



# Abstracts

## CONTENTS

<b>Welcome</b>	3
<b>Programme overview</b>	4
<b>Venue</b>	7
<b>Keynote speakers</b>	8
<b>Parallel symposium sessions</b>	11
<b>Abstracts parallel symposium sessions</b>	12
<b>Posters</b>	51
<b>Sponsors</b>	120
<b>List of participants</b>	121

## **Welcome to Groningen!**

In this document, we provide a programme overview and the abstracts of all talks and posters. We look forward to a few inspired and highly social days!

### **The ECBB2022 organizing committee:**

**Jean-Christophe Billeter, Cato Drion, Pleunie Kraak, Martine Maan, Simon Verhulst**  
Groningen Institute for Evolutionary Life Sciences, University of Groningen

**Maria Valbuena**

Congress by design

## Programme overview

[Link](#) to detailed programme

Wednesday 20th July, location Academy Building			
14:00-18:00	Registration & Information		
15:45-16:00	Opening and announcements		
16:00-17:00	<b>Plenary 1</b>	<b>Franjo Weissing</b>	<i>Reconciling mechanistic and functional perspectives on behaviour</i>
17:00-18:00	Welcome drinks		
Thursday 21st July, location Oosterpoort			
7:00	<i>Optional social event: Morning run through Groningen</i>		
08:00-18:00	Registration & Information		
09:00-10:00	<b>Plenary 2</b>	<b>Peter Kappeler</b>	<i>The evolution of primate social systems</i>
10:05-11:05	<b>Parallel Symposia</b>		
Location	<b>Kleine Zaal</b>	<b>Binnenzaal</b>	<b>Bovenzaal</b>
	<b>Individual variation in genetics, physiology and behaviour</b>	<b>The social brain</b>	<b>Open symposium</b>
11:05-11:30	Coffee break		
11:30-12:25	<b>Parallel Symposia</b>		
	<b>Individual variation in genetics, physiology and behaviour</b>	<b>The social brain</b>	<b>Open symposium</b>
12:30-13:30	Lunch break		
13:30-14:30	Poster session (odd numbers)		
14:30-15:30	<b>Parallel Symposia</b>		
Location	<b>Kleine Zaal</b>	<b>Binnenzaal</b>	<b>Bovenzaal</b>
	<b>Individual variation in genetics, physiology and behaviour</b>	<b>Cultural evolution</b>	<b>There is no 'I' in welfare – the social dimension of animal wellbeing</b>
15:30-16:00	Tea break		
16:00-17:00	<b>Parallel Symposia</b>		
	<b>Individual variation in genetics, physiology and behaviour</b>	<b>Cultural evolution</b>	<b>There is no 'I' in welfare – the social dimension of animal wellbeing</b>
17:05-18:00	<b>Plenary 3</b>	<b>Audrey Dussutour</b>	<i>Problem solving in slime molds: from decision making to learning</i>
18:30	<i>Optional social event: Dinner Lottery: meet other participants in restaurants</i>		

Friday 22nd July, location Oosterpoort			
7:00	<i>Optional social event: Morning run through Groningen</i>		
09:00-10:00	<b>Plenary 4</b>	<b>David Anderson</b>	<i>Neural control of innate social and defensive behaviors and their internal motive states</i>
10:05-11:05	<b>Parallel Symposia</b>		
Location	<b>Kleine Zaal</b>	<b>Binnenzaal</b>	<b>Bovenzaal</b>
	<b>Animal Communication</b>	<b>The emergence of novel behaviours during social evolution</b>	<b>Open symposium</b>
11:05-11:30	Coffee break		
11:30-12:30	<b>Parallel Symposia</b>		
	<b>Animal Communication</b>	<b>The emergence of novel behaviours during social evolution</b>	<b>Open symposium</b>
12:30-13:30	Lunch break		
13:30-14:30	Poster session (even numbers)		
14:30-15:30	<b>Parallel Symposia</b>		
Location	<b>Kleine Zaal</b>	<b>Binnenzaal</b>	<b>Bovenzaal</b>
	<b>Animal Communication</b>	<b>Social influences on mate choice</b>	<b>Social foraging: from mechanism to consequence</b>
15:30-16:00	Tea break		
16:00-17:00	<b>Parallel Symposia</b>		
	<b>Animal Communication</b>	<b>Social influences on mate choice</b>	<b>Social foraging: from mechanism to consequence</b>
17:30	<i>Optional social Event: Pubquiz and/or treasure hunt in Groningen city center</i>		
Saturday 23rd July, location Oosterpoort			
7:00	<i>Optional social event: Morning run through Groningen</i>		
09:00-10:00	<b>Plenary 5</b>	<b>Joel Levine</b>	<i>Using Drosophila To Understand Social Groups</i>
10:05-11:05	<b>Parallel Symposia</b>		
Location	<b>Kleine Zaal</b>	<b>Binnenzaal</b>	<b>Bovenzaal</b>
	<b>Endocrinology of social behaviour</b>	<b>Cognition</b>	<b>Dominance between the sexes in group-living animals</b>
11:05-11:30	Coffee break		
11:30-12:25	<b>Parallel Symposia</b>		
	<b>Endocrinology of social behaviour</b>	<b>Cognition</b>	<b>Dominance between the sexes in group-living animals</b>
12:30-13:30	Lunch break		
13:30-14:05	<b>Surprise talk</b>		

14:05-15:35	<b>Niko Tinbergen Prize from the German Ethological Society</b>	<b>Chaired by C. Fichtel</b>	
14:15-14:45	<b>Niko Tinbergen award 1</b>	<b>Lysanne Snijders</b>	<i>Social dynamics going wild – insights from novel technology and traditional observation</i>
15:00-15:30	<b>Niko Tinbergen award 2</b>	<b>Manon Schweinfurth</b>	<i>Reciprocal cooperation in animals: does it exist?</i>
15:35-16:00	Tea Break		
16:00-17:00	<b>Plenary 6</b>	<b>Rose Thorogood</b>	<i>If “All of life is social”, how do social interactions influence the evolution of species interactions?</i>
17:05-17:30	Closing ceremony and student prizes		
18:00	Conference dinner		

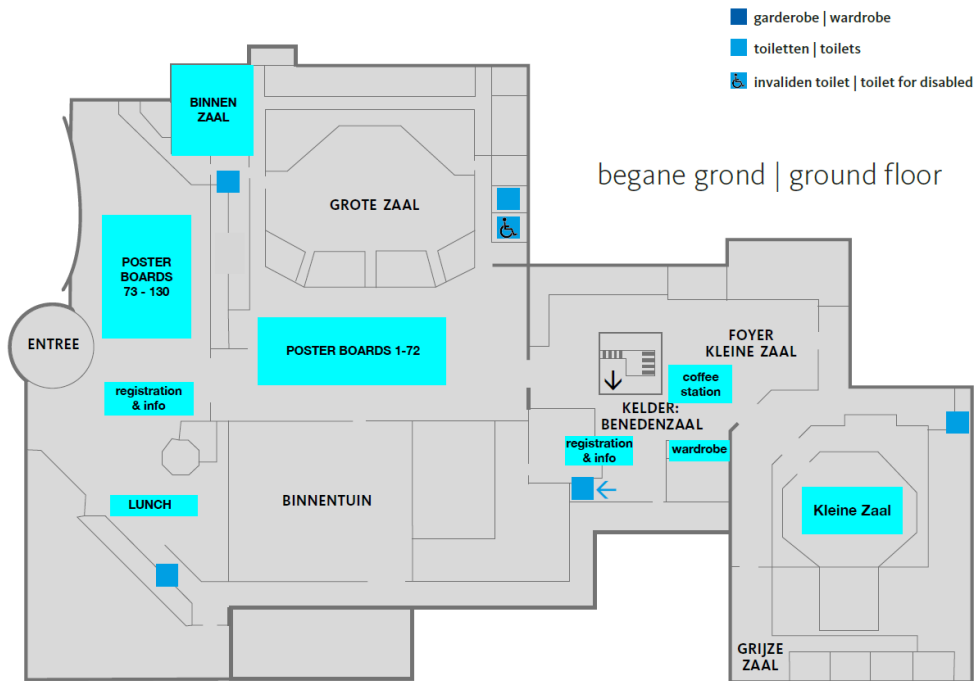
## Venue

The conference will be held in the theatre complex “de Oosterpoort”, with the exception of the opening lecture on Wednesday evening, which will be in the Academy building of the University.

Location Oosterpoort: Trompsingel 27, 9724 DA Groningen

Academy Building: Broerstraat 5, 9712 CP Groningen

## Floor plan Oosterpoort



## Keynote speakers in order of appearance

**Franjo Weissing** *Reconciling mechanistic and functional perspectives on behaviour*  
University of Groningen

Behavioural biology strives to understand how animals cope with the complex and dynamic environment they are living in. Such understanding can be achieved in very different ways. Disciplines like behavioural ecology strive to explain behaviour on the basis of processes like natural selection, while fields like neurobiology or endocrinology seek to unravel the mechanisms underlying behavioural responses. Communication across disciplines is hampered by the fact that mechanistic considerations play a minor role in most evolutionary arguments, while modern evolutionary insights are not easily incorporated into 'mechanistic thinking.' To achieve a (re-)unification of the proximate and ultimate behavioural sciences, an increasing number of researchers plead for a new approach that does not focus on the evolution of behavioural response patterns but on the evolution of the mechanisms underlying these patterns. This approach is still in its infancy, but first modelling studies show that it may have important implications. I will illustrate this with three examples. First, I will show that the evolutionary dynamics of cooperation can be strongly affected by the way animals perceive and process information. Second, I will demonstrate that kin selection can hamper, rather than foster, the evolution of effective outcomes when the structure of behavioural interactions is taken into consideration. Third, I will present a mechanistic model for the evolution of animal movement strategies, which reveals that evolution in mechanistic models can be orders of magnitude faster than in traditional models, with significant implications for the efficiency of foraging and the distribution of animals in space. Interestingly, mechanistic models also provide a new explanation for the emergence of individual differences in behaviour ('animal personalities').

**Peter Kappeler** *The evolution of primate social systems*  
German Primate Center & University of Göttingen, Germany

Primates exhibit great diversity in their social systems. The evolution of the diversity in their social systems has been studied in more detail than that of most other orders of mammals. Yet, several fundamental questions remain or have emerged in light of recent methodological and conceptual progress. My presentation will focus on four issues related to these questions. First, I will address the importance of conceptual clarity for comparative social systems research. Second, I will discuss the shift from qualitative classification to multi-dimensional quantification in comparative studies, highlighting the problem of intraspecific variation in this context. Next, I will tackle the question of how different components of a social system coevolve, focusing on functional integration and internal constraints in evolutionary transitions. Finally, I will argue that the field still lacks a comprehensive theory that integrates the key evolutionary mechanisms of social evolution. I will illustrate these points and questions primarily with examples from our own research on the social systems of the lemurs of Madagascar.

**Audrey Dussutour** *Problem solving in slime molds: from decision making to learning*  
University Paul Sabatier, France

The survival of all species requires appropriate behavioral responses to environmental challenges. Although single cell organisms lack the complex hardware of a true brain, they live in complex ecological niche and face the same decision-making challenges that animals are faced with: they must feed and mate, adapt to changing conditions, sense and avoid predators and find suitable microclimates to inhabit. However, behavioral processes such-as learning and decision making have hitherto been investigated almost exclusively in multicellular neural organisms. Evidence for learning and decision making in non-



neural multicellular organisms are highly debated and only a few unequivocal reports of learning and decision making have been described in single celled organisms.

Acellular slime molds are remarkable single cell organisms that belongs to the Amoebozoa, a kingdom usually considered to be a sister group to fungi and animals. Slime molds have often been used as a model organism to study problem-solving in a neural biological systems. To cite just a few examples, slime molds are able to find the shortest path through a maze, construct efficient transport networks, use social information, anticipate periodic events, avoid previously explored area, make multi-attribute decision..etc. In the first part of my talk, I will focus on decision making and explore various frameworks: nutritional geometry, speed versus accuracy trade-off, Weber's law and social influence. In the second part of my talk, I will review a series of experiments showing that slime molds display habituation, a simple form of learning. Hopefully by the end of my talk, you will be convinced that slime moulds are an ideal model system in which to investigate fundamental mechanisms underlying the ground-floor of cognitive abilities

**David Anderson** *Neural control of innate social and defensive behaviors and their internal motive states*  
Caltech, USA

tba

**Joel Levine** *Using Drosophila to understand social groups*  
University of Toronto, Canada

Over the last 20 years, there has been increasing interest into how *Drosophila melanogaster*'s social environment can affect its behaviour. More recently, studies on *Drosophila* social networks have emerged to better understand groups as an entity. How a group functions can change based on, for example, the genotype or number of individuals within it. I will introduce social behavioural studies in *Drosophila* which led me to investigate whether there are genetic determinants of social groups and how flies interpret and respond to their social environment. I will present evidence that the structure of *Drosophila* social networks is affected by a single gene and that flies have the ability to estimate the number of individuals around them. We anticipate that this research will provide insight into the genetic and neural basis of sociality in *Drosophila* and other organisms.

**Rose Thorogood** *If "All of life is social", how do social interactions influence the evolution of species interactions?*  
University of Helsinki, Finland

Darwin's theory of evolution by natural selection is the grounding principle that explains why the natural world is varied and diverse. Individual decisions influence how populations respond to selection pressures, whether they come from changing abiotic environments, interactions within species (i.e. social environments), or interactions with other species. However, how social interactions within species influence the ways in which selection is exerted on others, or how it affects population responses, is only beginning to be explored. Here I'll use field experiments with my favourite study system, reed warblers versus cuckoos, to explore how social transmission in particular fits into emerging theories about evolution and evolutionary dynamics.

## **Niko Tinbergen Prize winners**

**Lysanne Snijders** *Social dynamics going wild – insights from novel technology and traditional observation*

University of Wageningen

Sociality presents a key mechanism through which animals interact with their surroundings. Intriguingly, we see ample intraspecific variation in the social tendencies of animals. Why do we see this variation and what consequences does it have? Here, I will address these questions, referring to my studies of wild territorial great tits (*Parus major*) and of wild Trinidadian guppies (*Poecilia reticulata*). Using an automatic tracking system, personality assays and playback experiments, we studied the social and communication networks of great tits. These studies revealed that slower exploring males occupied less-central social network positions and that sexes responded in a contrasting way to perturbations to the communication network. To study wild guppies, I did not use novel technology, but instead relied on real-time focal observations in combination with food-provisioning experiments and (social) environment manipulations. These studies showed that more social individuals and individuals in larger groups enjoyed greater social foraging success. In essence, animal personality explained variation in the social connectivity of wild territorial songbirds, while variation in social connectivity influenced the foraging success of wild facultatively social fish. With my findings, I hope to illustrate the important roles of both novel and classic methodologies to gain relevant new insights into the hidden social lives of wild animals.

**Manon Schweinfurth** *Reciprocal cooperation in animals: does it exist?*

University of St Andrews

If only those behaviours evolve that increase the actor's own survival and reproductive success, then it might come as a surprise that cooperative behaviours, i.e., providing benefits to others, are a widespread phenomenon. Many animals cooperate even with unrelated individuals in various contexts, like providing care or food. One possibility to explain these behaviours is reciprocity. Reciprocal cooperation, i.e., helping those that were helpful before, is a ubiquitous and important trait of human sociality. Still, the evolutionary origin of it is largely unclear, mainly because it is believed that other animals do not exchange help reciprocally. Consequently, reciprocity is suggested to have evolved in the human lineage only. In contrast to this, I propose that reciprocity is likely to be widespread. In my talk, I will first shed light on the mechanisms of reciprocal cooperation in Norway rats (*Rattus norvegicus*). In a series of studies, my colleagues and I have demonstrated that Norway rats reciprocally exchange goods and services between and within different commodities and that reciprocal cooperation is not necessarily cognitively demanding. Furthermore, to understand the evolutionary origins of human reciprocity, and whether it is shared with other animals, I will then discuss evidence for reciprocity in non-human primates, which are our closest living relatives. A thorough analysis of the findings showed that reciprocity is present and not confined to unrelated individuals. Yet, the choice of commodities can impact the likelihood of reciprocation. Based on my findings, I conclude that reciprocal cooperation in non-human animals is present but largely neglected and not restricted to humans. In order to deepen our understanding of the evolutionary origins of reciprocity in more general, future studies should investigate when and how reciprocity in non-human animals has emerged and how it can be maintained.

## Parallel symposium sessions

### Thursday Morning 10:05 - 12:30

Individual variation in genetics, physiology and behaviour	The social brain	Open
--	------------------	------

### Thursday Afternoon 14:30 - 17:05

Individual variation in genetics, physiology and behaviour	Cultural evolution	There is no 'I' in welfare – the social dimension of animal wellbeing
--	--------------------	---

### Friday Morning 10:05 - 12:30

Animal Communication	The emergence of novel behaviours during social evolution	Open
----------------------	---	------

### Friday Afternoon 14:30 - 17:05

Animal Communication	Social influences on mate choice	Social foraging: from mechanism to consequence
----------------------	----------------------------------	--

### Saturday morning 10:05 - 12:30

Endocrinology of social behaviour	Dominance between the sexes in group-living animals	Open: Cognition
-----------------------------------	---	-----------------

## Abstracts parallel symposium sessions (in order by symposium)

Thursday Morning 10:05 - 12:30

### Individual variation in genetics, physiology and behaviour

**Christian Tudorache** *Coping with the clock - biological clock function is linked to proactive and reactive personality types*

Leiden University, The Netherlands

Many physiological processes in our body are controlled by the biological clock and show a diel (24-hour) rhythmicity. It is generally accepted that a robust diel rhythm is a prerequisite for optimal functioning of an individual, and that a lack of rhythmicity can contribute to the pathogenesis of various diseases.

In a previous study (Tudorache et al, 2018), we have observed a remarkable individual variation in diurnal rhythmicity in a wildtype zebrafish population, on various levels of biological function: clock gene expression, endocrine regulation and locomotor activity. Our data range from robust diurnal rhythms with large amplitudes and rhythm strength to a complete absence of rhythmicity. These clock phenotypes were correlated with coping styles, varying along a continuum between proactive and reactive extremes. Adult proactive fish displayed a strong diurnal rhythm while reactive fish showed a complete absence of rhythmicity.

In order to explore the role of the glucocorticoid receptor (GR) in both, stress coping and the rhythmicity of the biological clock, we tested mutant larval zebrafish with a non-functional GR (*grs357*). Interestingly, when compared to wildtype fish, the mutants displayed a weaker rhythmicity in locomotor activity, but a stronger one in angular velocity, an indicator for an erratic swimming path. The melatonin production of the mutants however, showed a weaker rhythmicity, but surprisingly, there were no differences in the rhythmicity of clock-related gene expression between genotypes that could explain a mechanism for GR functionality at the transcriptional level. These results therefore suggest that GR affects the diel rhythmicity of zebrafish larvae at the behavioural and endocrine level, but that these effects are not mediated by changes in the expression of clock-related genes.

