, then living conditions could increase the expression of certain behavioral traits in rats.

**Individual differences in impulsivity and behavioral flexibility: Effects of early rearing environment**

*Andrew T. Marshall (Kansas State University), Zhe Wang (University of Rochester), & Kimberly Kirkpatrick (Kansas State University)*

**P7** The early rearing environment (presence of conspecifics, novel objects) influences impulsive behaviors, while potentially more broadly impacting the adaptability of behavior (behavioral flexibility) in rats. The goal of the present study was to investigate how social and novelty enrichment in rearing environments moderated individual differences in impulsive choice, impulsive action, and behavioral flexibility. Twenty-four rats were reared in an isolated condition (IC), an isolated condition with a novel object (IC+), a pair-housed social condition (SC), or a pair-housed social condition with a novel object (SC+). In the impulsive choice task, the rats chose between a smaller-sooner (SS) reward (1 pellet; 10 s) and a larger-later (LL) reward (1, 2, or 3 pellets; 30 s). Rats then experienced a visual cue discrimination followed by a response discrimination set-shift to assess behavioral flexibility. Finally, they were tested with a differential reinforcement of low rate (DRL) task to assess impulsive action. The social and novelty rearing manipulations moderated the relationships between DRL task efficiency, impulsive choice task adaptability, and overall behavioral flexibility task performance. These results advance our understanding of the impact of distinct mechanisms within the rearing environment on the different aspects of and relationships between behavioral flexibility and impulsivity.

**Space-based representation of an acquired sequence in rhesus macaques**

*Ikuma Adachi (Kyoto University), & Robert Hampton (Emory University)*

**P8** There have been many reports of space-based representation of numbers and serial order in humans. Here, to explore evolutionary origins of such representations, we examined whether rhesus macaques map an acquired sequence onto space. The subjects were trained to perform a number sequence task in which they touched a sequence of "small" to "large" Arabic numerals presented in random locations. After they had acquired the task, probe trials were interspersed with trained baseline trials. On half of the probe trials 1 was located to the left of 5, whereas on the other half 1 was to the right to 5. On average monkeys responded more quickly when 1 was on the left of the 5 compared to the other way around. This result suggests that rhesus monkeys, like humans, spontaneously novel sequences onto space.

**Modified Two-Choice Hidden Food Task with Blue Jays Using Human Gesture and Gaze Information**

*Jonathan Nerdig, Rachel Rem, Allison Bird, Kyrie Dailey, & Kristy Gould (Luther College)*

**P9** Past research presented at CO3 (Gould et al. 2013) explored the ability of blue jays to utilize human gesture and gaze information to locate hidden food. In the previous study, difficulties arose habituating the birds to the presence of the human experimenter. The purpose of this study was to develop a modified procedure that would reduce the birds' anxiety around the experimenter and in turn lead to better results. One major modification was the way in which the birds made their choices, which reduced the amount of human interaction. In the experiment, two dishes were presented, one with food underneath. The birds would choose a dish based on the experimenter touching, pointing at, or gazing at the baited dish. There was also a control trial in which no gesture or gaze information was given. Two birds showed a significantly greater proportion of correct responses when compared to chance (bird 1: touch, point and gaze; bird 2: point). When compared to control, three birds did (bird 2: touch, bird 3: point, bird 4: gaze). We concluded that the modifications made to the experimental procedure were partially successful in improving the ability of the birds to use gesture and gaze information.

**Bottlenose dolphin (*Tursiops truncatus*) vocalizations during a cooperative task**

*Kelley Winship (University of Southern Mississippi), Brittany Jones (Dolphins Plus), Audra Ames (University of Southern Mississippi), Holli Eskelinen (Dolphins Plus), & Stan Kuczaj (University of Southern Mississippi)*

**P10** Although many species have proven capable of cooperating to achieve common goals, the role of communication in cooperation has received relatively little attention, despite its importance. Analysis of communication between partners is vital in determining whether actions are cooperative rather than serendipitous or learned via trial and error (Chalmeau and Gallo 1996). Wild cetaceans often produce sounds while cooperating in foraging, play and mating contexts, but the role of these sounds in cooperative events is largely unknown. Here we investigated acoustic communication between two male bottlenose dolphins while they cooperatively opened a container (Kuczaj, Winship, and Eskelinen, 2014). Analyses of whistles, burst pulses, and whistle squawks that occurred during four conditions (i.e., no container, no animals interacting with container, one animal interacting with container, and two animals interacting with container) revealed that overall sound production rate significantly increased during container interactions. Sound production rates were also significantly higher during cooperative successes than during solo successes, suggesting that the coordination of efforts rather than the apparatus itself was responsible for the phonation increase. The most common sound type during cooperative successes was burst pulse signals, similar to those found during cooperative herding by male bottlenose dolphins (Connor and Smolker, 2004).

**Evidence for human-like conversational strategies in an African grey parrot's speech**

*Erin N. Colbert-White (University of Puget Sound)*

**P11** Given the many similarities between human and parrot vocalization development, the purpose of this case study was to assess the extent to which a speech-using parrot might exhibit socially-learned features of human communicative competence (i.e., knowing what to say and how given a particular social context). Linguistic analysis of 16 hours of video footage of one African Grey parrot (*Psittacus erithacus*) and her female caregiver indicated (1) the parrot's vocal turn-taking behavior is qualitatively and quantitatively similar to that of a human; (2) the parrot may strategically modify her vocalization volume to accommodate for distance; and (3) the parrot responds differently when her requests (e.g., "Wanna peanut?") are ignored versus denied by her caregiver. Taken together, the findings illustrate the depth and specificity with which parrots attend to social partners as they not only learn the vocalizations of their flock, but also how to use them.

**Social status and signaling in tree squirrels**

*Aaron Teixeira, Esther Chung, Mikel Delgado, & Lucia Jacobs (University of California at Berkeley)*

**P12** The tail flag in the tree squirrel is a known alarm signal, and the determinants of the squirrels' social dominance hierarchy, such as sex and age, are well understood. However, little is known about how subordinate and dominant squirrels communicate with each other, or how tail flagging is used in a social context, particularly in the absence of a predator. We created a limited food resource, by presenting a food tray containing 50 peanuts, in an area with 18 free ranging fox squirrels on a university campus. We observed the squirrels' interactions until the food source was depleted. Dominant individuals were identified using both a percentile rank formula and a linear method. We used video coding to quantify approach/avoidance behaviors such as chasing, fleeing, and fighting. We also noted which squirrels controlled the feeding resource and the amount of food items retrieved by each subject. To understand the role of communication in social dominance we recorded several communicative behaviors, such as tail flagging, tail flicking, staring and foot stomping. We anticipate that the results will illuminate more about the squirrels' social system, and how they use tail flagging in different contexts.

**Effects of partner familiarity on conversational style in signed-interactions with chimpanzees**

*Susan Ann Keenan, & Mary Lee Jensvold (Central Washington University)*

**P13** Chimpanzees that use signs of American Sign Language (ASL) sign to friends and strangers, both human and nonhuman. Previous studies indicate that human dyads match aspects of their conversational styles. Signed conversations between four chimpanzees and 43 human interlocutors within a 4-minute trial were analyzed for their style including lexical diversity. Twenty-two of the human interlocutors were familiar to the chimpanzees, 21 were strangers, and all had basic or more knowledge of ASL. Overall, familiar signers used more vocabulary and had more conversations than unfamiliar signers. Only one chimpanzee, Loulis, participated in enough trials to be compared to the human participants. Novel signers and Loulis matched their mean length of utterances and their total number of signs. Loulis used the same lexicon for both conditions, however he repeated himself more with strangers than familiars. Familiar signers but not strangers matched lexical diversity with Loulis. Because familiar signers increased both their vocabulary items and total number of signs, they matched Loulis' diversity.

**Olfactory matching- and non-matching-to-sample in rats**

*Ashley Prichard, Katherine Dyer, Tiffany Phasukkan, Catharine Nealley, Michael Mathews, Alyssa Cawley, Katrina Gobenciong, Irene Fobe, Danielle Panoz-Brown, Erin Lackey, Mark Galizio, & Kate Bruce (UNC Wilmington)*

**P14** The ability to differentiate whether stimuli are the same (identity) or different (oddity) has been said to be the most fundamental abstract concept. There is evidence for such concept learning in nonhumans including apes, monkeys, sea lions and pigeons. Research with rodents has generally been less successful, but recent work from our laboratory has shown matching and non-matching to sample in rats using manually-presented odor stimuli. The present study was an effort to replicate these findings using a computer-controlled olfactometer apparatus. Rats were trained on successive conditional discrimination procedures (Go-No-Go) under matching or non-matching-to-sample contingencies with four different odor stimuli. When accuracy criteria were met, a different set of four odor stimuli was introduced, either under the same or reversed contingencies. Rats developed high levels of accuracy on both matching and non-matching contingencies and most showed evidence of transfer when novel stimuli were introduced. High levels of transfer are particularly noteworthy given the relatively few trained exemplars that preceded exposure to novel stimuli.

