28th Annual International Conference on Comparative Cognition

Sponsored by the Comparative Cognition Society

Virtually from April 7th to 10th, 2021

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Conference Schedule

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- 12:15 pm EDT **Early Career Award Presentation** and Talk by Dr. Lauren Guillette
- 1:00 pm – 4:30 pm EDT **Speaker Q&A**
    - 1:00 pm EDT Associative Processes
    - 1:30 pm EDT Attention | Auditory Discrimination
    - 2:00 pm EDT Canine Cognition
    - 2:30 pm EDT Choice
    - 3:00 pm EDT Cognitive Processes
    - 3:30 pm EDT Communication | Concept Learning | Development
    - 4:00 pm EDT Discrimination Learning | Animal Emotions

Thursday, April 8th

- 12:00 pm EDT **CCS Research Award Presentation and Master Lecture** by Dr. Irene Pepperberg
- 1:00 pm EDT **Q&A** with Dr. Pepperberg & Symposium Speakers
- 1:15 pm EDT **Social Event** honoring Dr. Irene Pepperberg

Friday, April 9th

- 12:00 pm EDT **CCS Research Award Presentation** to Dr. David Sherry and special video presentation
- 12:20 pm EDT **Social Event** honoring Dr. David Sherry

Saturday, April 10th

- 12:00 pm EDT **CCS Mentoring Event**
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- 2:00 pm – 4:00 pm EDT **Speaker Q&A**
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    - 4:00 pm EDT Social Learning | Spatial Cognition | Tool Use and Problem Solving
- 4:30 pm EDT **Wrap up CO3**

Animal Emotions

15-min talks

Canis Emoticus? How to measure dog emotions!

Anjuli Barber (University of Lincoln), Daniel Mills, Anna Wilkinson, & Kun Guo (UK)

Dogs have multifunctional societal roles as family pets, companions or in working roles. They therefore have great social and economic value but still very little is known about dogs' emotional lives. In order to safeguard dogs' welfare and maintain a satisfactory human-dog bond an appropriate understanding of dogs' emotional states is essential. We have therefore developed the EMOMETER (short for EMOtionMETER), an integrated toolbox for the measurement of dog emotions. This toolbox, relates each of the four components of emotional arousal that can be assessed in non-human animals, namely cognitive appraisal (e.g. attentional states), arousal (e.g. physiological responses), behavioural tendencies (e.g. physical activities), and communication (e.g. motor expressions and their laterality), and combines traditional with new innovative measures. We present a proof-of-concept, showing that EMOMETER can serve as a tool to evaluate and shape realistic expectations of dog emotional states, hence having the potential to promote human-dog bonds, ensure dog welfare, increase dog re-homing rates or reduce incidences of dogs bites.

From lab to barn - The impact of human emotional expressions on farm animal behaviour and applied perspective

Christian Nawroth (Leibniz Institute for Farm Animal Biology)

Human emotional expressions are not only highly informative for other humans, but also for non-human animals. Research on the interpretation of human emotional expressions by non-human animals has most often focused on other primates and canids, but studies on whether farm animals are receptive to human emotional expressions are slowly emerging. Our research shows that goats can discriminate human facial expressions with different emotional valences and prefer to interact with positive ones. We also found that goats use emotional cues from humans to guide their behavior towards a novel object. From a comparative perspective, these results provide evidence that a species domesticated for production rather than companionship is able to differentiate and act upon human emotional expressions. In order to bring research into practice, I will also outline how applied research could utilize these mechanisms to facilitate habituation processes of farm animals to new environments and to attenuate stress during routine handling practices.

How pet dogs perceive human emotions: multi-method evidence from fMRI, eye-tracking and behavioral research

Ludwig Huber, Sabrina Karl, Christoph J. Völter (University of Veterinary Medicine Vienna), Magdalena Boch, Ronald Slatky, Isabella C. Wagner, & Claus Lamm (University of Vienna)

The last decade has seen major advancements in the study of the dog's perception of emotional stimuli. Because of the challenging nature of understanding the emotions of other species, we started to combine three sophisticated methods: neuroimaging (fMRI), eye-tracking (including pupillometry) and behavioral preference testing with automatic body part tracking and gaze estimation. Here we report from two such multi-method experiments. The first one investigated the neural, perceptual and behavioral responses of dogs when watching videos of their caregiver, another familiar person and a stranger, all of them transforming from neutral to either happy or angry facial expressions. Varying the facial emotions enabled us to investigate the potential interplay of the humans' emotions and the attachment system of the dogs when facing their caregiver. In the second study, we investigated the dogs' neural, perceptual and behavioral responses to videos showing the caregiver or a stranger interacting with another dog (a real vs a fake dog) in a friendly (petting) or neutral (vet check) manner. Altogether, the convergent and cross-validating nature of our findings is promising in its prospect to overcome the hurdles of single-method approaches for the future of the non-invasive study of non-human emotions.

Is there a universal emotion expression and perception across species?

Kun Guo (School of Psychology; University of Lincoln; UK), Catia Correia-Caeiro (Primate Research Institute; Kyoto University; Japan), & Daniel Mills (School of Life Sciences; University of Lincoln; UK)

Facial expressions are a viable channel to express and perceive emotions in many animal species. Human-human emotion communication is facilitated by 'universal' facial expressions, in which the express of common expressions is associated with distinctive patterns of facial muscle movements that are culturally similar, and the recognition of these expressions is correlated with stereotypical gaze allocation at local facial regions that are characteristic for each expression, such as eyes in angry faces. Given the existence of homology in emotional behaviour and facial

musculature across mammals, it is plausible a similar universality process may be involved in inter-species facial communication. In a series of comparative eye-tracking studies, we have observed remarkable similarities in perceiving faces across human, monkey and dog participants, but the detailed gaze allocation in face-viewing is species- and experience-dependent. Crucially, these species demonstrate different gaze behaviour in viewing the same category of facial expression displayed by conspecifics and heterospecifics, and their gaze allocation is not necessarily correlated with indicative facial muscular movements for each expression, which may constrain accurate inter-species expression interpretation. We argue that social learning, rather than universality, plays significant role in discriminating even rudimentary types of heterospecific expressions.

Non-invasive polysomnography as a tool to measure emotion-related brain activity in family dogs

Anna Kis (Research Centre for Natural Sciences), Henrietta Bollló, Anna Gergely, & József Topál (Hungary)

Sleep is crucial for normal emotional functioning, yet little is known about this relationship in species other than humans and laboratory rodents. Here we first studied the effect of positive and negative social experiences on sleep macrostructure in N=16 dogs (within subject design) using non-invasive polysomnography (3-hour-long recordings). Sleep macrostructure was markedly different between conditions, with a shorter sleep latency after negative social interaction and a redistribution of the time spent in the different sleep stages. Furthermore dogs' behaviour during pre-treatments was related to the macrostructural difference between the two occasions. In the second study dogs' (N = 15, within subject design) sleep structure was manipulated by specifically disrupting REM versus Non-REM sleep, while maintaining equal sleep efficiency (monitored via non-invasive polysomnography). We found that both the number of awakenings as well as relative Non-REM (but not relative REM) duration influenced dogs' viewing patterns in a post-sleep task where sad and happy human faces were simultaneously projected with sad or happy human voice playbacks. These results prove a direct causal link between sleep and emotion processing in dogs.

Perception of emotions across species in humans and dogs

Miiamaaria V. Kujala (University of Jyväskylä)

How are humans (Homo sapiens) and domestic dogs (Canis familiaris) able to recognize the emotions of each other, across species? Dogs and humans share their living environment and social pack, as well as some mammalian emotional capabilities and perceptual mechanisms, which enable mutually beneficial interaction across species. By utilizing non-invasive physiological measurement techniques, we obtain a window into the millisecond-scale cognitive processes of human and non-human species alike. Along the trajectory from cognition to behavior, these represent the very first instances of an animal's response to the environment. In this presentation, I will summarize some recent eye gaze tracking and non-invasive neuroscientific findings on dogs' perception of human and conspecific emotional expressions. I will also explain how human characteristics, such as empathy or expertise, may affect the perception of emotions in other species such as domestic dogs. From the human point of view, it is valuable to be aware of these species-typical human characteristics, as it may offer a way to overcome their influence. Accurate understanding and evaluation of canine emotion likely also contributes to animal welfare through the everyday life of dogs and their guardian humans.

Associative Processes

10-min talks

Inadequate parental care activates nestling stress physiology without having long-term effects on spatial learning or hippocampal neuroplasticity in adult zebra finches

Michael G. Emmerson (Queen Mary University of London), Elizabeth R. Gilbert, & Kendra B. Sewall (Virginia Tech)

Inadequate parental care exposes young animals to adverse conditions (e.g. malnutrition and sub-optimal temperatures) that cause short-term stress physiology activation (e.g. raised glucocorticoid levels) and long-term reduction of hippocampal neuroplasticity markers (e.g. BDNF) and impaired hippocampal-dependent cognitive abilities (e.g. spatial learning). Such effects are reliably reported in response to maternal abandonment in uniparental species, but the effects of inadequate parental care in biparental species (e.g. from losing one parent or the presence of more siblings diluting parental care) are unclear. Here, we used biparental zebra finches to explore the effects of reducing parental care (via removal of one parent or brood enlargement) on nestling stress indicators (growth rate, surface temperature, glucocorticoid concentration), adult spatial learning abilities, and hippocampal neuroplasticity markers (e.g. BDNF). Nestlings raised by single parents or in enlarged broods grew slower and had elevated glucocorticoid levels compared to controls, but surface temperatures were similar in all birds. Adult spatial learning abilities and hippocampal neuroplasticity were also similar in all birds. Our results suggest inadequate parental care in biparental species short of complete parental abandonment is insufficiently adverse to impair neurocognitive phenotypes and emphasise the importance of exploring species-typical parental care systems when assessing the development of cognitive abilities.

5-min talks

Appetitive Conditioning in the Orange Head Cockroach (Eublaberus posticus)

Christopher Varnon, Erandy Barrera, & Isobel Wilkes (Converse College)

This presentation describes two experiments on using the orange head cockroach (Eublaberus posticus) as a model organism for behavioral research. While many invertebrate models are available, cockroaches have several benefits over others that show impressive behavioral abilities, such as bees. Most notably, cockroaches are generalists that can be maintained in controlled laboratory conditions while bees are highly specialized and many species must be kept outdoors. We believe the generalist nature of cockroaches may facilitate the development of robust procedures. In the first experiment, we investigated the ability of cockroaches to associate novel odors with appetitive and aversive solutions. We found that cockroaches learned to approach and inspect odors that were associated with a dog food sucrose solution, and also learned to avoided odors associated with salt water. The second experiment repeated the methods of the first experiment, but also tested for preferences between odors that were associated with appetitive or aversive stimuli across several retention periods, from 15 minutes to one day after the training procedure ended. We found that performance peaked 45 minutes after training, then decreased as a function of time.

Configural associations in the conditioned reinforcement procedure

Rachel Formaker, Valeria V. González, Benjamin M. Seitz, & Aaron P. Blaisdell (University of California Los Angeles)

The acquisition of instrumental responding can be supported by primary reinforcers or by conditional (aka secondary) reinforcers that themselves have an association to a primary reinforcer. While primary reinforcement has been heavily studied for the past century, the associative basis of conditioned reinforcement has received comparatively little experimental examination. Yet, conditioned reinforcement has been employed as a major behavioral assay in neuroscience studies. The present study evaluated the associations formed to a putative conditioned reinforcer. Three groups of rats received Pavlovian conditioning with a visual-auditory compound cue followed by food. After training, a lever was made available that, when pressed, produced the same trained compound (Group Compound), only the auditory cue (Group Element), or a novel auditory cue (Group Control). The rats in Group Compound pressed the lever at a higher rate than did rats in either Group Element or Group Control, demonstrating a strong conditioned reinforcement effect only in Group Compound. There was almost no difference in responding between Group Element and Group Control. This suggests that animals learned a configural association of the compound CS during training, and that presenting only an element was not sufficient to support acquisition of lever pressing due to generalization decrement.

Does a rat like the CS or what it predicts? Devaluation of a conditioned reinforcer requires its reexposure

Ken Leising, Cheyenne Elliott, Cokie Nerz (Texas Christian University), & Dave Stahlman (University of Mary Washington)

A change in motivational state does not guarantee a change in operant behavior. Only after an organism has had contact with an outcome while in a relevant motivational state does behavior change. While this is a reliable finding for primary reinforcers, it has not been established for conditioned reinforcers. We conducted an experiment with rats where lever-presses were reinforced by presentations of an audiovisual stimulus that had previously preceded food delivery; in the critical experimental groups, the audiovisual stimulus was then paired a single time with a strong electric shock. Some animals were reexposed to the audiovisual stimulus. At test, lever-presses yielded no outcomes. Animals that had been reexposed to the audiovisual stimulus after the aversive training responded less than did those that had not received reexposure. Animals that were not re-exposed did not differ from a control group that received no aversive conditioning of the audiovisual stimulus. These results reflect a change in behavior with respect to the conditioned reinforcer itself, rather than a change in the food's reinforcement value. These data to indicate that the affective value of conditioned stimuli, like that of unconditioned ones, is established when the organism comes into contact with them.

If it ain't broke don't fix it: breeding success affects nest-building decisions

Andrés Camacho-Alpízar, Tristan S. Eckersley, Connor T. Lambert (Department of Psychology University of Alberta Edmonton Canada), & Lauren M. Guillette (Department of Psychology University of Alberta Edmonton Canada; School of Biology University of St Andrews St Andrews UK)

Nest-building birds have a variety of material with which they can build their nest. Previous experiments with zebra finches (Taeniopygia guttata) show that birds learn to associate nest material with nesting success, which affects subsequent nest-building decisions when selecting between two familiar materials. In the current experiment, we ask if nesting success affects the subsequent selection of familiar versus novel materials that differ in their structural properties. Male-female pairs experienced one breeding attempt, all using the same nesting material (coconut fiber), and their breeding success was manipulated by allowing them to raise chicks (successful pairs) or removing their eggs (unsuccessful pairs). During a second breeding attempt, birds were provided with the material from their first nesting event and a novel material (white cotton string). Successful pairs used significantly more familiar material compared to novel material, while unsuccessful birds used the familiar and novel material types equally. These results show that birds use their experience in selecting between nesting materials that differ on their structural properties to build a subsequent nest.

Teamwork makes the string work: Cooperation in the African crested porcupine (Hystrix cristata)

Jordyn Truax, Joy Vincent, & Jennifer Vonk (Oakland University)

Cooperation can be defined as the process by which two or more participants perform independent actions on an object to obtain a reward for all parties. The frequency and magnitude of these behaviors in humans is unparalleled in comparison to other species, but cooperation is not uncommon in the animal kingdom. At first glance, cooperation seems to reduce individual fitness, so many theories, most notably, reciprocal altruism and kin selection, have been proposed to explain its prevalence. A full understanding of the selection pressures for cooperation can be accomplished only through studying a variety of species. Surprisingly, few monogamous species have been tested for their cooperative capacities. African crested porcupines are large rodents that pair for life. Thus, they are good candidates for cooperative behavior, although not much is understood about their social cognition. We tested two crested porcupines, one male and one female, in the loose-string task. The porcupines were required to simultaneously pull two ends of a rope to pull forward an inaccessible platform baited with food. The porcupines were able to complete the task when given simultaneous access, but further testing is needed to assess their understanding of the necessity of their partner.

2-min talks

Alteration of the kinesthetic-motor system and spatio-temporal dynamics of behavior in rats under displacement-contingent schedules

Alejandro León, Varsovia Hernández Eslava, Abraham Rivera, & Isiris Guzmán (Universidad Veracruzana)

Vestibular motor syndrome is a common alteration in laboratory rats that affect their displacement. In the present study we sought to evaluate changes in the spatio-temporal dynamics of behavior in rats with this syndrome using displacement-contingent schedules of reinforcement and to compare it with the behavior of intact animals. Subjects were four Wistar rats (two with vestibular syndrome and two without it) under 23 hours of water deprivation. The apparatus was an enlarged experimental chamber with a water dispenser located at the center of the arena. Subjects

were exposed in a counterbalanced way to a Fixed Distance 100 cm and to a Variable Distance 100 cm schedule. Once the criterion distance was satisfied, 0.3cc of water was delivered for 3sec. All subjects showed directed and functional patterns of behavior (sensibility to the water schedule) by the end of the experiment; however, the behavioral dynamics were markedly different and a clear pattern of behavior emerged late for rats with vestibular syndrome. It is suggested that the proposed methodological arrangement is useful for the study of the behavioral continuum in rats with alterations on their kinesthetic-motor system as well as with rats with no alteration.

Comparison of Behavioral Responses to Enrichment in Black-Footed Cats (Felis nigripes) and Domestic Cats (Felis catus)

Katie Gomez, & Brett Gibson (University of New Hampshire)

Enrichment treatments are frequently used in zoos to decrease the occurrence of stereotypical behaviors. These treatments are often designed based on the perception of what the caregiver thinks would be enriching for the animal. It is important to use quantitative and qualitative methods, as opposed to assumptions, to identify and test effective enrichment for individuals. Enrichments that are successful for one species may be used for other related groups of animals. Indeed, testing with enrichments across species may provide insight into more nuanced behavioral similarities and differences among them. This study explored the behavioral responses of five zoo-housed black-footed cats (Felis nigripes) in South Africa and four domestic cats (Felis catus) in the United States after being introduced to three enrichment treatments. Similar nuanced behaviors were identified in both species and the findings may have broad implications for the welfare of captive species.