We conclude that variation in diurnal rhythmicity is naturally present in wildtype populations, as an integral part of a reactive coping style, and interacts with various levels of biological function.

**A. Ramesh** *Individual personalities and not the social context predict movement tendencies in three-spined sticklebacks*

Aparajitha Ramesh, University of Groningen \*; Jakob Gismann, University of Groningen; Ton Groothuis, University of Groningen; Franjo Weissing, University of Groningen; Marion Nicolaus, University of Groningen

It is now widely accepted that animals of the same populations, same sex and morphological states often differ consistently in suites of behaviours (animal personalities). However, to reap the benefits of a group living, individuals often need to adjust their behaviour to some extent to match that of their interacting partners (social modulation of behaviour). One challenge faced by these studies is that detailed knowledge of an individual's social environment is often difficult to gain, especially for animals which form dynamic social groups. We here capitalize on a unique system of populations of migrant and resident

sticklebacks (*Gasterosteus aculeatus*) with markedly different movement tendencies but still show social interactions within a mixed shoal. By creating mixed shoals with different proportions of migrants and residents, we ask whether and to what extent individual movement tendencies are affected by the social group composition. Using a recently established semi-natural mesocosm system consisting of connected ponds, we collected individual movement data (over extended periods) in an ecologically relevant environment (larger spatial scales and social groups). We find that the tendency of residents to exit the first pond was increased by the presence of migrants, while the expression of movement tendencies between ponds is predominantly driven by the individual's inherent movement tendency. We thus conclude that in our system, movement tendencies over larger scale may largely be driven by individual tendencies and that that social effects on movement may play a role at a different life stage over ontogeny.

**M. Bracic** *Do optimists choose different environments than pessimists? Studying the ecological relevance of judgement bias in laboratory mice*

Marko Bračić\*, Lavanja Nimalavachchlan, Sylvia Kaiser, Norbert Sachser, S. Helene Richter, 1. Department of Behavioural Biology, University of Münster, Germany

Individuals differ in the way they respond to ambiguous information: while some individuals behave as expecting a positive outcome, others behave as expecting a negative outcome in ambiguous situations. Such "optimistic" or "pessimistic" biases are used in animal welfare science, where "optimism" levels in so-called judgement bias tests have become an important indicator of welfare. However, the ecological relevance of being "optimistic" or "pessimistic" in judgement bias tests is not yet explored. This is particularly surprising as, in nature, animals often need to make decisions in the face of ambiguity and the outcomes of those decisions can affect survival and fitness. For example, "optimists" might choose more dangerous environmental conditions than "pessimists". Therefore, we investigated whether "optimism" levels are linked to certain environmental preferences.

Specifically, we first assessed "optimism" levels of 38 female C57BL/6J mice by scoring their decisions in ambiguous situations, using an established judgement bias paradigm. Then we assessed their environmental preferences in a newly established "choice paradigm". Briefly, this paradigm is based on a trade-off between foraging and predation avoidance: mice could choose to either enter a safe environment and claim a small reward or to enter a dangerous environment (rat smell combined with bright light) and claim a large reward.

In contrast to our expectation, "optimism" levels of mice did not correlate with their preferences for choosing a dangerous or safe environment. One possible explanation is that evaluating ambiguity in judgement bias tests involves a different mechanism than evaluating predation risk. Interestingly, however, we found repeatable individual differences in environmental preferences, indicating that these preferences might represent a stable trait. Our novel paradigm thus provides a promising method for assessing environmental preferences in mice, mimicking a highly ecologically relevant situation.

**F. Berlinghieri** *Do stickleback parents influence the development of personality and brain laterality in their offspring?*

Flavia Berlinghieri\* University of Groningen and Macquarie University, Paolo Panizzon University of Groningen and Macquarie University, Marion Nicolaus University of Groningen, Bernd Riedstra University of Groningen, Culum Brown Macquarie University, Ton Groothuis University of Groningen.

Parental influences on offspring phenotype occurring through pathways other than inherited DNA are known as parental effects (i.e. epigenetic modifications). Such effects have been demonstrated to affect two traits that are very widespread and of fundamental importance in the animal kingdom with clear fitness consequences: laterality of brain and behaviour and personality traits. For example, reproducing

groups of adult sticklebacks exposed to predation cues produce offspring with decreased antipredator behaviour and reduced activity levels. This study investigated the impacts of parental effects on the development of brain lateralization, personality traits and somatic growth of offspring. Groups of reproducing sticklebacks were treated with a combination of several predator cues or lack thereof during egg production. Soon after laying, eggs were removed and a part of the clutch was reared in standard conditions until 12 weeks post hatching, whereas the other part was used for maternal hormone analyses of steroid in the androgenic and cortisol pathway. Results are currently being analysed. So far we found that offspring from predator-exposed parents were smaller than control offspring likely due to the ecological stressor of the predation consistent with the possibility that these eggs contained elevated levels of corticosteroids. We expect to find that our results support the hypothesis that stickleback parents influence the development of lateralized behaviour, personality traits and growth of their offspring via eggs to match their future environment.

**V. Franks** *Genetic and ecological drivers of early-life social structure in juvenile birds*

Victoria Franks, University of Chester\*; Rose Thorogood, University of Helsinki; Patricia Brekke, Institute of Zoology Zoological Society of London

In contrast, outside of the mother offspring bond, in chicks watching broodmates exposed to a stressor, we found the co-occurrence of socially-mediated arousal and behavioural and physiological contagion. Both observers and conspecifics responded with stress-induced hyperthermia as well as increased freezing, and reduced preening and ground pecking during conspecific stress. Subject-Observer behaviour was highly correlated within broods during control and stressor conditions, but with higher overall synchrony during conspecific stress. However, in another study, we found no evidence for either process in adult hens observing stress in a familiar adult.

## **The social brain**

**R. Oliveira** *Evolutionary conserved neuromolecular mechanisms of social transmission of fear in zebrafish*

Rui F. Oliveira\*, Ibukun Akinrinade, Kyriacos Kareklas, Michael Glikberg, Giovanni Petri, Gil Levkowitz

Emotional contagion is the most ancestral form of empathy that relies on simple perception-action mechanisms, on top of which more complex forms of empathic behaviors, such as consolation and helping, have evolved. Here we tested to what extent the proximate mechanisms of emotional contagion are evolutionary conserved by assessing the role of oxytocin, known to regulate empathic behaviors in mammals, in social fear contagion in zebrafish, which represents an evolutionary divergent line to that of tetrapods, within vertebrates. Using mutants for the ligand of the fish oxytocin nonapeptide and both of its receptors in zebrafish we showed that oxytocin is necessary for observer zebrafish to copy the distressed behavior of conspecific demonstrators. Exogenous administration of oxytocin to the ligand mutant rescued the ability of observers to express social fear transmission, indicating that oxytocin is not only necessary but also sufficient for emotional contagion. The brain regions in the ventral telencephalon that are associated with emotional contagion in zebrafish are homologous to those known to be involved in the same process in rodents (e.g. striatum, lateral septum), and receive direct projections from oxytocinergic neurons located in the pre-optic area. Finally, we ruled out the hypothesis that social transmission of fear in zebrafish merely relies on behavior contagion by motor imitation, and we showed that it rather relies on emotion discrimination. Together our results support an evolutionary conserved role for oxytocin as a key regulator of basic empathic behaviors across vertebrates.

**E. Leadbeater** *Ecology dictates the value of memory for foraging bees*

Christopher Pull, Royal Holloway University of London; Irina Petkova, Royal Holloway University of London; Cecylia Watrobska, Royal Holloway University of London; Gregoire Pasquier, Royal Holloway University of London; Marta Perez Fernandez, Royal Holloway University of London; Elli Leadbeater\*, Royal Holloway University of London

“Ecological intelligence” hypotheses posit that animal learning and memory evolves to meet the demands posed by foraging, and together with social intelligence and cognitive buffer hypotheses, provide a key framework for understanding cognitive evolution. However, identifying the critical environments where cognitive investment reaps significant benefits has proved challenging. Here, we capitalise upon seasonal variation in forage availability for a social insect model (*Bombus terrestris*) to establish how the benefits of short-term memory vary with resource availability. Through analysis of over 1700 foraging trips carried out over two years, we show that short-term memory predicts foraging efficiency – a key determinant of colony fitness – in plentiful spring foraging conditions, but that this relationship is reversed during the summer floral dearth. Our results suggest that selection for enhanced cognitive abilities is unlikely to be limited to harsh environments where food is hard to find or extract, highlighting instead that the complexity of rich and plentiful environments could be a broad driver in the evolution of certain cognitive traits.

**S. Simões Henriques** *A specialized genetic architecture for social learning in *Drosophila melanogaster**

Carla\*, Simões-Henriques, Instituto Gulbenkian de Ciência, Oeiras, Portugal; Joana, Marcos, Instituto Gulbenkian de Ciência, Oeiras, Portugal; Élio, Sucena, Instituto Gulbenkian de Ciência, Oeiras, Portugal; Maria L., Vasconcelos, Champalimaud Neuroscience Program, Champalimaud Foundation, Lisbon, Portugal; Susana A. M., Varela, Instituto Gulbenkian de Ciência, Oeiras, Portugal, ISPA-Instituto Universitário, Lisbon, Portugal; Rui F., Oliveira, Instituto Gulbenkian de Ciência, Oeiras, Portugal, Champalimaud Neuroscience Program, Champalimaud Foundation, Lisbon, Portugal, ISPA-Instituto Universitário, Lisbon, Portugal

Social and asocial learning are required to cope with the complexity of the environment. However, whether they use a shared (general-purpose) or distinct (special-purpose) cognitive mechanisms remains elusive. At the genetic level a general-purpose mechanism should comprise a single set of genes, while a special-purpose mechanism should comprise different sets of genes, possibly regulating different biochemical pathways and/or neural circuits. This study aims to disentangle the genetic architecture of social and asocial learning in *Drosophila melanogaster*. We firstly tested social and asocial learning abilities in 40 lines of the DGRP, a panel constituted of isogenic sequenced lines that together represent the genetic variation of a natural *Drosophila* population, using aversive conditioning paradigms for oviposition sites. We obtained significant learning performance variation across the tested lines that showed no correlation between social and asocial learning. Secondly, we performed a Genome-Wide Association Study between the genetic variants in the DGRP and each learning phenotype. We obtained two completely different sets of genes associated with social and asocial learning, ranging from genes with unknown biological activity to genes already known to be related to learning. Thirdly, to functionally validate the role of each candidate gene on each learning phenotype, we are using GAL4/RNAi-UAS lines. Preliminary results confirm the association of some genes with specific types of learning. Finally, we analysed the expression patterns of our candidate genes in the brain and found that some are expressed in the mushroom body, a brain region previously described to be involved in associative learning. Together, these results suggest so far the occurrence of a domain-specific genetic architecture for social learning in *Drosophila*.

**S. Lanooij** *Overlapping neurobiological substrate linking sociality and cognition: implications for*

### *Alzheimer's Disease*

Suzanne D. Lanooij \*, Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen; Ulrich L.M. Eisel, Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen; Eddy A. van der Zee, Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen; Martien J.H. Kas, Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen

Accumulating evidence points to the existence of a bidirectional relationship between social factors (e.g. social environment and social behavior) and Alzheimer's Disease (AD). Studies in both humans and rodents have shown that the social environment can affect the risk to develop AD and the disease progression. For example, loneliness is associated with an increased risk to develop dementia, while social support could be protective. In addition, AD patients suffer from cognitive deficits but also show behavioral and psychological symptoms, including social withdrawal. In fact, many psychiatric or neurological disorders present symptoms related to both social functioning and cognitive functioning. We have established an overview and the potential of the existence of an extensive neurobiological substrate underlying the close relationship between the social and cognitive domain. By mapping the rodent brain regions involved in any of these domains, we show that the vast majority of brain regions involved in the cognitive domain are also involved in the social domain. The identified neuroanatomical overlap has an evolutionary basis and aligns with the reported functional interactions of processes underlying cognitive and social performance. We argue that the social domain requires more focus as an important treatment target for many neurological and psychiatric disorders.

The implications of this intimate relationship between the social and cognitive domain are illustrated using examples from our own research in mouse models for AD. Longitudinal behavioral measurements of APP-transgenic J20 mice showed that social deficits are an early indicator of APP-pathology. Furthermore, changing the social environment (e.g. group size or composition) of wildtype and AD-transgenic mice indeed affected their behavior and brain health. Moreover, some unexpected findings offer new insights on the intricate relationship between social factors and brain health. Overall, our results highlight the importance of social factors in the development and treatment of AD.

This study is supported by the ZonMW memorable funding program (grant number: 733050831)

### **V. Vasas** *Choosing from the beginning: predispositions enhance learning in inexperienced animals*

Vera Vasas\*, Queen Mary, University of London; Shuge Wang, Queen Mary, University of London; Laura Freeland, Queen Mary, University of London; Elisabetta Versace, Queen Mary, University of London, The Alan Turing Institute

How can animals make decisions from the start of their lives, without the aid of previous experience? One vitally important example is the chicks' identification of their social partners. Here, we explore the cognitive mechanisms that aid domestic chicks (*Gallus gallus*) to correctly identify their conspecifics. Chicks hatch with a set of predispositions that prompt them to selectively approach their mother hen. We address the role of predispositions in imprinting by testing the chicks' colour preferences soon after hatching, and after being imprinted on stimuli with varying colours in short (1 day) and long (5 days) experiments. Initially, red is preferred over yellow, and blue is preferred over green. We interpret this finding in terms of Bayesian decision-making: we argue that it is not the hen's expected appearance per se that explains the chicks' colour preferences; rather, predispositions target features where the hen is most likely to differ from other objects in the environment. Over time, chicks develop a long-term attachment to the imprinting object. Given enough time (5 days in our experiments), exposure to a predisposed or a non-predisposed target results in equally strong attachment. However, the time course of the imprinting substantially differs: for predisposed stimuli, the selective preference is established



quickly and unequivocally, while for non-predisposed stimuli, the imprinting process takes longer, and passes through a phase where predisposed and learnt characteristics are equally attractive. Modelling shows that relatively simple mechanisms might be behind this dynamics. The interplay between predispositions and imprinting ensures that while the learning landscape is fully flexible and the result of the imprinting process is defined by individual experience, the process is channelled towards the best available target. Thus, our results exemplify how biases in cognition can enhance learning.

## Open Symposium

### **A. Cantarero** *Females select male behaviour over infection status when male ornaments do not show infection*

Alejandro Cantarero\* (Department of Physiology, Veterinary School, Complutense University of Madrid, Avenida Puerta de Hierro s/n, 28040 Madrid, Spain), Olga V. Dolnik (Konrad Lorenz Institute of Ethology (KLIVV), Department of Integrative Biology and Evolution, University of Veterinary Medicine Vienna, Savoyenstraße 1a, A-1160 Vienna, Austria), Matteo Griggio (Dipartimento di Biologia, Università di Padova, Via U. Bassi 58/B, I-35131 Padova, Italy) and Herbert Hoi (Konrad Lorenz Institute of Ethology (KLIVV), Department of Integrative Biology and Evolution, University of Veterinary Medicine Vienna, Savoyenstraße 1a, A-1160 Vienna, Austria)

Parasites are known to be a key driving force in mate choice and are important for the expression and evolution of ornaments and behavioural traits being used in this context. However, there is little experimental evidence on how parasite's burden of the choosing individual is integrated in the mate-choice process and how it affects decision-making, especially in relation to parasite infestation of potential mates. Thus the aim of our study is to determine whether female house sparrows, *Passer domesticus*, adjust their mate preference according to their own as well as the parasite load of prospective partners. To do this, we experimentally manipulated female parasite load and determined their mate preferences prior to and after parasite treatment. We manipulated the chronic coccidian parasite burden of females either by initiating the acute infection phase via re-infecting them with coccidian or by temporally reducing parasite load of coccidia. We then measured the effect of this manipulation on mate preference by presenting females with a choice of four stimuli: three males with similar ornaments, but unmanipulated, naturally varying chronic coccidiosis levels, and an unmanipulated control female. We found that, before manipulation, females preferred highly infested males, regardless of their own infestation level. However, after manipulation, infested females avoided highly infested males probably in response to the deterioration of their health condition by parasites. Our study suggests that mate choice decisions are more complex when they are mediated by parasites. The implications of parasites for evolutionary theories of sexual signalling and mate choice are discussed.

### **V. Chiara** *Groups are choosier than individuals: shoaling preference for kin and the effect of maternal age*

Violette Chiara\*, Jessica Comesaña Rodríguez, Sin-Yeon Kim

Grupo Ecoloxía Animal, Torre CACTI, Centro de Investigación Mariña, Campus de Vigo, Universidade de Vigo, 36310 Vigo, Spain

In gregarious or social species, groups tend to have a high level of phenotypic homogeneity with individuals being more similar within than between groups. This affirmation is particularly true if considering shoaling fish. It has been demonstrated that isolated fish present a preference in joining one group over another according to the group composition. But in the field, an isolated individual will not have the possibility to choose between groups and will generally join the first group that appears. Also, the observed homogeneity of the groups results from choices made at the group level through behavioral

processes of group fusion and fission. However, little is known about the fine scaled individual behaviors during these events and how these contribute to the maintenance of the within group homogeneity. Many fish species are known to prefer to shoal with kin, but the physiological or genetic quality of the fish family may influence this preference. In this study, we compared the shoal preference for kin or non-kin between isolated and grouped fish by using juvenile three-spined sticklebacks produced by young and old mothers that differ in quality. Sticklebacks showed shoal preferences when they were tested in groups but not when tested in isolation. Moreover, high quality families (from young mothers) shoaled preferentially with kin, whereas low quality families (from old mothers) preferred to shoal with non-kin. We also found that within-group homogeneity is ensured by group fission. For example, in fish from young mother, an individual was more likely to follow its kin who left the group when they were shoaling with non-kin than when they were shoaling with kin. These results provide strong insights into our understanding of the behavioral mechanisms underlying the maintenance of group homogeneity in shoaling fish.

**A. Costanzo** *Extracting a digital sociability score from passive smartphone data*

Andrea Costanzo\* and Martien J. Kas --- Affiliation: Groningen Institute for Evolutionary Life Sciences, University of Groningen, the Netherlands

Social interactions are a fundamental part of human healthy life. Social dysfunction and social withdrawal are associated with higher mortality and morbidity risk, including cardiovascular diseases, and are one of the first and most common signs of major neuropsychiatric disorders like Schizophrenia and dementia.