**Learning concepts: One step at a time**

*Victor Navarro, Edward Wasserman (University of Iowa), & Richard Levenson (University of California: Davis)*

**P15** Four pigeons were trained on 24 individual problems to categorize diverse images of malignant and benign human breast cancer tissue in a two-alternative forced-choice task. Each problem involved one malignant and one benign image, and was given daily until the bird achieved criterion (85% correct to each image) before advancing to the next problem. We used choice accuracy in the first 16 trials for the first day of each problem as a measure of immediate transfer between problems. We found that two of the birds increased their immediate transfer scores as a function of the number of previously learned problems, documenting effective inter-problem learning; additionally, curve estimation revealed a quadratic component in the cumulative number of successful transfers across problems for these two birds. In a subsequent test, all 24 problems were given in a single session. Regression analysis revealed that the mean accuracy score of each problem in the original training period was a reliable predictor, although differences among the individual birds did exist. The results suggest that the accumulation of associations can be sufficient to support advanced visual categorization. Pigeons thus show promise in becoming reliable stand-ins for human observers in performing important aspects of medical screening.

**Stimulus location and response position affect discrimination performance**

*Joshua Wolf, Chad Ruprecht, & Kenneth Leising (Texas Christian University)*

**P16** Many different factors contribute to the success of touchscreen-based visual discrimination procedures. We trained and tested rats on a simultaneous discrimination procedure with several different methodological manipulations of the displayed stimuli to determine the optimal parameters for a simultaneous discrimination task with an iPad-equipped apparatus. Experiment 1 investigated different locations for stimulus presentation and response locations, stimuli differing in luminance, and stimuli for which luminance was equated. During Experiment 2, naïve rats were trained with novel white shapes (clouds and star) as discriminative stimuli in the same response positions as Experiment 1. We added auditory feedback for correct and incorrect responses, manipulated the degree to which stimuli were separated on the display, and switched response locations for rats across the four phases of Experiment 2. Our results demonstrate that within the iPad-equipped apparatus, rats are best able to discriminate stimuli when they respond directly to the stimuli in the bottom response locations of the iPad display and that training in the bottom response location can provide a buffer for rats switched to a less optimal response location. In sum, these experiments support the use of the iPad in visual discrimination tasks and inform future touchscreen-equipped studies.

**Discrimination learning in salamanders (*Ambystoma tigrinum*)**

*Shannon M. A. Kundey, Roberto Millar, Justin McPherson, Logan Bachtell, Maya Gonzalez, Bethel Nicholas, & Erin Murray (Hood College)*

**P17** To date, few have explored amphibians' cognition. We explored tiger salamanders' (*Ambystoma tigrinum*) ability to learn several discriminations. In Experiment 1, salamanders were reinforced to turn in a consistent direction (counterbalanced across subjects) in a T-maze. When correct, each salamander was returned to its home cage. When incorrect, the trial was repeated (maximum of 10 trials/day). After three consecutive days of making the correct turn on the first trial, each salamander completed a test trial in which the maze was rotated 180º. All learned the initial task and continued to turn in the reinforced direction at a level greater than that expected by chance during test. In a second experiment utilizing a similar procedure to Experiment 1, two visual cues were placed at the maze junction. One was associated with the left side of the maze while the other was associated with the right side of the maze. Cue placement and which turn was reinforced were counterbalanced across subjects. Once the criterion was met, the cue placement was reversed. All learned the initial task, but turned in the reinforced direction at a level greater than that expected by chance rather than following the reinforced visual cue during test.

**Working memory systems in the rat**

*Alexander Bratch, Nilda Rivera-Reyes, Spencer Kann, Stefan Dalecki, Shiloh Cooper, Amanda R. Doyle, Matt J. Pizzo, Alexandra E. Smith, & Jonathon D. Crystal (Indiana University)*

**P18** A hallmark of working memory in humans is documented by the independence of multiple memory systems. Although working memory has been investigated in non-humans, it is not known whether this construct draws on independent working memory systems. Here we tested the hypothesis that spatial and olfactory memory act as two independent memory resources in the rat. In the olfactory task, rats chose a novel odor from a gradually increasing set of old odors. In the spatial task, rats searched for a depleting food source at multiple locations. Olfactory and spatial domains were interleaved: odor-study, spatial-study, odor-test followed by spatial-test. We used the delay between the odor-study and odor- test on other occasions without imposing a spatial memory load: odor-study, retention interval, followed by odor-test. We did not observe any evidence for interference, which is consistent with the hypothesis that olfactory and spatial memory each draw on independent working memory systems.

**Determinants of what-where-when memory in the rodent odor span task**

*Danielle Panoz-Brown, Sarah Maggio, Michael Mathews, Samantha Hess, Katrina Gobenciong, Chloe Myers, Kate Bruce, & Mark Galizio (UNC Wilmington)*

**P19** The Odor Span Task (OST) uses an incrementing non-match to sample procedure in which the rat is trained to respond to an odor only the first time it is presented in the session. In the present study 12 rats were trained on the OST procedure for a variable number of sessions before receiving a series of probe sessions. One type of probe session presented target scents outside the arena before the OST session [What-Where-When (WWW) condition]. When these appeared in the OST, rats generally selected them as if they were new. A yoked-time-control (YTC) condition was conducted to account for familiarity: time between initial odor presentation and the test. On YTC trials, rats were generally less likely to select target scents, took longer to make a response, and visited more comparison stimuli. Separation between YTC and WWW probe trials suggest that rats remember where an odor was presented (as well as what and when). This separation was generally large after extended OST training, but was often lacking after minimal training. These results suggest that initial OST responding involves relative stimulus familiarity, but that WWW memory may emerge with extended training.

**Effects of allowing mice to see beyond alley walls on spontaneous alternation in the Y-maze: The importance of a Y-maze with a view**

*Nick Guilbeault, Alex Badour, & Jerry Cohen (University of Windsor)*

**P20** Working memory has been implicated in spontaneous alternation within the Y-maze by rats and mice. In our opinion this attribution misses some of other functions of such behavior, namely 'patrolling investigation' by such animals in relatively open or novel environments as an anti-predator predisposition. We present a series of experiments that examine the course of habituation of such spontaneous alternation behavior in mice as a function of transparency of the Y-maze located within a large well lit square chamber. Specifically we present data that examines the degree to which mice will maintain such spontaneous arm choices in a Y-maze that is sometimes translucent or transparent. This study is designed to test the proposition of Timberlake's patrolling hypothesis that mice will display greater spontaneous choices and persist longer in such behavior when allowed to view the external area surrounding the maze. We also examine novel object recognition behavior within each type of maze.

**Concurrent cognitive demand impairs memory for order more than recognition memory in rhesus monkeys**

*Victoria L. Templer (Providence College), Benjamin M. Basile (National Institute of Mental Health), & Robert R. Hampton (Emory University)*

**P21** Rats and monkeys remember the temporal order of five consecutively presented items (Templer & Hampton, 2012; Fortin et al, 2002). These tests have been interpreted as capturing the "when," or temporal aspect, of episodic memory. Here we examined the extent to which this temporal order task relies on working memory by presenting rhesus monkeys with a concurrent cognitive load during the memory delay. Monkeys saw a list of five images and then categorized images that were unrelated to the samples as birds, fish, flowers, or people. Monkeys then completed either an order test in which they were required to report which of two test images came first in the study list, or a recognition test in which they reported whether a test image image had occurred in the study list. Concurrent cognitive load significantly impaired performance on both order and recognition tests, but more dramatically so on order tests. Evidence presented here suggests that working memory contributes to performance on this task in monkeys, bringing into question its utility as a model of long-term episodic memory.

**The effects of a stimulus mask in change detection in pigeons and humans**

*Martha R. Forloines, Andie Thompkins (Auburn University), John F. Magnotti (UT Medical School at Houston), & Jeffrey S. Katz (Auburn University)*

**P22** The ability to hold items in visual working memory (VWM) in the presence of distracting stimuli is crucial for many everyday tasks such as driving a car or an animal searching for food while avoiding nearby predators. The current experiment explored the capacity, duration, and stability of VWM across two species. Pigeons and humans completed a change detection task designed to determine whether the presence of a mask during the delay would impair successful change detection. Across four experiments, we manipulated stimulus display size (1 to 8 items), stimulus type (clip art vs. colored circles), probe delay (0ms to 2000ms), and mask (present vs. absent during the probe delay). For pigeons, the masking stimulus increased performance for clip art stimuli, but decreased accuracy for colored circles. For humans, the masking stimulus decreased accuracy regardless of stimulus type. Both species showed delay-dependent and display size decreases in accuracy.

**Change in the relative contributions of habit and working memory facilitate expertise in serial reversal learning**

*Thomas C. Hassett, & Robert R. Hampton (Emory University and Yerkes National Primate Research Center)*

**P23** Multiple memory systems likely evolved to facilitate learning in response to functionally incompatible demands. Multiple memory systems will interact in the learning of a particular task when learning demands are compatible with multiple systems. We tested whether multiple memory systems facilitate the development of serial reversal learning expertise. In reversal learning, subjects improve reversal performance through experience with the task. We tested whether the shift from early incremental reversing, to rapid win-stay, lose-shift reversing is due to a change in the relative contributions of habit and working memory. Monkeys received two serial reversal learning tasks, one in which the inter-trial-interval alternated between 1 and 30-seconds, and another in which the degree of concurrent cognitive demands alternated between trials. The results of 4 experiments indicate that naïve reversers are under greater relative control by habit while expert reversers are under greater relative control by working memory. Furthermore, our results indicate that the development of expertise cannot be accounted for by proactive interference. Future work will be aimed at better characterizing how habit and working memory interact in expertise.