Habituation in Wheel Running Rats

Tanner Raab, Daniel Torres, Jordan "Cokie" Nerz, Marissa Melo, Margarette Alvarado, Ethan Waterman, & Kenneth Leising. (Texas Christian University)

Habituation occurs when repeated exposure to an eliciting stimulus decreases response sensitivity. Habituation is independent of response loss due to sensory adaptation or fatigue (Rankin et al., 2009). Walking, as well as many other human movements can occur reflexively. Certain exercise (e.g., running) may be similarly reflexive. If exercising is at least partly reflexive, then repeated exercise should result in habituation (i.e., a loss of response vigor while exercising). This study attempted to further understand habituation by using a rat model of exercise. Wheel running is a naturally appetitive activity for rats (Mueller, Herman, & Eikelboom, 1999). In one group, the rats were placed in running wheels of different contexts every day. A variety of visual (e.g., cloud, star, or lined patterned poster boards) and olfactory (e.g., lemon, vanilla, mint) stimuli were included to create a unique context around each of four running wheels. The results were consistent with the findings of Aoyama & McSweeney (2001), such that habituation occurred within each session for both groups. In other words, the rats completed more wheel rotations early than late in a session. However, we found no effect of varying the context on habituation either within or across sessions.

Attention

10-min talks

Categorical and Item-Specific Mechanisms during Mid-Session Reversal with Pigeons

Muhammad A. Qadri, Rebecca M. Rayburn-Reeves, & Robert G. Cook (Tufts University)

To understand how categorization and memorization mechanisms are deployed during learning, eight pigeons were trained on a category-based midsession reversal task, using 80 distinct cars and 80 distinct flowers to compose the categories. In this task, one stimulus of each category was presented on each trial, with Category 1 correct for the first 40 trials and Category 2 correct for the second 40 trials. Critically, the pairs of stimuli displayed in each trial were always presented in the same order across sessions, making item-specific and category information available for each trial in the session. Using transposition tests and non-differentially reinforced probe trials, we identified that the pigeons were first controlled by the category-common features before learning the item-specific information. Additionally, both category and item-specific processing continued to occur after extended training. Implications regarding category learning and attention will be discussed.

Chimpanzees detect strange body parts: an eye-tracking study

Jie Gao, & Masaki Tomonaga (Kyoto University)

The knowledge about how body parts are located and what they look like is important for individual and species discrimination, as well as behavior understanding and prediction in animals. In this study, we tested whether chimpanzees have this body knowledge or not using eye-tracking tasks. We tested six individuals with pictures of chimpanzee bodies, focusing on manipulations of arms and legs. For either arms or legs, there were four conditions: 1) normal bodies as a control condition; 2) we misplaced an arm or a leg to a strange position; 3) we replaced an arm with a leg, or vice versa; and 4) we replaced an arm or a leg with a human arm or leg. The AOIs (areas of interest) were the strange body parts in the manipulated conditions or the corresponding ones in the control condition. We found that all three manipulated conditions had more trials in which chimpanzees had fixations to AOIs, as well as longer fixation durations to AOIs, than the control condition. The increased attention to strange body parts suggests that chimpanzees may have the important knowledge about the locations and appearances of their body parts.

Dimensional reinforcement prediction in visual discrimination task by pigeons

Olga V. Vyazovska (V.N. Karazin Kharkiv National University)

Eight pigeons (Columba livia) were trained on a stagewise go/no-go visual discrimination task. A total of 16 visual stimuli were created from all possible combinations of four binary dimensions: brightness (dark/bright), size (large/small), line orientation (vertical/horizontal), and shape (circle/square). In the first stage, we presented S+ and four S-stimuli: sharing one (brightness), two (brightness and orientation), three (brightness, orientation, and size) or no dimensional values with S+. Then all 16 stimuli were presented. At the beginning of the second stage, pigeon behavior was controlled mainly by dimensional reinforcement expectancy learned in the first stage. A statistically significant correlation between the number of the S- stimuli sharing dimension values with S+ in the first stage and the dimensional discrimination ratios during the first day of the stage 2 was very strong ($r = 0.99$, $p = 0.01$). There were no S- stimuli that shared shape value with S+ in the first stage and there were no mistake in shape discrimination at the beginning of the second stage. But three of four S- stimuli shared brightness value with S+, that is why most mistakes were made with brightness.

5-min talks

Controlling for Dogs' Use of Non-Mnemonic Strategies in a Spatial Working Memory Task

Sarah Krichbaum, Jordan G. Smith, Lucia Lazarowski, & Jeffrey S. Katz (Auburn University)

Tasks used to assess spatial working memory (SWM) in dogs typically require subjects to locate a visibly displaced object after a delay. However, such tasks often contain a major confound affecting the internal validity of results. For example, dogs can use non-mnemonic strategies, such as body orientation or sustained attention, to successfully locate the object without relying on SWM mechanisms. To further understand this issue, we designed the first study to compare dogs' performance in a SWM task with and without controlling for non-mnemonic cues. We found that dogs performed significantly worse in a control condition in which non-mnemonic cues were eliminated compared to a typical condition in which such cues were available. In addition, our results indicate a strong relationship between the percentage of delay time that a dog spends orienting their head or body to the correct stimulus position and task accuracy. These findings are the first to show a difference in SWM performance when dogs' use of non-mnemonic strategies is controlled, suggesting that typical tasks lacking such controls may not be an accurate representation of

pure SWM processes. Our results highlight the importance of considering the internal validity of SWM tasks in future work.

Hick's Reaction Time Task Performance by Pigeons

Jingxuan Guo, Mary Flaim, & Aaron P. Blaisdell (University of California Los Angeles)

Hick's Law states that reaction time (RT) increases linearly with the number of binary choices. Tasks that implement this law are commonly used to measure RT in humans, but few animal studies have investigated this phenomenon. One study found that pigeons are subject to Hick's Law, but the increase in RT was shallow compared to what is typically seen in humans. In this study, Hick's task was adapted to more closely resemble the original task for humans. In each trial, a home key and 1, 2, 4, or 8 potential targets (PTs) appear. The home key was presented at the bottom of the screen while the PTs were arranged in a semi-circle above. When subjects completed a variable number of pecks to the home key, one of the PTs became the target. Pecking at the target resulted in reinforcement. In Experiment 1 the location for each number of PTs was fixed: if two PTs were present, they would always appear at the same locations. In Experiment 2, the location of the PTs was pseudorandomized. Preliminary analysis shows no practice effect. The RT did not follow Hick's Law in either Experiment. The role of attention and stimulus-response compatibility are discussed.

Auditory Discrimination

5-min talks

Preference for and discrimination of syntactically ordered or scrambled chick-a-dee calls in black-capped chickadees (Poecile atricapillus)

Kimberley A. Campbell (University of Alberta), Marisa Hoeschele, Daniel Mann (Universität Wien), Jenna V. Congdon, Erin N. Scully, Shannon K. Mischler, Carolina Montenegro, William D. Service, & Christopher B. Sturdy (University of Alberta)

The North American black-capped chickadee (Poecile atricapillus) is a small songbird that produces an acoustically complex vocalization, the chick-a-dee call. Within this call notes occur in a set order (A>B>C>D), though in any given call note types may be repeated or omitted (Smith, 1991). Call direction (e.g., forward or reversed) is thought to affect the signal contained within a call and considering the fixed order of notes within the chick-a-dee call, we sought to determine how chickadees perceive calls that follow their natural A>B>C>D order in comparison to calls that deviate from that order. In the present study, we used two behavioural tasks to evaluate the relationship between preference for and ability to discriminate between natural- and scrambled-order chick-a-dee calls. Our results indicate that, not only do chickadees display individual preference for one type of call over the other, the magnitude and direction of their preference influences the rate at which they learn to discriminate between the two types of calls. The fact that birds applied the learned contingencies to testing stimuli suggests that natural- and scrambled-order calls may form distinct perceptual categories.

Seasonal neurogenesis in auditory brain regions of the European starling (*Sturnus vulgaris*)

Sean D. T. Aitken (Dalhousie University), Broderick M. B. Parks (Dalhousie University), Marjorie Sollows (Dalhousie University), Alexandra Oprea (Dalhousie University), Colleen A. Barber (Saint Mary's University), Leslie S. Phillmore (Dalhousie University)

During breeding season, male songbirds, like the European starling, sing stereotyped, complex songs to attract mates, and females use these complex songs to judge male fitness. Following breeding season males vocalize less frequently and their songs become more variable. Accompanying these changes in vocal behaviour are changes in neurogenesis, the process by which neurons are born, differentiate, migrate and are incorporated into neural circuits in the brain. Neurogenesis can also be affected by captivity; we therefore wanted to minimize this in our study. We examined seasonal differences in neurogenesis in three brains regions associated with vocal learning, performance, and discrimination: HVC, caudomedial nidopallium (NCM), and caudomedial mesopallium (CMM). We captured male and female starlings in spring and fall and counted neurons in these regions using an endogenous marker of neurogenesis, doublecortin. We also examined seasonal differences in stress using two blood measures: plasma corticosterone and heterophil/lymphocyte ratio. We found that male birds had more HVC neurogenesis in fall than in spring, and that female birds had more HVC neurogenesis than males. We also found a positive relationship between corticosterone levels and neurogenesis in HVC and NCM, suggesting that stress may modulate aspects of neurogenesis in specific auditory brain regions.

Why do female budgerigars and humans like rhythm?

Marisa Hoeschele (Austrian Academy of Sciences), Jan Kopač, Shahrzad Afroozeh (University of Vienna), & Daniel L. Bowling (Stanford University)

Snowball, the YouTube famous dancing cockatoo, sparked scientific investigation into the rhythmic abilities of other species. These investigations demonstrated that a variety of parrot species can move in time with acoustic rhythms, exhibiting a capacity for auditory-motor entrainment previously believed to be unique to humans. In a previous study, we asked whether parrots also enjoy rhythm in a similar way to humans. Our results showed that both female budgerigars, a small parrot species, and humans prefer to spend time in a room with a rhythmic sound than with an arrhythmic sound. Here we replicated and extended our findings using a novel apparatus that allowed both species to trigger the sounds they wanted to hear. We found that not only do female budgerigars prefer listening to rhythmic sounds over arrhythmic sounds, but they trigger them more often and listen longer than males, who preferred not to trigger either stimulus (silence). We also tested intermediary stimuli to determine what qualities of rhythm the females budgerigars are attracted to. Our results show that female budgerigars are attracted to both repetition and meter (beat structure) when choosing rhythmic stimuli. The implications of this for the biology of rhythm will be discussed.

2-min talks

Categorization of male and female zebra finch (Taeniopygia guttata) distance calls using simple acoustic features

Prateek Kumar Sahu (Department of Psychology University of Alberta Canada), Alexandra Oprea, Leslie Phillmore (Department of Psychology and Neuroscience Dalhousie University Canada), & Christopher B. Sturdy (Neuroscience and Mental Health Institute University of Alberta Canada)

Distance calls are frequently produced by zebra finches (Taeniopygia guttata) in many contexts. Male calls are generally more acoustically complex and shorter than female calls. While birds show differential behavioural and neuronal responses to these sexually dimorphic calls, the calls can be classified based on spectral and temporal features. As most of these features are complex and difficult to manipulate in an experiment,we used Linear Discriminant Analysis (LDA) based on simple acoustic features to classify male and female distance calls and compared the results with Scalar Vector Machine (SVM) and Artificial Neural Networks (ANN). LDAs correctly classified the calls with 95% accuracy. Call duration, start frequency, peak frequency are a few predicting features among many. All the calls of the testing set were correctly classified by SVM and ANN, while the training set had misclassifications. Our results reiterate the importance of call duration in the discrimination of male and female distance calls, along with providing an quantitative understanding of key acoustic features. Further studies are required to understand the importance of these features in perception.

Do budgerigar's prefer consonance? Negative results from two place preference studies and their implications

Bernhard Wagner (Acoustic Research Institute Vienna), Daniel Liu Bowling (Department of Psychiatry and Behavioral Sciences Stanford University School of Medicine), & Marisa Hoeschele (Department of Cognitive Biology University of Vienna)

"Consonance" describes the perceived pleasantness of musical tone combinations characterized by small integer frequency ratios. Such tone combinations occur naturally in the harmonic series present in harmonic sounds such as the human voice and non-human animal vocalizations. It has therefore been suggested that human preference for consonance may be rooted in a preference for the human voice. If this were the case, we should expect other species with harmonic vocal output to also show attraction to consonance. We conducted a place preference test with budgerigars (Melopsittacus undulatus) and humans, allowing them to freely spend time with either a consonant or a dissonant version of a piano melody and recording time spent with stimulus types as a measure of attraction. Human females spent more time with consonant stimuli, but males spent equal time with both. In budgerigars neither males nor females showed a significant bias towards either stimulus type. Subsequently, we ran the experiment with consonant and dissonant stimuli designed to be more ecologically relevant to budgerigars. Yet no preferential response could be observed. Considering the differences between human and budgerigar vocal behaviour in relation to the harmonic series has important implications for future directions in non-human animal consonance research.

Canine Cognition

10-min talks

Can Spot go the distance? Owners' predictions of dog impulsivity

Jeffrey R. Stevens, Madeline Mathias, Megan Herridge, Kylie Duvall, & London Wolff (University of Nebraska-Lincoln)

Impulsivity is an important behavioral trait in dogs that affects their relationships with humans. But how well can owners predict their dog's levels of impulsivity? Two studies have investigated how owner perceptions of their dog's impulsivity correlate with the distance traveled in a spatial impulsivity task (smaller, closer vs. larger, more distant food treats) with mixed results (Brady et al., 2018. Applied Animal Behaviour Science and Mongillo et al., 2019. Animals). This study aimed to replicate these studies by correlating owner responses to the Dog Impulsivity Assessment Survey (DIAS) and the dog's maximum distance traveled in a spatial impulsivity task. We found that neither the DIAS overall score nor it's three subcomponent scores correlated with dog distance traveled. This result replicates Mongillo et al.'s lack of an relationship but does not replicate Brady et al.'s effect, questioning the generalizability of owner's predicting dog impulsivity. The lack of replication could result from differences in methodology and sample populations, but it raises intriguing questions about possible differences in dog characteristics and owner knowledge of their dogs across cultures.

5-min talks

"Do that again!" Training dogs (Canis lupus familiaris) to repeat recent actions on cue

Allison Scagel, & Eduardo Mercado (University at Buffalo)

Dog training usually depends on associating cues with specific actions. What exactly dogs remember about those actions remains unclear. Most studies of nonhuman animal memory focus on memories for objects, images, or spatial information. Less is understood about animals' abilities to flexibly retrieve memories of recent actions and to use those memories to guide their responses to cues. One way to reveal how animals encode and retrieve memories of their own actions is by testing their ability to self-imitate. Training dogs to repeat actions on cue can potentially reveal what they remember about their recent actions and how long they retain this information. This project examined self-imitation in domestic dogs using techniques previously applied to bottlenose dolphins, rhesus macaques, and pinnipeds. We tested two dogs' abilities to recall five trained behaviors immediately after completing an action and after a delay. Both dogs learned the "repeat" cue and could correctly repeat actions multiple times and after a delay. The dogs are also being tested on the ability to repeat novel behaviors upon first exposure, including self-selected actions. This study can advance our knowledge of what dogs remember and how they represent recent actions.

Are dogs motivated to help humans?

Blanca Vidal Orga, Juliane Bräuer (Max Planck Institute for the Science of Human History), Theresa Epperlin, Karel Novak, Katrin Schumann, & Stefan Schweinberger (Friedrich Schiller University Jena)

The project focuses on cooperative behavior displayed by domestic dogs, when presented with a situation where a human expresses a need for help. Cooperation can be defined as a type of prosocial behavior, aimed at voluntarily benefiting an external party other than the own individual. More specifically, cooperation falls under the category of instrumental helping, in which an individual behaves in a way that, regardless of incurring into a cost for their own sake, allows another individual to achieve their goal. For this to happen, two essential elements must be present: recognition of the other individual's goal, and on the other hand, motivation to help In other to determine the presence of these two factors in the behavior of dogs when embedded in a situation of cooperation with a human, we investigate whether dogs engage in instrumental helping towards humans in an experimental setting with dog-owner dyads, where we vary whether the human communicates their goal in the situation (wanting to retrieve an object from a locked room that the dog knows how to open) and the level of training of the dog (regular obedience training vs. certified education -i.e.: rescue or police dogs).

Methodological features that influence dogs' detour performance in the cylinder task

Lucia Lazarowski, & Sarah Krichbaum (Auburn University)

Inhibitory control refers to the ability to refrain from a counterproductive or prepotent response, enabling adaptive behavior across various contexts. Detour paradigms such as the cylinder task are commonly used to assess inhibitory control in non-human animals, in which the subject must refrain from reaching for a visible but directly inaccessible reward in favor of an indirect path. However, numerous studies have failed to find correlations between dogs' performance on the cylinder task and other measures of inhibitory control, calling into question the validity of the task

as a measure of inhibitory control. Further, non-cognitive features related to the reward, apparatus, and individual factors have been suggested to confound performance. Across a series of experiments, we evaluated the effects of reward type and visibility on cylinder task performance. Our results indicate that dogs' detour performance is differentially influenced by the type of reward used during testing, possibly reflecting arousal levels induced by higher- or lesser-preferred rewards. Other factors including perceptual characteristics of the task and experience also influenced performance. These results suggest that procedural modifications may be useful in examining the utility of the cylinder task as a measure of dogs' inhibitory control.