Social functioning is traditionally measured using questionnaires. Though, questionnaires require active participation of patient and interviewer, are difficult to scale to large number of patients, are limited to only few timepoints, and suffer from non-objective answers by the participants.

Smartphones are nowadays very widely used, and are a powerful tool to measure (social) behaviour of people. We aim at exploiting smartphone usage data (i.e. no content of messages and calls, but only phone usage and location data), that are passively collected by the smartphone application Behapp (behapp.com), to objectively measure social behaviour. This measurement technique has the advantage of not requiring any action by the patient after app installation, it can be easily scaled to large number of patients, and it objectively and continuously measures (social) behaviour.

The Behapp application has been already successfully used for assessing neuropsychiatric phenotypes. It also successfully measured behavioural changes during the COVID-19 pandemic, where imposed quarantine restrictions resulted in more time spent using communication apps, more time spent at home, and less number of places visited.

The continuous measurement and tracking of (social) behaviour over time can be exploited to detect early warning signals (in our case social withdrawal) to successfully tackle the onset or the relapse of psychiatric diseases. Yet, a major challenge to detect early warning signals with smartphone data is to convert raw smartphone data into a measurable quantity describing social behaviour. Extracting such a digital sociability score, and validating it with questionnaire data as reference, is the aim of the present work.

**C. Benvenuto** *“Social control” of reproduction*

University of Salford, UK \*; Maria Cristina Lorenzi Université Sorbonne Paris Nord, France

Multi-member groups with high variance in reproductive success are often somehow hierarchically structured, with dominant individuals securing the majority of mating events. This reproductive skew

culminates in eusocial systems where only a single individual (or a single pair) reproduces. Traditionally, dominants have been considered able to control other individuals' reproduction: social control of reproduction has been described in eusocial (e.g., naked mole-rats) and in cooperatively breeding mammals (e.g., banded mongooses), in social insects (from hymenopteran to termites), in many fishes (from cichlids to sex changing species), in eusocial crustaceans (snapping shrimp) and more. From hymenopteran queens, who impose sterility on workers, to sequential hermaphrodites who suppress other individual's change of sex and simultaneous hermaphrodites who affect partners' sex allocation, dominance appears to regulate the physiology of the reproductive state of other individuals, across sexual systems. But how can one individual control the status of others inhibiting their ability to reproduce or stopping the full optimization of their reproductive output? Alternatively, "subordinates" could self-restrain their reproductive potential in presence of dominant individuals. Using a multi-taxa approach, we propose a resolution of reproductive-skew conflicts based on signaling rather than control, along a continuum of mechanisms of social regulation of reproduction.

**T. Dehnen** *Strategic dominance interactions in vulturine guineafowl*

\*Tobit, Dehnen, Centre for Ecology and Conservation, University of Exeter; Danai, Papageorgiou, Department of Evolutionary Biology and Environmental Studies, University of Zurich; Brendah, Nyaguthii, Department of Ornithology, National Museums of Kenya; Wismer, Cheron, Mpala Research Centre; Julia, Penndorf, Cognitive and Cultural Ecology Research Group, Max Planck Institute for Animal Behavior; Neeltje, Boogert, Centre for Ecology and Conservation, University of Exeter; Damien, Farine, Department of Evolutionary Biology and Environmental Studies, University of Zurich

Dominance is important for access to resources. As dominance interactions are costly, individuals should be strategic in whom they interact with. One hypothesis is that individuals should direct costly interactions towards those closest in the hierarchy, as they have most to gain—in terms of attaining or maintaining dominance—from winning such interactions. We find that male vulturine guineafowl, a gregarious species with steep dominance hierarchies, strategically express higher-cost aggressive interactions towards males immediately below themselves in the hierarchy. By contrast, lower-cost aggressive interactions are expressed towards group members further down the hierarchy. By directly evaluating differences in the strategic use of higher- and lower-cost aggressive interactions towards competitors, we show that individuals disproportionately use highest-cost interactions—such as chases—towards males found one to three ranks below themselves. Our results support the hypothesis that the costs associated with different interaction types can determine their expression in social groups with steep dominance hierarchies.

**S. Harrower** *Does distinctiveness enhance the memory of previous help in Norway rats (*Rattus norvegicus*)?*

Sophie Harrower\* and Manon K. Schweinfurth (both University of St Andrews, School of Psychology & Neuroscience)

Reciprocity – that is, selectively helping those who previously helped you – is one of the most debated explanations for cooperation. Recent work suggests that reciprocity is present in many nonhuman species and hence potentially widespread. However, some researchers argue that it is limited to few species because it is cognitively demanding mainly due to high memory demands. Indeed, memory is integral to reciprocity. To effectively direct help to others, individuals must memorise their prior interactions and adjust their helping level accordingly. Thus, the more information there is and the longer it needs to be stored, the greater the imposed cognitive demands become. It is currently unclear how different species overcome these demands to reciprocate help. However, certain factors may enhance

memory during such interactions. For example, distinctiveness has been shown to enhance memory for events and stimuli in multiple species, which might be important for reciprocity. We address this by testing Norway rats on an established food-donation paradigm. First, focal rats will experience four partners: i) a cooperator donating a routine food (that focal rats experienced regularly during training); ii) a cooperator donating a distinct food (that they did not experience during training); iii) a defector not donating a routine food and iv) a defector not donating a distinct food. After 10 days (chosen to increase memory demands) focal rats will be able to share food with each of these partners. The data will demonstrate if distinctiveness enhances memory for reciprocal interactions by focal rats donating more food to cooperators than defectors after receiving distinct food, but donating equally to both cooperators and defectors after receiving routine food. These results will further our understanding of how species can overcome high memory demands to achieve reciprocity, thus informing current debates regarding the ubiquity of reciprocity in nonhuman species.

Thursday Afternoon 14:30 - 17:05

## **Individual variation in genetics, physiology and behaviour**

**A. Guenther** *Does a change in food quality induce an adaptation in a pace-of-life syndrome within three generations?*

Anja Guenther\* MPI for Evolutionary Biology; Neel Prabh, MPI for Evolutionary Biology

Life history variation usually aligns along a slow-fast continuum with slow development and low reproductive rate at the slow and opposing traits on the other end. Physiological and behavioural traits are hypothesised to integrate with individual differences in life history into pace-of-life syndromes. Traits generally show covariation that can arise from genetic and environmental influences on phenotypes and constrain the independent evolution of traits, resulting in fitness consequences and impacts on population dynamics. How such syndromes emerge, are maintained and adapt to changes in the environment, is as yet not well described. Here, we manipulated food quality to induce a faster pace-of-life in house mice (*Mus musculus*) living under semi-natural conditions. Across three generations, we investigated whether this change in life history would induce concurrent changes in risk-taking and stress-coping behaviour. Furthermore, we tested if the observed trait changes could be explained by changes in gene expression profiles. We observed the expected increase in pace-of-life which was mainly explained by faster growth and earlier onset of reproduction. Going along with these changes in life history, we observed a decrease in risk-taking. Furthermore, individuals having a fast pace-of-life and living under high quality food conditions, showed a significant change in catabolic processes of liver gene expression, pointing towards a molecular mechanism involving many metabolic processes. Taken together, our data demonstrate that pace-of-life syndromes can adapt to changes in the environment very fast, relying on inter-and transgenerational plasticity rather than the much slower change in gene frequency due to selective processes alone.

**D. Hebesberger** *Friends with benefits? Assessment of bond-related social buffering effects and facilitation of exploratory behaviour in domestic horses (*Equus caballus*)*

Denise V. Hebesberger\*<sup>1,2</sup>, Jacob C. Dunn<sup>1,3</sup>, Dawn Hawkins<sup>1</sup>, Claudia A.F. Wascher<sup>1</sup> <sup>1</sup>Behavioural Ecology Research Group, Department of Life Sciences, Anglia Ruskin University, Cambridge, United Kingdom; <sup>2</sup>University of Veterinary Medicine, Vienna, Austria; <sup>3</sup>Biological Anthropology, University of Cambridge, Cambridge, United Kingdom

In this session, I will discuss these and other studies in terms of shedding light of the role of social

relationships in empathic processes, as well as discussing the interaction between empathic and other social processes and the importance of valence in determining the capacity for emotional contagion.

**T. Ratz** *The rival widows: how prey availability affects individual responses to intraspecific competition in a black widow spider*

Tom, Ratz\*, Ludwig-Maximilians-University of Munich; Pierre-Olivier, Montiglio, University of Quebec at Montreal

Individuals affect the phenotype and reproductive success of their conspecifics as a result of competitive social interactions. Such effects can alter the intensity of selection or change the rate of evolution. However, the magnitude of the effects of competition, and thus their evolutionary impact, should depend on how individuals adjust their phenotype to variation in key environmental variables such as the availability of food resources. We tested this hypothesis in the western black widow spider *Latrodectus hesperus* by manipulating the number of available prey and the presence or absence of a competitor in the environment. Black widows use their web for both prey capture and protection against intruders. We monitored whether spiders modified the structure of their web and aggressiveness towards prey stimuli in response to the presence of a competitor and whether these responses depended on prior access to prey. We also tested if indirect effects of competition varied with individual differences, such as in web structure, of competitors. Spiders with limited access to prey were less likely to attack prey stimuli when they were in the presence of a conspecific competitor, whereas spiders with greater access to prey showed the opposite response. In contrast, all spiders built webs with a greater emphasis on protection when in the presence of a competitor, regardless of prior access to prey. Thus, access to resources can change how individuals respond to competition drastically. More generally, our findings suggest that environmental conditions and the magnitude of among-individual variation can be important mediators of the effects that social interactions have on phenotypes and eventually on their evolution.

**P. Shit** *Hierarchy formation in a clonal ant*

(Piuli Shit, University of Regensburg)\*, (Jürgen Heinze, University of Regensburg), and (Abel Bernadou, University of Regensburg)

In animal societies, the determining factors for the dominance hierarchy can be anything, starting from age, body weight, morphological traits, and previous experience. However, dominance hierarchies may also exist in groups of individuals, which are almost identical in such traits. Factors governing hierarchy formation and task specialization in such cases remain poorly understood. If every society member can become the dominant, what influences individuals' fate at an early stage?

To answer this question, we studied hierarchy formation in the clonal ant *Platythyrea punctata*. Colonies contain genetically identical individuals that reproduce through thelytokous parthenogenesis. Young individuals establish a hierarchy through fighting, and colonies have a strict division of labor. Only the dominants lay eggs while other nestmates clean the nest, take care of the offspring, forage, and do all other tasks except reproducing. In our study, we characterized young workers after emergence through behavioral, physiological, and morphological measurements. We were in particular interested in intrinsic "quality differences" among workers, and whether these differences at an early stage may cause task allocation and specialization within colonies. Our results will help us elucidate the link between social rank and the morphological, behavioral, and physiological features of the colony members.

**U. Urhan** *Cognitive and behavioural determinants of innovativeness*

Utku Urhan\*, NIOO-KNAW, Wageningen, The Netherlands - Lund University, Lund, Sweden; Anders Brodin, Lund University, Lund, Sweden; Kees van Oers, NIOO-KNAW, Wageningen, The Netherlands

Behavioural innovation allows animals to invent plastic behavioural responses to novel ecological challenges. Theory predicts that species with a higher level of this ability are better able to adapt to unpredictable environmental changes. Innovation ability varies not only between species, but also between populations of the same species, and even individuals within populations. Although studies on innovativeness have indicated its importance for adaptation and fitness, it is still largely unclear why some animals are better capable of coming up with solutions to novel problems compared to others. We tested the hypothesis that a combination of correlated cognitive and behavioural specialisations that have evolved for specific purposes other than innovation ability per se, act together to allow animals to innovate. We determined executive functions (motor inhibition, reversal learning) and object permanence as likely cognitive traits, and exploratory behaviour, neophobia and motivation as likely behavioural traits to effect innovative problem solving performance. We investigated this in three members of the Paridae family: the great tit (*Parus major*), blue tit (*Cyanistes caeruleus*), and marsh tit (*Poecile palustris*) at the between and within-species level. These species are closely related but show fundamental differences in foraging behaviour and cognitive specialisations. We expect variation in problem solving performance between these species due to their niche specialisation. We also expect that these species' performance in cognitive and behavioural traits co-vary with their performance in innovative problem solving tasks. Our results on these species with distinct behavioural characters will allow us to explore what factors may cause the evolution of cognitive differences at species level. Moreover we expect that the individuals' performance in these cognitive and behavioural determinants would predict the performance of innovation ability within the same species. This study will shed more light on the evolution of innovative ability in natural bird populations.

**E. Wilwert** *Where I go is what I see? Visual adaptation and matching habitat choice in cichlid fish*  
Elodie Wilwert\*, University of Groningen, Danielle M. Crowley, University of Groningen, Owen Clements, University of Groningen, Danielle Flux, University of Groningen, Rampal S. Etienne, University of Groningen, Louis van de Zande, University of Groningen, Martine E. Maan, University of Groningen

Individual fitness may be enhanced by moving into habitats that better match the phenotype. Such habitat matching behaviour modifies the spatial distribution of phenotypes and genotypes, potentially facilitating niche segregation and assortative mating. Because identifying and evaluating suitable habitats often relies on sensory systems, variation in sensory abilities among individuals or species may translate into differences in habitat choice, with individuals choosing habitats matching their sensory system properties. Here, we explored whether variation in visual system properties correlates with visual habitat preferences, using three cichlid species occupying different water depth ranges in Lake Victoria. In addition, we assessed whether visual plasticity influenced individual tendency to explore alternative visual environments and tested for a correlation between opsin gene expression patterns and the amount of time spent in a particular light condition. We found that each of the three tested species spent most time in short-wavelength (blue) light conditions. In one of the species, variation in the light conditions experienced during ontogeny changed the visual habitat preference. We found only weak support for an association of opsin gene expression and light preference. Together, our results show that variation in visual system properties does not lead to different visual habitat preference in haplochromine cichlids; instead they showed consistent preferences for a blue light environment.

## **Cultural evolution**

**A. Whiten** *The Extension of Behavioural Biology through Culture: Gene-Culture Coevolution in Animals*  
Andrew Whiten

Social learning (learning from others) appears universal in vertebrates and at least some invertebrates, notably insects. It provides animals with a “second inheritance system” atop the genetic inheritance that characterizes all life, and can lead to the spread and persistence of traditions across populations and generations: “culture”. Cultural inheritance is increasingly documented across vertebrate and invertebrate taxa (Whiten, ‘The burgeoning reach of animal culture’ *Science* 2021). This may generate a second form of evolution: cultural evolution. Cultural evolution may occur through drift, or through the Darwinian trio of variation, (cultural) inheritance and natural/sexual selection. This Darwinian trio can have cumulative effects including enhanced behavioural efficiency and/or complexity, phenomena once thought unique to humans but increasingly documented in non-human animals (Whiten, ‘Cultural evolution in animals’ *An. Rev. Ecol. Evol. Syst.* 2019). These cultural phenomena may further interact with the primary inheritance system, creating gene-culture coevolution (GCE). Now extensively documented in humans, such coevolution is predicted in cultural animals too and we find evidence is accumulating (H. Whitehead et al., ‘Gene-culture Coevolution in Animals’ *Nature Comm.* 2019). In this talk I reprise and update the core discoveries in this body of work. Apparent GCE effects to date have been conceptualised within six main categories: (i) Culture shapes functional genetic effects, such as anatomy and digestive systems of Orca fish-eating versus mammal-eating cultures; (ii) Reliance on culture selects for organic effects that support it, like encephalization and longer juvenile periods among primates; (iii) Culture shapes interactions between species, such as shifts in predatory cultures affecting responses of prey; (iv) Culture shapes neutral genetic diversity, as in mitochondrial haplotypes of different dolphin predatory cultures; (v) Culture reduces genetic diversity as in ‘culture-gene hitchhiking’ in matrilineal cetaceans; (vi) Culture initiates speciation, as when socially learned vocal or other courtship displays differentiate culturally and spatially.

**R. Harrison** *The Natural History of Conformity*

Rachel Harrison\*, University of Lausanne; Pooja Dongre, University of Lausanne, Carel van Schaik, University of Zurich; Erica van de Waal, University of Lausanne

Accounts of conformist transmission have delineated two functional benefits for conformity; informational (copying the majority in order to access the most successful behaviour) and normative (copying the majority to fit in socially). Normative conformity has also been termed social conformity when majority-biased learning serving to facilitate social integration is observed in non-human animals.

We will argue that, rather than informational and social conformity being underpinned by separate mechanisms, all conformist social learning may be derived from a drive to fit in socially. We expect this to be particularly true of animals living in stable social groups. The potential ecological adaptiveness of behaviours acquired via conformist social learning may therefore be a by-product of a (likely implicit) strategy to promote social integration. Thus, in group-living animals like human and nonhuman primates, the same mechanism (a preference for behavioural synchrony) seems to be shared by ecological, weakly social (integration) and strongly social (norm compliance) functions.

This is supported by evidence from both human and non-human animals showing that similarity in both instrumental and social behaviours promotes affiliation. In addition, priming human participants with cues of ostracism leads to increased social learning, suggesting that this is a strategy used by humans to integrate socially. We will also discuss potential biological mechanisms by which this might operate, with evidence that hormonal changes may increase the tendency to conform. Finally, we will suggest new avenues for future research into conformist social learning, with a particular focus on behaviour during dispersal in wild primates.

**T. Volle** *Learning to sing like your neighbours: a long-term field study of the black redstart, *Phoenicurus**

*ochruros*

Tifany, Volle\*, Laboratoire Ethologie Cognition Développement; Sébastien, Derégnaucourt, Laboratoire Ethologie Cognition Développement; Tudor, Draganoiu, Laboratoire Ethologie Cognition Développement

Both humans and oscine songbirds learn their vocalizations by imitating mainly conspecific adults. In oscine songbirds, song learning programs are diverse; for example, some species can only learn during the first months before their songs crystalize while others can learn new songs throughout their lives. We investigated the lifetime evolution of male song repertoires in a migratory population of a territorial songbird, the black redstart, by recording colour-ringed individuals during eight consecutive breeding seasons (2015-2022). Our study population is situated in a French mountain village of the Forez mountains with scattered patches of human buildings which constitute the breeding habitat of the black redstarts. We previously described the existence of micro-dialects between the different male clusters of 2-8 territorial birds. Males (n=24) were recorded at their arrival from migration for their first breeding season as well as during the following years. Most males sang the full local dialect upon arrival and those individuals kept their song repertoires stable throughout their lifetime (2 to 8 years). Those who shared only a few or no songs with their neighbours when they first established breeding territories (9/24), changed their repertoires mostly at their arrival for their second breeding season. Three types of modifications were observed: 1) addition of shared songs (4 individuals), 2) selective attrition of unshared songs (6 individuals) and 3) syllable structure adjustments (3 individuals). All the repertoire changes resulted in an increase in song sharing with neighbours. Our results suggest that black redstarts are able to adapt their song repertoires to their social environment.