**A preliminary study of whether horses equate real objects with computer-generated images**

*Tammy McKenzie (Brandon University)*

**P24** There has been much debate about whether non-human animals recognize pictures or computer generated objects / scenes as equivalent to real objects (for a review see Fagot, 2000). It has been common practice for the cognitive abilities of pigeons and non-human primates to be studied using images or videos presented on computer monitors (Bhatt et al., 1988; Hebranson et al., 2002; Wasserman et al., 1996; etc.). This procedure has been used to a much lesser extent in studies examining cognitive abilities in horses (Hanggi, 2001; Hanggi, 2009; Hanggi & Ingersoll, 2009). The present study was a preliminary examination of whether horses equate real objects with computer-generated images and videos of those real objects. Some horses were trained to discriminate between pairs of computer-generated objects and then tested with real objects that the computer-generated images represented. Other horses were trained to discriminate between real objects and then tested with computer-generated images of the real objects. Success of transfer between real objects and computer-generated images will be discussed.

**Exploring the role of musical consonance in the extraction of abstract rules**

*Paola Crespo-Bojorque (Universitat Pompeu Fabra), & Juan M. Toro (ICREA - Univeristat Pompeu Fabra)*

**P25** Musical consonance is a salient perceptual feature in harmonic music associated with pleasantness. Besides being deeply rooted in how we experience music, research suggests consonant chords are more easily processed than dissonant chords. Results from our lab show that consonance facilitates detection of abstract patterns in human adults. In the present work we explore if the mechanisms of such processing advantage is present in an animal with no extensive experience with harmonic stimuli and a limited vocal repertoire. We ran experiments on rule learning over consonant and dissonant chords with rats. Results show the animals discriminated rules implemented over both consonant and dissonant chords at the same rate. However, they did not generalize the learned rule to novel items in either the consonant or dissonant condition. So, contrary to humans, consonance does not facilitate rule learning in rodents. In a third experiment rats showed an increased generalization performance when there is a mapping between categories defining the rule (A and B) and consonant and dissonant chords. Results suggest that contrasting consonance and dissonance improves rule learning in a non-human animal.

**Picture-object correspondence in bumblebees (*Bombus impatiens*)**

*Vicki Xu, & Catherine Plowright (University of Ottawa)*

**P26** This study examines picture-object correspondence in an invertebrate. Two questions are addressed for bumblebees (*Bombus impatiens*): (1) Do bees perceive the difference between an object and its corresponding picture even when they have not been trained to do so? (2) Do they also perceive the similarity? Twenty bees from each of four colonies underwent discrimination training of stimuli placed in a radial maze. Bees were trained to discriminate between two objects (artificial flowers) in one group and between the photos of those objects in another. Subsequent testing on unrewarding stimuli revealed, for both groups, a significant discrimination between the object and the photo of the object: there was no picture-object confusion. In the absence of flower that had been rewarded, the corresponding photo was accepted as a substitute, and in the absence of the photo that had been rewarded, the complete object was accepted as a substitute, i.e both object-to-picture and picture-to-object transfer were obtained. Bees do not so much treat pictures of flowers spontaneously as "floral stimuli", but rather as "similar-to-flowers-but-different".

**A preliminary assessment of mass judgment in two species of new world vultures: Quantity discrimination by olfaction**

*Adam M Stern (University of South Alabama), Stephanie E Jett, & Heidi Lyn (University of Southern Mississippi Gulf Coast)*

**P27** Complex cognition did not emerge in a vacuum, but emerged from ecological necessity. Little is known about the cognitive and sensory capabilities of vultures. Research suggests that turkey vultures are more dependent on olfaction for locating food, while black vultures utilize sight. This study assessed the ability of two turkey vultures and one black vulture to discriminate between two discrete masses of a food item, representing multiples of 5g, using olfaction alone. Three communally housed vultures were given a two choice mass judgment task modeled after the traditional quantity judgment task. The vultures were presented with 13 ratios per session. Early results suggest no significant ability to discriminate between the two masses. The dominant turkey vulture has completed 10 trials each for 4 of the 13 ratios, preliminarily indicating no significant ability to discriminate between masses by olfaction, but demonstrating a left side bias in selection. Two possible explanations arise from these results, both revolving around a reduction in competitive pressures. For all vultures, the ratios presented may not represent a large enough cost for making an incorrect choice. The second involves the dynamics of dominance hierarchies, with reduced competitive pressure for the dominant bird to choose the larger mass.

**Are spatial grouping deficits the underlying cause of motion deficits after posterior entopallium lesions?**

*Helyne R. Adamson, Muhammad A. Qadri, Daniel I. Brooks, Ashlynn M. Keller, Gabriel Rothman, Toru Shimizu, & Robert G. Cook (Tufts University)*

**P28** Separate subregions of the avian entopallium have previously been characterized as broadly sensitive to dynamic visual features (posterior entopallium) and static visual features (anterior entopallium). Is there a more fundamental cognitive process that might account for this division? We tested two alternative processes that underlie this previously identified dynamic deficit: difficulty integrating features across space and difficulty integrating features across time. To examine these alternatives, eight pigeons with bilateral lesions to either the posterior or anterior entopallium were successively trained in three distinct visual discrimination tasks. In the first, we used a multiple necessary cues paradigm with static and dynamic features to evaluate lesion-specific preferential cue use; in the second, we examined spatial grouping deficits using a texture perception task; and in the third, we tested the pigeons' abilities to integrate information over time by using a change detection task. Although the pigeons with posterior entopallium lesions exhibited some general deficits with both the preferential cues task and the spatial integration task, they showed no deficit in the change detection task. This pattern of results implicates spatial grouping as a fundamental cognitive process affected by lesions to the posterior entopallium.

**Lending a helping paw: The role of gender and stress levels in pro-social and empathy behaviors in rats**

*Julia E. Meyers-Manor, Brett Campbell, Nicole Mathews, Wendy Chu, Emily Sanford, & Eric Wiertelak (Macalester College)*

**P29** Rats are capable of both pro-social behavior and emotional contagion. It has been suggested that the pro-social behavior of rats may indicate a basic form of empathy. The current studies set out to determine: 1) whether rats demonstrate the ability to recognize a conspecific's distressed state from a non-distressed state and act accordingly, and 2) what role sex differences play in such responsivity. Separate groups of male and female rats were placed in individual Plexiglas restrainers; one habituated to the restrainer, one not habituated. Habituation was used to produce trapped rats that differed on stress levels. Free-roaming cagemates were then placed into the open-field containing the restrainer. While there was no difference in opening based on habituation, when videos were coded for signs of distress, the rats released the distressed cagemates at a greater rate than cagemates with lower levels of distress. Male and female rats showed similar rates of pro-social helping behavior. Although the manipulation to induce "empathetic" responding was unsuccessful, behavioral video coding indicates that opening occurred at a higher rate when the trapped rat demonstrated greater stress behaviors, in both males and females, perhaps suggesting "empathetic" responses.

**Do fish subitize? Numerical discrimination in goldfish (*Carassius auratus*)**

*Stephanie L. Barbato, & Caroline M. DeLong (Rochester Institute of Technology)*

**P30** Humans and other animals appear to use a process called subitizing to estimate the numerosity of a set when the item count is 1 to 4. The goal of this study was to examine goldfish's ability to differentiate between numerosities when presented with pairs of stimuli both inside and outside of the subitizing range. The goldfish were trained with the ratio 1 vs. 2 (2:4, 6:12) and tested on 1 vs. 3 (1:3, 5:15), 1 vs. 2 (2:4, 6:12), and 2 vs. 3 (2:3, 10:15). We controlled for the non-numerical cues of surface area, density, and space in some of the stimuli. The results indicate that the goldfish were able to successfully discriminate between numerosities both inside (M = 83%) and outside (M = 82%) of the subitizing range. Average performance accuracy remained high across all non-numerical controls, (surface area controlled = 83%, surface area not controlled = 81%, density controlled = 81%, space controlled = 83%) which suggests that the fish were attending to the numerosity of the stimuli. Finally, performance accuracy was higher with the 1 vs. 3 stimuli compared to the 2 vs. 3 stimuli, which indicates a ratio effect consistent with Weber's Law.

**The influence of human familiarity and attentional state on eating behavior in blue jays**

*Debra Hansberry, Elizabeth Beckham, & Kristy Gould (Luther College)*

**P31** Animals are sensitive to the familiarity of humans interacting with them and some are sensitive to the attentional state of humans (e.g. dogs and horses). We combined these two attributes in a study looking at the amount of time it takes blue jays to eat food in the presence or absence of a person. One manipulation was a familiar versus an unfamiliar person and another manipulation was varying the attentional state of that person (looking at the bird, looking down, back turned, eyes closed). When investigating the overall means, familiarity and proximity of the person to the cage impacted the time it took the birds to eat. The attentional state of the person had no impact on their behavior. However, when looking at individual bird behavior, one bird was much more sensitive to the attentional state of the person and another bird was sensitive to the presence versus absence of a person. These individual differences in behavior due to the presence of a human experimenter suggest that in experiments where humans need to interact with the birds, results can be heavily influenced by the individual temperaments of the birds in the study.