Pet dogs' neural responses to the visual perception of their caregiver positively interacting with a conspecific: an fMRI study

Sabrina Karl (University of Veterinary Medicine Vienna), Ronald Sladky, Claus Lamm (University of Vienna), & Ludwig Huber (University of Veterinary Medicine Vienna)

In humans, observing a beloved person enjoying a pleasant interaction with another social rival can result in increased attention and fear of losing a valued relationship. Anectodical notions suggest that dogs could experience similar emotions. While undergoing fMRI, twelve pet dogs perceived 10s-videos of either their caregiver or a stranger petting another dog (social interaction with a positive joint affectivity), or examining its head (non-social, task-oriented, non-affective vetcheck). Based on comparative studies in humans, we hypothesized that dogs distinguish between both interactions and persons, and show increased activations in the amygdala, the insular cortex, and the hypothalamus, areas associated with affective evaluation, interoceptive awareness, and autonomic regulation in humans. More specifically, when contrasting with the non-social interaction, increased activations in the left amygdala and the insula during the social interaction were observed. In addition, we found significant activation in the hypothalamus for the contrast between the caregiver's vs. stranger's social interaction. These findings suggest that the dogs differentiated between the two interactions with higher attention, arousal, and salience attribution towards the social interaction. We will discuss the similarity of the dogs' neural responses to the visual perception of their caregiver positively interacting with a conspecific with jealousy-induced responses in humans.

The Effect of Repeated Testing on Judgement Bias in Domestic Dogs (Canis Familiaris)

Clara Wilson, Kerry Campbell, Gareth Arnott (Queen's University Belfast), Nathaniel Hall (Texas Tech University), & Catherine Reeve (Queen's University Belfast)

We tested dogs (N=11) on a judgement bias task once a week, for five weeks, to investigate whether there was an effect of repeated testing on their responses. Judgement bias was assessed based on the dogs' latency to approach a bowl placed in one of three ambiguous locations (Near Negative, Middle, Near Positive) between non-baited (Negative) and baited (Positive) bowl locations. Generalized Linear Mixed Model Analyses revealed that the week number (1, 2, 3, 4 or 5) had a significant effect on the dogs' latencies to reach the ambiguous bowl locations ($F_{4,34}=16.072$, $p<.001$), with visualisation of the data revealing that dogs were slower to approach the ambiguous locations as the number of test sessions increased. Week number also had a significant effect on the number of times the dogs did not approach the bowl ($F_{4,425}=14.748$, $p<.001$), with the number of no approaches increasing with each session. Results suggest that, with repeated exposure, the dogs learned that the ambiguous locations were not rewarded. We conclude that this judgement bias task is limited in its application across multiple exposures and repeated results should be interpreted with caution as they may reflect learning rather than affective state.

2-min talks

Head-Mounted Wearable Eye-Tracking in the Domestic Dog: A New Method

Madeline H. Pelgrim (Brown University), Julia Espinosa (University of Toronto), & Daphna Buchsbaum (Brown University)

Humans rely on dogs for countless tasks, ranging from companionship to highly specialized detection work. In many of the tasks found in both cognitive research and in their daily lives, dogs must navigate a human-built visual world, yet comparatively little is known about what dogs look at as they move through their environment. We developed and evaluated a novel method for eye-tracking in dogs using an easy to use head-mounted mobile apparatus designed for dogs and mounted onto commercially available dog goggles. This new method, newly adapted from systems that are widely used in humans, allows for more naturalistic behaviours, namely walking around and interacting with real-world stimuli. Using this new method, we trained 7 dogs in relatively little as compared to traditional stationary methods (34 days of at-home training requiring on average with 1.1 in-lab visits). Using this new method, we explored dogs searching behaviors in a simple forced-choice treat finding task. We successfully calibrated and validated the eye-tracking data for 5 dogs that contributed data (data collection stopped due to COVID-19). This is the first robust, easily deployed and widely applicable eye-tracking method for dogs and has significant implications for future research into both working and pet dogs.

Investigating indirect and direct reputation formation in dogs and wolves

Hoi-Lam Jim, Marina Plohovich, Sarah Marshall-Pescini, & Friederike Range (University of Veterinary Medicine Vienna)

Reputation is a key component in social interactions of group-living animals and can be formed through direct or indirect experience. Considering dogs' dependence on humans, it may benefit them to form reputations of humans to choose an appropriate partner with whom to interact. Aside from the current mixed results on whether dogs are capable of this sociocognitive ability, another aspect is whether it is an effect of domestication or inherited from their ancestor, wolves. This study investigates whether dogs and wolves can form reputations of humans through indirect and/or direct experience in a begging situation.

Seven wolves and six dogs, equally raised and living at the Wolf Science Center, participated in an experiment that comprised three parts: baseline, observation, and testing. In the observation phase, the subject saw a familiar dog interact with two people – one generous and one selfish. The observer could then choose which person to approach in the test phase. The subjects were also tested after direct experience with the two people.

Preliminary results suggest that dogs and wolves cannot form reputations of humans through indirect or limited direct experience. This research may further our understanding of how domestication has changed dogs' sociocognitive abilities.

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CCS Early Career Award Winner

15-min talks

Do birds with experience use social information?

Lauren M. Guillette (University of Alberta; University of St Andrews), Tristan Eckersley (University of Alberta), Alexis J. Breen (University of St Andrews; Max Planck Institute for Evolutionary Anthropology), Andrés Camacho-Alpizar, Connor T. Lambert, Gopika Balasubramanian (University of Alberta), & Susan D. Healy (University of St Andrews)

Inexperienced nest-building birds, those that have neither interacted with nest material nor built a nest, use social information when building their first nest. Specifically, first time nest-building zebra finches (Taeniopygia guttata) copy the material choice of familiar conspecifics. These data are consistent with the hypothesis that social information is advantageous when an individual lacks their own (asocial) knowledge. Here I talk about the results from two experiments that test whether birds with experience also use social information (i.e., will they copy as do inexperienced birds). In experiment 1 we provided zebra finches with an asocial experience: building a nest with 100 pieces of material. As the material was either stiff (preferred) or flexible we could also determine whether asocial information about the quality of material affected whether the birds used social information. In experiment 2 we provided the birds with a complete nesting experience and manipulated whether their attempt was successful (raised chicks) or unsuccessful (eggs removed). In this way we could determine whether satisfaction with asocial information affected social information use. In experiment 1 birds that built with the preferred material did not copy. The birds that built with the flexible material, however, increased their preference for the material used by conspecifics observed building with that material. Birds in experiment 2 that built complete nests did not copy regardless of whether or not they successfully produced chicks. The use of social information for experienced nest builders appears to be based on the quality and extent of their previous experience.

Choice

10-min talks

Decision-making under ambiguity as a cross-species measure of animal affect

Vikki Neville (University of Bristol), Shinichi Nakagawa (University of New South Wales), Josefina Zidar (Linköping University), Elizabeth S Paul (University of Bristol), Malgorzata Lagisz (University of New South Wales), Melissa Bateson (Newcastle University), Enrico Sorato, Hanne Løvlie (Linköping University), & Michael Mendl (University of Bristol)

Decision-making under ambiguity is increasingly used as a measure of animal affect, and there is now a substantial literature on its use across different species, manipulations of affective state, and study designs. We conducted two systematic reviews and meta-analyses to assess the reliability and validity of this measure and to investigate the potential methodological factors moderating the influence of affect on animals' decision-making under ambiguity. One meta-analysis focused on pharmacological manipulations of affective state and the other on non-pharmacological manipulations. Data were extracted from total of 91 articles studying 22 different species. Overall, a relationship between decision-making under ambiguity and affect was supported, with animals in a relatively better treatment typically responding more 'optimistically' towards ambiguous stimuli than animals in a relatively worse treatment (e.g. affectively negative or punishing), whereas animals in a relatively worse treatment responded more 'pessimistically'. However, there was substantial variation in the extent to which putative affect was found to alter decision-making, which was partially explained by several moderating factors including: sex, task type (i.e. go/no-go vs. active choice), stimulus type (e.g. tactile, visual, auditory), stimulus ambiguity level, reinforcement scheme (e.g. reward-reward, reward-punishment), neurobiological effect (e.g. anxiogenic/depressant vs. anxiolytic/antidepressant), and neurobiological target of the pharmacological manipulation.

Sequential choice by pigeons and humans: Don't let the pigeon chair the search committee.

Walter Herbranson (Whitman College)

The Secretary Problem is a brainteaser of interest to mathematicians and behavioral scientists, usually articulated as a hiring decision. Individual applicants are considered sequentially, and each can either be hired or irrevocably rejected. If an applicant is rejected, the next is presented, and another hire/reject decision is made. The mathematically optimal strategy is to reject the first n/e applicants, and then select the first applicant that ranks higher. To see if pigeons could learn the optimal strategy, a task was designed with the same structure and solution as the Secretary Problem. Pigeons viewed sequences of 10 colors, associated with different probabilities of reinforcement. Birds made a decision after seeing each to accept (by pecking the color) or reject (by pecking an alternate "reject" key). After accepting, birds received reinforcement according to the probability linked to that color. At the end of training, pigeons' responses matched the optimal strategy on only 15% of trials, and the consistently viewed fewer applicants than is optimal. Nevertheless, pigeons earned close to the optimal number of reinforcers. In a second experiment, human participants faced the same task. Like pigeons, they failed to adopt the optimal strategy, making their selections too early.

What underlies cognitive bias? An investigation with bumblebees

Caroline Strang, & Felicity Muth (University of Texas at Austin)

Cognitive bias tasks are often used to investigate emotion-like states in animals, with relevance to animal welfare. In these tasks, individuals are trained on a S+/S- discrimination, they are then given a 'positive' or 'negative' experience before being presented with an 'ambiguous' stimulus that is perceptually between the trained stimuli. A diminished or enhanced response to the ambiguous stimulus is described as 'pessimistic' or 'optimistic' respectively, with those terms serving as operationalized definitions of emotion-like states. While this paradigm has now been used across a broad variety of taxa, including invertebrates, the cognitive mechanism underlying the observed behavior remains unclear. Using bumblebees trained to artificial flowers, we tested the hypothesis that stimulus response curves associated with the S+/S- are altered by motivational state. We found that our experimental manipulation of a 'positive' (motivating) experience caused a change to stimuli response curves. These results indicate that 'optimism' and 'pessimism' may be explained by changes to stimulus response curves and that motivational state may alter how stimuli are classified.

5-min talks

A comparative perspective on the paradox of choice

Maisy D. Bowden (Georgia State University)

The paradox of choice is the tendency to be drawn to more choices or larger arrays, even when there are negative consequences when choosing from larger arrays (choice overload). This phenomenon has been primarily studied in adult humans, and it is unclear whether the paradox of choice may be shared among mammals or whether it could result from cultural influences relevant to humans. Research with monkeys and young children sheds light on the evolutionary/developmental precursors of the paradox and may highlight the human-uniqueness of this effect. I found that children exhibited choice overload when choosing among six and twelve toys but not when choosing among three toys, in line with my hypothesis. No evidence of choice overload was found for monkeys, although this may be due to methodological limitations in the use of computerized tasks to assess this. Consistent with previous literature on choice and control, monkeys also demonstrated a preference for more options over fewer options. The results of this study were not conclusive enough to answer the question "is the paradox of choice a phenomenon shared with other species?" However, this study was a promising first attempt, and sets the stage for future research on this topic.

Optimist or pessimist? Individual differences in decision-making under ambiguity

Marko Bračić, Lena Bohn, Sylvia Kaiser, Norbert Sachser, & S. Helene Richter (Department of Behavioural Biology; Münster Graduate School of Evolution; University of Münster)

Is the glass half-full or half-empty? This question reflects that some people tend to expect positive outcomes and other negative outcomes: optimists and pessimists. Recent studies found a similar phenomenon in other animals when they make decisions in ambiguous situations (so-called cognitive judgment bias). "Optimism" levels differed largely between individuals in those studies; hence we aimed to explore those individual differences in "optimism". Specifically, we investigated the influence of genotype and environment on "optimism" levels in laboratory mice. Individuals of two strains (C57BL/6 and B6D2F1) lived in two different housing environments (standard or enriched). Using an established touchscreen paradigm, we assessed their "optimism" levels by scoring their decisions in ambiguous conditions. Furthermore, to investigate if individual differences are consistent over time, we repeated the test three more times. As in previous studies, we revealed vast variation in the level of "optimism" among individuals. Interestingly, this variation could neither be explained by genetic background or environmental factors alone nor by their interaction. However, between-individual differences were moderately consistent across time, indicating that "optimism" is a trait.

What You See May Not Be What You Get: How Expectation Affects Pigeon's Choice

Daniel Peng, Wilson Clayton, Jacelyn Sturgill, & Thomas R. Zentall (University of Kentucky)

A pigeon is offered 2 pellets of food vs. 1 pellet, but if choses the 2 pellets, one of them is taken away so both alternatives provide only 1 pellet. Thus, pigeons should show indifference or possibly they should prefer the alternatives that show 2 pellets. Instead, they prefer the alternative that shows then 1 pellet. Losing 1 pellet provides negative contrast. What if a pigeon is offered 2 pellets of food vs. 1 pellet, but if choses the 1 pellet it gets a second pellet? In either case it gets 2 pellets. Now it prefers the alternative that provides it with a second pellet. Gaining a second pellet provides positive contrast. What is expected affects the value of what is obtained. The same is likely a characteristic of human gambling behavior. Given the mostly unlikely event of winning the lottery or slot machine pull, gamblers expect to lose. When they occasionally win, the unexpected win increases the absolute value of the win leading to enhanced excitement and additional gambling.

2-min talks

If I Fits I Sits: A Citizen Science Investigation into Illusory Contour Susceptibility in Domestic Cats (Felis silvestris catus)

Gabriella E. Smith (Hunter College (CUNY)), Philippe A. Chouinard (La Trobe University), & Sarah-Elizabeth Byosiere (Hunter College (CUNY))

Cats have a well-known tendency to sit in spaces such as boxes, laundry baskets, and even outlines taped on the floor. This study asks whether domestic cats (Felis silvestris catus) will also sit in illusory enclosures, utilizing their attraction to box-like spaces to assess their perception of the Kanizsa square illusion. Carried out during the COVID-19 pandemic, this study had citizen science participants to print out and place stimuli pairs on the floor. Owners observed and videorecorded their cats' behavior with the stimuli and reported findings from home over the course of six trials. Of the 30 cats that completed the study's trials, nine selected at least one stimulus by sitting within the contours with all limbs for at least three seconds. This study revealed that cats selected the Kanizsa illusion just as often as the square and more often than the control, indicating that domestic cats may treat the subjective Kanizsa contours as they do real contours. Given the drawbacks of citizen science such as participant attrition, future research

would benefit from controlled replication. This study demonstrates the potential of more ecologically valid study of pet cats and provides an interesting new perspective into cat visual perception research.

Preference for Paternal, Maternal, and Hybrid Males by Long-tailed-x-Bengalese Finch Hybrid Females

Moises Rivera (The Graduate Center of the City University of New York), & Sarah M.N. Woolley (Zuckerman Institute at Columbia University)

Filial imprinting in Estrildid finches plays an important role in the attention to and learning of conspecific behaviors crucial for adult social behaviors. In the majority of Estrildid mating systems, males display courtship behaviors (e.g., song, dance, plumage advertisement) toward conspecific females, and females select conspecific males based on their preference for these displays. Hybridization presents a series of complications leading to the maladaptive development and exhibition of genetic, physiological, and behavioral traits. The present study explores whether female Long-tailed-x-Bengalese finch hybrids exhibit social preference for males of their maternal, paternal, or sibling (hybridized) species. We tested female Long-tailed finches, Bengalese finches, and Long-tailed-x-Bengalese hybrids using an iterative Miller two-choice paradigm. We predicted that females would prefer males of their paternal species given the important role of males as song tutors in Estrildids, and would prefer hybrid males given that they were tutored by male Long-tailed finches. We found that female hybrids exhibit preference for males of their maternal species over males of their paternal species as well as over hybrid males.

Cognitive Processes

10-min talks

Serial reversal learning in fish and reptiles

Vera Schluessel (University of Bonn)

Serial reversal learning is considered a reliable approach for the testing of behavioral flexibility, which animals that inhabit fluctuating environments are expected to possess. Four species, the grey bamboo shark, the ocellate river stingray, a Malawi cichlid and the New Guinea snapping turtle were comparatively tested in a visual serial reversal tasks using two dimensional geometric objects. Experiments were conducted as two-alternative forced-choice tasks, in which a food-rewarded stimulus and an unrewarded alternative stimulus were presented in pseudorandom order on either side of a barrier. The learning criterium (LC) was determined to be at ≥70% correct choices over three consecutive sessions. In the session after an individual reached LC, food was associated with the alternative stimulus, and the reward association continued to be switched whenever LC was achieved. Overall, most individuals of all four species reversed successfully at least once. Most stingrays, sharks and turtles demonstrated progressive improvement across (up to) ten reversal phases, thus showing the ability to inhibit a previously learned association faster with experience, an indication for rule learning. Cichlids also successfully reversed up to seven times, but did not significantly improve performance over time. Stingrays took much longer than the other three species to reverse learning.