#### **O. Höner** *The cultural basis of social hierarchies in spotted hyenas*

Oliver, Höner\*, Leibniz Institute for Zoo and Wildlife Research; Eve, Davidian, Ngorongoro Hyena Project; Alexandre, Courtiol, Leibniz Institute for Zoo and Wildlife Research

In many group-living species, the members of a group engage in agonistic interactions to establish dominance relationships, resulting in what is referred to as a dominance hierarchy. The importance of the social rank in the hierarchy for access to resources, life history and fitness of the group members has been studied in detail. Much less is known about the proximate and ultimate origins of social ranks and dominance hierarchies. One well-known mechanism involved in rank establishment is the cultural transmission of rank from mother to offspring. But this mechanism cannot explain the mother's rank, how a group hierarchy is established or what drives the dynamics and stability of hierarchies. We used 26 years of data on behaviour, demography and kinship from eight clans of free-ranging spotted hyenas in the Ngorongoro Crater, Tanzania, to show that hierarchies can emerge from differences in social support between individuals and that bystanders follow simple, socially learned rules based on kinship when deciding which of two interacting individuals to support. We further developed an algorithm based on these decision rules that accurately predicts hierarchies, social ranks and changes in ranks using basic demographic and pedigree data rather than behavioural interaction data. We discuss the implications of our results for the study of the ultimate drivers of social dominance and the evolution of social traits.

#### **I. Daras** *Modelling cultural transmission: do learning mechanisms matter?*

I. M., Daras, GELIFES\*. G. S., Van Doorn, GELIFES. F. J., Weissing, GELIFES.

Whether the mechanisms underlying social learning matter for the course and outcome of cultural evolution is a hotly debated issue in the field. In this respect, a key question is that of whether the transmission of cultural information can be considered akin to the replication of genes in biological evolution. To date, most models of cultural evolution assume that cultural transmission corresponds to the direct copying of 'cultural traits' between individuals. Critiques to such modelling approaches have



stressed the role of cognition in transforming acquired cultural information, yet whether this matters for the dynamics of cultural evolution has not yet been investigated in modelling studies. Here we present a novel model for cultural transmission that differs fundamentally from trait-copying approaches. The individuals of our model are endowed with a neural network that allows them to learn from the feedback provided by a 'teacher'. During learning, the properties of the neural network change, thus modifying the responses to the input stimuli. Learning content is not directly copied; instead, it needs to be progressively reconstructed by the learning individual. We investigated this model in a multi-generation context, where individuals learn from 'cultural parents' and subsequently act as teachers for the next generation. We show that in this model cultural information (specific input-response patterns) can readily spread across generations. Interestingly, some patterns (akin to so-called 'cultural attractors') can be learned more easily, and therefore spread more effectively in the population. Hence, not all cultural information is equivalent with respect to transmission, and in our model this can systematically be unravelled. We conclude by comparing our results with insights from 'standard' models of cultural evolution, and stress key differences that could lend themselves to novel research avenues.

## **There is no 'I' in welfare – the social dimension of animal wellbeing**

**J. Edgar** *The foundations of empathy...in chickens*  
Bristol Veterinary School, University of Bristol

Commercial chickens are routinely housed in flocks of many thousands of individuals and the extent to which they cope with husbandry-related challenges (e.g. handling, transport) is likely to be influenced by the interaction of various social processes. Amongst these are socially-mediated arousal and behavioural/physiological contagion; some of the building blocks of emotional contagion – an underpinning valenced feature of empathy.

Within the mother-offspring bond, domestic hens show socially-mediated arousal during chick stress. We found that the response of hens did not simply mirror their chicks (as would be the case with behavioural/physiological contagion) but included specific responses to chick stress, including maternal cluck calls. Furthermore, complex cognitive processes can also be built into socially-mediated arousal; with hens applying information that they have learnt about a particular context to their chicks in the same situation. We found that hens increased maternal cluck calling and walking, and decreased preening, when they perceived their chicks to be threatened, regardless of the chicks' reactions to the situation. The chicks' response, irrespective of their own expectations, was to increase distress calling and reduce preening behaviour. The absence of behavioural/physiological contagion within the mother/offspring bond in this context is likely to be adaptive, with hens acting to mediate their chicks' behaviour and stress response, rather than simply mirroring chick response (as would be the case in contagion).

In contrast, outside of the mother offspring bond, in chicks watching broodmates exposed to a stressor, we found the co-occurrence of socially-mediated arousal and behavioural and physiological contagion. Both observers and conspecifics responded with stress-induced hyperthermia as well as increased freezing, and reduced preening and ground pecking during conspecific stress. Subject-Observer behaviour was highly correlated within broods during control and stressor conditions, but with higher overall synchrony during conspecific stress. However, in another study, we found no evidence for either process in adult hens observing stress in a familiar adult.

In this session, I will discuss these and other studies in terms of shedding light of the role of social relationships in empathic processes, as well as discussing the interaction between empathic and other social processes and the importance of valence in determining the capacity for emotional contagion.

**J-L Rault** *A stake in the well-being of others: the case of social animals*

Institute of Animal Welfare Science, University of Veterinary Medicine Vienna

The concept of well-being is usually focused on the individual, but for social species, an individual's well-being is intertwined with the well-being of its group members. A sense of self and the cognitive ability to distinguish themselves from others progressively develop as animals mature. Prosocial actions may overcome this physical distinction of a "me vs. the other" for a "me and the other" or even a "me through the other" perspective. Hence, prosocial actions may bring about an extended self that incorporates consideration for the well-being of others. Little attention has been given to the proximate mechanisms of this interdependency. In addition to benefiting another individual, prosocial actions may feel good for the donor. Evidence of an emotional, intrinsic reward for prosocial behaviour in non-human animal species remains sparse, despite their welfare implications. Our group aims to investigate the relevance of prosocial behaviour for animal welfare. Together with collaborators, we have developed various approaches that allow us to pioneer research on various types of prosocial behaviour in farm animals, for example with the joint log-lift task, the fake apple tree, and the rescue paradigm. These paradigms were designed to possess characteristics advantageous from an ethological basis, in that they trigger biologically relevant actions, that animals can spontaneously express or learn (i.e. without the need for training), and that can be presented to groups of animals in their home environment. These paradigms can help us to better understand how, in social species, individuals oscillate between a more nuclear or extended sense of self. They also offer opportunities to elucidate the proximate mechanisms of prosocial behaviour, their potential link to emotional (self-) rewards, and the underlying physiological mechanisms such as the role of oxytocin for its link to social processes and potentially other-oriented motivation.

Keywords: altruism, cooperation, group service paradigm, oxytocin, prosocial, welfare

**K. Grethen** *Social organisation of large and small flocks of chicken: Same same, but different?*

Klara J. Grethen\*, Yamenah Gómez, Michael J. Toscano ZTHZ, Division of Animal Welfare, VPH Institute, University of Bern, Switzerland

Within natural group sizes of chicken (*Gallus gallus*), the birds establish a dominance hierarchy, or so-called 'pecking order' by agonistic interactions. In large, cage-free groups of laying hens however, possibilities for stable hierarchy formations seem questionable, as the number of necessary agonistic encounters increases drastically, and recognition might be hampered. Researchers have reported that aggression in large groups is reduced, and chickens appear to adopt a tolerant strategy, potentially based on badges of status. How this strategy change affects the hierarchy structure and the individuals is unknown. Therefore, we observed interactions of 420 laying hens split into 6 groups of two different sizes (3x20 and 3x120 individuals) at 24 weeks of age and evaluated their dominance rank by the Elo rating system. Comparisons between dominance hierarchies of small and large groups revealed very similar hierarchical structures: Pecking in both group sizes followed a downward heuristic, i.e. aggression was uniformly distributed against lower ranking individuals. Triangle transitivity was high in large ( $ttri = 0.9$ ) and small ( $ttri = 0.87$ ) groups and the 20% percent top ranking individuals accounted for more than 65% of interactions in both group sizes. To investigate the impact of badges of status, we selected 14 focals from each group ( $N = 84$ ) and related weight and comb size to rank. We found no clear evidence for an effect of weight or comb size on the rank in neither small, nor large groups. In a preference test paradigm, when confronted with the choice of joining a conspecific on the left or right, the odds of going left were increased by 2.9 ( $p = .026$ ,  $CI[1.16, 7.65]$ ) if the animal originated from a small group. This result indicates

that recognition, which is processed in the right hemisphere (left eye), plays a larger role in small groups and is thus prioritized.

**L. Oldham** *Gaze direction early in contests reflects aggressive personality and contest outcome in pigs*

\*Lucy Oldham (SRUC), Gareth Arnott (Queen's University Belfast), Irene Camerlink (Polish Academy of Sciences), Andrea Doeschl-Wilson (Roslin Institute), Marianne Farish (SRUC), Francoise Wemelsfelder (SRUC), Simon P. Turner (SRUC)

Consistent individual differences in aggressiveness affect group stability and welfare. Defeat reduces subsequent aggression, and this is assumed to operate through reduced confidence of winning. The interaction between aggressiveness and the effects of victory or defeat on future confidence are unknown. We hypothesised that unaggressive pigs and prior losers would show increased vigilance, which we defined as gaze directed to the opponent without approaching. Resident-intruder tests at age 9 weeks assessed aggressiveness (Agg+ or Agg-) of 255 pigs, *Sus scrofa*. Pigs had a win/lose experience at 10 weeks of age and gaze direction up to agonistic contact was observed in dyadic contests at 13 weeks. Prior winning experience reduced vigilance in Agg- pigs only ( $\chi^2=7.0$ ,  $p=0.008$ ) and overall, Agg+ pigs gazed for longer towards the opponent without approaching ( $\chi^2=4.2$ ,  $p=0.03$ ). Pigs with experience of defeat gazed towards the exit for longer than prior winners ( $\chi^2=5.4$ ,  $p=0.002$ ). Attention towards the exit was not associated with aggressiveness. We conclude that visual bias towards an opponent indicates aggressive personality and reflects winner-loser effects only in unaggressive pigs.

Friday Morning 10:05 - 12:30

## **Animal Communication**

**M. Spierings** *Rhythm or Syllables: Separate learning mechanisms in zebra finches*

Communication requires both the ability to produce informative signals, as well as perceiving these signals in a meaningful manner. Vocal learning has been one of the key capacities linked to complex vocal communication. Humans are the foremost learners of speech through imitation, and rhythm seems to play a fundamental part in this process. Moreover, rhythm perception seems to be a more widespread cognitive feature shared between multiple species. This research studies the rhythmic properties of a male zebra finch song and the extent to which temporal structures are copied during vocal learning. Using recorded vocalizations of zebra finch songs, the rhythmic song structures were visualized and Inter-Syllable-Onsets were measured. The results show that zebra finches copied the adult temporal structure accurately, even when the syllables were not copied in the right location. This indicates that there might be separate learning mechanisms for the temporal structure and the syllable structure in zebra finch song.

**M. Hauber** *From meta-replication to true discovery: the case of antiparasitic referential alarm calling in Yellow Warblers*

Mark Hauber

Referential communication is frequently detected in the context of predator-prey interactions, and it is rarer for it to function in host-parasite interactions, including obligate brood parasitic birds and their hosts. Here I recount the discovery, detailed study, meta-replication, and a new discovery in the context anti-parasitic referential alarm calls uttered by Yellow Warblers in response to Brown-headed Cowbirds in North America. Predictors of conspecific referential alarm calling include parasitic threat, breeding stage, social signaling, and sympatry with the brood parasite. In turn, heterospecific eavesdropping by a second

host species on warbler alarm calls is also predicted by breeding stage, whereas other predictors are yet to be discovered. Despite the uniqueness of this study system, its scientific outputs are robust, and have held up to several meta-replication studies.

**K. Riebel** *"Seeing voices": testing the importance of multimodal exposure to social song tutors in bird song development*

Katharina Riebel\*, Institute of Biology, Leiden University; Judith M. Varkevisser, Institute of Biology, Leiden University, Ezequiel Mendoza, Freie Universitaet Berlin, Constance Scharff, Freie Universitaet Berlin, Ralph Simon, Vrije Universiteit Amsterdam & Zoo Nuremberg; Wouter H. Halfwerk, Vrije Universiteit Amsterdam

Birdsong has to be learned from social models early in life. Much work has focused on when and from whom birds have to hear specific songs to imitate them. A sole focus on the acoustic dimension neglects the multimodal character of song with its pronounced visual components such as the beak movements associated with producing specific sounds. Here we asked whether seeing the visual components of singing (versus seeing and socializing with a companion) is of importance for song learning and development. We raised zebra finches manipulating quality and quantity of visual and social input (using live, video and robot song models and/or companions) during song exposure. Birds engaged differently with uni- than multimodal stimuli and birds clearly paid attention to synchronised audio-visual cues but not all stimulus engagement improved song learning. The results suggest that not only the social but also the multimodal dimension of singing might be important in tutor choice and learning outcomes. We will discuss how both video and robot tutoring experiments might be employed in the future to further disentangle the relative importance of multimodal versus social cues in vocal learning.

**S. de Kort** *Female blue tits sing (quite a lot)*

Javier Sierro, Lancaster University, Selvino de Kort Manchester Metropolitan University \* Katharina Riebel Leiden University, Ian Hartley, Lancaster University

When competition for mates increases fitness, we should expect adaptive signalling in both sexes, but the role of female sexual signals is generally understudied. A case in point is female birdsong, that has received considerably less attention than male song. This holds for an important model species in evolutionary ecology, the blue tit (*Cyanistes caeruleus*), mentioned in over 30,000 scientific studies. Although there have been incidental reports of female song from three distinct populations, no quantitative study has been conducted on female song in blue tits. Here, we report systematic sampling from a population of individually marked blue tits over a period of three years, revealing that females sang regularly throughout the sampling period. Daytime singing of females occurred in functionally similar contexts as in males (agonistic, solo song and alarm context). Notably, females were not observed singing during the dawn chorus, when males sing intensively just before copulations take place. Female and male song overlapped substantially in acoustic structure (i.e., same song types, peak frequency or trill rate) but females had smaller individual song-type repertoires, shorter trills and lower vocal consistency. Differential selection pressures related with functional differences in the role of male and female song might explain the observed variation in acoustic structure. With the first descriptive study of female song in such a well-studied species, we hope to stimulate further investigations into the functions of female singing, especially in the Northern Temperate zones where female song in monomorphic species may have been systematically overlooked

**H. Loning** *The role of soft and social singing by zebra finches in the wild*

Hugo Loning\*, Simon C Griffith, Marc Naguib

Birds sing to compete for a partner and territory. The substantial evidence supporting this dual function of birdsong is predominantly based on ecological research conducted in the seasonal northern temperate zone. Yet, many environments are not seasonal or temperate, and therefore differ in the selection pressures underlying the evolution of birdsong and communication in general. To obtain a broader understanding of the function of song and the context in which it is used, we here studied zebra finches (*Taeniopygia guttata*) in a wild population in arid Australia. Zebra finches here form long-term monogamous bonds, are not territorial, and pairs stay together most of the time, but frequently join others when moving around the vast landscape. We combined multiple observational and experimental methods, including calibrated song recordings, transect monitoring, monitoring of social hotspots, song recordings throughout different breeding stages and large-scale playback experiments. This enabled us to characterise various aspects of the song ecology of zebra finches in several years during a successful breeding episode and a severe drought. We show that the social context of wild zebra finch song is integral to their song ecology, overall not linked primarily to breeding and mate choice but also various other social activities, and discuss which potential functions this may indicate. Our results expand on the findings that birdsong serves generally in situations such as territory defense, antagonistic signaling and partner attraction, and they raise the question of how well the current songbird literature represents the variety seen in natural systems.

## **The emergence of novel behaviours during social evolution**

**A. Jordan** *The relationships between social structure, behavioural repertoire size, and neuroanatomy in ecologically similar but socially divergent fishes*

Social living may require the evolutionary development of novel behaviours, lead to the development of more advanced cognitive abilities, and potentially more complex brain architectures, as individuals navigate a greater number of differentiated relationships with social partners. Alternatively, processes of distributed intelligence, or cognitive division of labour may reduce the behavioural cognitive requirements for socially living animals compared with their solitary counterparts. In this talk I will discuss work examining the relationship between social complexity, behavioural repertoire, and neuroanatomy of Tanganyika cichlid fish. Although these species share almost identical life histories, morphologies, and ecologies, the Lamprologine cichlids differ greatly in their social structures and behaviour, solving identical ecological tasks either individually or in complex social groups. Studying wild groups in their natural habitats, we use machine vision and automated tracking to quantify differences in social network structure of wild groups in Lake Tanganyika, creating detailed maps of the number and types of relationships individuals in each species have. We then use a combination of direct observations and computational behavioural decomposition to map out the behavioural repertoire of each species, asking whether species with more complex social structures have richer repertoires, or if conserved behavioural repertoires take on different functional effects ('meanings') in different species. Finally, we create neuroanatomical maps of each species, examining whether differences in social structure and behaviour are reflected in changes in brain morphology. Overall, we ask whether social evolution produces specialised behaviours and brain architectures, or whether a shared behavioural and neuroanatomical template can produce diverse social behaviour across species.

**C.A. Olivier** *Primate Social Organization Evolved from a Flexible Pair-Living Ancestor*

Charlotte-Anaïs Olivier\* (Institut Pluridisciplinaire Hubert Curien, UNISTRA, CNRS, France), Jordan Martin (Human Ecology Group, Institute of Evolutionary Medicine, University of Zurich, Switzerland), Camille Pilisi (Institut Pluridisciplinaire Hubert Curien, UNISTRA, CNRS, France), Paul Agnani (Institut Pluridisciplinaire Hubert Curien, UNISTRA, CNRS, France), C. Kauffmann (Institut Pluridisciplinaire Hubert Curien, UNISTRA, CNRS, France), Loren Hayes (Department of Biology, Geology, and

Environmental Science, University of Tennessee at Chattanooga, USA), Adrian Jaeggi (3Human Ecology Group, Institute of Evolutionary Medicine, University of Zurich, Switzerland) & Carsten Schradin (Institut Pluridisciplinaire Hubert Curien, UNISTRA, CNRS, France)

Understanding primate social evolution is central to understanding human sociality and social evolution more broadly. Previous research has typically assumed that many understudied primate species were solitary and then inferred that ancestral primates were solitary. However, primates exhibit inter- as well as intra-specific variation in social organizations ranging from solitary to pair-living to various kinds of group-living. So far studies were limited by assigning a single type of social organization to each species, ignoring an increasingly documented variability within- and between populations. To address this issue, we built a detailed database from primary field studies quantifying the number of social units expressing different social organizations in each population, and we used Bayesian phylogenetic models to infer the probability of each social organization, conditional on several socio-ecological predictors, in ancestral populations. In contrast to prior studies, we show that when intra-specific variation is accounted for, the ancestral social organization of primates was variable, with the most common social organization being pair-living but with approximately 15-20% of social units of the ancestral population deviating from this pattern. Collectively, socio-ecological predictors such as diet, dispersal, habitat, or terrestriality explained low-to-moderate variation in social organization. Body size and activity pattern had larger effects, with smaller-bodied and nocturnal species being more likely to exhibit pair-living, while larger-bodied species were more likely to live in groups. Our results challenge previously published assumptions that the ancestral primates were solitary and that pair-living is a derived state. We argue that pair-living may have evolved in ancestral primates as a strategy for increasing males' mating success and reducing intrasexual competition among females, as compared to solitary living. Our results also suggest that intraspecific variation in social organization has been widespread throughout primates' evolutionary history, encouraging greater attention to the within-population causes and consequences of this underappreciated heterogeneity.