**Mirror-induced, mark-directed behavior in blue jays**

*Emily Hasher, Kristen Flick, Rachel Rem, Zoe Bachman, Angelica Mangiamele, & Kristy Gould (Luther College)*

**P32** Previous research has shown that three species of Corvids show significantly more mark-directed behavior (MDB) in front of a mirror when compared to controls (Gould et al. submitted; Prior et al. 2008). Since not all Corvids that have been tested show this behavior, we wanted to test another Corvid, the blue jay. We affixed a small, circular sticker to the neck region of blue jays that was either colored or clear and exposed them to either a mirror or a non-reflective plate at one end of the test cage. Two birds showed statistically significant MBD during the colored sticker/mirror conditions compared to control conditions. We then hung a mirror in the home cage of each bird for 4 weeks to see if more exposure to a mirror would cause additional birds to show MBD. We then re-ran the experiment and found one additional bird that showed significant MBD during experimental conditions compared to controls. MDB during mirror exposure has been hypothesized by some to suggest a level of self-awareness, but is argued to not be a good measure of self-awareness by others. Differences in MDB among different species and individual differences in MDB within species is none-the-less interesting and warrants further study.

**Integration of dynamic and static cues during the nonverbal assessment of human actions predicts autistic traits**

*Emily D. McDowell, Muhammad A.J. Qadri, Daniel I. Brooks, Ashlynn M. Keller, Pamela L. Follett, & Robert G. Cook (Tufts University)*

**P33** Individuals with autistic traits have shown differences in how they integrate sensory information as compared to typically developing individuals. Some have suggested that this difference underlies associated disparities in social behavior and cognition. Here, we investigated the relationship between social cognition and sensory integration in non-clinical human participants. We measured autistic traits using the Autism-Spectrum Quotient (AQ) and then tested sensory integration with complex action sequences that required the processing of visual form information over time. On each trial, participants categorized a static or dynamic display by choosing one of two response keys. Initially, the keys mapped onto the two complex human behaviors (martial arts or Indian dance) depicted in the display. Then, to investigate the degree to which participants integrated the static and dynamic information after learning the task, the response assignments for the dynamic displays were switched. The AQ scores—specifically participants' preferences for and comfort in social environments—correlated with the degree of integration between static and dynamic processing. The communicative and social differences observed along the autistic spectrum may partially stem from this underlying disparity in visual cognition. This behavioral assay may be a useful diagnostic tool for identifying autistic traits in pre- or non-verbal individuals.

**Links across temporal reference memory: Transfer across different durations**

*Benjamin J. DeCorte, & Matthew S. Matell (Villanova University)*

**P34** Interval timing is often assessed using the peak-interval (PI) procedure, in which the onset of a stimulus indicates that reinforcement may be earned for responding after a set "criterion duration" has elapsed (e.g., 8 seconds). During probe trials, responses peak around this criterion duration. Using a PI task, Roberts (1982) trained rats to associate a tone and houselight with the same criterion duration. He then changed the criterion time for only one of the two cues and found the responses for both cues shifted toward this new duration. We evaluated whether this effect would be observed when two cues were initially associated with different durations. Rats associated a tone and light with either a long or short criterion duration (e.g., 8 and 16 seconds, respectively). The short duration was then changed to 4 seconds. During this phase, rats were not exposed to the long duration's cue. After responses stabilized, the long duration's cue was presented during extinction trials. Similar to Roberts (1982), responses to the long duration's cue shifted towards the short duration's new criterion time. This suggests that different temporal memories may be linked, such that a change in one can cause a corresponding change in another.

**The role of laterality in beluga visual discrimination**

*Deirdre Yeater (Sacred Heart University), Ashley Hogan (University of Connecticut), Michelle Weiman, Meredith Nyser, Michael Lombardi, Keaton Mangi, Lindsay Dunlea (Sacred Heart University), Heather Hill (St. Mary's University), & Stan Kuczaj (University of Southern Mississippi)*

**P35** While the concept of lateralized behavior has been addressed in cetaceans, it is only recently that efforts have begun to explore its importance in cetacean cognition. The current study combined concepts from a series of earlier studies on familiarity and lateralization in belugas. Two consecutive presentations of stimuli were shown to the belugas in front of a curtain using a violation of expectation procedure. Human and object stimuli were integrated within the same trial, and the familiarity level of each stimuli was varied. Three belugas at an aquarium facility in the Northeast were tested. Results indicated that the belugas tended to look longer at unexpected events especially when they were unfamiliar objects or humans. The belugas preferred to view all stimuli types with both eyes; however, these data were driven by one individual.

**Representations of humans and objects in belugas (*Delphinapterus leucas*)**

*Michelle Weiman, Meredith Nyser, Keaton Mangi, Lindsay Dunlea, Kelly Miles (Sacred Heart University), Sarah Gallup (St. Mary's University), Deirdre Yeater (Sacred Heart University), Heather Hill (St. Mary's University), Stan Kuczaj (University of Southern Mississippi), & Steve Lacy (Sea World)*

**P36** Cetaceans attend to and categorize various types of stimuli and respond appropriately. Two studies were conducted to investigate visual laterality and the ability to differentiate between familiar and unfamiliar humans (Study 1) and objects (Study 2) in belugas. Seven belugas were studied from Facility A and three belugas from Facility B in a free swim scenario. Stimuli were presented in front of a curtain at an underwater viewing window. Results indicated that the effect of familiarity on gaze duration was not significant for human stimuli, although the belugas gazed at humans longer than the apparatus. Individual differences occurred in gaze durations for both humans and objects, with some belugas gazing longer at familiar objects. Type of stimuli appeared to be important with longer mean gaze durations for human stimuli over objects at both facilities. The belugas also demonstrated a preference for investigating humans and objects with both eyes. Binomial results did not show a clear lateralized preference. Although a strong lateralized preference did not emerge it appears that each individual may have a lateralized preference when removing the both eye viewing condition.

**The fallacy of the domestication hypothesis**

*Stephanie E. Jett, & Heidi Lyn (University of Southern Mississippi Gulf Coast)*

**P37** To test the premise of the domestication hypothesis (DH), stating that dogs are biologically predisposed to attend to human communicative cues (points), we tested shelter dogs using the object choice paradigm. The dogs were presented with three point types in blocks of ten trials (twenty for each point type): proximal-proximal (PP – cups close in proximity, point close to baited cup), proximal-distal (PD – cups close, point further away), and distal-distal (DD – cups and point further away). The results indicate that, for the 32 dogs that completed all 20 trials of each point type, there were significant differences between the three point types, with the highest performance on DD and the lowest on PD. These results support previous work with dogs focusing on DD points. However, the DH is based on comparisons made with apes only tested on PD, which was the point type with the lowest performance for these dogs, suggesting that, as with human infants, following points is not something that is an innate capacity, but, instead, is learned through experience with the environment. These results indicate that, when given proper exposure to human communication systems, both dogs and apes could be capable of following points.

**Functional analysis and treatment of visual fixation in border collies**

*Victoria Self, Lindsay Mehrkam, & Nicole Dorey (University of Florida)*

**P38** The border collie breed has been bred to express an exaggerated eye-stalk-chase predatory motor sequence with respect to livestock, referred to here as visual fixation. Although inherently functional, when generalized to inappropriate stimuli (e.g., light or shadows, a vacuum cleaner, windshield wipers) visual fixation is often maladaptive, becoming problematic for both canine and owner. Because the behavior sequence has been shown to have a specific onset time and little variability within the border collie breed, it is likely that the eye-stalk sequence reflects a modal action pattern. It is possible, then, that sensory stimulation through automatic reinforcement maintains visual fixation in border collies. The current study aims to use functional analysis methodology to determine the function of visual fixation in individual border collies. If behavior is found to be maintained by automatic reinforcement through sensory stimulation (i.e., not social consequences), then treatment in the form of differential reinforcement of alternative behavior (DRA) and a stimulus fading procedure will be administered.

**Evaluating the ability of dogs to form functional categories of target odors**

*Lucia Lazarowski (Auburn University), Melanie Foster, & David Dorman (North Carolina State University College of Veterinary Medicine)*

**P39** The ability of dogs to assign novel odors to learned categories is critical in explosives detection, due to the variable nature of explosive odors. Previously, we found that dogs trained to respond to ammonium nitrate (AN) often failed to respond to novel, chemically-related odors. The present study investigated the ability of dogs to form functional categories of odors and the effect of training set size on generalization to novel category members. Dogs (n= 10) were trained to discriminate between a class of AN-related odors and unrelated odors. Dogs were randomly assigned to one of two groups: Group 1 trained with a set-size of two odors, and Group 2 trained with a set-size of six odors. After meeting performance criteria with the training stimuli, dogs were tested for generalization to a novel AN-related odor. Neither group responded to the novel odor significantly greater than chance (mean ± SEM responses were 56 ± 5 and 54 ± 4% for Group 1 and Group 2, respectively). Likewise, individual performance was not statistically higher than chance (one-tailed binomial test vs. chance). Further investigation of factors hindering and facilitating generalization to novel odors is needed.