Servomechanisms operating on oscillators as a basis for navigation and orientation

Ken Cheng (Macquarie University)

I have previously argued that navigation can be characterized largely as the operation of navigational servomechanisms. I now expand this idea further by claiming that many organisms navigate (getting to a particular place) or orientate (getting to a better place) by having servomechanisms operate on ongoing oscillators. Oscillators, considered a basic unit of action by Gallistel, run cyclically, an example relevant to navigation and orientation being the movement of limbs. Navigation and orientation consist in modifying the work of oscillators by way of servomechanistic feedback mechanisms. In a wide-ranging comparative spirit, examples will be given from global scale navigation in sea turtles swimming across oceans, to small-scale orientation in nematode worms, to the micro-scale of orientation in single-celled eukaryotes and bacteria (prokaryotes), with perhaps the best developed models in ant navigation. Servomechanisms operating on oscillators make perhaps a basal form of cognition and intelligence that has spread across many lifeforms.

Visual Discrimination of Potential Prey by Bottlenose Dolphins

Heidi E. Harley (New College of Florida and The Seas at Epcot® Walt Disney World® Resorts), Wendi Fellner, Kim Odell, & M. Andrew Stamper (The Seas at Epcot® Walt Disney World® Resorts)

Prey capture requires stealth; echolocation clicks may alert prey to dolphins' interest. Can vision serve? In this study, 3 adult male bottlenose dolphins living in a large mixed-species salt water habitat discriminated 35 marine species in a matching task: Dolphins viewed a photo sample and chose among 3 video alternatives in 18-trial sessions balanced for sample identity and alternative position. Observers naïve to the sample identified dolphins' choices. In later sessions, sample stimuli alerted the dolphins to the opportunity to engage in these trainerless, self-initiated "foraging" sessions; correct matches led to food fish appearing at the water's surface. The dolphins successfully discriminated 30 3-alternative sets (5 sessions per set; M=81.20%, SD=10.04%), indicating they have the potential to forage using vision alone. The dolphins also chose to participate 97% of the time with an average latency to response of 5 sec to first samples of sessions, suggesting that they were motivated to participate in these cognitive problem-solving sessions.

5-min talks

Devaluing Time in a Within Session Reversal Task: Can Pigeons Win-Stay/Lose-Shift in Sequence Learning?

Angelle Antoun (Emory University), Muhammad A. Qadri (College of the Holy Cross), & Robert G. Cook (Tufts University)

Midsession reversal tasks allow one to study the organization of extended behavior and sequence learning. Past research indicates that pigeons (Columba livia) track the passage of time to anticipate when reversals will occur, a timing strategy that interferes with sequence learning. Our goal was to shift pigeons from a timing strategy to utilizing sequence information in a four-phase, four-item within session reversal task. To reduce the reliability of time as a cue,

phase lengths and inter-trial intervals were varied randomly, and a correction procedure was used. Test sessions with all choices reinforced revealed pigeons were no longer exclusively using timing strategies. To determine if this shift in strategy affected sequence learning, probe trials were presented using items from an alternate sequence set as lures. The pigeons reliably ignored alternate set lures, adhering to the appropriate sequence in a way not previously found, indicating they had gained knowledge of the sequence set. Thus, when timing reliability was reduced, pigeon sequence learning improved.

Implicit versus explicit learning

Alexandra Nosarzewska, Daniel Peng, & Thomas R. Zentall (University of Kentucky)

A distinction has been made between implicit (unconscious) learning and explicit (declarative rule) learning by humans. Recent theory suggests that delayed reinforcement can eliminate implicit learning but preserve explicit, rule-based learning (Smith & Church, 2018). In the present research, pigeons learned color matching-to-sample task, however, reinforcement was delayed by 1 trial. That is, the pigeons received feedback for matching on trial N only after responding on trial N+1. When a non-correction procedure was used, three of eight pigeons showed some indication of learning. When a correction procedure was introduced (with up to 5 repeats of the incorrect trial), all pigeons learned the task. Thus, contrary to theory, either pigeons can learn implicitly over significant delays with interference from the current trial or pigeons are capable of explicit learning involving the 1-back rule.

Pigeon (Columba livia) Performance on the Delayed Match to Sample (DMTS) as a Function of Age

Mary Flaim (University of California), & Aaron P. Blaisdell (Los Angeles)

The delayed match to sample (DMTS) task, where subjects are first shown a sample, then select the matching comparison after a delay, is a measure of working memory that has been used across a wide variety of ages and species. When a small stimulus set is used, for example two colors, the prefrontal cortex (PFC) is implicated in performance. Tasks that rely on the PFC are sensitive to age related declines, and age-related deficits in the DMTS have been found in humans and non-human primates, where older subjects generally show worse performance compared to younger subjects. Pigeons show similar performance to non-human primates, and performance relies on an equivalent underlying brain structure, the nidopallium caudolateral (NCL). Yet age-related changes in DMTS have not been investigated in this species. Pigeons can live 20 years in captivity and show age-related deficits in performance on hippocampus-dependent memory tasks. We administered the DMTS, using two colors as the stimulus set, to pigeons ranging in age from 1 - 18 years old to investigate age-related changes in pigeon NCL function. We found subject age to have no effect on performance.

Public perception of reptile cognition

Agnese Crisante, Oliver Burman, & Anna Wilkinson (University of Lincoln)

Reptiles have become increasingly common as pets. Unfortunately, this popularity has resulted in a concomitant rise in the prevalence of poor health and welfare. A major reason for the inability to determine welfare problems at a sufficiently early stage is the common perception that reptiles are not behaviourally or cognitively complex and therefore do not have complex captive needs. Recent research has found remarkable cognitive abilities in this group. Since there is a relationship between how intelligent an animal is considered and it's welfare requirements in captivity, this study investigated public understanding of reptile cognition (e.g. learning and memory capacity) and their welfare needs (e.g. the provision of environmental enrichment and complexity). We also investigated whether this differed between reptile owners and non-owners. The data was collected via an online questionnaire. The results will be used to identify major knowledge gaps in public perception of reptile cognition and will be considered in light of recent research findings in the area. They will be used to allow targetted future interventions focused on the education of pet owners and the improvement of animal welfare.

Recognition of Novelty in Leopard Geckos (Eublepharis macularius) and Tiger Salamanders (Ambystoma tigrinum)

Shannon M.A. Kundey, Mitchell Phillips, Aniela Gruzenski, & Hailey Williams (Hood College)

Novelty recognition helps organisms identify changes over time. Studies to date have usually involved mammals, particularly rodents. We explored leopard geckos' (Eublepharis macularius; Experiment 1) and tiger salamanders' (Ambystoma tigrinum, Experiment 2) sensitivity to spatial and object novelty. We used an exploratory paradigm adapted from rodents where time spent near objects in an open-field box was compared. Subjects first habituated to three objects. To evaluate spatial novelty recognition, one object was moved to a new location. Subjects again habituated to the objects' locations. To evaluate object novelty recognition, one object that had not been moved earlier was replaced with an unfamiliar object. Results indicated when one object was moved to a new location, geckos and salamanders spent more time near that spatially-displaced object. Additionally, when a familiar object was replaced with a new object, geckos and salamanders spent more time near the substituted object. These results suggest geckos and salamanders recognized changes in objects' identities and locations. Geckos and salamanders acted differentially

depending on familiarity in both spatial and object domains. These results support attempts to include lesser-studied species in our efforts to characterize cognition.

The Effect of a Distractor on the assessment of Pigeons' Delay Discounting

Peyton Mueller, Daniel Peng, & Thomas R. Zentall (University of Kentucky)

A procedure for the assessment of delay discounting by pigeons is to present a red light for a specified time. If the pigeon pecks the red light, it receives 1 pellet of food. If it does not peck the red light, the light changes to green and a peck to the green light provides 5 pellets. In the present research, on some trials, we turned on a white light (a distractor) at the start of each trial. Pecks to the white light had no programmed consequence. We found that pigeons were able to withhold pecking the red light and wait for the green light better on white light distractor trials than without the white light. These results are analogous to findings by Mischel with the "marshmallow test." When children were offered 1 marshmallow now or 2 marshmallows after 15 min, they were better able to wait for the second marshmallow if they distracted themselves. In our experiment the white light served as an external distractor.

2-min talks

Searching for inhibition of return in foraging strategies of Clark's Nutcrackers (Nucifraga Columbiana)

Angie Dion, Haley Knudson, Mara So, Gabrielle Clark (Dalhousie University), Debbie M. Kelly (University of Manitoba), Raymond M. Klein, & Leslie S. Phillmore (Dalhousie University)

Many avian species forage for food and store it for future consumption, a behaviour known as caching. In retrieving caches, novelty seeking may make foraging more efficient as it would discourage revisiting depleted locations. In humans, inhibition of return (IOR) is the inhibitory tagging of previously viewed locations on a screen during visual search. Here, we investigated whether there was evidence of an IOR-like mechanism in Clark's Nutcrackers during cache retrieval. We hypothesized if they used an IOR-like mechanism to drive retrieval behaviour, they would not revisit previously depleted locations or locations where no seeds were cached. We analyzed videos of male and female nutcrackers retrieving pine nuts they had stored in a previous session. We did not find evidence for IOR-like behaviour in preliminary data analyses. However, this could be for a number of reasons, for example, the videos we analysed were from a study not designed to specifically test for IOR in foraging, or IOR is present in other avian species besides nutcrackers. Further research is required to determine definitively if IOR like-mechanisms are used by nutcrackers or other food-storing avian species.

Communication

10-min talks

The impact of anthropogenic noise on individual identification via female song in Black-capped chickadees (Poecile atricapillus)

Carolina Montenegro, William Service, Erin Scully, Shannon Mischler, Thomas Benowicz, Katelyn Fox, Prateek Sahu, Kimberley Campbell, & Christopher Sturdy (University of Alberta)

Anthropogenic noise can mask acoustic signals that animals produce, thus jeopardizing perception and discrimination. However, little research has focused on how anthropogenic noise affects the identification of acoustic communication signals. Black-capped chickadees produce several vocalizations including the fee-bee song which is used for mate attraction and territorial defense, and contains information about dominance hierarchy and native geographic location. Previously, we demonstrated that black-capped chickadees can discriminate individual female chickadees via their fee-bee songs. The current study used an operant discrimination go/no go paradigm to discern whether the ability to discriminate between individual females chickadees by song would be impacted by differing levels of anthropogenic noise. Following discrimination training, two levels of anthropogenic noise (low: 35-40 dB; high: 70-75 dB) were played simultaneously with stimuli to determine how anthropogenic noise would impact discrimination. Our results show that discrimination performance declined as the noise levels increased. These results add to the growing literature underscoring the impact of human-made noise on avian wildlife, specifically the impact on perception of auditory signals.

In Sync or Vocal? How Bottlenose Dolphins Coordinate in a Cooperative Task

Kelly Jaakkola, Emily Guarino, Katy Donegan, Christina McMullen (Dolphin Research Center), & Stephanie L. King (University of Bristol)

Cooperation experiments have long been used to explore the cognition underlying animals' coordination towards a shared goal. While the ability to understand the need for a partner has been demonstrated in a number of species, far fewer studies have explored the behavioral strategies animals use to coordinate their behavior in such tasks. Here, we investigate the strategies two dolphin dyads used to coordinate their behavior during a cooperative button-pressing task that required precise behavioral synchronization. Both dyads were more likely to succeed if they used whistles prior to pressing their buttons, but the results showed that they adopted different strategies. Specifically, one dyad favored physical synchrony, waiting nearby for their partner and swimming together to approach the buttons. The other dyad was much more vocal, and more likely to swim independently before coordinating at the buttons. Only for this second dyad did increased whistling lead to more success. Our results suggest that bottlenose dolphins have the behavioral flexibility to employ either vocal signals or physical synchrony to coordinate their cooperative efforts.

5-min talks

Can humans understand birds? An investigation of humans' ability to categorize black-capped chickadee songs that vary in the sex and geography of the producer

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

The black-capped chickadee is a monomorphic species of songbird, common across North America. The black-capped chickadee's fee-bee song is primarily used for mating and territoriality. Hahn et al. (2015, 2016) conducted operant go/no-go discrimination experiments and determined that black-capped chickadees could discriminate between conspecific songs produced by: (1) males vs. females, and (2) Ontario vs. British Columbia chickadees. Songbirds and humans are often subjects of comparative auditory perception studies as both species are vocal learners and have to learn their species-specific vocalizations. Thus, we sought to replicate the Hahn et al. (2015, 2016) findings with humans. We predicted that participants would be able to discriminate songs based on sex and geography (Experiment 1 and 2). Our results indicate that although human participants could not discriminate between songs based on the sex of the producer, they could discriminate between songs based on the geographical location of the producer. These results suggest that the sex of heterospecific signalers may be unimportant. However, the latter results support the notion that chickadees' 'dialect' varies across geographical locations and that this is a salient auditory cue that a heterospecific vocal learner (i.e., humans) are capable of recognizing and using to discriminate between songs.

2-min talks

Human screams elicit heterogenous emotional perceptions

Engelberg Jonathan (Emory University), Schwartz Jay (Emory University and Western Oregon University), & Gouzoules Harold (Emory University)

Screams occur across taxonomically widespread species, typically in antipredator situations, and are strikingly similar acoustically, but in nonhuman primates, they have taken on acoustically varied forms in association with more contextually complex functions related to agonistic recruitment. Humans scream in an even broader range of contexts, but the extent to which acoustic variation allows listeners to perceive different emotional meanings remains unknown. We investigated how listeners responded to 30 contextually diverse human screams on six different emotion prompts as well as how selected acoustic cues predicted these responses. We found that acoustic variation in screams was associated with the perception of different emotions from these calls. Emotion ratings generally fell along two dimensions: one contrasting perceived anger, frustration, and pain with surprise and happiness, roughly associated with call duration and roughness, and one related to perceived fear, associated with call fundamental frequency. Listeners were more likely to rate screams highly in emotion prompts matching the source context, suggesting that some screams conveyed information about emotional context, but an analysis of screams from happiness contexts revealed that they more often yielded higher ratings of fear. The expanded diversity in human screams might represent an effect of language on human call types.

Mutual Synchronization of Eyeblinks between Dogs/Cats and Humans

Hikari Koyasu 1 2 (1 Azabu University), Risa Goto 1 (2 Japan Society for the Promotion of Science), Saho Takagi 1 2, Tamami Nakano 3, Miho Nagasawa 1, & Takefumi Kikusui 1 (3 Osaka University)

Dogs (Canis Familiaris) and Cats (Felis Silvestris Catus) are unique animals living most closely to humans. One of the bases for this coexistence is their non-verbal communication skills with humans. In humans, eyeblinks synchronize between two individuals, which is related to effective communication and mutual understanding. Dogs and cats also communicate with humans through their gaze. Here we report the mutual synchronization of blinks between dogs/cats and humans: humans blinked after the blink of dogs/cats, and dogs/cats blinked after the blink of humans. In addition, we examined whether the blink synchronization was related to affiliation between humans and dogs/cats, and revealed that the owner had a shorter time lag from dog/cat's blinks to the owner's blink, as compared to the non-owner did. These results suggest that blink synchronization facilitates communication between humans and dogs/cats. While the function of blink synchronization in inter-specific communication needs to be investigated, a blink synchronization during gazing can play a role in effective communication between dogs/cats and humans.

Concept Learning

10-min talks

Functional Class Formation in Rats Using Olfactory Stimuli

Kate Bruce, Kyndra Lawson, Jonathan Shaw, & Mark Galizio (University of North Carolina at Wilmington)

We adapted repeated reversal procedure that has been used to demonstrate the formation of functional classes in pigeons and sea lions for rats using olfactory stimuli. Rats were exposed to simple discrimination training with responding reinforced on an FI 5-s schedule for six odors (Set 1 positive) and extinction for a different set of six odors (Set 2 negative). When responding was well differentiated, the discriminations were reversed (i.e., Set 2 positive, Set 1 negative). Discrimination reversals were repeatedly performed, and performances on the initial session of a reversal were analyzed to determine whether contacting the reversed contingencies with some set members would transfer to other set members without direct training. We found transfer in most rats tested, but mainly after exposure to the changed contingencies with five of the set members first. These data provide some of the first evidence of functional class formation in rats.

5-min talks

Relational Complexity Influences Analogical Reasoning

Kevin Leonard, Parisa Sepehri, Breanna Cheri, & Debbie M. Kelly (University of Manitoba)

Analogical reasoning is a complex cognitive skill, wherein an individual makes inferences about some novel situation or stimulus by drawing upon their knowledge of familiar situations, and the systematic correspondences between the new and the old. Recent comparative work has used relational matching-to-sample (RMTS) tasks to assess analogical reasoning by nonhuman animals. These tests provide evidence that some primates and corvids can reasoning by analogy. We developed an operant experiment which expands on previous RMTS tasks but is structured to examine how individual stimulus elements, and overall relational complexity, influence analogical reasoning. Human participants were presented with a pair of exemplar stimuli that were either the same or different according to a stimulus dimension (colour, shape, or pattern), followed by a probe stimulus and several choice stimuli. Participants needed to select the single choice stimulus which formed a relationship with the probe in the same way as existed between the exemplars. Trials were made successively more difficult by increasing the number of relevant dimensions involved in the relationship between the exemplar stimuli. As relational complexity increased, response accuracy decreased and reaction time increased. This task offers a new comparative approach for the study of analogical reasoning in nonhuman animals.