**C. Aumont** *Immune gene family diversity across termite phylogeny and sociality*

Cédric Aumont\*, Dino McMahon

The phylogeny of the Blattodea boasts a wide degree of sociality spanning from solitary cockroaches to advanced ecosystem-dominating higher termite societies. The emergence of sociality in the termites was associated with the acquisition of a diverse range of social structures and behaviours. Previous work has found evidence for a caste-specific social defence system in termites leading to an immune system that may favour group over individual defence. While preliminary work suggests a correlation between social transitions and a reduction of immune gene family diversity, the lack of available high-quality termite genomes hampers complete knowledge of the true diversity of immune gene evolution across termite phylogeny. Here, we report on the sequencing and assembly of 58 high-quality long-read-based genomes across major termite and cockroach sister-branch lineages. We investigate the diversity and evolutionary history of immune genes across genomes, focusing particular attention on correlations between immune gene evolution, transitions in sociality, and acquisition of social behaviours over termite phylogeny.

**J. Frommen** *Social structure, relatedness and helping behaviour in the cooperatively breeding cichlid *Neolamprologus savoryi**

Joachim G. Frommen\*, Manchester Metropolitan University, Manchester, United Kingdom; Dario Josi, University of Bern, Switzerland; Annika Freudiger, University of Leipzig, Germany; Michael taborsky, University of Bern, Switzerland

Cooperatively breeding species are fascinating examples for highly derived social systems.

Understanding the functions and mechanisms shaping such societies provides insights into the evolution of complex social behaviour in general. To that aim, it is crucial to comprehend the social structure of cooperatively breeding groups as well as the associated fitness benefits. We describe such social structure and fitness benefits for a wild colony of the cichlid *Neolamprologus savoryi*, a cooperative harem breeder endemic to Lake Tanganyika. Breeding females defend their own sub-territories within a male's harem, and are often assisted by helpers of various sizes and both sexes. Harems are socially and genetically structured, with higher relatedness within subgroups compared to different subgroups within the same harem. Furthermore, relatedness between breeders and helpers declines strongly with increasing helper size. Some male helpers defend their own sub-territory within the territory of a breeder male, or patrol between the females within the harem. Helpers engage in egg cleaning, territory maintenance and predator defence. This results in a higher likelihood of successful reproduction for breeder females that accept helpers. These findings highlight both direct and indirect fitness benefits of cooperation and group membership in a society comprising complex social and relatedness structures.

**J. Kreider** *Resource sharing leads to the emergence of division of labour*

Jan J. Kreider<sup>1,\*</sup>, Thijs Janzen<sup>1</sup>, Abel Bernadou<sup>2</sup>, Daniel Elsner<sup>1,3</sup>, Boris H. Kramer<sup>1</sup>, Franz J. Weissing<sup>1</sup> <sup>1</sup> Groningen Institute for Evolutionary Life Sciences, University of Groningen, Nijenborgh 7, 9747 AG Groningen, The Netherlands. <sup>2</sup> Zoology / Evolutionary Biology, University of Regensburg, Universitätsstraße 31, 93053 Regensburg, Germany. <sup>3</sup> Department of Evolutionary Biology and Ecology, Institute of Biology I (Zoology), University of Freiburg, Hauptstraße 1, 79104 Freiburg (Breisgau), Germany

Individuals of social organisms often exhibit behavioural specialisation, leading to division of labour within groups. Yet, how division of labour can emerge in the absence of pre-existing interindividual differences is poorly understood. By means of a simple but realistic individual-based model, we show that in a group of initially identical individuals, division of labour spontaneously emerges if returning foragers share part of their resources with other group members. In the absence of resource sharing, individuals follow a 'behavioural schedule' of alternating between foraging and other tasks. If, however, non-foraging individuals are fed by other individuals, this alternating schedule becomes interrupted, delaying the onset of foraging and eventually leading to the emergence of division of labour. Accordingly, behavioural specialisation and division of labour emerge only due to resource sharing and in the absence of pre-existing individual differences. Division of labour is strongly reinforced by any nutritional asymmetries, such as increased metabolic rates associated with foraging, or by nutrition-based dominance interactions during resource sharing. Overall, our model proposes resource sharing as a plausible mechanism for the self-organised emergence of division of labour. We discuss how this mechanism could have played a role in the evolution of eusociality and multicellularity.

## Open Symposium

**L. Pedruzzi** *What makes some yawns so contagious? An experimental approach in monkeys*

Luca, Pedruzzi<sup>\*</sup>, Department of Biology, University of Pisa; Juliette, Aychet, Univ Rennes, Normandie Univ, CNRS, EthoS (Éthologie animale et humaine); Lise, Le Vern, Univ Rennes, Normandie Univ, CNRS, EthoS (Éthologie animale et humaine); Veronica, Maglieri, Department of Biology, University of Pisa; Arnaud, Rossard, Univ Rennes, Normandie Univ, CNRS, EthoS (Éthologie animale et humaine); Elisabetta, Palagi, Department of Biology, University of Pisa AND Natural History Museum, University of Pisa; Alban, Lemasson, Univ Rennes, Normandie Univ, CNRS, EthoS (Éthologie animale et humaine) AND Institut Universitaire de France

Yawns can be triggered by others' yawns, and this propensity is widespread among highly social species,

where yawn contagion (YC) seems to promote behavioural synchronization among group mates. Despite its automaticity, the processes underlying YC are flexible enough to allow yawns emitted by individuals of different species to evoke a response. Furthermore, contagiousness is higher between subjects belonging to specific social categories (e.g., familiar individuals). In primates, it is still unknown whether the phenomenon is modulated by familiarity also when involving heterospecific subjects, and in monkeys the factors influencing the contagiousness of a stimulus have been poorly studied. To fill this gap, we experimentally investigated intra- and inter-specific YC in red-capped mangabeys (*Cercocebus torquatus*) by showing Yawn vs Control video stimuli depicting familiar and unfamiliar individuals from three different species (conspecifics, humans, hamadryas baboons). The monkeys yawned more often in response to Yawn than Control videos and did so independently from which species the triggers belonged to, indicating the presence of both intra- and interspecific YC. Conversely, familiar conspecific or human yawns were more contagious than their unfamiliar counterparts: the social or emotional closeness between yawners and responders somehow eased the mechanism underlying YC. Importantly, the amount of time spent looking frontally at the screen (stimulus perception) was biased towards unfamiliar subjects and did not influence the likelihood of the response. Similarly, the rate of self-directed behaviours performed by the tested subjects (proxy of their anxiety levels) could not account for the results. In conclusion, we provide the first evidence in non-human primates that familiarity modulates YC at both intra- and interspecific level. This suggests that the social experience allowing interspecies interactions under captive contexts may extend the natural ability to recognize and congruently respond to others' faces despite the phylogenetic distance separating subjects.

**I. Redondo** *To breed or to float: predictors of reproductive status in the spotless starling*

Iraida Redondo\* Departamento de Ecología Evolutiva, Museo Nacional de Ciencias Naturales (MNCN) CSIC José Gutiérrez Abascal 2 28006 Madrid Spain; Lorenzo Pérez- Rodríguez Instituto de Investigación en Recursos Cinegéticos (IREC) CSIC-UCLM-JCCM Ronda de Toledo 12 13005 Ciudad Real Spain; Raquel Monclús Laboratoire d'Ethologie Expérimentale et Comparée UR 4443 Université Sorbonne Paris Nord 93430 Villetaneuse France; Jaime Muriel Department of Zoology, Faculty of Sciences, University of Granada 18071 Granada Spain; Diego Gil Departamento de Ecología Evolutiva, Museo Nacional de Ciencias Naturales (MNCN) CSIC José Gutiérrez Abascal 2 28006 Madrid Spain

In most species' populations, there is a pool of sexually mature individuals that spend part of their lives as non-breeders and that receive the name of floaters. To know whether floating status constitutes an alternative reproductive strategy or an imposed condition, studies comparing the phenotype, behaviour and life-history traits of breeders and floaters are sorely needed. Despite their ubiquity in wild populations, our knowledge about floaters is very scarce, principally due to their secretive and elusive habits. In this study, we analysed data collected from long-term monitoring (2012-2020) on a wild colony of spotless starlings (*Sturnus unicolor*) in which a great number of individuals are PIT-tagged. We examined if several phenotypical (body condition, size, and ornamental throat feathers) and non-phenotypical (birth date, brood size) variables from early and adult life could predict reproductive status. We found that reproductive status in males was strongly influenced by their body condition both at the adult and nestling stage. Path analysis revealed that male reproductive status could be predicted only by using the body condition attended at the nestling stage. In the case of females, we detected a negative association between reproductive status and hatching date. We did not find any association between ornamentation and the reproductive status in any of the sexes. Our study suggests that predictors of reproductive status are sex-specific in the spotless starlings, indicating an important role of body condition in the access to breeding resources in males. Our study also highlights the importance of early-life conditions shaping individual life trajectories. Our data suggest that floating status in our population responds to a 'best of a bad job' rather than to a true alternative reproductive strategy. Further research should investigate differences in life-history traits (i.e. lifetime reproductive success and survival) to confirm it.



**A. Strauss** *Synchronisation of diel timing during chick provisioning within breeding pairs in wild Great Tits*  
Aurelia F. T. Strauß\*, Barbara M. Tomotani, Marcel E. Visser and Barbara Helm

For breeding birds, parental care is a particularly challenging period. In socially monogamous species, provisioning of the nestlings is shared between breeding partners. Nest visits are usually synchronised between partners, especially with larger broods, to ensure equal allocation of food and decrease predation risk. However, individuals differ in their diel activity patterns due to their genetic make-up, modulated by environmental conditions such as photoperiod and food availability. Based on their consistent differences, individuals can be categorised into early and late chronotypes that differ in the time of their physical and cognitive peak performance throughout the day. Chronotypes of breeding pairs might align or differ and thus, could affect the parental coordination. In contrast, individuals could adjust their diel timing to synchronise with their partner. This study aims to investigate the differences of chronotypes between parents during chick provisioning, the effects of the breeding partner on the chronotype of their partner and the possible consequences on brood success. We monitored provisioning of 36 breeding pairs of wild Great Tits by recording each parent's nest visits. From these data we extracted daily activity onset and offset to assign chronotypes and estimate temporal flexibility. Brood monitoring allow us to assess fitness consequences for each parent which we then relate to its chronotype, the partner's chronotype and on how well the breeding pair can synchronise. This will give new insights into the natural variation of diel timing within and between breeding pairs and the potential consequences for the breeding success.

**J. Zheng** *Egg burial protects eggs being hurled out the wind-swayed nest in Chinese penduline tits*  
Jia Zheng

Egg burial behaviour, that is, when parents bury the eggs with a layer of nest material during the egg-laying stage, has been described in various egg-laying animals. Several functions of egg burial have been described in animals with different life histories and breeding traits, but rarely reveal distinctive functions between sister species. In the polygamous Eurasian penduline tit, *Remiz pendulinus*, sexual conflict over care has been proposed to drive egg burial since, during egg laying, females hide eggs from males to prevent them abandoning the nest. Females then have the option to desert the clutch themselves and leave parenting to the male. However, in a congeneric species, the Chinese penduline tit, *Remiz consobrinus*, males have been seen with females in the nest at night, which indicates males know of the eggs' existence. In this study, we investigated egg burial function in Chinese penduline tits and experimentally tested four hypothesized functions of egg-burying behaviour. (1) We found that egg burial is unlikely to play a role in sexual conflict resolution, as both males and females appeared to bury eggs during egg laying and both freely entered and roosted in the nests with eggs exposed at night. (2) Egg burial does not prevent nest parasitism, as no egg rejection or clutch abandonment was observed in clutches with model parasitic eggs. (3) Our results do not support the temperature regulation hypothesis since the temperature difference between buried and experimentally unburied eggs did not affect hatching success. (4) Notably, our results support the novel egg protection against wind hypothesis since the burying layer efficiently prevented the eggs from rolling out of wind-swayed nests. The difference our study found between the two *Remiz* species highlights that one behaviour, egg burial, can serve different evolutionary functions between closely related species.

**R. Lesch** *Comparative morphometric analysis of the wolf and dog larynx*  
Raffaella, Lesch\*, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Vienna, Austria; Michaela, Gumpenberger, Clinic of Diagnostic Imaging, University of Veterinary Medicine Vienna, Vienna, Austria ; Andrew C., Kitchener, Department Natural Sciences, National Museums Scotland,

Edinburgh, UK; Georg, Hantke, Department Natural Sciences, National Museums Scotland, Edinburgh, UK; W. Tecumseh, Fitch, Department of Behavioural and Cognitive Biology, Faculty of Life Sciences, University of Vienna, Austria

Wolves howl frequently and rarely bark, the opposite is true for dogs. These differences in vocal behaviour make dogs and wolves an ideal model group to investigate changes to voice-producing structures caused by domestication. Domestication has had clear effects on domestic dog morphology. Curly tails, white patches, floppy ears, and smaller teeth are examples of traits common among domestic mammals, but are atypical for wild species. These traits have long been observed and described, but recently a potentially unifying explanation was found: In 2014 Wilkins et al. suggested that in the process of domestication animals were selected for increased tameness, which led to a mild deficiency in neural crest cells. This deficiency in neural crest cell migration and proliferation is thought to cause depigmentation, reduced adrenal glands, and changes to the cranium and possibly voice-producing structures. Based on the neural crest hypothesis, we hypothesise that domestication led to smaller and differently shaped larynges in dogs compared to wolves. In this preliminary study we CT-scanned the larynges of wolves and dogs and carried out a geometric morphometric analysis of their morphology. We found our data to support our hypothesis. Not only do dogs have smaller larynges compared to wolves, they also differ in their general laryngeal morphology. These results further support the hypothesis by Wilkins et al., supporting the connection between neural crest cells and domestication.

**S. Salazar** *Repeatability and plasticity of risk-taking in breeding blue tits*

Stephen, Salazar\*, Bielefeld University & University of Groningen; Kasper, Hlebowicz, University of Adelaide; Jan, Komdeur, University of Groningen; Peter, Korsten, Bielefeld University

Individuals respond adaptively to their environment. Yet, they may differ in their responses even when confronted with the same environmental challenge. Several complementary conceptual frameworks suggest that within populations among-individual variation in life-history strategies aligns not only with individuals' propensities to take risks across different situations but also with their sensitivity to variation in environmental cues. Risk-prone individuals—suggested to invest relatively more in current reproduction at the cost of their future reproductive prospects—are predicted to be less sensitive to environmental variation compared to risk-averse individuals. We tested this prediction in a population of breeding blue tits (*Cyanistes caeruleus*) by confronting them with different levels of predation threat at their nests and recording their latency to resume brood provisioning after the removal of the predator stimulus. We presented taxidermic woodpecker (*Dendrocopos major*; a common brood predator) and sparrowhawk (*Accipiter nisus*; a common adult predator) mounts at each nest, respectively representing low and high levels of threat to adult blue tits. As a non-predator control stimulus, we presented a blackbird (*Turdus merula*) mount. We found that on average parents took longer to resume provisioning after presentation of a sparrowhawk compared to a woodpecker or blackbird. Furthermore, individual latency responses across all threat levels taken together were repeatable. However, despite the population-level plastic adjustment to the level of predation threat, we found no evidence for among-individual variation in plasticity. Instead, individual differences in responses were roughly maintained across all levels of threat. While our findings show that individuals differ in their level of risk-taking, in the high-stakes and ecologically relevant context of predation risk during parental care, commonly held expectations about among-individual variation in behavioural plasticity were not met.

Friday Afternoon 14:30 - 17:05

**Animal Communication**

**E. de la Peña** *Unravelling the information conveyed by the ventral dark patch during the rut in male red deer*

Eva de la Peña\* (Wildlife Research Unit, University of Cordoba, Cordoba, Spain) , Jose Martín (Department of Evolutionary Ecology, Museo Nacional de Ciencias Naturales (MNCN-CSIC), Madrid, Spain) & Juan Carranza (Wildlife Research Unit, University of Cordoba, Cordoba, Spain)

Sexual signals play a key role during sexual selection processes, in particular during mate competition for mates in polygynous species. Through these traits, individuals communicate their ability to overcome successfully agonistic interactions by revealing relevant attributes to maximise their reproductive success. During the rutting season, male red deer may show a visible dark patch in their ventral fur. The main goal of this work was to study the information contained in this trait from a comprehensive point of view and to advance in the understanding of the mechanisms underlying its evolution. This work has shown that the dark ventral patch is a clearly bimodal trait so there are two types of males in relation to the trait expression suggesting that there may exist two behavioural alternatives to face the rut. It is an indicator of male age and dominance rank, and it is costly to produce, as the size of the dark ventral patch is positively related to the release of testosterone and implies higher susceptibility to parasitism. This trait is not only a visual signal, but it also contains a large number of chemical compounds impregnating the hair of this zone, which shows the reproductive status and the individual's ability to compete with other males. Thus, the dark ventral patch is a flexible trait that provides information in the short term, revealing the males' reproductive effort and implication in the intrasexual competition during the current mating season. Under an integrative view, this study tries to contribute to the understanding of sexual selection processes in red deer as a model species, focusing on the relevance that the competitive environment acquires in the investment of individuals in the production of relevant sexual traits during mate competition.