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**Assessment of the neural basis of odor familiarity in working dogs using fMRI**

*Jeffrey Katz, Lucia Lazarowski, Andie Thompkins, Tuo Shi, John Paul Anglin, Sinan Zhao, Pradyumna Lanka, Oleg Pustovyy (Auburn University), Paul Waggoner (Canine Detection Research Institute), Ronald Beyers (Auburn University), Lizzie Benecke (iK9 LLC), Thomas S. Denney, Edward Morrison, Vitaly Vodyanoy, & Gopikrishna Deshpande (Auburn University)*

**P40** Given that dogs are widely considered the most capable tool available for explosives detection, characterization of the cognitive processing of odors in dogs in order to improve procedures for selection and training of detector dogs is warranted. Functional magnetic resonance imaging (fMRI) procedures may provide a powerful non-invasive tool for in vivo examination of cognitive processing of odor information by the canine brain. Because outstanding service dogs require demonstrating a desirable response to discriminative (trained) odors as opposed to non-discriminative (un-trained) odors, we investigated canine brain regions that are differentially activated in response to odors varying in novelty and reinforcement history. Dogs selected for eventual odor detection roles were trained to lie motionless and awake during fMRI using a procedure previously reported by us. Odors were presented via a custom-built device allowing for precise computer-controlled air flow delivery of pre-determined quantities of odorants over a precise time interval. fMRI activation results show how the response of the structures involved in recognition of odors associated and unassociated with reward changes across odor detection training. Further, activation magnitude correlated with canine behavioral variables such as environmental soundness, hunting, retrieval and training ease.

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**The development of sociality and play in an orca calf**

*Sara Guarino, Heather Hill (St. Mary's University), & Julie Sigman (SeaWorld San Antonio)*

**P41** Bottlenose dolphin calves preferred to socialize and play with other calves, juveniles and sub-adults. It is also known that bottlenose dolphin calves' sociality is related to maternal behaviors. Less is known about the development of sociality for orcas. The purpose of the study was to examine social interactions and play behaviors of an orca calf across 3 years. Focal follow videos of a mother-calf pair housed at SeaWorld San Antonio were recorded 2-6 times a day for 5-15 minutes at 6 month intervals. Developmental changes were observed for the calf's mean percentage of time involved in social interactions with her mother or with other adults and independent play. The time the calf spent socializing with her mother was 4.5 times, on average, greater than the time spent socializing with others at each month until the 3rd year. The calf preferred to socialize with the other adult female over the males. The rate and time spent in independent play increased as she matured. The developmental trends of emerging independence and sociality replicate research conducted with dolphin calves. Additional research with orcas when multiple calves are present is necessary.

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**A rodent aquathlon: A comparison of positively-reinforced running and negatively-reinforced swimming in the production of behavioral variability**

*Rachael Dearborn, Cierra Everette, M. Sarah Phillips, Siara Rouzer, & W. David Stahlman (University of Mary Washington)*

**P42** Systematic examinations of behavioral variability as a phenomenon in animal learning have almost universally utilized only a small subset of possible reinforcement schedules. These studies have employed variations of positive reinforcement procedures whilst manipulating parameters such as food palatability or magnitude, reward probability, and delay to reward. Such work has demonstrated a predictive, inverse relationship between reward expectation and behavioral variability. We were interested to discover whether a similar pattern holds in negative reinforcement and how relevant- vs. irrelevant motivational states impacts performance variability. We trained two groups of rats to traverse a maze under either High- or Low-hunger conditions. Similarly to recent work, one group (POS) was trained to run through the maze to obtain a palatable food reward; for the other group (NEG), the apparatus was filled with water and animals were trained to swim through it to reach an escape platform. We recorded the pathways through which animals passed, recording two critical measures (i.e., number of errors and randomness of correct pathways chosen). Our results extend the knowledge of the nature of the relationship between reinforcement and variability. This experiment represents the first direct comparison of positive- and negative-reinforcement schedules in behavioral variability production.

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**Do rats prefer informative over non-informative stimuli? Evidence from a radial arm maze**

*William A. Roberts, Heidi L. Marsh, & Caroline G. Strang (University of Western Ontario)*

**P43** One method to investigate metacognitive abilities in non-human animals is to assess their propensity to seek information when it is necessary, but not when it is redundant, in order to solve a problem. Thus far, evidence for the existence of metacognition in rodents has been controversial. Here, we present research in which rats were given a choice between two levers placed in the centre of a radial arm maze. Pressing either lever granted access to the remainder of the maze by opening the doors to all eight arms. However, one of the levers additionally provided information about the location of the baited arm, whereas the other lever provided no information. We recorded rats' preferences for the informative option across successive trials. Subsequent conditions controlled for side biases and delay to reinforcement. Once the preference was established, we changed the amount of information that was given by each of the levers, as well as the necessity of the information (when rats could, instead, rely on reference memory), and measured for changes in preference. Results are discussed in terms of the phylogenetic emergence of metacognitive information gathering abilities.

**Monkeys use similar discriminative cues across two tests of metamemory**

*Emily Kathryn Brown (Emory University), Benjamin M. Basile (Laboratory of Neuropsychology NIMH NIH), Victoria L. Templer (Providence College), & Robert R. Hampton (Emory University)*

**P44** Metamemory is the ability to monitor and adaptively control memory. We directly compared performance of rhesus monkeys (*Macaca mulatta*) on two metamemory paradigms to test the assumption that these tasks assess the same underlying cognitive capacity. In both paradigms, monkeys performed a match-to-sample memory task. In the decline test paradigm, monkeys could avoid some tests and receive a small, guaranteed reward. In the information seeking paradigm, monkeys could choose to repeat the sample on some trials. In both experiments, the availability of the metacognitive option improved accuracy, compared to trials on which the metacognitive choice was not available. To begin to assess whether the same cues control metacognitive judgments in both paradigms, we presented the metacognitive response prospectively, before test stimuli, or concurrently with the test stimuli. In prospective choices, monkeys may base metamemory judgments on the contents of working memory carried through the retention interval. In concurrent choices, presentation of the test stimuli provide additional cues about test difficulty. In both paradigms, monkeys showed a greater benefit of metacognitive responding on concurrent than prospective tests. Similar patterns of performance strengthen the hypothesis that metacognitive responding is similarly controlled in both paradigms.

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**How to impair rat serial pattern learning in one 'easy' transfer**

*Samantha M. Renaud, Megan E. Miller, Carly N. Logan, & Stephen B. Fountain (Kent State University)*

**P45** Evidence indicates rats learn discriminative cues and abstract rules concurrently to guide performance in serial pattern learning. One would predict that as long as relevant cues and rules are maintained when transferring rats to a new serial pattern, savings should be observed. To test this hypothesis, rats learned a pattern where digits represent spatial locations within an octagonal chamber: 123-234-345-456-678-781-818 by making nose-poke responses until they achieved high levels of performance. They were then transferred to a similar pattern, which maintained the cues and rules of the original pattern but also included a cued interleaved "8" response: 182838-283848-384858-485868-586878. Results indicated no savings on transfer, with rats making more errors on the first day of transfer than on the first day of training, and poor transfer asymptotic performance. Transfer acquisition for chunk-boundary elements, previously attributed to discrimination learning and serial-position learning, was faster than transfer acquisition for within-chunk elements, previously attributed to rule learning, thus contradicting prior studies. Element-by-element results indicate that using the former violation element "8" as the interleaved element in transfer interfered with the transfer acquisition. Thus, even though relevant cues and rules were maintained when transferring rats to a new serial pattern, no savings were observed.

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**Effects of environmental enrichment during adolescence on a memory precision deficit observed in middle-aged female rats**

*Jessica Sharp, Samantha M. Renaud, Megan E. Miller, Stephen B. Fountain, & David C. Riccio (Kent State University)*

**P46** Environmental enrichment during development generally promotes cognitive function and performance in a wide range of learning and memory tasks in adulthood. In contrast, aging impairs learning and memory of contextual cues in rats. The passive avoidance paradigm was used to test memory precision, which is conceptually defined as the ability to discriminate between an initial fear conditioning context and a novel context when tested 24 hours later. The current experiment examined whether enrichment during adolescence would ameliorate memory precision deficits in middle-aged 11-month-old rats. Rats were provided environmental enrichment during adolescence during postnatal day 21-89 (P21-89), consisting of group housing, running wheels, and toys or a standard environment. At P343-349, rats were tested for memory precision. Results showed that fear generalization occurred after a 24-hour retention interval in both control and enrichment groups, as indicated by long re-entry latencies in both the same and different contexts. Fear generalization at this time point indicates a memory deficit not seen in young adult rats. Rats with environmental enrichment during adolescence did not perform better than control rats. Thus, adolescent environmental enrichment did not ameliorate the memory precision deficit observed in middle-aged rats.