Assessing abstract-concept learning after small set-size training by a dog

Emma Cox, Lucia Lazarowski, Jordan G. Smith, Sarah Krichbaum, Adam Davila, Lane Montgomery, Jacob Vaughn, & Jeffrey Katz (Auburn University)

Abstract-concept learning requires judging relationships between stimuli and forms the basis for many higher-order cognitive processes. Evidence of abstract-concept learning has been demonstrated in a wide range of species, though quantitative differences exist in the number of training stimuli needed to learn a concept. Using an olfactory matching-to-sample (MTS) procedure with 48 odors in the training set, we recently demonstrated the first evidence of MTS abstract-concept learning in dogs. In the current study, we examined MTS concept learning by a dog after training with a small set size (3). After more than 1,000 training sessions without meeting the acquisition criterion (two consecutive sessions >83% correct), despite having met the criterion on non-consecutive sessions, we tested for transfer to novel stimuli across three sessions. Transfer performance was 100% (6/6 trials) on the first session, but was inconsistent across the remaining sessions. The inconsistent performance could be due to the training set size or to individual factors. Nevertheless, the findings suggest a potential indication of abstract-concept learning after training with only three stimuli. Further testing with additional subjects and examinations of set-size functions will be needed to confirm whether dogs are capable of abstract-concept learning after training with small set sizes.

Paper Wasps form Abstract Concept of Sameness and Difference

Chloe Weise, & Elizabeth Tibbetts (University of Michigan)

One of the most critical abstract concepts is that of sameness and difference (Same/Different). Same/Different concept formation is considered a complex ability, and much remains unknown about which taxa are capable of abstract concept learning. Very few invertebrates have been tested for Same/Different concept formation, because they are often overlooked for complex cognitive processes due to their relatively small brains. However, some

invertebrates have behaviors that suggest that they may rely on Same/Different concept formation. Here, we tested same/different concept learning in Paper wasps (Polistes fuscatus). We trained P. fuscatus to form Same/Different concept on one type of stimuli (e.g. colors), then, we tested whether wasps could apply the concept to new stimuli types (e.g. odors). P. fuscatus readily learned the Same/Different relationship and applied it to novel sets of stimuli. P. fuscatus performed equally well on both the original test and the tests transferring to novel stimuli types. Therefore, P. fuscatus can classify stimuli based on their relationships and apply abstract, relational concepts to novel stimuli types. These results indicate that abstract concept learning may be more taxonomically widespread than previously thought.

Development

5-min talks

Development of Holistic Face Processing in Paper wasps

Juanita Pardo-Sanchez, & Elizabeth A. Tibbetts (University of Michigan)

Most recognition is based on identifying features, but specialization for face recognition in some taxa relies on a different mechanism, termed 'holistic processing' where facial features are bound together into a gestalt which is more than the sum of its parts. Although experience is thought to be necessary for developing holistic processing, we lack experiments that test how age and experience influence the development of holistic processing in non-primates. We tested how age and experience influence the development of holistic face processing in Polistes fuscatus paper wasps. Previous work has shown that P. fuscatus are capable of individual face recognition and use holistic processing to discriminate conspecific faces. We raised and tested P. fuscatus on conspecific faces in three treatment groups: upon reaching maturity (young), two weeks after maturity (older, experienced), two weeks after maturity but isolated after maturity (older, inexperienced). We found that older, experienced wasps exhibited holistic face processing and younger wasps and older, inexperienced wasps did not. These results show that experience rather than age facilitates the development of holistic processing. This work disentangles the effects of age and experience on face recognition and shows that experience is necessary for the development of holistic processing.

Behavioral, transcriptomics, and structural variation translates time across the lifespan in humans and chimpanzees

Christine Charvet (Department of Psychology and Center for Neuroscience)

How human cognition arose in evolution is a question of enduring interest. Yet, it is still unclear how to compare cognitive abilities between humans and great apes. This in part because there is no standardized approach with which to translate ages across humans and apes. This information would provide a baseline with which to compare development and aging across species in order to resolve which cognitive processes show evidence of heterochrony in humans. I harness temporal variation in behavior, anatomy, and transcription to determine corresponding ages from fetal to postnatal development and aging across humans and chimpanzees. This work builds on our previous project called translating time (http://www.translatingtime.org). This multi-dimensional approach results in 155 time points across the lifespan in humans and chimpanzees. I used these data to test for variation in biological and behavioral programs across species. I find that weaning deviates from the timing of other biological programs across humans and chimpanzees. This dataset, which is the largest with which to determine corresponding ages across humans and chimpanzees provides a rigorous approach to control for variation in developmental schedules and identify the neural basis of human cognitive abilities.

2-min talks

Effect of rearing environment on the development of spatial cognition in egg-laying hens

Claire Jones, Allison Pullin, Richard Blatchford, Maja Makagon, & Kristina Horback (University of California Davis)

The American egg industry is transitioning towards cage-free environments for laying hens. Unfortunately, it is unknown whether the visual complexity of the rearing environment may impact adult use of three-dimensional space in aviaries. This study investigated the ontogeny of distance and depth perception in 450 Dekalb White hens reared in three environments of increasing vertical complexity (perches, ramps, and platforms). Distance perception was evaluated via a Y-maze task with a 1:3 ratio or a 1:1 ratio difference in escape arm length. Behaviors recorded include time spent in each arm, latency to exit, and exit choice. Depth perception was evaluated via performance in a visual cliff test at three depths (15, 30, and 90 cm). Behaviors recorded include latency to jump from the perch on the visual cliff to the platform on the deep side, quality of jump, and proportion of time spent on shallow versus deep side. It is predicted that performance in the Y-maze (percent of correct choices) will relate to performance in visual cliff test (latency and quality of jump), and, that general performance will be impacted by the visual complexity of rearing environment.

Development of Spatial Working Memory in Puppies

Jordan G. Smith, Sarah Krichbaum, Emma Cox, Tanner Hough, Jeffrey S. Katz, & Lucia Lazarowski (Auburn University)

The ability to search for and locate objects in the environment is an adaptive process requiring the use of spatial working memory (SWM). In humans and non-human animals, such mechanisms demonstrate ontogenetic effects including improvements during early development and aging-related declines. However, tasks commonly used to assess SWM, in which subjects are required to remember the location of a hidden object across delays, may be measuring attention rather than SWM. To investigate the development of SWM in dogs, we tested 3- and 5-mo old puppies as well as young adults (12+ mo) on a SWM task that controlled for sustained attention. Sessions consisted of six trials with delays of either 10 or 40 seconds from the time the experimenter hid the reward in one of two containers to when the puppy was released to locate the reward. Our results indicate that although there was no significant difference in overall accuracy between the age groups, 5-mo-old puppies and young adults performed significantly above chance at all delays whereas 3-mo-old puppies only performed significantly above chance on 10-second delays. These findings extend previous work on puppies' SWM abilities, demonstrating that puppies can solve SWM tasks without relying on attentional mechanisms.

Discrimination Learning

10-min talks

A Pavlovian Mid-Session Reversal Task in Leopard Geckos (Eublepharis macularius)

Matthew S. Murphy, & Scott L. Parker (Coastal Carolina University)

Reptiles represent an under-studied taxa of vertebrates in the field of comparative cognition, partially because they are not as mobile or easily-reinforced as mammals and birds. We wanted to study a complex discrimination reversal task as a comparison to birds and mammals. We trained leopard geckos in a Pavlovian mid-session reversal, in which color-food associations were reversed at the temporal mid-point of a 40-minute session, and tested them in a choice preference task. One group of geckos received a hypoxia treatment during incubation, compared to sham. Results show strong individual differences, with some subjects showing marginal evidence of reversal, and some showing a response bias. There is little to no evidence of hypoxia treatment on the success rate of this reversal.

Evidence for the Effects of Stimulus-Response Compatibility on a Spatial Occasion Setting Procedure With Pigeons

Joshua Wolf (Carroll University), Cheyenne Elliot, Jackson White, Cokie Nerz, & Ken Leising (Texas Christian University)

An occasion setting procedure can be used to investigate stimulus-response compatibility (SRC) effects within spatial learning. Differing levels of response compatibility during training may influence the degree (e.g., latency and accuracy) of stimulus control by an occasion setter paired with a landmark. Occasion setting trials began with the OS (i.e., a colored square) positioned on the left or right side of a touchscreen-equipped display. After a peck to the OS, the LM appeared to the left or right of the OS, and subjects were required to peck a hidden goal location in the same (compatible, e.g., OS◊LM◊goal) or opposite (incompatible, e.g., OS◊goal⇓LM) direction. On other trials, LMs were presented alone and non-reinforced. Previous research with humans and pigeons demonstrated that the proximity of stimuli to the goal influenced stimulus control more than stimulus-response compatibility. The current experiment included different combinations of transfer trials, in addition to limiting subjects to a single response during training. During the second half of acquisition pigeons responded faster on compatible trials. The data from transfer testing indicated equal control by the OSs, but the LM from the compatible training trial type controlled responding better than the LM from the incompatible training trial type.

5-min talks

A Role for Response Uncertainty in Serial and Simultaneous Feature-Positive Tasks with Rats

Sara Bond, Marisa Melo, Tanner Raab, & Kenneth Leising (Texas Christian University)

In discrimination learning, a response is followed by reinforcement only when occurring in the presence of a discriminative stimulus (A+). In a typical operant feature-positive procedure, a separate stimulus, the feature, determines if responding in the presence of a discriminative stimulus is followed by the reinforcer (XA+, A-). The current study examined whether a discriminative stimulus could control one response when paired with the feature and a separate response when encountered alone. Rats were reinforced for different responses (left or right lever press) on feature-positive trials and discriminative stimulus alone trials. In one group, the stimuli on feature-positive trials were presented simultaneously (X:A+) and in the other group were presented serially (X→ A+). Lever pressing was analyzed during non-reinforced test trials of XA, X, and A before and after extinction of X. The simultaneous group responded more accurately than the serial group on XA and A trials. Before extinction of X, the simultaneous group responded less to X than XA, but the serial group trended toward responding more to X than XA. Extinction lessened accuracy in the serial group. These results contrast with the extant literature, such that response accuracy was disrupted by extinction when stimuli were presented serially.

Affect in chickens: Judgement biases are associated with individual- but not consensus-preferences for housing conditions

Elizabeth S. Paul, William Browne, Michael T. Mendl, Gina Caplen, Suzanne Held, Anna Trevarthen (University of Bristol), Christine, & J. Nicol (Royal Veterinary College)

A popular method for assessing affective states in animals is the Judgement Bias Test, which makes use of a discrimination-learning task to find out whether individuals are 'optimistic' in their evaluation of ambiguous stimuli. The task requires an animal to judge ambiguous probe stimuli, that are intermediate between two previously trained discriminative stimuli (one predicting reward, the other punishment), as either reward-predicting or punishment-

predicting. Here, laying hens housed in 'positive' conditions for 6 weeks (comprising resources and events that chickens in general are known to prefer) were compared with hens housed in 'negative' conditions (comprising resources that chickens in general do not prefer) (n=30 per group). Results showed that hens in the generally preferred, 'positive' conditions did not differ from those in the non-preferred, 'negative' conditions in their judgement bias performance. But choice tests reveal that hens' individual preferences did not completely align with general hen consensus-preferences; birds that preferred their own housing condition (regardless of whether it was 'positive' or negative') showed significantly more 'optimistic' responses in the Judgement Bias Test. We conclude that in hens, judgement biases are more closely related to individual birds' appraisals of, and preferences for, a living condition, than to generally established consensus-preferences.

2-min talks

An innovative approach in studying the evolution of cognition in parrots

Maria Dimitriou, Anna Wilkinson, Carl D Soulsbury, & Thomas W Pike (University of Lincoln)

The extent to which the cognitive abilities of a species are shaped by social interactions, ecological factors and life-history traits remains a fundamental, yet poorly understood, topic in animal cognition. Crucially, very little is known about the impact of phylogenetic relatedness on learning and cognition. Previous studies in the field have focussed either on a broad range of taxonomically distinct species, or on a limited number of closely related species. However, both of those approaches are limited, because they impair our understanding of tempo, mode and rates of evolution of cognitive traits. This work aims to address this problem by analysing cognition in an appropriate evolutionary framework, employing a well corroborated phylogeny with accurate divergence times of sampled species and a suitable model group, in this case, parrots. This lightning talk will describe the design and development of a complete automated system for testing parrot (and other species) cognition. We present a cognitive test battery which comprises of 5 different tasks carried out on a touchscreen set-up. Whilst this work is at an early stage, we want to present the ideas behind it in honour of the Comparative Cognition Society awardee Irene Pepperberg.

The effect of differential outcomes on a visual discrimination with rats

Cokie C. Nerz, Ethan Waterman, Sara Bond, Cheyenne Elliott, & Kenneth J. Leising (Texas Christian University)

Learning to make different responses to different stimuli is facilitated by different outcomes (e.g., food vs. water) for each response. The current research aimed to extend this differential outcomes effect (DOE) to rats performing a visual discrimination. Rats were required to nose-poke to initiate the presentation of either a flashing or steady light. Pressing a lever to the left of the feeding niche was reinforced during one visual stimulus (e.g., flashing light), whereas presses to the right lever were reinforced during the other visual stimulus (e.g., solid light). In the experimental group, the rats received a different outcome for each correct response (e.g., flashing light ◊ left lever ◊ sucrose; solid light ◊ right lever ◊ chocolate pellets). In the control group, rats received one outcome (e.g., sucrose) for both responses. During initial training, a reinforcement bias for the chocolate pellets was detected in all groups. After retraining, rats that received differential outcomes acquired the discrimination faster than rats in the control groups. Subsequent analyses of subgroups counterbalanced for lever position revealed a lasting effect of reinforcer preference on discrimination performance.

Graduate Student Featured Session

5-min talks

Black-capped chickadees (Poecile atricapillus) can identify individual females by their fee- bee songs

Carolina Montenegro, William D. Service, Erin N. Scully, Shannon K. Mischler, Kimberley A. Campbell (Department of Psychology; University of Alberta), & Chris B. Sturdy (Department of Psychology; University of Alberta; Neuroscience and Mental Health Institute)

Individual recognition occurs in many bird species. The ability to discriminate between familiar and unfamiliar conspecifics is critical to avoid wasted time and energy during social interactions. In the current study, we used an operant discrimination go/no-go paradigm to determine whether female and male chickadees can discriminate between fee-bee songs produced by individual female chickadees, as well as to test which song component(s) could enable this discrimination. Birds trained on natural categories—the songs of different individual females—learned to respond to rewarded stimuli more quickly than birds trained on randomly selected song stimuli, and were able to transfer this learning to new songs from the same categories. In addition, when exposed to only the bee portion of the fee-bee song of rewarded individuals, chickadees were able to generalize their response however, this generalization did not extend to the fee portions of rewarded individuals. Our results provide evidence that black-capped chickadees can use female-produced fee-bee songs for individual identification. However, the acoustic features underlying individual identification require further investigation.

Can Goldfish (Carassius auratus) Visually Discriminate Between Rotated 3D Objects That Lack Color Cues?

Jessica Wegman, Janessa Morelli, Kaitlin Gunther, Alix Janssen, Hunter Barnett, & Dr. Caroline DeLong (Rochester Institute of Technology)

In past studies, we found that goldfish were able to discriminate between stimuli shown from multiple aspect angles in different rotation planes using a two-alternative forced choice task. Fish were trained with stimuli at 0 degrees and were then tested with stimuli at novel aspect angles (90, 180, and 270 degrees). Performance accuracy was very high (M = 93%) when fish viewed 3D full-color stimuli (green and gray turtle vs. red and yellow frog). In Experiment 1, 7 goldfish were presented with two 3D objects made of black LEGO bricks that varied in shape but not color. Six fish failed to discriminate between the stimuli during the training phase. Only one fish advanced to the test phase and successfully discriminated between the stimuli at novel aspect angles when the stimuli were rotated in the picture plane (M = 67%) or depth plane (M = 80%). In Experiment 2, currently in progress, 6 fish are being presented with the same 3D turtles and frogs from our past study, but painted black to remove color cues. If the fish are unsuccessful in both studies, then color may be a significant aspect of visual discrimination of rotated 3D objects in goldfish.

Extending the Reach of Tooling Theory

Jennifer A. D. Colbourne, Alice M. I. Auersperg, Megan L. Lambert, Ludwig Huber, & Christoph J. Völter (University of Veterinary Medicine Vienna)

Tool use research suffers from a lack of robust theories. There is a plethora of tool use definitions, and the most widespread ones are so inclusive that the behaviors that fall under them do not have much in common at the cognitive level. The situation is aggravated by the prevalence of anecdotes, which have had an undue influence in the literature. To advance the field, we suggest the adoption of Fragaszy & Mangalam's (2018) tooling framework, which is characterized by the creation of a body-plus-object system that manages a mechanical interface between tool and surface. Tooling is limited to a narrower suite of behaviors than tool use, which might facilitate its neurocognitive investigation. Indeed, we found that tooling has distinct neurocognitive underpinnings not shared by other activities typically classified as tool use. We also conducted a systematic survey of the comprehensive tool use catalogue by Shumaker et al. (2011), revealing that the majority of tool use cases are poorly supported and do not qualify as tooling. Furthermore, tooling appears to be phylogenetically less widespread than tool use. We recommend more systematic research in the future to understand the evolution and neurocognitive mechanisms of tooling, particularly with currently underrepresented taxa.