**A. Krasheninnikova** *Phylogenetic map of vocal learning in parrots*

Anastasia Krasheninnikova\*, Max-Planck Comparative Cognition Research Group; Merel Snijders, Wageningen University; Julie Carpenter, University of Vienna; Esha Haldar, Max-Planck Comparative Cognition Research Group; Auguste MP von Bayern, Max-Planck Comparative Cognition Research Group

Vocal learning is considered a crucial component of human language. The ability of vocal learning is rare and among birds has been detected only in songbirds, hummingbirds, and parrots. Parrots are probably the most advanced vocal learners who learn new vocalisations throughout their lives and are known for their ability to imitate human speech. Thus, parrots present an intriguing model to shed light on how human language evolved. However, only little is known about how widely vocal learning is distributed in Psittaciformes, an avian order comprising 399 species. In the past decade, surveying behaviour from online video repositories has become a promising research tool to investigate animal behaviour. In this study, we conducted a YouTube survey to provide an overview of the phylogenetic distribution of (allospecific) vocal learning in parrots. In total, we collected 2966 and analysed 1103 videos from which 751 videos featured evidence for vocal learning. We found that all species in the genus *Ara*, most of the genera *Poicephalus*, *Cacatua*, and *Brotogeris* and none of the species from the genera *Vini*, *Micropsitta*, *Chamosyna*, *Cyclopsitta*, *Pyrilia*, and *Touit* showed evidence for vocal learning. Further analyses of additional parameters (e.g., quality and frequency of imitation) will help to evaluate the differences in the vocal learning ability across parrots. We discuss why some parrot species are better imitators than others.

**J. Prieur** *Social negotiation and “accents” in gorillas’ gestural communication*

Jacques Prieur\*, Free University of Berlin, Katja Liebal, Institute of Biology, Leipzig University; Simone Pika, Cognitive BioCognition, Institute of Cognitive Science, Faculty of Human Sciences, University of Osnabrück

Despite the wealth of research on the evolution of human language, its evolutionary roots remain largely unresolved. Comparative approaches are useful to identify precursors of human language by studying the communication of our closest relatives, the great apes, and how they acquire their communicative repertoires during their ontogeny. Recent findings on chimpanzee infants' gestural development show that they use some gesture types flexibly and adjust them depending on their interaction partner and social context, suggesting that gestural communication is shaped by learning rather than genetically determined. However, how gestures are influenced and which factors are important remains unclear. We addressed this question for the first time by focusing on gesture morphology and conducted a fine-grained analysis of gestural form during spontaneous intraspecific social-play interactions in two captive groups of gorillas. We focused on the most frequent gesture types (i.e. BEAT CHEST, SLAP BODY, SLAP GROUND and TOUCH BODY) produced by subadults (infants, juveniles and adolescents). We considered twelve morphological gesture characteristics (e.g. horizontal and vertical hand trajectories, thumb and fingers flexion and spread). Our multifactorial investigation provides the evidence that morphological characteristics of several distinct gesture types can be shaped by social factors, namely signaller's sociodemographic characteristics (group and kinship), signaller's behavioural characteristics (body posture) and context-related characteristics (recipient's sex, attentional state and position in the signaller's visual field). We nurtured the lively debate concerning the origins of language and gestures by revealing (1) the existence of "accents" in gestural communication and (2) the highly variable adjustment of gestural form to different conspecifics and interactional characteristics.

**T. Petrusková** *Singing behind the stage: thrush nightingales produce more variable*

Tereza Petrusková\*, Abel Souriau, Nicole Geberzahn, Vladimir V. Ivanitskii, Irina M. Marova, Jana Vokurková, Radka Reifová, Jiří Reif

The songs of migratory passerine birds have a key role in mate attraction and territory defence during the breeding season. Many species also sing on their wintering grounds, but the function of this behaviour remains unclear. One possible explanation, proposed by the song improvement hypothesis, is that the birds take advantage of this period to develop their singing skills for the next breeding season. If so, non-breeding songs should reflect features of an early phase in song development, characterized by high vocal plasticity. In our study, we tested this prediction by comparing songs of thrush nightingales (*Luscinia luscinia*) recorded at two different breeding areas in Europe and one wintering area in Africa. While all songs from European localities had a typical structure characteristic of the study species, 89% of the songs recorded from Africa were highly variable, lacking such typical structure. We conducted further detailed analysis of breeding and winter songs that exhibited species-specific structure. First, we explored plasticity at the syllable level using a cross-correlation analysis, to obtain similarity scores as a measure of consistency. Second, we asked multiple human observers to quantify element variability. Our results showed significant differences in syllable consistency between breeding and wintering grounds, with more consistent delivery of syllables in the breeding areas. Likewise, element variability was substantially lower in the breeding populations. While both results fit the predictions of the song improvement hypothesis, more research is needed to elucidate the roles of singing on the wintering grounds.

**V. Beeck** *Vocal flexibility in the Asian elephant's social communication*

Veronika C., Beeck\*, Department of Behavioural and Cognitive Biology, University of Vienna; Gunnar, Heilmann, MeCalc Technologies GmbH, Berlin; Angela S. Stoeger, Department of Behavioural and Cognitive Biology, University of Vienna

In their complex multi-tiered fission-fusion society elephants make use of diverse vocal signals to maintain and coordinate social interactions yet the production mechanism and functions of their vocal repertoire

are not fully understood, especially in Asian elephants. Elephants demonstrate both bio-mechanical and cognitive flexibility in sound production being even among the few mammals capable of vocal production learning. Their vocal repertoire is relatively small with 8-13 call types described but spans a wide acoustic range from infrasonic rumbles (F0 8-35 Hz) with graded information coding to higher pitched trumpets (F0 300-600 Hz) and in Asian elephants also species-specific squeaks (F0 300-2300 Hz). We used an acoustic camera to visualise sound emission across call types and analysed the related acoustic structure for information coding in mainly female captive Asian elephants. Our data showed oral emission of squeaks and suggests they are produced by vibration of the tensely closed lips, a sound production mechanism unique in the animal kingdom except for humans. One female produced squeaks through her narrowed trunk tip revealing a first of its kind flexibility of sound production even within one call type that points towards the involvement of learning in squeak production. Trumpets were clearly produced through the trunk. Rumbles in 9 females were emitted orally or nasally as previously described in African elephants and in addition simultaneously through the mouth and trunk demonstrating velopharyngeal coupling for the first time in a non-human animal. Individual acoustic differences were found in squeaks, trumpets and rumbles providing the means for individual recognition. We discuss the potential function of the Asian elephant's extensive vocal flexibility for close and long-distance communication.

**F. Rossetto** *The bird community as an orchestra: synchronization of singing activity among species with different songs*

Federica Rossetto\* (Biodiversity Research Institute (CSIC, UniOvi, P. Asturias) - Mieres, Spain), Paola Laiolo (Biodiversity Research Institute (CSIC, UniOvi, P. Asturias) - Mieres, Spain)

During dawn choruses different bird species sing altogether. While the intraspecific significance of bird acoustic interactions is well known, acoustic signalling among individuals of different species remains largely unexplored. Heterospecifics may sing together with species with similar song characteristics when conditions such as climate or habitat promote song transmission, i.e. the behavioural synchronization occurs because of environmental filters. Alternatively, heterospecific co-singing may be a form of territorial communication with hererospecifics, as observed in species with similar songs or that are phylogenetically closely related. Lastly, birds may benefit of heterospecific acoustic signals that may indicate, for example, a low-risk environment; thus, they would be socially stimulated by heterospecific songs. We evaluated these contrasting hypotheses by analysing acoustic signalling in 13 species of forest birds through passive recordings and by testing bird active response through playback stimuli in forests in Northern Spain in spring. With passive recordings we found that birds with divergent songs are more likely to sing together in time and space. By broadcasting playback stimuli, song activity was significantly higher after heterospecific songs than during silent control indicating an active acoustic response. Additionally, we have found that the playbacks triggering the stronger response were from species with the higher dissimilarity, supporting the results obtained with passive recordings. Our findings do not support interspecific communication between species with similar songs and environmental filter hypotheses. Instead, they suggest that co-singing is subject to biotic filters, and may represent a social facilitation dynamic- birds might take advantage of a dissimilar acoustic scenario that on the whole might make their song performance more effective during dawn chorus. This phenomenon, comparable to an orchestra in the wild, might benefit birds in social behaviours such as courtship, an issue demanding further studies

## **Social influences on mate choice**

**S. Nöbel** *Mate copying in fish and flies*

Sabine Nöbel\*, IAST

One of the most fascinating questions in the field of sexual selection is why and how females and males choose certain conspecifics as mates. Models of sexual selection assume that individuals choose among potential mates independently of other conspecifics and based on their genetically determined preferences. However, there is strong evidence that females and males choose a mate non-independently of other conspecifics using social information. A sophisticated form of publicly available social information arises as a by-product of performance activities of individuals and can be used by observing individuals to gain information about the quality of potential mates. Mate copying occurs when, after observing a demonstration of another females' mate choice, an observer female tends to preferentially mate with the same male ("individual based" mate copying) or with males with the same phenotype ("trait-based" mate copying) as the one chosen during the demonstration. Copying the mate choice of others can be a fast and reliable strategy to gather information about potential mates' quality and attractiveness but can be misleading as well. Mate copying has been experimentally demonstrated in an array of species of vertebrates including birds, mammals, fish, and invertebrates like fruit flies. In my talk I will focus on few examples showing how various factors like personality, sex ratio as well as the type of social information that is available are affecting mate copying.

**T. Szekely** *Can we understand sexual selection without knowing social environment?*

Mate choice, mating and pair-bonding are some of the most diverse forms of social behaviour, and huge amount of theoretical, experimental and comparative works are investigating the proximate and ultimate causes of sexually selected behaviours. A crucial aspect of these behaviours is social environment – how many and what quality of potential mates are around a focal individual. Here I focus on adult sex ratio (ASR, the proportion of males in the adult population) to illustrate the significance of social environment. Recent studies show that the relative frequency of adult males and females vary between populations, and wild populations often exhibit persistent male-skewed or female-skewed ASRs. The ASR variations are associated with mate choice decisions, mating and pair bonding in both ecological and evolutionary time scales. Importantly, shifts in ASR influences reproductive success and thus ASR impacts on population growth and viability. However, social behaviour may also influence adult survival and thus feed-back into ASR; for instance competing for mates and/or retaining the mates for future breeding can have mortality implications for a focal individual, for its mate, and for the composition of the breeding population. I conclude that a major challenge for future studies of sexual selection is to understand the frequency-dependent selection emerging from the social environment by teasing apart the tangled relationships between social behaviour that influences demographic processes and thus ASR, and in turn, how ASR variations feed-back into social behaviour.

**N. Doubovetzký** *Drosophila melanogaster females manipulate sperm allocation based on the sensing of pheromones indicative of male quality*

Nicolas Doubovetzký\*, Sanne Bal, Jean-Christophe Billeter, Department of Neurobiology, Groningen Institute for Evolutionary Life Sciences, University of Groningen

Sexual selection is built on the premise that in most species, females invest significantly more in reproduction and offspring than males. Due to this differential investment, females have evolved mechanisms to correctly assess the quality of their mates before mating. However, in polyandrous species, females can store sperms from different males in their reproductive tract and exert post-mating sexual selection by favoring the sperm of one male over the other, biasing the paternity of their offspring. This process is known as cryptic female choice. While evidence of this cryptic mate choice exists in multiple taxa, the mechanisms underlying this process have remained difficult to unravel. In the vinegar fly *Drosophila melanogaster*, females can modulate the timing of sperm ejection depending on their social environment, which could be a plausible form of cryptic female choice. The mechanisms behind how

females regulate timing of sperm ejection and its functional consequences on paternity remain unclear.

To understand how females regulate timing of sperm ejection, we measured the sperm ejection latency of females in different social or pheromonal context. In this study, we show that females eject sperm of their first mate faster when sensing the pheromones of attractive males compared to less attractive males. We identify these particular pheromones as 11-cis Vaccenyl Acetate or heptanal and their female odorant receptors sensing these pheromones. Using transgenic males expressing fluorescent sperm, we show that twice-mated females can manipulate sperm allocation depending on the quality of the male in their presence after the first mating, affecting the quantity of offspring from the second male. We therefore provide a mechanism for females to exert cryptic female choice, increasing the paternity of more attractive males, thus, giving insight into processes of post-mating sexual selection.

**R Fusté** *Climbing the social ladder: association preferences, network centrality and reproductive status in the spotless starling (*Sturnus unicolor*)*

Roger\*, Fusté, Museo Nacional de Ciencias Naturales (MNCN); Diego, Gil, Museo Nacional de Ciencias Naturales (MNCN)

In many bird species, a fraction of mature individuals does not reproduce. These individuals are known as floaters, and little is known about the way in which they interact with breeding individuals and become breeders themselves. We conducted a study on a nest box population of spotless starlings using radio frequency identification. We investigated the social structure of the population to analyze how floaters interact within the colony. To do so, we constructed a social network using foraging detections at feeders placed in the area during the winter. We first analyzed whether individuals associate based on their reproductive status (floaters or breeders), sex and age. We then obtained network centrality metrics to study whether floaters and breeders occupied the same position within the social network. Finally, of those floaters that were detected the following breeding season, we compared if their network centrality metrics differed between those that became breeders and those that remained floaters. Starlings were found to associate more strongly with individuals of their same status and age. Our results may reflect the outcome of different strategies, in which floaters may try to avoid fighting with more socially dominant individuals (breeders) while breeders may socially relate more strongly to other breeders. Furthermore, the reproductive status had an influence on the individual's social position, with breeders occupying a more central position in the network than floaters. Finally, among floaters, those that became breeders the following season occupied a more central position than those that remained floaters. These results show that the position within the winter social structure of the colony is strongly related to individual long-term fitness, although the link between social position and fitness may arise through individual differences.

**F. Speelman** *Causes of mate fidelity and divorce in the Seychelles warbler*

Frigg Speelman\* (RUG) Hannah Dugdale (RUG) Simon Griffith (Macquarie University) David Richardson (University of East Anglia)

In socially monogamous species, individuals may occasionally divorce. This is often adaptive, although causes of mate switching can be non-adaptive as well. To date, there is a lack of studies investigating multiple adaptive and non-adaptive predictors of divorce and mate fidelity in birds. Here, we investigate the causes of divorce in a socially monogamous cooperative breeder; the Seychelles warbler (*Acrocephalus sechellensis*). We test several hypotheses on why some partnerships persist whereas others result in divorce using a 25 year dataset of a closed population based on the following factors: reproductive success, partnership length, age, breeding experience, partner quality, number of breeding vacancies, breeding territory quality, and food abundance. Firstly, we hypothesize that divorce may be caused by low reproductive success with the current breeding partner and breeding territory, especially

directly following a failed breeding attempt. Secondly, we expect older individuals in long-lasting partnerships to divorce less due to mate familiarity and the breeding experience of their partner. Thirdly, available breeding vacancies may provide opportunities to improve in territory and partner quality, resulting in higher divorce rates. Alternatively, limitations in breeding vacancies may induce forced divorce, whereby one partner is evicted by a usurper taking over the breeding position, due to high competition for breeding positions. Finally, variable food availability may affect divorce likelihood; low food availability may disrupt the pair bond due to challenging conditions and costs in terms of reproduction and physiology. This study provides a comprehensive overview on the adaptive and non-adaptive causes of mate fidelity and divorce.

## **Social foraging: from mechanism to consequence**

### **A. El Hady** *Mechanistic theory of (social) foraging*

Foraging is a ubiquitous behavior performed by all animals as search for food is crucial for survival. When the animal is foraging throughout its environment searching for resources, it is employing a variety of cognitive computations from decision making to planning to learning in addition to adjusting its bodily dynamics. Foraging as a behavior allows studying cognitive dynamics in a natural context and opens up the opportunity for evolutionary comparison across species. In this talk, I will provide a conceptual framework for an integrative understanding of patch foraging focusing on recently developed mechanistic theoretical models, that delineate the potential decision strategies an animal might employ to decide when and how to leave a patch of food across environments with different statistics. I will discuss how these models can be extended to the social foraging realm. These theoretical models can be fit to field data from a variety of species, to unravel the diversity of foraging strategies across environments. Closing the loop between theoretical models and field studies will shape the future of social foraging studies.

### **C. Ioannou** *Linking collective motion to foraging*

The movement of animal groups such as bird flocks and fish shoals is widely believed to be critical in detecting and responding to ecologically important stimuli such as food and predators. However, given the challenges around measuring collective behaviour in animals, empirical studies linking collective properties to foraging efficiency have been lacking. Here, a method is presented that develops existing approaches of measuring collective movement and information transfer in fish shoals to be able to explore in detail the link between collective behaviour and foraging. As examples of this approach in practice, the first study presented demonstrates how understanding spatial and movement characteristics of individuals and groups in relation to the sudden appearance of food, and consistent inter-individual differences in this response (i.e. personality variation), can explain why animal groups often switch collective 'states', specifically from disorganised swarms to highly ordered, polarised groups ([https://youtu.be/TvU\\_k7GRqf4](https://youtu.be/TvU_k7GRqf4)). The second study, currently unpublished, uses manipulation of water turbidity to illustrate how the method can be used to explore the effects of environmental variables, including those driven by anthropogenic change, on the interaction between collective behaviour and foraging performance. The potential and limitations of the method will also be discussed.

### **J. Arbon** *Learned social tolerance in wild jackdaws*

Josh Arbon, University of Exeter; Noa Truskanov, University of Exeter; Emily Stott, University of Exeter; Guill Mclvor, University of Exeter; Alex Thornton, University of Exeter

Animals regularly use others as information sources, but some models may be more reliable or profitable



than others. Young individuals, whose lack of experience can limit their value as social information sources, are often the subject of aggression and displacements. However, youngsters are often less neophobic and more innovative than adults. A lack of social tolerance towards juveniles could therefore limit adults' access to valuable information. Whether animals can learn to modify their social tolerance towards juveniles in order to access new sources of social information is unknown. Here we demonstrate that wild adult jackdaws learn to use juveniles as information sources to gain foraging benefits. Using an automated feeder experiment, we show that adults increased their associations with, and decreased their displacements of, juveniles, demonstrating flexible information use and learning of social tolerance. This represents the first such demonstration in a wild study. Together, our results demonstrate how, by learning to adjust their social tolerance, animals can access the benefits provided to them by previously unlikely sources. Such flexibility in information use may be especially important in a rapidly changing anthropocentric world, where novel problems and opportunities frequently present themselves. Such processes are also critically important to social learning and the potential for flexible social learning strategies, with important implications for our understanding of cultural transmission in nature.