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**Environmental enrichment during adolescence impairs learning in a serial multiple choice task in adult female rats**

*Megan E. Miller, Samantha M. Renaud, & Stephen B. Fountain (Kent State University)*

**P47** Environmental enrichment has been shown to have putatively positive effects on neural, behavioral, and cognitive systems in rodents. This study aimed to identify the effects of environmental enrichment during adolescence on complex cognition using a serial pattern learning task. Female rats from postnatal days 21-89 experienced either an enriched environment consisting of both social and physical types of enrichment or a standard environment. Once they reached adulthood, all rats were trained in a serial multiple choice task where they learned a 24-element pattern of responses, 123-234-345-456-567-678-781-818, where digits represent the clockwise position of successive correct receptacles in a circular array on the 8 walls of an octagonal chamber, and dashes indicate 3-second pauses that served as phrasing cues. Rats completed up to 20 patterns daily for 900 total patterns. The pattern consisted of three element types: within-chunk, chunk-boundary, and violation elements, each of which assesses different cognitive mechanisms. Results indicated that environmental enrichment impaired learning for chunk-boundary elements, previously attributed to discrimination and serial position learning, but not other element types. Thus, environmental enrichment during adolescence appears to have differentially impaired adult female rats' ability to learn about discriminative phrasing cues or serial position cues.

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**A comparison of male, female normal, and female estrogen receptor knockout C57BC/6 mice on single alternation, double alternation, and serial pattern learning**

*Tsu-Yi Su, Tasnuva Enam, Auburn Davidson, Dalisa Kendricks, Holly Boettger-Tong, & James D. Rowan (Wesleyan College)*

**P48** Recent research has found sex differences in rats' acquisition of serial patterns with males learning patterns overall faster than females. This set of experiments examines the influence of sex and the role of female estrogen receptors in pattern learning in the B6 mouse. Using the Sequential Multiple Choice (SMC) task, normal male, normal female, and estrogen receptor knockout female B6 mice first learned single alternation (SA) patterns for 18 days, were then transferred to double alternation (DA) patterns for 18 days and finally, were transferred to a perfect runs serial pattern (prSPL) for 40 days. The results suggest that SA learning was the same for all groups. Males and female normal B6 mice learned the DA patterns marginally faster than the B6 estrogen knockouts. Finally, in the learning of the prSPL pattern, normal male and female B6 mice learned the pattern significantly faster than the female B6 estrogen knockouts. These experiments show that estrogen is important in the acquisition of structured patterns especially as these patterns become more complex.

**Effects of acute nicotine administration on the acquisition and retention of double alternation patterns in male C3HeNsd mice**

*Madison K. McCarty, Alyssa Rivero, Anika Tabassum, Shavini Aryal, Kelsie Saddler, Holly Boetter-Tong, & James D. Rowan (Wesleyan College)*

**P49** No studies have observed the effects of nicotine on pattern learning, thus far, in mice. This experiment used the 2 choice Sequential Multiple Choice (SMC) test to examine the effects of nicotine on the acquisition of double alternation patterns (DA). The option of using mice and simpler patterns (as opposed to more complex serial patterns) maybe as efficient in detecting these cognitive deficits but takes a simpler testing chamber and acquisition is faster. In an operant chamber with two response choices labeled 1 and 2, the double alternation pattern consists of responses: 11221122. Male C3H/HeNHsd mice were separated into three groups: 0 mg/kg (saline solution), 0.1 mg/kg, and 0.25 mg/kg nicotine and were tested on the DA pattern for 18 days. After 18 days, the saline control group moved on to a transfer phase, where they were administered 0.25 mg/kg of nicotine for 5 days, and retention of the DA pattern was observed. No differences in error rate between the groups were found in either the training or the transfer phase. This could be due to variability in performance, the low dosage of nicotine, or that nicotine does not affect the acquisition of such structurally simple patterns.

**Social affiliation choices in a Y-maze by rats: Influence of different restraint durations**

*Kelsey A. Heslin, & Michael F. Brown (Villanova University)*

**P50** This study recorded responses of rats to the distress of restrained conspecifics. It aimed to identify systematic differences in subject rat behavior toward conspecifics that were restrained for different lengths of time. Stimulus rats were held in restraining tubes for two different durations prior to the choice trial: long duration (20+mins) and short duration (1 min). Subject rats were then allowed to freely interact with one restrained long duration (LD) rat and one restrained short duration (SD) rat in a Y-maze. Subject rats showed a significant first approach choice preference for SD rats. However, subjects also preferred to spend more total time with LD rats over the course of the 1-minute choice trials. These results could reflect an avoidance of SD rats (after initial contact) or a preference for LD rats. In either case, subject rats appear able to differentiate the two types of stimulus rats consistently. Possible explanations for this pattern of results will be discussed.

**Observational learning in captive wolves**

*Adam Potopa, & Sarah Jones (St. Norbert College)*

**P51** Recent work with wolves demonstrates similar performance to domestic dogs in social learning tasks; this suggests that evolutionary mechanisms may play a larger role in explaining the social abilities of dogs than artificial selection though domestication. To further explore the social learning capacities of wolves, we engaged captive wolves in a food location task, using a conspecific demonstrator. One of two visually-discriminable containers was consistently baited throughout each session. Two wolves solved the task in both social and non-social conditions. In social sessions, subjects had visual access to a naive conspecific completing an identical discrimination; in non-social sessions, subjects could only solve the task with within-session trial and error learning. Preliminary findings indicate that wolves were more effective at learning this discrimination after observing a conspecific complete the task, but not after observing a human complete the task.

**Does observational learning influence spatial pattern learning for humans?**

*Matthew C. Bruster, Kent D. Bodily (Georgia Southern University), Michael F. Brown (Villanova University), & Bradley R. Sturz (Georgia Southern University)*

**P52** Recent research has been interested in the influence of social information on spatial learning tasks (for a review, see Brown, 2011). The present experiment examined the effect of observational learning on the performance of humans in a spatial pattern learning task. One group of participants (i.e., Optimal Observation) watched a virtual character complete a spatial pattern learning task using an optimal search strategy whereas another group of participants (i.e., Random Observation) watched a virtual character complete the spatial pattern learning task using a random search strategy. Both groups then completed a spatial pattern learning task. To the extent that observation learning occurs and influences completion of the spatial pattern learning task, measures of learning for participants in the Optimal Observation group should be superior relative to those of the Random Observation group. Results and implications will be discussed.

**Using a delayed match-to-sample task to further investigate the isolated processing of geometric shapes and their corresponding shape words**

*Joshua E. Edwards, Candyce Asby, Travis Baker, Destiny Brooks, Allison Dyches, Ty W. Boyer, & Bradley R. Sturz (Georgia Southern University)*

**P53** Recently, Sturz, Edwards, and Boyer (2014) investigated the isolated processing of geometric shapes and their corresponding shape words using a delayed match-to-sample (DMTS) paradigm. They obtained an asymmetric pattern of interference, such that shape words interfered with identifying geometric shapes but geometric shapes did not interfere with identifying shape words. The present experiments attempted to replicate and extend these results. Experiment 1 investigated the possibility that the asymmetric pattern of interference resulted from a greater saliency of shape words compared to geometric shapes. Increasing the saliency of the geometric shapes did not appear to influence performance as we obtained an asymmetrical pattern of interference, replicating the previous finding. Experiment 2 attempted to force all processing through a linguistic network by reversing the matching criteria (match shapes to shape words and shape words to shapes). Under these conditions, we obtained a symmetric pattern of interference. Collectively, these results provide further converging evidence for the isolated processing of geometric shapes and their corresponding shape words.

**Non-goal cues can be used to disambiguate the correct from the rotationally equivalent location: Evidence from blind-folded adults**

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**P54** Within the reorientation paradigm, strict associative-based accounts have suggested that responses to the rewarded beacon also result in an increase in the associative value of the corner in which it is situated [i.e., the geometrically correct corner] (Miller & Shettleworth, 2005). Given the focus on the rewarded beacon and the geometrically correct corner, little to no information should be gleaned from non-goal beacons; however, recent evidence suggests that information about non-goal beacons is acquired because the presence of a non-goal beacon can be used to disambiguate the correct from the rotationally equivalent location during testing (Sturz & Kelly, 2013). In the present experiment, we examined the extent to which a non-goal textural cue could be utilized to disambiguate the correct from the rotationally equivalent corner in the absence of vision. Specifically, we trained blind-folded adult humans to locate a target object located in a corner of a rectangular environment. Each corner contained a unique textural cue. During testing, we removed three textural cues (one of which always included the removal of the trained textural cue). Results indicated that blind-folded humans were able to utilize the presence of a non-goal texture to disambiguate the correct from the rotationally equivalent corner.

**Flexible spatial representation of magnitude in monkeys (*Macaca mulatta*)**

*Rachel F.L. Diamond (Emory University), Regina Paxton Gazes (Bucknell University), & Robert R. Hampton (Emory University)*

**P55** Humans often activate a mental representation of a number line when performing quantitative tasks. This is illustrated in the spatial numerical association of response codes (SNARC) paradigm in which people report whether a sample number is odd or even. Humans respond more quickly on the left when the number is small and on the right when the number is large. This indicates that responding is facilitated when the response is congruent with the mental number line even though no explicit magnitude processing is required. The capacity to represent space is fundamental and available to many species. To determine whether spatial representations are involved in quantity processing across species, we tested for SNARC phenomena in monkeys. Monkeys matched the color of a sample array that ranged from 1 and 10 dots to color comparison stimuli on the bottom left and right sides of the screen. After being trained to associate small with left responses and large with right responses, monkeys were more accurate in color matching when responding on the left after seeing a small numerosity sample. This effect reversed after monkeys were trained in the opposite spatial association. These results are consistent with a spatial representation of magnitude in monkeys.