Garter snakes change their social groups across development

Morgan Skinner, & Noam Miller (Wilfrid Laurier)

We examined the social tendencies of a group of 6 Eastern garter snakes over the first year and a half of their lives. We then compared their behavior to two groups of adult garter snakes. To assess their social patterns and construct

social networks, we recorded their social interactions over an 8-day period. We repeated this process 7 times across the snakes' development. Additionally, two females were removed from the social group across the 7 trials. We examined changes in association patterns and found that preferences to associate with particular individuals tended to increase across development. Two factors drove this change: First, when male snakes reached maturity, they began regularly choosing the same social groups. Second, the removal of females from the network caused the network to tighten more than computer simulations predicted. This was represented by a significant increase in the global efficiency of the network. Global efficiency measures the spread of information (or pathogens) through a group. As such, the behavioral changes we observed could have important consequences for the spread of pathogens through a population. This research shows that even in a species without permanent social groups, social context can have important effects on sociability.

Investigating gaze-choice associations in domestic dogs

Julia Espinosa, Liyuzhi Dong (University of Toronto), & Daphna Buchsbaum (Brown University)

Effective comparison of foraging options is fundamental to survival. Humans visually compare food and tool options prior to deciding about which to consume or interact with, looking longer at higher value items (preferential gaze) and objects that they subsequently interact with (predictive gaze). Domestic dogs share the human visual world but have a markedly different visual system. We examined how dogs gather visual information, with a particular focus on gaze-choice associations, using a standardized 2-alternative preference test and investigated gazing behaviour toward high and low value items prior to item selection for evidence of preferential or predictive gaze in dogs. We presented pet dogs (N=49) with 10 choice trials across 5 conditions (1 baseline and 4 experiments). When examining patterns of visual attention to the items prior to choice, we found that overall dogs looked significantly longer at the high value over the low value item, and were more likely to choose a high-item if they spent proportionally more time looking at it. At the same time, dogs chose correctly in baseline condition but were barely above chance selecting high value items across experiments. Together, these results suggest a dissociation in dogs' visual information gathering and behaviour.

The Goffin's cockatoo can learn to discriminate objects by their weight alone

Poppy Lambert (University of Veterinary Medicine Vienna), Alexandra Stiegler (University of Vienna), Theresa Rössler, & Megan Lambert Alice Auersperg (University of Veterinary Medicine Vienna)

The property of weight is important when considering object efficacy or value in certain contexts (e.g. tool use, foraging). Proprioceptive discrimination learning, with objects that differ only in weight, has so far been investigated in a handful of primate species. We show that Goffin's cockatoos can discriminate between objects on the basis of their weight alone. We find that subjects given experience with the same task but where objects can also be distinguished by colour, appear to still pay attention to the difference in weight between objects. If the performance of our subjects, measured by the number of trials required to reach criterion, is taken in comparison to results from previous studies, the Goffin's cockatoos appear to learn to discriminate weighted objects more quickly than do the primates.

The impact of environmental factors on learning: A meta-analysis

Connor T. Lambert (University of Alberta), & Lauren M. Guillette (University of Alberta; University of St Andrews)

Since the 1950's, researchers have examined how differences in the social and non-social environment affect the learning and memory of rats, mice, and, more recently, a variety other species. Despite this large body of research, little has been done to empirically evaluate and synthesize these extant findings. As such, we asked the following questions: 1) is there an absolute effect of the environment on learning, 2) do 'enriched' animals consistently out-perform more 'deprived' animals (a directional effect), and 3) is the type of environmental variable (e.g., social, non-social) important? To address these questions, we conducted a meta-analysis examining how different environmental features impact learning. Using 537 mean-differences from 176 published articles across 27 species we conducted phylogenetically-corrected mixed-effects models meta-analysis that revealed: 1) the absolute effect is significant at $|d| = 0.48$; 2) the directional effect is significant but small at $d = 0.21$; 3) social treatments had much smaller effects than asocial treatments. These results suggest environmental factors generally do affect cognitive abilities, but the type of treatment is an important predictor of the strength of these effects.

Invited Contribution to David Sherry

15-min talks

(Image set) size matters: Working memory, familiarity, and metacognition

Robert Hampton (Emory University)

David Sherry contributed crucially to making memory systems a theme in comparative neurocognitive research (Sherry & Schacter, 1987). Accurate choice in visual recognition memory tests occurs by at least two different memory systems in monkeys: working memory and familiarity. Working memory involves active maintenance of information over relatively short intervals, and is cognitively taxing. Familiarity is passive during retention and is only activated upon representation of previously seen images. These memory systems can be doubly dissociated, meaning that they operate independently in parallel. Concurrent cognitive load impairs working memory but not familiarity, while passive exposure affects familiarity but not working memory. Working memory is critical in tests with small sets of repeating images; familiarity is effective when images are novel each trial. Directed forgetting affects working memory but not familiarity. Monkeys metacognize about working memory but not familiarity during retention. These memory systems depend on different neural substrates. This set of related differences creates a psychologically rich account of these memory systems and creates a foundation for comparative studies. Our first directly comparative efforts resulted in the mystery of missing familiarity in orangutans. Sherry, D. F., & Schacter, D. L. (1987). The Evolution of Multiple Memory-Systems. Psychological Review, 94(4), 439-454.

Cerebral myelin tract development tracks developmental changes in vocal learning of songbirds

Adriana Diez, Tara Farrell, & Scott MacDougall-Shackleton (University of Western Ontario)

Myelination of nerve fibres is widely known for its importance in motor control, but myelination within the brain is also important in cognitive development. We examined myelinated tracts in songbird brains, including the vocal control system that supports imitative vocal learning. Myelination of the tracts of the vocal control system, for example the HVC-RA tract, occurs relatively late in development. In European starlings (Sturnus vulgaris) myelination of this tract increases from juvenile to yearling to adult (> 1 year), reflecting increases in song complexity. In zebra finches (Taeniopygia guttata) myelination of the HVC-RA tract rapidly increases in males around the time of song crystallization. Sex differences in myelination of this tract are large, and emerge late in development well after sex differences in the size of vocal control brain regions are established. In addition, manipulations of the acoustic environment that affect song learning also affect myelination of HVC-RA, indicating that behavioural feedback can alter the development of cerebral myelination. Thus, although the neurobiological underpinnings of cognition are often thought of in terms of circuits of neurons, white matter in the brain is an important factor in controlling cognitive processes such as vocal learning.

Coal tits use familiarity, but not recollection, when retrieving caches.

Tom V. Smulders, Lucinda H. Male, & Jenny C.A. Read (Newcastle University)

When humans recognize things they have seen before, they can call on (a combination of) two separate memory systems: familiarity and recollection. When food-hoarding birds retrieve their own caches, the memory for the cache locations could be retrieved as familiarity or recollection (or both). One method of measuring the relative contribution of familiarity and recollection is the use of Receiver Operating Characteristics (ROC) curves, which normally requires participants to report the confidence levels of their decisions. Using human participants, we validated a new ROC method, using order of decisions as a proxy for confidence. Using this method, we estimated relative contributions of familiarity and recollection in coal tits (Periparus ater) retrieving their own caches after different retention intervals (1 day, 3 days, 1 week, 2 weeks, 4 weeks, 6 weeks). We compared this performance to that of naïve coal tits searching for the same caches. Familiarity-based performance was higher than in naïve birds, and declined with increasing retention intervals. Recollection-based performance, however, was never above that of naïve birds, and did not change with retention interval. We conclude that, at least in captivity, coal tits only use familiarity to recognize their cache locations, and not recollection.

Nest building in birds: both temperature and memory of reproductive success matter

Susan D. Healy, Sophie E. Edwards (School of Biology - University of St Andrews), Tanya T. Shoot, Jeff Martin, & David F. Sherry (Advanced Facility for Avian Research - Western University)

Most birds build nests in which to lay their eggs and from which to raise their young. How they know what to build is still commonly considered to be ‘genetic’. However, in a world facing climate change, it might be beneficial for birds to be able to modify their nest design to better fit their current environment. Observational data suggest that birds do build nests appropriate for their environment: specifically, that in colder temperatures, they build bigger nests. But

such data come from across populations, and not from observations of the same individuals building in different conditions. Having now observed blue tits in the wild building nests around St Andrews, Scotland, and from experimental manipulations of zebra finches building in the laboratory, we can see that individual birds can, and do, change their building decisions in response to ambient temperature, and how they respond depends on the context in which they are building. Furthermore, reproductive success also appears to play a significant role. In sum then, while the role for genetics in nest building in birds is yet to be properly examined, it is increasingly apparent that the common view for why birds build the nest they do is incorrect.

Numerical abilities in a brood parasite, the brown-headed cowbird

Mélanie F. Guigueno (McGill University), Justin Arthur, Alex Coto, & David F. Sherry (University of Western Ontario)

Species in which the reproductive roles of females and males differ are valuable for understanding the evolution of cognitive abilities. In the brood-parasitic brown-headed cowbird, Molothrus ater, females are responsible for the selection and parasitism of suitable host nests, tasks that may be facilitated by enhanced numerical abilities. We trained wild-caught female and male cowbirds to use touchscreens and discriminate between pairs of stimuli differing in number. Cowbirds of both sexes were able to distinguish images based on number alone, but there was a consistent female-biased sex difference across combinations of 1-6 objects, with no difference between stimulus type (cone vs egg). Performance was increased in non-probe trials, indicating that subjects used non-numerical cues (i.e., surface area, perimeter) when available. Reaction time was increased in breeding versus non-breeding subjects and in female versus males for choice trials. Breeding females may trade speed for increased accuracy, thus facilitating successful brood parasitism.

The Physiology of Spatial Information Processing in the Avian Hippocampus

Diano F. Marrone (Wilfrid Laurier University)

Spatial cognition is critical to the survival of any animal. Accordingly, a wealth of research has investigated this vital form of cognition in a number of species, revealing a fundamental role for the hippocampal formation (HF) and homologous structures. Mechanistic research into the neural circuitry supporting spatial cognition, however, has focused largely on mammals. As a result, relatively little is known about the neural substrate of spatial information processing in birds, despite their ability to solve advanced spatial problems (e.g., food caching, migration). This is in part because the avian HF lacks many of the defining anatomical features of its mammalian counterpart. In fact, even the subdivisions of the avian HF remain a matter of debate. We may be able to resolve this issue by defining the regions of the avian HF on the basis of their functional, rather than anatomical, homology. Towards this goal, recent work by my lab and others using both electrophysiological recordings and activity-dependent gene expression across regions of the avian HF (largely in homing pigeons and Japanese quail) will be presented.

Invited Contribution to Irene Pepperberg

15-min talks

In Honor of the Contributions of Dr. Irene Pepperberg: Do pinyon jays (*Gymnorhinus cyanocephalus*) discriminate between thieving and non-thieving conspecifics?

Debbie M. Kelly, Alizée Vernouillet, & Hera J. M. Casidsid (University of Manitoba)

I am privileged to open this symposium honoring the contributions of Dr. Irene Pepperberg to the field of comparative cognition. Irene's research has made a considerable impact on our scientific field, from the experimental procedures used to ask questions to the breadth of species investigated to find answers. Indeed, the international expertise represented in this symposium speaks to this contribution. My presentation will highlight one study during which we examined whether pinyon jays, a highly social corvid, use information from the social environment to modify their caching behavior. Pinyon jays were given an opportunity to make caches in two distinctive trays, while being observed by a non-pilfering conspecific, a pilfering conspecific, an inanimate heterospecific, or alone. After caching, one of the caching trays was placed in the adjoining compartment where caches could be pilfered (pilfering conspecific and inanimate heterospecific conditions) or remained intact (non-pilfering conspecific and alone conditions). Overall, pinyon jays reduced the number of pine seeds cached in the tray that was subject to pilfering when observed, compared with caching alone. However, their caching behavior did not differ when observed by either the pilfering conspecific or the non-pilfering conspecific. Our results suggest that either pinyon jays were unable to discriminate between the pilfering and non-pilfering conspecifics, or they generalized their experience of risk from the pilfering conspecific to the non-pilfering conspecific.

Can cognitive abilities evolve by female preferences for problem solving males?

Carel ten Cate (Institute of Biology - Leiden University), & Jiani Chen (Institute of Innovation Ecology - Lanzhou University)

Darwin proposed that mate choice might contribute to the evolution of cognitive abilities. An open question is whether observing the cognitive skills of another individual makes it more attractive as a mate. I present an experiment showing that initially less-preferred budgerigar males became preferred after females observed that these males, but not the initially preferred ones, were able to solve extractive foraging problems. This preference shift did not occur in control experiments in which females observed males with free access to food or in which females observed female demonstrators solving these extractive foraging problems. I will discuss whether the solving task as we used it provides females with information concerning variation in cognitive abilities (learning abilities) of the observed males or whether it may only serve to reveal non-cognitive variation in problem-solving skills of the observed males. If based on learning abilities, female preferences for problem solving males will contribute to the evolution of cognitive abilities.

Kea (Nestor notabilis) show flexibility and individuality in within-session reversal learning tasks

Raoul Schwing (University of Vienna), Monika Laschober (University of Vienna), Roger Mundry (University of Vienna; Platform Bioinformatics and Biostatistics - University of Veterinary Medicine Vienna), & Ludwig Huber (University of Vienna)

The midsession reversal paradigm confronts an animal with a two choice discrimination task where the reward contingencies are reversed at the midpoint of the session. Species react to the reversal with either win stay/lose shift, using local information of reinforcement, or reversal estimation, using global information, e.g. time, to estimate the point of reversal. Besides pigeons, only mammalian species were tested in this paradigm so far and analyses were conducted on pooled data, not considering possible individually different responses. We tested twelve kea parrots with a 40-trial midsession reversal test and additional shifted reversal tests with a variable point of reversal. Birds were tested in two groups on a touchscreen, with the discrimination task having either only visual or additional spatial information. We used Generalized Linear Mixed Models to control for individual differences when analysing the data. Our results demonstrate that kea can use win stay/lose shift independently of local information. The predictors group, session, and trial number as well as their interactions had a significant influence on the response. Furthermore, we discovered notable individual differences not only between birds but also between sessions of individual birds, including the ability to quite accurately estimate the reversal position in alternation to win-stay/lose-shift. Our findings of the kea's quick and flexible responses contribute to the knowledge of diversity in avian cognitive abilities and emphasize the need to consider individuality as well as the limitation of pooling the data when analysing midsession reversal data.

Tool transfers to a partner in Goffin's cockatoos

Alice Auersperg (University of Veterinary Medicine Vienna), Jorg Massen (University of Utrecht), & Isabelle Laumer (University of California)

Flexible targeted helping requires an actor to assess different situations that a conspecific may be in, and to subsequently satisfy different needs of that partner depending on the nature of the situation at hand. We tested Goffin's cockatoos, a tool skilled parrot in a transfer task in which an actor had access to four different objects/tools and a partner to one of two different apparatuses that each required a specific tool to retrieve a reward. We recorded playful object transfers across all conditions. Yet, three birds actively transferred the correct tool more often in the test condition than in a condition lacking the partner. Furthermore, one of these birds transferred that correct tool first more often before transferring any other object in the test condition than in the no-partner condition (a non-significant trend for the two others). Additionally, there was no difference in the likelihood of the correct tool being transferred first for the two different apparatuses. In summary our findings suggest that some (but not all) Goffins can flexibly adjust the transfer of tools depending on both, the presence of a partner and the type of apparatus available to the latter.

Talking Productively with Pigeons

Robert G. Cook, Suzanne Gray, and Muhammad Qadri. (Tufts University)

The testing of different production tasks with language-trained animals, such as Irene Pepperberg's research with Alex, has been one of the most important developments in animal cognition. The capacity to generate flexible, open-ended, productive responses during experimental testing has been highly valuable in providing insights into the cognitive representations used by animals. Animals, like rats and pigeons, have not been as easily tested in such tasks for a variety of reasons. We describe several efforts to overcome this limitation in pigeons by using more open-ended discrimination tasks involving multiple choices. For instance, we have successfully trained pigeons to indicate the depth ordering of several objects in artificially generated scenes points. Besides describing several of these experimental approaches and outcomes, the possibilities and difficulties of using such flexible "production-like" techniques with non-verbal animals will be considered.

Memory

10-min talks

Episodic memory impairment in a transgenic rat model of Alzheimer's disease

Danielle Panoz-Brown, & Jonathon D. Crystal (Indiana University)

Loss of episodic memory is the most debilitating impairment in Alzheimer's disease (AD). Despite advances in the development of animal models of episodic memory and genetic models of AD, an AD animal model that recapitulates an age-related decline specifically in episodic memory (under conditions wherein non-episodic memory is precluded) remains elusive. Therefore, we developed a model of episodic memory decline in transgenic rats that carry some of the genes associated with AD (TgF344-AD). We used our items-in-context approach (Panoz-Brown et al 2016, Current Biology) to dissociate episodic memory function from judgements of familiarity. Here we show that episodic memory in TgF344-AD and age-matched wildtype (WT) controls is intact at an early timepoint and selectively impaired in TgF344-AD rats at a late timepoint. Control conditions suggest that the impairment in TgF344-AD rats was selective for episodic memory and not dependent on familiarity or non-specific factors. Histological and biochemical analyses confirmed that TgF344-AD rats had more amyloid beta (Aβ), a hallmark of AD, than WT rats. Moreover, Aβ was negatively correlated with cognitive decline in memory at the late timepoint. Our work provides a model that may be used to test novel therapeutics for AD that specifically target episodic memory function.