**B.C. Saldanha** *Effects of dietary tryptophan supplementation in the collective behaviour of a highly social bird*

Beatriz, C. Saldanha\*, CIBIO/In-BIO; Patrícia, Beltrão, CIBIO/In-BIO; Ana Cristina, R. Gomes, CIBIO/In-BIO; Marta, C. Soares, CIBIO/In-BIO; Gonçalo, C. Cardoso, CIBIO/In-BIO; Sandra, Trigo, CIBIO/In-BIO

Tryptophan (Trp) is an essential amino acid, precursor of the neurotransmitter serotonin, known to influence social behaviour, with animals generally becoming more prosocial and less aggressive. There is little information on how serotonergic effects influence social structure in free-living, gregarious animals. To investigate this, we gave a Trp-enriched diet to common waxbills (*Estrilda astrild*) living under semi-natural captive conditions in a large outdoor mesocosm. We monitored their group behaviour, including foraging, aggression and social networks, using an array of radio-frequency identification (RFID) antennae. Compared to control periods, the size of foraging groups increased during treatment with Trp, individuals joined more foraging groups per day and, despite group visits to the area with feeders becoming shorter, individuals spent more time feeding per group visit. These results are consistent with Trp increasing prosocial behaviour, and show increased efficiency of collective foraging. However, the mean strength of associations among individuals did not differ in the Trp treatment, indicating that participating in larger foraging groups did not increase close-range associations among individuals. Aggressive displacements at the feeders also increased with Trp treatment but, although this result pertains to aggressiveness, most displacements at feeders use low levels of aggression and appear part of the normal social life of common waxbills. Our results show that Trp, a serotonin precursor, influences various aspects of waxbill group behaviour and social structure in an ecologically-relevant way, since it resulted in an overall increase in the efficiency of collective foraging.

**A. Schakowski** *Socio-ecological drivers of human foraging dynamics in the wild*

Alexander Schakowski\*, Max Planck Institute for Human Development; Raine Kortet, University of Eastern Finland; Petri T. Niemelä, University of Helsinki; Dominik Deffner, Max Planck Institute for Human Development; Christopher T. Monk, Institute of Marine Research; Ralf H.J.M. Kurvers, Max Planck Institute for Human Development

Foraging plays a central role in the ecology and evolution of all species. Successful social foraging requires organisms to navigate uncertain environments, to track foraging success of competitors, to exchange information with group members, and to integrate and balance social and non-social information. In humans, the diversity in foraging styles across socio-ecological contexts is considered a key driver of evolution and human success. And while individual human foraging has been investigated in

laboratory experiments and observational studies, study systems investigating collective foragers in natural socio-ecological environments, are largely lacking. That is, little is known about the social influences on individual decision processes in human foraging and how these shape collective dynamics. Exploring a novel study system, we attempt to close this gap by studying large groups of ice-fishers competing for resources. In February 2022 ten ice-fishing competitions were organized on ten different lakes in Finland with 39 to 51 participants per competition either incentivized on an individual or group level. All participants were equipped with smartwatches recording high resolution GPS position and heart rate, as well as head-worn cameras to identify behavioral states (i.e., drilling, angling, fish handling, relocating). This novel study system will offer unprecedented data on the behavioral mechanisms underlying temporal and spatial foraging dynamics and the socio-ecological drivers of variation in foraging strategies.

Saturday morning 10:05 - 12:30

## **Endocrinology of social behaviour**

### **A. LeBoeuf** *Endocrinology at the superorganismal scale*

Adria LeBoeuf, University of Fribourg

Many successes in life are based on collaboration – this extends to the molecular level, where life is fueled by the chemical processes of metabolism. Microorganisms exchange nutrients through cross-feeding, and multicellular organisms are made up of tissues with different metabolic roles and needs. Social insects take this collaboration still further: Many ant colonies engage in social exchanges of experimentally accessible fluids that contain both exogenously sourced and endogenously produced materials in a behavior called trophallaxis. Some species engage in this behavior infrequently and only in the presence of certain cues, while others perform trophallaxis so frequently that this network of fluid exchange creates a social circulatory system that mediates a form of shared metabolism. I will describe our work on how the endogenously produced proteins transmitted in these fluids relate to colony life in the carpenter ant *Camponotus floridanus*. We show that different stages of the colony life cycle circulate different types of proteins: young colonies prioritize direct carbohydrate processing; mature colonies prioritize consolidation and transmission of stored resources. Further, colonies circulate proteins classically implicated in oxidative stress, aging, and social insect caste determination, indicating that these molecules may act as superorganismal hormones. Comparing the trophallactic fluid of different individuals within a colony, we find that protein abundance and gene expression in relevant tissues do not correlate for many of the most critical colony resource proteins, indicating division of metabolic labor across the superorganism, where some individuals produce while others use. This globalization of processed goods across the colony has far-reaching implications for aging, ecology, worker miniaturization, and the fixing of division of labor.

### **C. De Dreu** *Oxytocin has Tend-and-Defend Functionality Across Group-living Vertebrates*

Carsten De Dreu\* Leiden University; Katie Daughters, University of Essex; Zegni Triki, Stockholm University

Group-living confronts individuals with a social dilemma between cooperating in service of the group, and free-riding in service of personal interests. At the neurobiological level, the release or administration of the neuropeptide oxytocin resolves this dilemma in favour of cooperation. Possibly, oxytocin-induced enhanced pro-sociality can also motivate protective aggression towards enemy conspecifics. Here we

investigate this hypothesis with a critical review of experiments and field observations conducted with various group-living vertebrates, humans included. Results suggests a 'tend-and-defend' functionality for oxytocin. Across a range of social vertebrates, including various primates, oxytocin amplifies (i) cooperation with genetically or culturally related 'in-group' individuals, and (ii) defensive aggression towards outside intruders and enemy conspecifics.

**K. Bebbington** *Prolactin as a measure of evolutionary conflict between social partners*

Kat Bebbington\*, University of Groningen; Ton Groothuis, University of Groningen

Since providing care for offspring is costly, parents are assumed to be in an evolutionary conflict over the division of parental care duties, with each parent aiming to invest as little care as possible while forcing the partner to provide the majority of offspring care. However, the extent to which this assumption holds in real systems is poorly understood, partly because the underlying motivation for parental care may not be reflected adequately in behaviour. Therefore, measuring individual variation in the hormones underlying parental behaviours may provide important new insights into evolutionary conflicts between social partners. In addition, in many biparental species, social partners remain together for multiple breeding attempts; forcing a current partner to provide a super-optimal level of care may reduce that partner's investment and survival in subsequent years. We therefore expect that selection will favour individuals who increase their relative contribution to parental care when mated with a partner who is likely to contribute substantial social benefits to future reproductive success. We tested these predictions in a captive population of black-headed gulls, *Chroicocephalus ridibundus*, where pair bond duration and behavioural compatibility between partners are known to affect reproductive success and thus a current partner's future reproductive value. We used the hormone prolactin and its interaction with corticosterone as an endocrinological indicator of intrinsic motivation to provide parental care, and tested whether baseline and stress-induced levels of plasma prolactin (reflecting the motivation of the bird to stay at the nest after exposure to a stressor) were related to the social benefits an individual could expect to gain from its current partner in future breeding attempts. We argue that measuring individual variation in hormone secretion is a powerful way to test long-standing evolutionary theories, and highlight the importance of considering social context in understanding the evolution of reproductive investment.

**S. Fischer** *The role of the stress axis in mediating behavioural flexibility in a social cichlid, *Neolamprologus pulcher**

Stefan, Fischer\*, University of Veterinary Medicine Vienna; Zala, Ferlinc, University of Vienna; Katharina, Hirschenhauser, University for Education Upper Austria; Barbara, Taborsky, University of Bern; Leonida, Fusani, University of Veterinary Medicine Vienna; Sabine, Tebbich, University of Vienna

Behavioural flexibility refers to animals' cognitive ability to adapt to changing environments. Learning plays a major role in the way how animals flexibly cope with novel situations, while physiological stress responses are adaptive and highly efficient mechanisms to cope with unpredictable situations. The stress response is highly conserved among vertebrates and characterised by the activation of the hypothalamic-pituitary-interrenal (HPI) axis, the hypothalamic-pituitary-adrenal (HPA) axis equivalent in fishes. Ultimately, after a stressor is encountered, the activation of the HPI axis regulates the release of glucocorticoids (GC) which induces the stress response and also binds on glucocorticoid receptors (GR) in the hypothalamus to stop the further release of GCs, terminating the stress response. These short-term elevations of GCs lead to enhanced attention and memory formation. However, whether a potential resulting change in learning performance is due to a change of cortisol levels is less investigated. To verify this, we pharmacologically blocked GRs in adult cichlid fish (*Neolamprologus pulcher*) using a non-invasive short-term application of a GC antagonist, mifepristone (RU486). After the application, we repeatedly exposed fish to a mild stressor and tested their behavioural flexibility with a detour task. We

measured the latencies to find a shelter and the number of failed attempts when the shortest route was blocked. Although latencies were not different between the treatments, we found that test fish treated with the GC blocker had more failed attempts during the detour tasks than control test fish without the blocker. This confirms the causal role of the stress response in mediating behavioural flexibility with potential consequences for animals' adaptation to changing environments.

**W. Goymann** *Androgen-aided amazons – classical polyandry in coucals is associated with testosterone in females but not males*

Wolfgang Goymann\*, MPI for Ornithology

Steroid hormones such as testosterone may be important proximate factors regulating mating decisions. Indeed, comparative data suggest that seasonal patterns of circulating testosterone are related to mating strategies and testosterone manipulations affect mating decisions in some species.

The black coucal (*Centropus grillii*) is the only altricial bird with social polyandry, where females compete for territories, and only males care for the offspring. Territorial aggression of females is modulated by progesterone and females have a higher sensitivity for testosterone in a part of their brain that regulates social behaviour. Hence, sex steroids seem to play a role in the regulation of the 'sex-role reversed' behaviour of this species. Here, I ask if the steroid profiles of female and male black coucals differ from those of white-browed coucals (*C. superciliosus*), a close relative with 'conventional' sex roles. In this species, females and males form pairs and jointly defend a territory with both parents raising the offspring. Based on this difference in mating strategies, I predicted female black coucals to express higher levels of testosterone and lower levels of progesterone than female white-browed coucals. During the mating phase, male black coucals should express higher levels of testosterone than male white-browed coucals, because there is intense competition for fertilizing females in black, but not in white-browed coucals. During parenting, testosterone should be low in males of both species, but particularly so in black coucals: testosterone has been shown to inhibit paternal care – and that would be particularly fatal in a species with male-only care. Female coucals followed the predicted pattern in testosterone and progesterone, but there was no difference in testosterone concentrations of male coucals. In conclusion, gonadal steroids seem to play a role in regulating differences in mating strategies of females coucals but they seem to play a minor role in male coucals.

## Cognition

**J. Abdai** *Investigating animacy perception in cats and dogs using artificial agents*

Judit Abdai\*, MTA-ELTE Comparative Ethology Research Group, Budapest, Hungary; Stefania Ucheddu, MTA-ELTE Comparative Ethology Research Group, Budapest, Hungary; Márta Gácsi, MTA-ELTE Comparative Ethology Research Group, Budapest, Hungary; Ádám Miklósi, MTA-ELTE Comparative Ethology Research Group, Budapest, Hungary and Department of Ethology, Eötvös Loránd University, Budapest, Hungary

Self-propelled motion cues elicit the perception of inanimate objects as animate. Studies usually rely on looking behaviour of subjects toward stimuli displayed on a screen, but utilizing artificial agents (UMOs) provides more natural, interactive context. Here we investigated whether cats and dogs discriminate between UMOs showing animate or inanimate motions, and how they react to UMOs' interactive behaviour. We hypothesised that both species display more interest toward the animate UMO because they recognize it as potential social partner or as prey. Subjects first observed in turn the motion of two UMOs: the animate UMO displayed self-propelled motion (starting from rest, acceleration, deceleration), but these changes were not visible in the motion of the inanimate UMO. After observation, subjects could move freely for 2 min while both UMOs were present (Phase I). In Phase II, only the animate UMO

showed one of three interactive behaviours: pushing a ball, luring motion, moving toward the subject (between-subject design). Then, subjects moved freely for 2 min again. We found that in Phase I, dogs approached the UMOs sooner than cats, regardless of their animacy. Dogs looked at the animate UMO more often, and both species touched the animate UMO more frequently. In Phase II, dogs approached the UMO sooner and more frequently than cats, but there was no difference in their behaviour toward the UMOs displaying any of the three interactive behaviours. Thus, both species displayed distinctive behaviour toward the animate UMO, but in dogs, this was detected in the looking behaviour and physical contact as well, whereas in cats only in the latter. Results also show that dogs are more likely to interact with the UMO than cats, irrespectively of the context. The findings indicate the importance to measure multiple behaviours. Live demonstration by artificial agents provide unique opportunity to study social behaviour.

**V. Mazza** *Smarts in the city: innovation in rural and urban small mammals*

Valeria Mazza\*, University of Potsdam; Jana A. Eccard, University of Potsdam

The expansion of human-altered environments presents wildlife with multiple novel situations in which the ability to produce innovative behaviour could be beneficial. Innovativeness is generally considered crucial for survival, particularly in novel, complex, and dynamic environments. In fact, species that do not display high innovation propensity might be forced out of anthropogenic environments. However, current research is heavily biased towards species with high dispersal abilities, namely birds and larger mammals. The potential role of innovation in coping with anthropogenic environments in species that cannot easily elude anthropogenic disturbances remains relatively uninvestigated. Additionally, different behavioural innovations may not be functionally equivalent. Here, we focused on ground-dwelling rodents, which are often found in urban areas, partly as synanthropic. Using standardized tests in the field, we compared behavioural innovations of several urban and rural populations of free-living small mammals in a battery of repeated tests, including four foraging extraction tasks, an escape test, and dietary innovation assessments. We investigated the consistency of the innovative performance within and across tests. In addition, we tested the link between innovativeness and personality traits exploration and boldness. Results support the hypothesis that living in human-altered environments favours increased innovativeness, and that personality mediates innovative performance. Among-individual variation in innovativeness might thus play a key role in individuals' successful coping with the rapid and recent expansion of human-altered environments.

**M. O'Hara** *The use of a tool set by wild Goffin's cockatoos*

Mark, O'Hara\*, Messerli Research Institute, University of Veterinary Medicine Vienna, Austria; Berenika, Mioduszezowska, Messerli Research Institute, University of Veterinary Medicine Vienna, Austria; Roger, Mundry, Messerli Research Institute, University of Veterinary Medicine Vienna, Austria; Yohanna, Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences, Indonesia; Tri, Haryoko, Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences, Indonesia; Rini, Rachmatika, Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences, Indonesia; Dewi, Prawiradilaga, Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences, Indonesia; Ludwig, Huber, Messerli Research Institute, University of Veterinary Medicine Vienna, Austria; Alice, Auersperg, Messerli Research Institute, University of Veterinary Medicine Vienna, Austria

Wild Goffin's cockatoos (*Cacatua goffiniana*) were opportunistically observed to use wooden fragments as tools to access the embedded seed matter of a tropical fruit, the Sea Mango (*Cerbera manghas*). Only two out of 15 birds, temporarily kept in a field aviary used tools. They manufactured and used tools immediately and repeatedly upon the first provision of the fruit. Furthermore two distinct manufacture

techniques were observed: severing and splitting. Based on the measurements of three-dimensional models, a cluster analysis revealed that the tools differed in their physical properties and could be allocated into three categories: sturdy, fine, and medium. Each type seemed to serve a specific function during the extraction of the embedded seed (wedging, piercing, extraction) which follows the definition of a 'tool set'. The repeated observations of the two tool users and indications from free-ranging individuals suggest that this behavior occurs naturally in the forest but is not a species-wide trait. Wild Goffins forage on multiple easy-to-access resources and thus do not seem to rely on tool-obtained food. This first report of a tool set in a non-primate species significantly diversifies the phylogenetic landscape of technology and might provide insights into the underlying convergent factors promoting this skill.

**R. Schwing** *Sequential Learning in Kea (Nestor notabilis)*

Raoul, Schwing, Messerli Research Institute, University of Veterinary Medicine Vienna/University of Vienna/Medical University Vienna, Vienna, Austria\*; Adele, Tuoizzi, Messerli Research Institute, University of Veterinary Medicine Vienna/University of Vienna/Medical University Vienna, Vienna, Austria & Department of Anthropology, University of Zürich, Switzerland; Uzay, Dündar, Messerli Research Institute, University of Veterinary Medicine Vienna/University of Vienna/Medical University Vienna, Vienna, Austria; Ludwig, Huber, Messerli Research Institute, University of Veterinary Medicine Vienna/University of Vienna/Medical University Vienna, Vienna, Austria

Sequential learning requires the subject to associate items of a sequence with one another in a particular order, and to be able to reproduce said order when prompted. This ability is at the basis of many of the complex tasks and skills found in nature, but also within human society, which require certain actions to be performed before others in order to reach a goal. Considering the widespread requirement of sequential learning in natural settings, but also experimental methodologies, the number of studies specifically investigating sequential learning are few and far between, even when studies on this topic have made headlines beyond the scientific community, i.e. Matsuzawa showing that chimpanzees can learn to touch sequences of Arabic numerals, utilizing superior visual memory to even beat humans when the numerals were shown for only fractions of a second. In our study, we tested kea mountain parrots (*Nestor notabilis*) on their ability to learn sequences of touches on a 3x3 grid. We chose this methodology over the numerals, as we wanted to present the kea with a task that only utilized relative spatial position to indicate the sequence order, over the prelearned numeric sequence. Each sequence was demonstrated at the beginning of each trial, by lighting up LEDs which made up the 3x3 grid for 1sec each in the required sequence, before allowing the subjects access to touch the LEDs. Two experiments were conducted, the first looking at factors influencing the ability to learn a set sequence (the same for each trial) when said sequence was either ordered or random, and the second looking at the ability to learn sequences that changed from trial to trial. In both cases, subjects learned the task in a stepwise fashion, adding another step to the sequence once the previous number of steps had been achieved.

**S. Whalan** *Brainless sponge larvae can settle to conspecifics, but is that evidence of communication and cognition?*

Steve Whalan\*, Southern Cross University

Deciphering the behavioural ecology of adult (sessile) sponges is challenging. A basal invertebrate that relies on a functioning of cells to get by in life, and without obvious and measurable signs of behaviour, mean this taxonomic group are not routinely thought of in the behavioural ecology space. However, their motile larval stages afford opportunities to investigate dispersal behaviour as larvae determine dispersal and selection of habitat. For larval stages, finding optimal habitat is critical for population level persistence, but can these "brainless animals" selectively respond to environmental cues to settle (metamorphose), or is the process of recruitment to habitat simply a random event. This talk outlines

behavioural choice experiments that tested if sponge larval behaviours, to disperse and settle, are selectively influenced by conspecifics. Larvae from *Luffarilela variabilis* were exposed to experimental treatments of unique secondary metabolites extracted from adults (conspecific cues) and their settlement behaviours quantified. When presented with conspecific cues larvae settled within hours in comparison to treatments of no-cue, where settlement still occurred, but days later. Exhibiting a behaviour whereby larvae can communicate, via identifying and responding (settlement) to conspecifics, provides obvious advantages for reproductive success; close proximity to mates can be critical for sessile taxa...it also raises a curious discussion point central to minimal cognitive behaviours in animals without brains.