**Tool use and spatial reasoning in three species of great ape: A product of environment and evolution**

*Mystera M. Samuelson (University of Southern Mississippi), Jamie Russell, Jennifer Schaeffer (Yerkes National Primate Research Institute), Bill Hopkins (Yerkes National Primate Research Institute Georgia State University), & Heidi Lyn (University of Southern Mississippi)*

**P56** Comparing the abilities of our closest evolutionary ancestors provides insight into the environmental pressures that supported complex cognition in humans. We tested performance on a modified version of the Primate Cognitive Test Battery (PCTB) used by Russell, Lyn, Schaeffer and Hopkins (2011). The sample consisted of 21 apes including bonobos (*Pan paniscus*) (n=7), chimpanzees (*Pan troglodytes*) (n=7) and orangutans (*Pongo spp.*) (n=7), and were matched across housing environments. Our findings indicate that orangutans outperformed bonobos and chimpanzees on causality tasks ($p < .05$), but were outperformed by both species on relative numbers ($p < .05$). This disparity reveals that orangutans may have developed complex spatial reasoning capabilities due to adaptations allowing for survival in their native arboreal habitats. In captivity, this skill is reflected in heightened reasoning regarding the physical properties of objects and tools.

**Role of distance and direction during a 3D virtual reality search task**

*Christian G. Sullivan, Arielle V. Elliott, Chad M. Ruprecht, & Kenneth J. Leising (Texas Christian University)*

**P57** We recently reported that undergraduates (Ruprecht, Quintana, Wolf, & Leising, 2014) and pigeons (Leising, Hall, Wolf, & Ruprecht, in press) could learn that a colored background, X, set the occasion for the direction of a hidden goal in relation to a dynamic landmark, A (e.g., ←XA; YA →). In the current study, we wanted to examine a second dimension of spatial control, distance, and also incorporate the landmark search paradigm into a 3-D video game. Two groups of undergraduates learned that occasion setters (distal colored walls) indicated either the distance (near vs. far) or direction (left vs. right) of the reinforcer, whereas landmarks indicated the other dimension (direction or distance, respectively). We measured the latency to navigate across the virtual room and find the goal across training. Latency data indicated that having the occasion setter indicate direction (and the landmark distance) facilitated early acquisition of accurate responding, but in general, participants in both conditions performed comparably. Investigating how spatial search operates under the control of conditional relationships will further elucidate how mobile organisms integrate various forms of search with cues that vary widely in their proximity, validity, and reliability.

**Competition between cues in a spatial task in the living fossil, Chambered Nautilus.**

*Jennifer Basil (City University of NY), Gregory Barord (City University of NY), Rebecca Derman (City University of NY), & Cheng Hui Ju and Theresa Vargas (City University of NY)*

**P58** Our previous work demonstrated spatial learning in nautilus showing that animals rely both on proximate and distant visual cues to orient. We examined 1) the role route information plays in solving spatial problems and 2) how simultaneously learned information is processed into memory. Animals learned to orient toward an escape from a maze cued by a beacon. We also trained nautiluses with no beacon to determine if route memory alone was sufficient. If animals are tested with the component stimuli (beacon, route) of a compound (e.g., beacon& route) on their own, 1) they should perform less well than with the stimuli in combination (Rescorla & Wagner, 1972). An alternative would be 2) that the two sources of information are stored and accessed separately, as demonstrated in vertebrates (e.g. rats: Gibson & Shettleworth, 2005). We determined that nautiluses can use route information alone to learn and remember the location of the escape from the maze. We also found that nautiluses remember the escape location better when they were not trained with the compound beacon/route stimulus, indicating that the memory streams are shared and compete for memory space.

**Spatial occasion setting persists following reassignment training in a landmark-based touchscreen task with pigeons**

*Lauren Cleland, Chad Ruprecht, & Kenneth Leising (Texas Christian University)*

**P59** It is easy to imagine the time of day (rush hour vs. other times) setting the occasion for which direction you take on your commute home. We have studied an analogous kind of spatial occasion setting procedure with pigeons and humans. In a recent study, three landmarks were rendered unstable during training. During training, a colored background (X) set the occasion for where a hidden goal was located in relation to a dynamic landmark (A). On some trials the goal was to the left of the landmarks (<-WA, <-YB, <-C) and on others the goal was to the right (XA->, ZB->B, C->). When the novel pairing XB was tested, pigeons responded in the direction of the goal signaled by X. In the current study, we hypothesized that W would continue to control spatial behavior following training of an unambiguous A-goal relationship. We reassigned two previously ambiguous landmarks, A and C, so that they signaled the hidden goal in one direction (<-C, A->). Transfer tests (WA, XA) indicated continued control by the occasion setter on WA trials, but more accurate responding to the congruent pair XA. Configural versus hierarchical theories of occasion setting will be discussed.

**Where to bury a nut? Tree squirrel principles for cache organization**

*Mikel Maria Delgado, & Lucia F. Jacobs (University of California at Berkeley)*

**P60** Previous studies demonstrate that the food-storing decisions of fox squirrels are complex, allowing them to match their caching effort to the potential energetic returns of food items (e.g. perishability, weight). We examined how squirrels distribute their caches, looking at four key variables: distance traveled, dispersal direction, distinctness of cache areas by food type, and density of caches. We presented individual free-ranging fox squirrels with a series of 16 nuts of up to four types, in either "chunked" or pseudo-random order. In Experiment One, each nut was distributed to the subject in a different location. In Experiment Two, all caches were distributed from a central location for each subject within a session. We localized over 1100 caches using handheld GPS. Our results suggest that the squirrel's cache organization can be described using three principles. First, match distance traveled to food item value; second, systematically cover a caching area; and third, match cache density to minimize pilferage risk to the highest-valued food items. This model could explain many previous results related to squirrel caching behavior and cache density. I will present our results in the context of our emerging model of how the scatter-hoarding squirrel invests in and organizes its caches.

**Evidence for electro-sensory cues used in spatial memory in axolotls (*Ambystoma mexicanum*)**

*Frank W. Grasso, & Zohaib Qasi (Brooklyn College CUNY)*

**P61** Axolotls (*Ambystoma mexicanum*) are obligate aquatic salamanders with a neotenic adult phase. They are lie-in-wait ambush predators that possess a well-developed electro-sensory modality that they can use in prey capture. We tested six juvenile axolotls in a custom-designed "inverse Morris water maze" where escape from shallow water to deeper water was the goal. We tested these animals in a control condition and an experimental condition in which a weak electric field was present as a cue. We found that over a series of six trials, separated by an inter-trial interval of 5 minutes, the animals showed no significant difference or pattern in time to arrive at the escape hole. When these same animals were run in similar trials in the presence of a weak electric field the time to reach the escape hole declined systematically over trials, $F(4,20) = 3.57$ $p < 0.05$. These results are the first indication that axolotls are can use electric cues to guide spatial navigation and for higher cognitive processes, in this case spatial memory.

**Flexibility and use of a novel tool in asian small-clawed otters (*Aonyx cinerea*)**

*Erin Frick (University of Southern Mississippi), Leor Friedman, Jessica Peranteau, Kaitlyn Bujnowski (Six Flags Great Adventure), & Stan Kuczaj (University of Southern Mississippi)*

**P62** Asian small-clawed otters demonstrate remarkable hand dexterity when gathering and consuming prey, but little is known about their ability to use objects as tools. The present study used a tool choice paradigm in which six Asian small-clawed otters were tested individually and presented with two identical tools. For each trial, only one tool was positioned such that pulling it allowed an otter to obtain food. Pulling the other hook resulted in the correct hook being moved out of reach, necessitating selection of the correct tool as its first choice. The two males performed above chance levels, but the four females did not. The females' poor overall performance may have reflected their initial inability to understand the tool choice task. Two of the females' performances improved by 20% over the course of the trials, and another female showed 5% improvement over time. In addition, some incorrect responses appeared to be due to side preferences rather than to the configuration of the apparatus. Although otters do appear capable of learning which tool should be used in a forced choice comparison such as the one used here, other factors appear to influence the choices individual otters make.

**An evaluation of environmental enrichment program for scarlet macaws (*Ara macao*) at the Blank Park Zoo**

*Kristine Micheletti, Kayla Salsberg, & Olga Lazareva (Drake University)*

**P63** Environmental enrichment has been thought to decrease stereotypical behaviors such as feather picking, and improve the well-being of captive animals. We focused on a group of six Scarlet Macaws (*Ara macao*) at the Blank Park Zoo. During initial observations, behaviors were classified as sedentary, active non-aggressive, aggressive, and grooming. The evaluation program consisted of three stages: baseline behavior in absence of any enrichment, toy enrichment, and food enrichment. Observation periods lasted 46 minutes and were videotaped. Behaviors were recorded in two-minute intervals using scan sampling. Both enrichment phases decreased sedentary behaviors, although the decrease was more pronounced during food enrichment. Food enrichment decreased sedentary behavior while increasing active-non-aggressive behavior. Toy enrichment produced a significant increase in grooming behaviors but not in active non-aggressive behaviors. The number of aggressive behaviors was consistently low throughout all stages. Overall, our results indicate that for these macaws, toy enrichment decreases sedentary behaviors but increases grooming. In contrast, food enrichment appears to be an effective way of decreasing sedentary behaviors and increasing active non-aggressive behaviors. In addition to providing zookeepers with valuable information on the effectiveness of different types of enrichment, this method of evaluation could be applied to other animal species.