Long-Term Object Recognition Memory in Goldfish (Carassius auratus)

Caroline M. DeLong, Janessa Morelli, Jessica Wegman, Hannah Sheldon, Kaitlin Gunther (Rochester Institute of Technology), & Kenneth T. Wilcox (University of Notre Dame)

Object recognition memory is the ability to discriminate between novel and familiar objects. This form of memory aids fish in natural environments in avoiding predators, locating food, choosing mates, and selecting a suitable habitat. Many species have shown object recognition memory using adaptations of the novel object recognition (NOR) task. Fish (e.g., zebrafish, guppies, damselfish) remember objects after intervals from 5 min to 24 hr. The present study utilized the NOR task to evaluate if seven goldfish remembered objects after memory intervals ranging from 5 min to 30 days. The objects were plastic figurines of aquatic animals (e.g., whale, octopus). Preliminary results for the 5 min, 10 min, 15 min, 30 min, 45 min, 60 min, 2 hr, 4 hr, and 6 hr sessions indicated memory for objects in the 5 minute, 10 minute, and 30 minute intervals. Four out of seven fish showed a preference to touch the novel stimulus more often than the familiar stimulus. Additional subjects are being tested and statistical analyses are ongoing. Contrary to the popular myth of a three second memory, these results using the NOR task suggest that goldfish remember objects for many minutes, possibly multiple hours or days.

Manufacturing a physical template from memory: Goffin's cockatoos attend to different model features

Isabelle B. Laumer (University of California Los Angeles and University of Vienna), Sarah A. Jelbert (University of Bristol), Alex H. Taylor (University of Auckland), Theresa Rössler (Messerli Research Institute), & Alice M.I. Auersperg (Messerli Research Institute and University of Veterinary Medicine)

What shape are a fox´s ears? Most people visualize the corresponding image before answering the question. Although several non-human animals have the ability to recognize and match templates in computerized tasks, we know little about their ability to recall and then physically manufacture specific features of mental templates. Across three experiments, Goffin cockatoos were exposed to two pre-made template objects, varying in either colour, size or shape, where only one template was rewarded. The birds were then given the opportunity to manufacture these objects themselves with the template being absent at test and being rewarded at random. Our results show that Goffin cockatoos possess the ability to attend to different model features and can recreate some but not all object properties from memory.

5-min talks

Massed versus spaced learning in horses

Tammy McKenzie, & Anna Hawkins (Brandon University)

Horses are routinely trained to perform a variety of tasks, yet relatively little research has been conducted to determine how often and for how long a horse should be trained to obtain the best short-term and long-term training outcomes. A question of interest is whether learning is more effective if it is conducted all in one chunk (massed) or spread out over a number of learning bouts within a training session (spaced or distributed). Research on other species, including humans, indicates that spaced training often, but not always, results in better acquisition and retention of new skills

than does massed training. The purpose of the current research was to examine the effects of massed versus spaced learning within training sessions on horses' rates of learning and retention of an obstacle task. Horses were divided into three comparable groups. Training sessions were 30 min in length. Group 1, massed learning, was trained with three 5-min learning bouts back to back. Group 2, equal spaced learning, was trained with equal amounts of rest time between three 5-min learning bouts. Group 3, variable spaced learning, was trained with variable amounts of rest time between three 5-min learning bouts. Results will be discussed.

Mild Traumatic Brain Injury Impairs Spatial Working Memory in Rats

Gabriel Nah, Nicholas Port, & Jonathon D. Crystal (Indiana University)

Mild Traumatic Brain Injury (mTBI), or concussion, is the most common form of traumatic brain injury, which may lead to cognitive impairment. We used the Wayne State University closed-skull weight-drop model (WDM) in which a 450-g weight is dropped from a height of 1 m. The weight produces rapid acceleration of the head, neck and torso, causing the rat to fall through an aluminum sheet, undergo a 180 degree rotation, and land on a foam pad. Sham rats were treated the same as the mTBI rats but were not administered the injury. Rats were trained in an 8-arm radial maze to assess spatial working memory before and after manipulation. In the study phase, food was available at four randomly selected accessible arms. The trial continued after a brief delay in the test phase with all runways accessible. Food was available at previously inaccessible arms. After injury, accuracy in avoiding previously baited locations declined in mTBI rats relative to sham rats. This study suggests the WDM model produces a deficit in spatial working memory in rats.

Proactive interference effects on dogs' performance in an olfactory match-to-sample task

Adam Davila, Sarah Krichbaum (Auburn University), Lucia Lazarowski (Canine Performance Sciences), Jordan G. Smith, Emma Cox, & Jeffrey Katz (Auburn University)

Proactive interference occurs when memories from events earlier in time cause errors in the present moment. In a match-to-sample (MTS) procedure, interference typically happens when a previous trial's correct comparison reappears as an incorrect choice, causing confusion when choosing between alternatives. In our experiments, 6 purpose-bred detection dogs, after initial olfactory MTS training, were evaluated for the effects of proactive interference through several approaches, including reducing set size and adding probe delays. In a second procedure, we inserted interfering probe trials into otherwise trial-unique sessions. We found that performance was negatively impacted by reducing set size to two items, and by adding longer probe delays. These reductions in MTS performance can be attributed to proactive interference.

2-min talks

Monkeys learn by observation from conspecific videos only when individual learning is impossible

Jad Nasrini, & Robert Hampton (Department of Psychology Yerkes National Primate Research Center Emory University Atlanta GA)

Monkeys are often considered poor social learners, based largely on studies that compare imitation between culturally experienced children and nonhuman primates that have no significant training in imitation. Tests of "spontaneous" imitation may underestimate the capacity for social learning in monkeys. In Experiment 1, monkeys (n=6) learned 260 image discriminations concurrently. Each trial of 80% of the discriminations began with a video of a demonstrator monkey selecting the correct image. Videos did not facilitate learning (Mean sessions to criterion with video=10.66, without=10.83; $F(1,5)=0.056$, $p=0.822$), indicating that monkeys learned by trial and error, even when the video was available. In Experiment 2, a single image pair was used, and the correct choice varied randomly, so that monkeys could only do better than chance by selecting the image demonstrated in the video. Monkeys learned to make the same choice as the monkey in the video, showing significant learning within the first 30 sessions, and with all 6 gradually reaching 85% correct (asin-transformed data; $F(29,145)=10.126$, $p<0.001$). Rhesus monkeys with limited social learning experience may not default to learning by observation from a video, but are capable of doing so.

Metacognition

5-min talks

Rhesus monkeys (Macaca mulatta) monitor evolving decisions to control adaptive information seeking

Ryan J. Brady, & Robert R. Hampton (Emory University)

Decision making in humans depends on feedback between monitoring, which assesses mental states, and control, by which cognitive processes are modified. We investigated the extent to which monitoring and control interact iteratively in monkeys. Monkeys classified images as birds, fish, flowers, or people. At the beginning of each trial, to-be-classified images were not visible. Monkeys made a brighten response to incrementally brighten the image. Brightness increased with each brighten response unpredictably, and the monkeys could choose to classify the images at any time during a trial. We hypothesized that if monkeys monitored the status of their classification decision then they would seek information contingent on the amount of information available. Across three experiments we found that monkeys rarely used the brighten response when images were bright initially, made more brighten responses when the presented image did not belong in any of the trained categories, and the probability that monkeys used the brighten response correlated with their ability to correctly classify when the brighten response was not available. These findings add to the literature documenting the metacognitive skills of nonhuman primates by demonstrating an iterative feedback loop between cognitive monitoring and cognitive control that allows for adaptive information seeking behavior.

Spatial fractal analysis: broadening our knowledge of drawing behavior in hominids

Lison Martinet, Cédric Sueur (University of Strasbourg (France)), Satoshi Hirata (University of Kyoto (Japan)), Jérôme Hosselet (University of Strasbourg (France)), Tetsuro Matsuzawa (University of Kyoto (Japan)), & Marie Pelé (Catholic University of Lille (France))

In humans, drawing behavior begins at an early age with scribbles and then evolves into more concrete figures. But Homo sapiens is not the only species to draw since this behavior is also observed in captive great apes as chimpanzees (Pan troglodytes). Like very young children, they are not able to express themselves on their productions, making analysis more complicated and questioning intentions and representativeness behind the drawing behavior. We collected 356 drawings made on touchscreen by humans (children and adults) and 12 realized by chimpanzees. Here, we developed a new index giving us access to the degree of efficiency of the lines drawn. Results showed differences between chimpanzees and humans as well as within humans, the youngest and adults having a less efficient representation than children between 5 and 10 years old. Complemented by behavioral analyses, these initial results demonstrate the relevance of pursuing the study of new analytical methodologies and the evolutionary perspectives of comparative research that could emerge.

Numerosity

5-min talks

Kea show three signatures of domain-general inference

Bastos Amalia, & Taylor Alex (The University of Auckland)

One key aspect of domain-general thought is the ability to integrate information across different cognitive domains. We tested whether kea (Nestor notabilis) can use relative quantities when predicting sampling outcomes, in a task where subjects had to indicate which of two hands that had sampled from two jars containing rewarding and unrewarding tokens was most likely to contain a rewarding token. We then tested whether kea could integrate both physical information about the presence of a barrier, and social information about the biased sampling of an experimenter, into their predictions. Our results show that kea exhibit three signatures of statistical inference, and can integrate knowledge across different cognitive domains to flexibly adjust their predictions of sampling events. This result provides evidence that true statistical inference is found outside of the great apes, and that aspects of domain-general thinking can convergently evolve in brains with a highly different structure from primates. Domain-general thinking may allow animals to perceive their environment in more nuanced ways and combine information to make sophisticated predictions about future events.

Social Preference for Group Size in Captive Pinyon Jays

London Wolff, & Jeffrey R. Stevens (University of Nebraska-Lincoln)

Numerical cognition is often studied in vertebrate populations using object or food stimuli. Yet, little is known about how corvids use numerical information in social settings. According to the dilution effect, flocking bird species should choose to be in large groups to mitigate the risk of predation. Therefore, corvids should choose to associate with larger over smaller groups when given the opportunity. This study investigates how numerical cognition influences social preferences in pinyon jays when offered a binary choice between various conspecific group sizes. Subjects (N=11) chose between two groups using every paired combination of group size between 0 and 6. In line with the dilution effect, subjects chose to preferentially associate with larger groups. However, neither the numerical difference nor the ratio between the group sizes predicted the Pinyon Jay's choices. These data do not align with previous work showing effects of numerical difference and/or ratio on numerical preferences. Possibly, our conspecific group sizes were not large enough to see these effects. Future work is needed with larger group size differences to further explore Pinyon Jay numerical cognition.

Summation of Numeral Value in a Computerized Maze Task by Rhesus Monkeys (Macaca mulatta)

Elizabeth Haseltine & Michael Beran (Georgia State University)

Past research has indicated that monkeys can associate quantities with Arabic numerals. We tested rhesus macaques' comprehension of symbolic stimuli and symbol summation to determine potential factors affecting their choices. Using a 2-arm computerized maze task, monkeys were presented with varying Arabic numerals from 0 to 5, and they received reward quantities matching the face value of any Arabic numeral they contacted in a maze. In Experiment 1, one numeral was in each arm but at varying distances from the starting point to determine if distance was a factor in reward choice. Monkeys were more likely to travel a greater distance for a larger reward. Experiments 2 and 3 introduced paired numbers in one or both maze arms. In Experiment 2, monkeys tended to make their choice based on the first presented number in each pair, and thus maximized reward only for the first numeral in each arm. However, in Experiment 3, the monkeys overcame this error by also taking into account the value of the second numeral in an arm when choosing which arm to commit to completing. Overall, these results indicate that rhesus macaques can sum Arabic numerals and use these symbols to maximize their reward intake.

Performance of Asian elephants (Elephas maximus) on a quantity discrimination task is similar to that of African savanna elephants (Loxodonta africana)

Lisa P. Barrett, Rebecca J. Snyder, Rachel A. Emory (Oklahoma City Zoo), & Bonnie M. Perdue (Agnes Scott College)

Using an object-choice task, we measured the relative quantity discrimination ability of Asian elephants. Two zoo-housed elephants were given auditory cues of food being dropped into two containers, and in one condition they could also see the food on top of the containers. Elephants received sets of varying ratios and magnitudes. We found that the elephants exhibited responses in line with the accumulator model. We also compare our findings to those from a study using the same methods with two African savanna elephants and found that the two species performed at similar levels, but given our small sample size it is difficult to make strong species-level conclusions. In

discussing our results, we consider the animals' behavioral ecology and behavioral husbandry/management in human care, and we provide recommendations for extensions of this work.

Perception

10-min talks

Do dogs know what they smell?

Juliane Bräuer Julia Belger Damian Blasi (Max Planck Institute for the Science of Human History)

Most current knowledge about dogs' understanding of, and reacting to, their environment is limited to the visual or auditory modality, but it remains unclear how olfaction and cognition are linked together. We therefore want to develop methods to study canine cognitive abilities in the olfactory modality Here we investigated how domestic dogs search for an object or a person using their excellent olfactory sense. We raise the question whether dogs have a representation of someone or something when they smell their track. The question is what they expect when they follow a trail or whether they perceive an odor as a relevant or non-relevant stimulus. We adopted a classical violation-of-expectation paradigm. In the critical condition subjects could track the odor trail of one target, but at the end of the trail they found another target. We found that dogs behaved differently when their expectation was violated, as the target did not correspond with the trail –compared to a control condition. Moreover, we found huge individual differences in searching behavior. Results are discussed in the light of how cognitive abilities, motivation, training background and odor perception influence each other.

5-min talks

Face, body and object representations in the human and dog brain

Magdalena Boch, Isabella C. Wagner (University of Vienna), Sabrina Karl, Ludwig Huber (University of Veterinary Medicine Vienna), & Claus Lamm (University of Vienna)

Neural representations for faces, bodies, and objects have been studied extensively in humans. However, much less is known on how our socio-cognitive niche shaped the evolution of these neural bases. Canine neuroscience allows us to close this gap by non-invasively studying a longstanding, close companion of humans. Here, we test and compare the neural underpinnings of face, body and everyday object processing in pet dogs (Canis familiaris) and humans. Fifteen awake and unrestrained dogs (11 females, 4-11 years) and forty humans (22 females, 19-28 years) underwent MRI scanning. Across two runs, they viewed faces and bodies of unfamiliar dogs and humans, everyday objects, and a visual control (scrambled images). Data analyses are ongoing. Preliminary results for the dogs indicate temporal regions selective for animate stimuli and a potentially distinct subregion selective for bodies, and we replicate previous findings of distinct but adjacent face, body and object-selective regions in humans. Investigating the multivariate patterns of activation indicates similar categorical object representations in the occipitotemporal cortex and limbic regions of both species, again replicating earlier findings in humans. Taken together, our findings will provide insights into the potentially convergent evolution of face, body and object representations in the dog and human brain.

Effect of water turbidity on camouflage and environment preference of cuttlefish (Sepia officinalis)

Alice Goerger, & Ludovic Dickel (University of Caen; Ethos (Ethologie animal et humaine) UMR 6552; Caen; France)

In La Manche, even if turbidity changes seasonally and daily in seawater, its level remains high enough to consider that visual cues only based on intensity of contrast are limited. Some marine species like the cuttlefish Sepia officinalis (Mollusk Cephalopod) evolve in such turbid environment. Since previous work on camouflage were led in clear seawater, how cuttlefish can use turbidity to conceal themselves is unknown to date. To tackle this question, hatchlings were reared for four months under three conditions: clear seawater, slightly turbid seawater and highly turbid seawater. At two months we assessed cuttlefish camouflage when in clear or turbid seawater on 2D background (checkboard and uniform grey). In parallel, animal preference for turbid or clear seawater were determined using a shuttle tank. Our results show that cuttlefish display more mottle and stipple body patterns in turbid seawater, and their preference for turbid environment seems age-dependant. In fact young individuals seem to spend more time in clear seawater whereas older individuals spend more time in turbid water.These results could provide valuable information to consider water turbidity as a possible factor for the improvement of cuttlefish well-being in artificial rearing systems according to current European regulations (Directive 2010/63/EU).

2-min talks

Children (Homo sapiens), but Not Rhesus Monkeys (Macaca mulatta), Perceive the One-is-More Illusion.

Emma J. McKeon, Michael J. Beran (Georgia State University), & Audrey E. Parrish (The Citadel)

Visual illusions are of particular interest to cognitive researchers because they reflect the active role of the brain in processing the world around us. Yousif and Scholl (2019) recently described a new visual illusion, the One-is-More illusion, in which adult humans perceived continuous objects as longer than sets of discrete objects of equal length. In the current study, we investigated this phenomenon in human children (Homo sapiens) and rhesus macaques (Macaca mulatta). Children were presented with a computerized two-choice discrimination task and successfully selected the longer of two images for control trials. On trials in which two versions of the same image were presented, and one was of a continuous form and the other consisted of two or more distinct units, children showed a bias for the continuous object. Monkeys were given the same computerized task and learned to choose the longer of two otherwise identical stimuli. However, monkeys did not show a bias to choose the continuous probe images as longer than when presented with the discrete images. These results are discussed in light of comparative research on perceptual completion.

Olfactory Self-Recognition in Eastern Garter Snakes

Troy Freiburger, Morgan Skinner, & Noam Miller (Wilfrid Laurier University)

Mirror Self Recognition (MSR) tests, originating in Gallup (1970), have been administered to various species from apes to fish; however, the test has not been attempted on reptiles. Snakes often detect and react to the world through odor; we therefore administered a modified olfactory MSR test (Horowitz, 2017) to Eastern Garter Snakes (Thamnophis sirtalis). To measure self-recognition, we compared snakes' interest (measured by time spent and the frequency of tongue flicks) near their own scent compared to their scent with an added scent 'mark' (olive oil). Snakes displayed, by an increase in long tongue flicks near the stimulus, a preference for their scent with the mark over their scent alone. Moreover, snakes show a preference for their scent plus the mark over the mark substance alone. This indicates that snakes' preference is not attributable to an interest in the scent mark alone, nor their scent alone. These results suggest that snakes can discriminate when a scent 'mark' is added to their scent. In the wild, snakes are thought to follow conspecific scent trails to seasonal aggregation sites; they must also navigate their hunting and shelter locations during the summer. Self scent recognition may be important for performing such tasks.

Social Learning

20-min talks

The burgeoning reach of social learning and culture in animals' lives

Andrew Whiten (University of St Andrews)

Culture – the totality of traditions acquired in a community by social learning from others – has increasingly been found to be pervasive not only in humans but in many animals' lives, with profound implications for comparative cognition as well as evolutionary biology, anthropology and conservation. Compared to individual learning, learning from others can more safely and efficiently assimilate the wisdom already accumulated in them. Here I offer an overview and update focused on recent discoveries charting the reach of culture across an ever-expanding diversity of vertebrate and invertebrate species, from primates to cetaceans, birds, fish and insects, and spanning numerous behavioral domains including foraging, migration, vocal repertoires, tool use and social behavior. The present century has seen an enormous expansion of discoveries on animal culture, in part delivered by long term field studies, but also by a variety of methodological advances, from new experimental designs applied in both labs and in the wild, to sophisticated new statistical approaches that identify the signatures of social learning as innovations spread across social networks. In many species cultural transmission is critical in juvenile phases, but recent studies have shown it also to be relevant through the lifetime, playing an important role where mature individuals disperse to other groups, and there learn from the existing local knowledge of new groupmates. The psychological reach of culture is reflected in the knowledge and skills an animal thus acquires, achieved via an array of different social learning processes. These have been found to range from the simplest, where learners' attention is simply channeled towards ecologically important cues, such as in foraging, to those where there is evidence of copying complex patterns of behavior or other elements such as tool use techniques. Such social learning has in recent times been shown to be further guided by a suite of adaptive learning biases. A variety of such biases have been identified in four major categories: those that are 'state-based' (e.g. copy when uncertain), 'frequency dependent' (e.g. copy what a majority of others do), 'model-based' (e.g. copy high rankers) or 'content based' (e.g. copy behavior seen to earn highest payoff). In humans, cumulative cultural change over generations has generated the complex cultural phenomena we witness today. Animal cultures have been thought to lack this cumulative power, but recent findings suggest that elementary versions may be important in animals' lives.

10-min talks

Chimpanzees' behavioral flexibility, social tolerance, and use of tool-composites in a progressively challenging foraging problem

Rachel Harrison (University of Lausanne), Edwin van Leeuwen (University of Antwerp), & Andrew Whiten (University of St Andrews)

Behavioral flexibility is a critical ability allowing animals to respond to changes in their environment. We provided two groups (N = 22) of sanctuary-housed chimpanzees in Zambia with a foraging task in which possible solutions were progressively restricted over time. Initially, juice could be retrieved from within a tube by hand or by using tool materials, but effective solutions were then limited in a second phase by narrowing the tube, necessitating the abandonment of previous solutions and adoption of new ones to obtain juice. Group differences were found in the extent to which chimpanzees showed behavioral flexibility, with chimpanzees in one group continuing to attempt solutions which had been rendered ineffective, whilst the second group primarily used effective solutions appropriate to the task phase, and spontaneously invented multiple novel composite tool solutions. The more flexible group also showed higher rates of socio-positive behaviors, such as tool transfers and co-action, and fewer socio-negative behaviours, such as displacement and aggression, at the task. In conjunction, these findings support the hypothesis that social tolerance may facilitate the emergence and spread of novel behaviors.

5-min talks

A unique cyclical hierarchy observed in a herd of African elephants (Loxodonta africana) under human care and its implications in a cooperation task

Joy Vincent (Oakland University), Kristina Przystawik (ZooTampa), Katie Willgohs (Eckerd College), Michael Burns (ZooTampa), & Lauren Highfill (Eckerd College)

This study is the culmination of a two-year exploration of the social dynamics within a herd of African elephants (Loxodonta africana) under human care. This study was conducted in conjunction with a cooperation study, in an effort

to discover any potential effects their participation in the study had on herd dynamics. Behavioral observations of the elephants' interspecific interactions were conducted, with specific regard to their agonistic behaviors. The six main behaviors recorded were displacement, bluff, trunk swing, charge, hit and head slam. These are common behaviors observed in wild populations of elephants, used to maintain set hierarchies and defend resources. This study found low incidence of all observed behaviors, apart from displacement, which is a behavior more in line with de-escalation and hierarchy maintenance, rather than aggression. Elephants are a matriarchal species, forming linear hierarchies within close family groups, consisting of adult females and their juvenile offspring. The patterns of displacement in this study, however, demonstrate a unique hierarchy pattern among the adult females; the results show a distinct cyclical hierarchy within the herd. The implications of this social structure for their management, as well as for the ongoing cooperation study will be discussed.

Invention and social information use in a cumulative task

Gillian Vale (The University of Texas MD Anderson Cancer Center), Nicola McGuigan (University of the West of Scotland), Emily Burdett (University of Nottingham), Susan Lambeth (The University of Texas MD Anderson Cancer Center), Amanda Lucas (University of Exeter), Bruce Rawlings (University of Texas at Austin), Steve Schapiro (The University of Texas MD Anderson Cancer Center), Stuart Watson (University of Zurich), & Andrew Whiten (University of St Andrews)

Humans appear unique in their capacity to accumulate cultural improvements over generations, to the extent that current variants are frequently beyond the scope of individuals to invent without the knowledge of their predecessors, a process termed cumulative cultural evolution. We explored cumulative culture in one of our closest living relatives, focusing on whether chimpanzees' (Pan troglodytes) innovation and/or social learning propensities may restrict their progress on a task that required increasingly complex solutions. Chimpanzees (N = 53) were found to be inventive, but relatively complex solutions were infrequent and largely predicted by individuals' past experience with similar tools. Despite exploration of the task space and some individuals reaching higher levels, we saw no evidence of cumulative cultural learning as the complexity of group tested individuals' solutions did not surpass what individuals tested by themselves invented. Social information nevertheless afforded communities greater task success and richer behavioral repertoires than individually tested chimpanzees, albeit more complex solutions discovered by some individuals did not socially transmit other group members. Failure to pass on particularly complex solutions suggests a potential limit to chimpanzees' social learning dispositions, with implications for the complexity of their cultural repertoires.

The effect of population density on cluster size and timing of collective digging in Drosophila melanogaster: A theoretical approach

Tanya T Shoot, Tristan AF Long, & Noam Miller (Wilfrid Laurier University)

Being part of a group entails both costs and benefits. When and with whom animals choose to group can help us identify which benefits are being reaped in a specific situation. Collective digging behaviour in Drosophila melanogaster larvae has been shown to provide individuals within the group more access to food than when alone. Collective digging has been observed in third instar larvae, at a time when hunger is elevated due to the imminence of pupation. To isolate how population density affects digging frequency and cluster size, we created an agent-based model of collective digging, based on existing empirical findings. We find that higher densities aid individuals in increasing food intake, up to a threshold, beyond which increased density is detrimental. Cluster size and duration are consistent across the range of population densities tested. As expected, time spent clustering increases as population density increases. By modeling both collective and individual behaviours, group behavior dynamics can be understood at a mechanistic level.

*Fin*mates forever! Cognitive challenge that brings the boys together

Eszter Matrai, Shaw Ting Kwok, Michael Boos (Ocean Park Hong Kong), & Ákos Pogány (Eötvös Loránd University)

Cognitive enrichments have gained considerable popularity over the past decades thanks to their multifactor benefits of linking science and welfare. A cooperative enrichment device was introduced to 23 dolphins at Ocean Park Hong Kong. The investigation focused on the potential impact of demographic and social factors on cooperative actions using systematic group testing. The cooperative enrichment device was made of a PVC tube containing fish and ice, that was temporarily sealed with two PVC caps with rope handles attached. The device was designed to be operated by pairs of dolphins, opened by simultaneous pull of its two handles. The analysis focused on two behaviours, cooperative opening and cooperative play with the device. Adult males showed higher success rate in cooperative opening than females. Cooperative play was exclusively displayed by adult males with strong correlation between the participants of the opening and the play events. Further investigation revealed increased frequency of cooperative opening with growing group size, while partner choice remained the same. These results are in support of using cooperative, cognitive enrichment devices to promote alliance formation resembling those found in nature in adult male dolphins.

2-min talks

Food-sharing tendencies in parrots

Anastasia Krasheninnikova (Max-Planck Comparative Cognition Research Group MPIO Seewiesen), Penny Kuijer (Behavioural Ecology Group Wageningen University Research), Antonia Lamprecht (Ludwig-Maximilians-Universität München), Désirée Brucks (Justus Liebig Universitat Giessen), & Auguste M.P. von Bayern (Max-Planck Comparative Cognition Research Group MPIO Seewiesen)

Prosociality is considered one of the driving forces for cooperation in human and animal societies. The presence of prosociality in different taxa suggests convergent evolution. To broaden the phylogenetic spectrum in our understanding of prosociality, we examined two parrot species (i.e., African grey parrots (AGP) and blue-headed macaws (BHM)) using a food-sharing paradigm. In previous work, AGP, but not BHM, helped their partners in a token transfer paradigm. Here, actors could directly donate food to their neighbour. By controlling the parrots' hunger level, we tested how satiation may affect their willingness to share food with their most affiliated partner and a lesser affiliated partner. To verify whether the birds understood the contingencies of the task we varied the presence of the partner and manipulated the partner's need for help. We also assessed whether the birds reciprocated if roles were reversed and examined their regurgitation behaviour following the test condition. Preliminary results show that the parrots did not directly transfer any food pieces to their partner. However, food-sharing by regurgitation subsequent to the test situation occurred between most affiliative partners and more frequently in the AGP than the BHM. This study highlights parrots as a fruitful model for studying prosociality.

Spatial Cognition

5-min talks

Differences in spontaneous preference for novel locations in two avian species

Chelsey C. Damphousse, Noam Miller, & Diano F. Marrone (Wilfrid Laurier University)

Our understanding of the avian hippocampal formation (HF) may be furthered by studying spatial behaviours that are less species-specific, as this permits direct comparisons between avian families, and potentially across classes. Towards this goal, we adapted a y-maze test from mammalian studies. In the easiest variation of the task, birds explore a y-maze for 5 minutes with one arm blocked. After a 1 minute delay, the subject is placed back into the maze with all arms open at test. In the hardest variation, birds explore two identical y-mazes with different arms blocked in two different rooms with unique extra-maze cues. Birds then explore both mazes with all arms open. Both Japanese quail (Coturnix japonica) and Silver King pigeons (Columba livia) show preference for the novel arm in a single y-maze, but only pigeons differentiate between the two contexts. These data show that reaction to novelty can be utilized across a number of avian species as the basis for testing spatial cognition. Studies of this nature may provide evidence that a number of tasks previously used exclusively in mammals may be adapted for birds.

Tool Use & Problem Solving

10-min talks

Tool transfer in the Goffin's cockatoo

Paula Ibáñez de Aldecoa (University of Vienna), Alice Auersperg (University of Veterinary Medicine Vienna), & Sabine Tebbich (University of Vienna)

Are Goffin's cockatoos capable of transferring a tool-use skill acquired in a certain situation to a new contextual setting on which they have no previous experience? In our study, performance of thirteen adult subjects (divided into two groups: experimental or control) was compared in a two-stage experiment where the learning component about the tool was manipulated by providing a more diverse training for the experimental group in stage one. We hypothesized that this broader learning of the tool's affordances would enable to transfer its use to solve a novel task. Our results show that the experimental group outperformed the control group in stage two (higher success rate and faster learning speed), which we interpret as a product of behavioural flexibility being enhanced during stage one: by operating the tool in more diverse contexts, these individuals might have acquired an advantageous experience, transferrable to tackle an untrained problem more efficiently.

5-min talks

Everything in order? A sequential tool-use experiment with Goffin´s cockatoos

Thereas Rössler (Messerli Research Institute - University of Veterinary Medicine Vienna Department of Cognitive Biology - University of Vienna), & Alice M.I. Auersperg (Messerli Research Institute - University of Veterinary Medicine Vienna)

Sequential tool-use describes using a tool to access one or more other tools, which in turn is used to reach an ultimate goal. Sequentially organized problems pose challenges on an agent such as inhibition control from acting on the goal directly, to mentally distance oneself from an immediate external (food) reward and to keep track of the individual stages. Here we present a newly developed sequential tool-use task: in contrast to earlier studies the subjects were presented with two different kinds of tools in the beginning of each trial – a choice that would already determine whether or not the task could be solved in the basic setting. To investigate whether they would flexibly adjust to different task demands we further confronted them with different configurations of boxes, sometimes yielding sequential tool-use unnecessary. This task was presented to a tool skilled parrot, the Goffin`s cockatoo (Cacatua goffiniana). They are non-habitual tool-users in captivity, can solve multi-step sequential tasks, which do not require the use of tools, and have proven inhibitory control while waiting for a preferred food item. Therefore, they are a promising candidate to investigate sequential tool-use behavior.

Golfing Goffin cockatoos, associative tool use with an ill-structured problem

Antonio J. Osuna-Mascaró (Messerli Research Institute. University of Veterinary Medicine Vienna. Vienna (Austria)), Roger Mundry (Platform Bioinformatics and Biostatistics. University of Veterinary Medicine Vienna. Vienna (Austria)), & Alice M. I. Auersperg (Messerli Research Institute. University of Veterinary Medicine Vienna. Vienna (Austria))

Tool use is a rare yet phylogenetically widespread phenomenon in nature, which some bird species are particularly good at. However, tool use is very diverse in both its forms and its cognitive requirements. Human tool use is flexible, innovative, and often requires the use of complex spatial relations between objects. Goffin's cockatoos (Cacatua goffiniana), although apparently not dependent on tool obtained resources, have demonstrated the ability to make, modify, and use tools, as well as being able to apply tools innovatively in different contexts. In this study, we wanted to test their innovative capacity on a associative tool use problem that can only be solved by using two objects (in this case a stick tool to push a compact object towards a goal). Three out of eleven cockatoos found the solution by slightly different means (one of them on its first attempt) and mastered the tool use problem in a quick and efficient way. Two more cockatoos were able to solve it, but did not meet the given criterion for reasons we discuss. Finally, we conducted a second experiment to test to what extent the skills could be socially acquired. We found evidence of emulation, corroborating previous related studies

Repeated innovation in captive Asian elephants using a novel problem-solving task

Sarah L Jacobson (The Graduate Center City University of New York), Amanda Puitiza (Hunter College City University of New York), Rebecca Snyder (Department of Conservation and Science Oklahoma City Zoo and Botanical Garden), Ashley Sheppard (Rosamond Gifford Zoo), & Joshua M Plotnik (The Graduate Center and Hunter College City University of New York)

While innovative problem-solving has been observed in elephants, individual variation and other behavioral traits associated with problem-solving have not yet been studied in detail. We used a novel extractive foraging device comprised of three compartments to evaluate 14 captive Asian elephants' innovative problem-solving over two phases. The first phase provided elephants with an opportunity to learn one solution, while the second gave them a chance to innovate to open two other compartments with different solutions. We measured each elephant's latency to first approach the apparatus (neophilia), as well as their persistence, motivation, and motor diversity in each session. We hypothesized that greater neophilia, greater motivation, longer persistence, and higher motor diversity would be associated with more innovation. Nine elephants innovated to solve three compartments, three solved two, and two solved only one. None of our behavioral measures were associated with elephants' innovation scores. However, increased persistence and a higher neophilia score were associated with a greater proportion of doors opened per session. This work suggests that elephants are an exciting candidate for the study of individual variation in problem-solving, and that future work on wild and captive populations could help us better understand how innovation is expressed in distinct environments.

Behavioral Flexibility in a Coyote using a Multi-access box

Victoria O'Connor (Oakland University), Sruti Jamalapuram, Kim Ellis (Creature Conservancy), & Jennifer Vonk (Oakland University)

It is critical to understand the behavioral flexibility of coyotes (Canis latrans) and other urban wildlife faced with changing environments and increasing populations. Coyotes' behavior has been shown to be significantly affected by human activity, including decreasing activity during daylight hours, and increasing vigilant behaviors in the presence of humans. We investigated innovation and inhibition – two components of behavioral flexibility - in one male captive adult coyote using a multi-access puzzle box (MAB) that has been used with other carnivora. The coyote opened all three solutions to the puzzle box requiring a variety of techniques in under five minutes on each trial. In comparison to other species, our results suggest that coyotes may learn faster and be more innovative than other successful large carnivores. An exploration of coyote cognitive abilities can help predict their behavior in the face of increasing anthropogenic pressures.