**Do belugas form expectations that can be violated when looking at novel humans or objects?**

*Meredith Nyser, Michelle Weiman, Kelly Miles, Keaton Mangi, Lindsay Dunlea, Deirdre Yeater (Sacred Heart University), Heather Hill (St. Mary's University), & Stan Kuczaj (University of Southern Mississippi)*

**P64** The representational skills of pre-verbal human children and non-human animals can be assessed by examining their reactions to properties of objects and other creatures, a procedure that was used to investigate the representational capacity of belugas (*Delphinapterus leucas*). The reaction to surprising unexpected stimuli involving humans (Study 1) and objects (Study 2) were assessed in this study. The stimuli were presented in front of a curtain within two consecutive presentations at an underwater viewing window. Three belugas housed at a facility in the Northeast were free swimming and were not reinforced for participating in the trials. It was predicted that the belugas should look longer at unexpected outcomes (when a different person/object appears in the second presentation) than at expected outcomes (when the same person/object appears in the second presentation). Gaze duration and eye preference were measured. Preliminary results indicated that belugas look significantly longer at unexpected humans and objects. Finally, for Study 1 and 2 the belugas tended to view both of the presentations with both of their eyes.

**Enrichment for aging bottlenose dolphins (*Tursiops truncatus*) in human care**

*Megan Broadway, Heidi Lyn (Institute for Marine Mammal Studies; University of Southern Mississippi), Tim Hoffland, Jamie Klaus (Institute for Marine Mammal Studies), Mystera Samuelson (University of Southern Mississippi), Emma Jarvis, Kelly Pulis, Delphine Shannon, & Moby Solangi (Institute for Marine Mammal Studies)*

**P65** Two dolphins currently housed at the Institute for Marine Mammal Studies, Gulfport, MS (IMMS) were tested with A-B-A-C (etc.) design with multiple enrichment items. All data were taken between feeding sessions and included habitat usage, object interaction, social interaction (between the dolphins and/or with people), as well as unwanted behaviors, for instance, regurgitation. The most successful intervention included highly novel items, which resulted in avoidance of the items, but positive behavioral changes including a reduction in circle swimming and an increase in social behavior. These data suggest that simply adding new "toys" to the environment may not be enough to affect behavioral change, but rather highly novel forms of enrichment are more effective in encouraging more natural behaviors.

**Rats' skilled walking performance on the elevated ladder as a function of paraquat-induced neurodegeneration of the substantia nigra pars compacta (SNpc).**

*Marisa Vennettilli, Chelsey Damphousse, & Jerry Cohen (University of Windsor)*

**P66** Humans afflicted with Parkinson's disease typically display movement disorders characterized an inability to change gait behavior to avoid unexpected obstacles. In developing rodent models of Parkinson's disease (PD) we have modified a skilled walking task that requires rats to change gait stepping behavior to avoid leg slips on the elevated ladder. Rather than simply measuring how often a rat exhibits leg slips and misses grasping rungs with unevenly spaced rungs, we examine how easily rats will change their stepping behavior to avoid a faulty, collapsible rung signaled by a lower intact rung located immediately before it. We present preliminary research that more directly measures rats' ability to step over a collapsible rung by first stepping on the prior lower rung it usually steps over during baseline training. The present study compares rats with Paraquat-induced PD-like neurodegeneration with intact control animals in their ability to avoid stepping on a signaled faulty rung.

**A killer whale's (*Orcinus orca*) response to video media**

*Pepper Hanna, Beri Brown, Kelley Winship (University of Southern Mississippi), Dianne Cameron (Six Flags Discovery Kingdom), & Stan Kuczaj (University of Southern Mississippi)*

**P67** A lone killer whale (*Orcinus orca*), Shouka, was provided 20 videos featuring cetaceans, elephants or humans as a form of enrichment. Each video was presented in two conditions: (1) with sound and (2) without sound. Shouka's behavior during all presentations was video recorded and subsequently analyzed to determine viewing time, behavioral responses, and visual laterality. Shouka spent significantly more time at the television when programs were on screen, compared to when the television was off. She was significantly more likely to watch videos accompanied by sound than those presented without sound. Shouka was also more likely to watch videos with monocular rather than binocular vision and had a right eye preference when watching videos the first time they were presented with sound. Shouka exhibited the highest rates of behavioral responses when watching videos of cetaceans. These results demonstrate that videos can be enriching to at least some marine mammals and reveal that not all video content and formats are equally interesting.

**Comparing the effectiveness of spaced vs. massed horse training within a single training session**

*Fred R. Holcomb, Kristi S. Multhaup, Savannah R. Erwin (Davidson College), & Sarah E. Daniels (University of Wyoming)*

**P68** Twenty-nine ridden horses (*Equus ferus caballus*) were repeatedly exposed to an obstacle-crossing task until they had reached a set performance criterion within a single session (maximum of five training sessions). Days between sessions, total work per session (time during which they were shaped to cross the obstacle), and total rest per session were held constant, while distribution of rest and work was manipulated by randomly assigning horses to one of two conditions. Horses in the spaced training condition experienced 2-min of work, 2-min of rest, 2-min of work, and 2-min of rest while horses in the massed training condition experienced 4-min of work, followed by 4-min of rest. Fifteen out of 16 horses in the spaced-training condition reached performance criterion (94% success) while only 5 of 13 horses in the massed-training condition reached performance criterion (39% success). Horses were also assessed on anxiety and refusal behavior through video-recordings of each training trial. Despite experiencing the same total work and rest time per session, horses in the spaced-training condition demonstrated superior task performance. These findings have applied relevance to animal management practices and extend literature on the importance of distributed practice to a new species.

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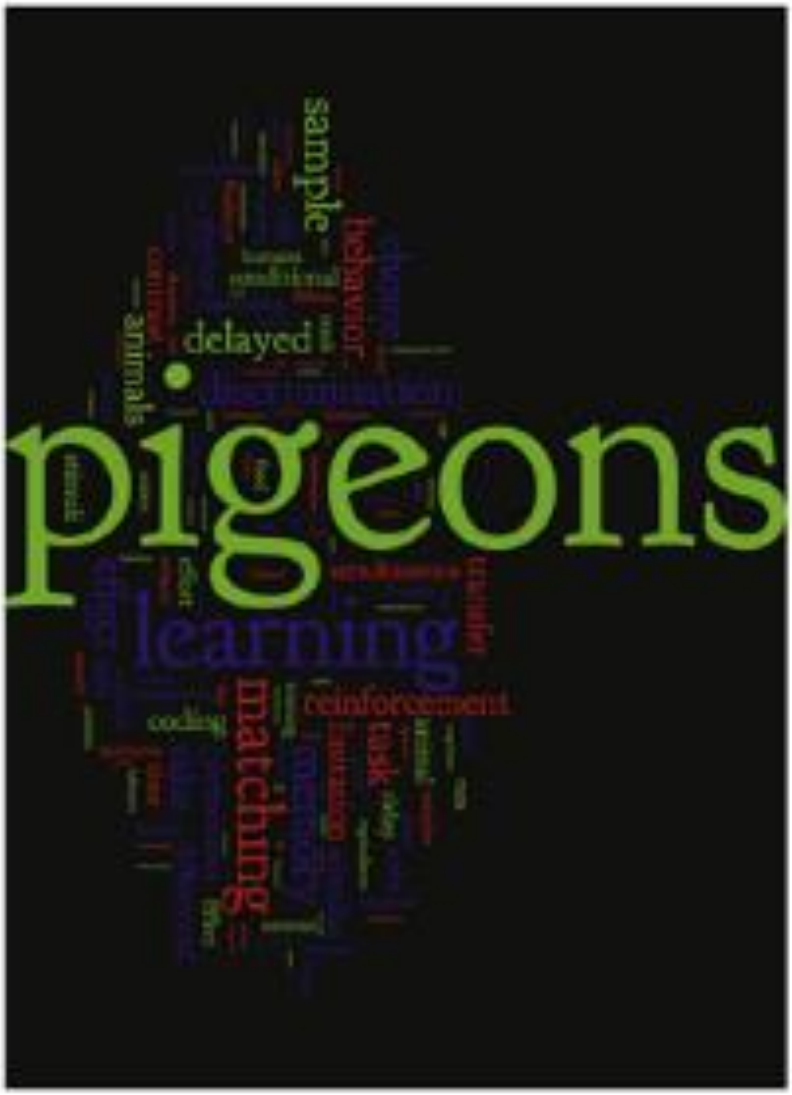
# Behavioural Processes




Editors: J.J. Bolhuis & O. Lazareva

## Special issue:

### Tribute to Tom Zentall

Guest Editor: Michael Brown

COMPARATIVE COGNITION & BEHAVIOR REVIEWS

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Christopher B. Sturdy & Marcia L. Spetch, Editors



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