**J. Massen** *Do birds enjoy flying?*

Jorg Massen\*, Utrecht University; Kate Malone, Utrecht University; Roos de Vries, Utrecht University; Mandy Beekmans, Utrecht University; Yvonne van Zeeland, Utrecht University; Christine Oei, Utrecht University

You may have wondered whether birds that are performing seemingly useless aerial acrobatics might in fact be enjoying themselves. Though, assigning joy to an animal for something that seems enjoyable to ourselves would be an anthropomorphic stance that would not be considered very scientific. Assigning any emotion to an animal has been notoriously difficult since animals cannot report (verbally) on their emotions and/or feelings. Recently though, researchers have more and more started to adopt a componential view on emotions, which contains elements that in fact can be measured in animals. Taking such a componential perspective, in this study we examined whether flying has a positive valence for birds, and in particular for galah (*Eolophus roseicapilla*), integrating three aspects of emotions: Behavior, cognition, and physiology. Specifically, we measured an increase or a decrease in stress related behaviour, corticosteroids in droppings, and cognitive bias (is their glass half empty or half full) in galahs ( $n = 17$ ) that actively participated in a flight show at Avifauna bird zoo and compared these measurements to days on which these animals did not fly in a show. We will discuss our findings considering the study of animal emotions in general and in light of animal welfare issues. Given that such bird shows are popular attractions in zoos all around the world, this research is paramount to investigate how such shows benefit or harm these birds' welfare, and/or to even define flying as an ethological need.

**Dominance between the sexes in group-living animals**

**E. Davidian** *The ecology and evolution of male-female power relationships in social mammals*

Eve Davidian\*, Ngorongoro Hyena Project, Ngorongoro Conservation Area, Arusha, Tanzania; Martin Surbeck, Harvard University, Department of Human Evolutionary Biology, Cambridge, MA, USA; Dieter Lukas, Department of Human Behavior, Ecology and Culture, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany; Peter M. Kappeler, German Primate Center, Behavioral Ecology Unit, Leibniz Institute of Primate Biology, Göttingen, Germany & University of Göttingen, Department of Sociobiology & Anthropology, Germany; Elise Huchard, Anthropologie Évolutive, Institut des Sciences de l'Évolution de Montpellier (ISEM), France

In mammalian societies, control over resources and reproduction is often biased towards one sex. Yet, the ecological and evolutionary underpinnings of male-female power asymmetries remain poorly understood. Historical hypotheses and our current understanding of intersexual power relationships have been shaped by long-standing stereotypic views of sex roles and advances in our understanding have been limited by a number of conceptual and methodological limitations. I will present a unified and comprehensive "Intersexual power framework" to describe, quantify and predict variations in male-female power within and across mammalian societies. Building on recent empirical developments, I will illustrate that male-female power relationships are more nuanced and flexible than previously acknowledged;

societies are not restricted to strict male or strict female power but show many shades of biases in power along a continuum that encompasses societies with balanced power between the sexes. Using key features of the social and mating systems of various species – including spotted hyenas, baboons, and our closest relatives, bonobos and chimpanzees – I will illustrate the three core principles of the framework: (i) intersexual power arises from conflicts over reproductive control (i.e., when and with whom to mate) and over social control (i.e., food, shelter and other non-reproductive resources), (ii) features of the mating system predict the extent of intersexual biases in reproductive control and (iii) reproductive empowerment of one sex precedes and predicts its social empowerment at both the ecological and evolutionary level. I will end by outlining the eco-evolutionary pathways and feedbacks for the emergence of intersexual power, and by highlighting the distinct pathways that lead to male- and female-biased power: coercion and male-biased dimorphism constitute a co-evolutionary highway to male power, whereas female power emerges through multiple physiological, morphological, behavioural, and socio-ecological pathways.

**C. Hemelrijk** *The winner-loser effect contributes to female co-dominance with males as shown in theoretical and empirical studies*

Charlotte Hemelrijk, University Groningen

Dominance relationships among adults are central in the social life of group-living animals. Between the sexes, however, they are usually either ignored or males are automatically assumed to be dominant over females, because they are bigger. Nevertheless, females are sometimes dominant over a percentage of males in the group (co-dominance or partial dominance). This is usually attributed to coalitions among females against males or to male deference to females. However, these two behavioural mechanisms cannot explain all instances of female co-dominance. A less understood mechanism is the winner-loser effect. This effect implies that after winning, the winner is more likely to be victorious again and after being defeated, the loser is more likely to be defeated again. The winner-loser effect is known to underlie the development of a dominance hierarchy among members of the same sex in animals of all taxa but has so far largely been ignored in studies of dominance between the sexes.

In this talk, by combining theoretical and empirical work we show the consequences of the winner-loser effect on female co-dominance with males. First, I will demonstrate its effects in the computational model, DomWorld. Second, I will test model-based hypotheses in data of 4 species of primates and one non primate species. Third, I will show the generality of female co-dominance with males in primates, birds, and mammals. Considering the generality of these processes, we urge future empirical studies of intersexual dominance of all kinds of animals to consider the winner-loser effect as one of their explanations.

**L. Seex** *Feeding competition underlies female dominance over males in lemurs, an agent-based model, LemurWorld*

Lauren Seex\*, Titus Hielkema, Charlotte K Hemelrijk. University of Groningen

In group-living animals, females are supposed to invest more effort in contests over food than males because of their higher energetic demand during reproduction. When females have a similar fighting capacity as males (i.e., monomorphism), this may result in females dominating males (cost-asymmetry hypothesis). Indeed, in most species of lemurs, a monomorphic primate, females dominate males, although in some species females and males are equally dominant (co-dominance). What causes the different degrees of female dominance over males among species is unclear. We here study in an agent-based model, LemurWorld the hypothesis that female dominance relates to the degree of competition for food which depends on its spatial distribution. In the model, agents group, forage and fight. Agents forage on leaves (distributed uniformly) and fruit (distributed from uniform to patchy). Agents become less hungry after eating and more hungry over time and after fighting. Hungrier individuals invest more effort in fights



which increases their probability of winning. We represent the energetic demand of females during reproduction by making females lose more energy per timestep than males. We show that the degree of female dominance over males increases if the energetic demand of females is higher than that of males, even if it is only a little, and when the distribution of fruit is patchier. This is because individuals are closer together when food is patchy which increases competition, particularly among females. Moreover, we show that when fruit is distributed uniformly in the model, patterns of behaviour resemble egalitarian societies of lemur and when it is distributed patchily they resemble despotic species. Thus, the intensity of competition for food may underlie differences female dominance over males and dominance style in lemurs. We hope that this inspires future research in both lemurs and other monomorphic species.

**M. Puentes-Escamilla** *Female wild rats (*Rattus norvegicus*) are co-dominant with males despite females being half the size of males*

Miguel Puentes-Escamilla\*, University of Groningen; Manon Schweinfurth, University of St Andrews; Charlotte Hemelrijk, University of Groningen

In group-living animals, males are typically assumed to be dominant over females when they are larger than females. Yet, this is not an automatic consequence. The computational model DomWorld has shown that among group-living individuals, even when females are smaller than males, females may dominate some males via the winner-loser effect, and female dominance becomes greater the higher the intensity of aggression in the group. Although these predictions have been confirmed empirically in primates, including humans, they have not been tested in other taxa. Norway rats (*Rattus norvegicus*) are suitable to test this because they fulfil the assumptions of DomWorld: they form groups, males are larger than females, and aggression can be intense. Moreover, their intersexual dominance has seldom been studied. In the present study, we investigate whether there is dominance of females over part of the males in rats and how it emerges. We study twelve mixed-sex colonies, housed in a semi-natural environment. We show that females were dominant over on average 55% of the males even though males occupied the alpha position in all colonies but one. Moreover, as expected by DomWorld, (i) females were dominant over more males when (a) the aggression of the colony was more intense and when (b) dominants spent more time in the open arena in colonies with intense aggression, and (ii) the spatial segregation of the dominants did not depend on the intensity of aggression. In sum, we show that although females are smaller, they dominate part of the males probably through the winner-loser effect. It is of great interest to investigate these patterns in other taxa with male-biased sexual dimorphism and intense aggression.

**L. Horn** *Context affects preschool children's dominance in between-sex competition*

Lisa Horn\*, Thomas Bugnyar; Affiliation (both authors): Department of Behavioral and Cognitive Biology, University of Vienna

Children in peer groups, as typically found in preschool, regularly need to compete for resources (e.g., material objects, support from others). Children's differences in their ability to prevail in resource competition are indicative of their dominance in the group. Preschool groups offer an exceptional perspective onto the development of between-sex dominance in humans. Height and weight dimorphism is still limited at this age, yet preschool boys have been found to outperform girls in strength and physical fitness. Preschool children associate dominance and power more readily with male characters than female characters, teachers often rate boys as more dominant than girls, and it is typically assumed that boys outperform girls in between-sex resource competition. However, there has been little systematic investigation of between-sex dominance in natural groups of preschool peers.

Here we used a two-level approach to investigate dominance in mixed-sex groups of preschool children aged 2–6 years during naturalistic interactions and in a resource competition experiment. In study 1, we

observed three preschool groups during ten sessions of unstructured playtime each. We recorded all naturally occurring conflicts and the identity of winners and losers. In study 2, we conducted an experiment that simulated a situation of scramble competition (i.e., competing for preferential access to a non-monopolizable resource) with five preschool groups.

During unstructured playtime - contrary to our predictions - we found that girls were more likely to win conflicts against boys than conflicts against other girls. Boys were equally likely to win against girls and boys. In the scramble competition experiment, however, boys outcompeted girls. Consequently, the outcome of between-sex dominance interactions seems to depend strongly on the context in preschool children (e.g., whether the interactions are framed as a competitive event or not). We will discuss these results in consideration of effects of age and sex composition.

## Posters (by author in alphabetical order)

Authors of odd numbered posters are asked to be present at their posters during the poster session of Thursday. Those with even numbered posters are asked to stand near their poster during the poster session of Friday.

### **1 Atharva Andhare** *Among-individual variation in intra- and inter-specific aggressiveness in a wild bird population*

Atharva Andhare, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands\*, Gaoyang Yu, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands, Xia Zhan, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands, Irene Martinez-Baquero, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands, Maaïke A. Versteegh, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands, Peter Korsten, Department of Animal Behaviour, Faculty of Biology, Bielefeld University, Germany, Jan Komdeur, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands

An individual's aggressiveness is likely an essential determinant of its fitness. For example, higher levels of aggressiveness may be advantageous in acquiring a breeding territory but at the same time be costly in terms of energetics, injuries and even death. In most animals, aggressive behaviour can be observed prominently during the breeding season, as in this period, individuals compete for mates, territories and resources. Typically, the ecological causes and consequences of among-individual variation in aggressive behaviour towards intra-specific competitors are studied. However, individuals may not only compete with conspecifics, but also with individuals of sympatric species that use the same resources and breeding sites. This study aims to obtain a better understanding of inter-specific aggressiveness and how it relates to the aggressiveness against conspecifics. We chose the blue tit (*Cyanistes caeruleus*) as our focal species and another cavity-dwelling passerine, the great tit (*Parus major*), as an inter-specific competitor. In the late nest-building and early egg-laying stages, we scored the aggressiveness of blue tits against taxidermic mounts of blue tits (only males) and great tits (males and females) in simulated territorial intrusions. We will quantify the repeatability in aggressiveness shown by individuals in response to these different intruders. Additionally, we will examine if the aggressiveness shown by focal individuals in intra- and inter-specific contexts is correlated. Considering the evidence from previous studies, we expect high repeatability of the aggressiveness of individuals. Moreover, we foresee that intra- and inter-specific aggressiveness are positively correlated among individuals.

### **2 Katerina Antonova** *Holistic perception in predator recognition by untrained great tits (*Parus major*)*.

Katerina Antonova\*, Charles University in Prague, Petr Veselý, University of South Bohemia, Ondrej Fiser, University of South Bohemia, Roman Fuchs, Charles University in Prague, University of South Bohemia

Holistic perception of objects simultaneously evaluates the presence and configuration of object particular features. This type of fast perception has been repeatedly proven in human face recognition due to specific reactions of people to modified, especially inverted faces. Holistic perception has also been demonstrated in a number of other animals, but in birds so far has not been sufficiently tested. In the predator-prey relationship has not been tested at all. We have presented modified dummies of the

European sparrowhawk (*Accipiter nisus*) to the untrained wild great tits (*Parus major*). Aviary experiments were conducted in old orchard. We have observed tits behaviour before and during presentation of tested dummies. We have also provided control dummies such as harmless domestic pigeon (*Columba livia* f. *domestica*) and unmodified dummy of the sparrowhawk. We have recorded reactions of 420 tits during two years. Only one dummy was presented to each tit. On the basis of our results, we can conclude that tits perceived not only presence of key features (beak, eyes), but their configuration as well. We could see that tits paid more attention to the dummy with inverted face only when the whole body is presented. On the other hand, if we have presented inverted sparrowhawk's body, tits paid no attention to this dummy at all. We can summarize that raptors face is important for evaluation of potential threat and could be perceived in holistic way. Due to strong inversion effect of raptors body we could claim that raptors body seems to be even more important in this evaluation process.

**3 Kerstin E. Auer** *Female mice do not adjust maternal investment based on the genetic quality of mates*  
Kerstin E., Auer\*, Institute of in-vivo and in-vitro models, Vetmeduni Vienna, Austria; Sonja, Istel, Institute of in-vivo and in-vitro models, Vetmeduni Vienna, Austria; Maik, Dahlhoff, Institute of in-vivo and in-vitro models, Vetmeduni Vienna, Austria; Jasmin, Primus, Institute of in-vivo and in-vitro models, Vetmeduni Vienna, Austria; Thomas, Rüllicke, Institute of in-vivo and in-vitro models, Vetmeduni Vienna, Austria

Maternal investment can affect the survival and development of offspring, and females should increase maternal investment when mating with males, which are of high quality. Here we investigated in mice, whether females alter implantation rates and pup survival depending on the genetic quality of their mates. We controlled for confounding genetic effects in mating females with vasectomized males and in performing embryo transfers. We experimentally selected the MHC genotype and genetic background of males and paired CBA females either with males that shared the same MHC haplotype and genetic background (CBA), that shared half of the MHC haplotype and genetic background (B6CBAF1 hybrids), or that had a different MHC haplotype and genetic background (C57BL/6N). We performed 304 pairings, resulting in 81 vaginal plugs, which confirmed mating. Females paired with B6CBAF1 males had a significantly higher plug rate (36.9%) compared to CBA males (19.5%). The plug rate of C57BL/6N males (26%) did statistically not differ from CBA or B6CBAF1 males. Out of 81 surrogate mothers 74 litters were born. We found no difference in the number of implantation sites, or born pups depending on male genetic background. Similarly, pup survival until weaning, litter mass at weaning and offspring sex ratio were unaffected by male genetic background. In summary, we found highest mating rates in females paired with hybrid males, which could be explained by females being more attracted to heterozygous males, as they can provide genetic benefits for offspring. Alternatively, hybrid males might be better in courting or coercing females into matings. We tested whether females adjust pregnancy rates and offspring survival, depending on the genetic quality of their mating partners, while controlling for confounding genetic effects, and our results provide no evidence that females differentially invest into offspring based on the genetic quality of their mating partners.

**4 Tiphaine Bailly** *Social modulation of oogenesis and egg-laying in *Drosophila melanogaster**  
Tiphaine P. M. Bailly\*, Philip Kohlmeier, Rampal S. Etienne, Bregje Wertheim, and Jean-Christophe Billeter

Being part of a group facilitates cooperation between group members, but also creates competition for limited resources. This conundrum is problematic for gravid females who benefit from being in a group,

but whose future offspring may struggle for access to nutrition in larger groups. Females should thus modulate their reproductive output depending on their social context. Although social-context dependent modulation of reproduction is documented in a broad range of species, its underlying mechanisms and functions are poorly understood. In the fruit fly *Drosophila melanogaster*, females actively attract conspecifics to lay eggs on the same resources, generating groups in which individuals may cooperate or compete. The genetic tractability of this species allows dissecting the mechanisms underlying physiological adaptation to social context. Here, we show that females produce eggs increasingly faster as group size increases. By laying eggs faster in group than alone, females appear to reduce competition between offspring and increase offspring survival. In addition, females in a group lay eggs during the day, while isolated females lay them during the night. We show that responses to the presence of others are determined by vision through the motion detection pathway and that flies from any sex, mating status or species can trigger these responses. The mechanisms of this modulation of egg-laying by group is connected to a lifting of the inhibition of light on oogenesis and egg-laying by stimulating hormonal pathways involving juvenile hormone. Because modulation of reproduction by social context is a hallmark of animals with higher levels of sociality, our findings represent a protosocial mechanism in a species considered solitary that may have been the target of selection for the evolution of more complex social systems.

**5 Awani Bapat** *Social integration of free-flying juvenile common ravens into a non-breeder flock*

Awani Bapat\*<sup>1,2</sup>; Varalika Jain<sup>2</sup>; Petra Sumasgutner<sup>1,2</sup>; Palmyre Boucherie<sup>1</sup>; Thomas Bugnyar<sup>1,2</sup>; <sup>1</sup> Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria; <sup>2</sup> Konrad Lorenz Research Centre, Core Facility for Behaviour and Cognition, University of Vienna, Grünau im Almtal, Austria

In many social species, individuals vary in the number and nature of social relationships and hence their degree of social integration. This variation may reflect differences in social competence, the development of which can be affected by opportunities for social interactions during early life. Adult common ravens (*Corvus corax*) defend large breeding territories, whereas juveniles, sub-adults and non-territorial adults form dynamic non-breeder flocks that are structured by dominance and social bonds. Little is known about how juvenile ravens integrate into these non-breeder groups when they leave the family unit. We here test the assumption that early life social experience is a key factor for understanding inter-individual differences in ravens' social integration. We make use of a long-term program, in which we manipulate the social experience of the yearly offspring in our captive colony: young ravens grow up in large or small families and then stay in similar-sized cohorts of same-aged peers over summer before they are equipped with GPS loggers and released into free flight to eventually join a local non-breeder flock in the Northern Alps. We here focus on the period after the release into free flight over five consecutive years (2017-21). We use a combination of behavioural observations at a highly attractive foraging site, along with movement and area use patterns obtained with the help of GPS data to measure the degree of integration into the non-breeder group. We then examine the effects of individual attributes (sex and kinship) and upbringing (family size and previous social experience) on the observed degrees of integration. Preliminary analyses seem to support our prediction that aside from the individuals' attributes, upbringing may also play an important role in how fast and well juvenile ravens integrate into non-breeder groups.

**6 Matteo Beccardi** *Male aggressiveness during female fertile phase in relation to plumage ornaments, female traits and extra-pair paternity*

Matteo Beccardi\* Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany; Mireia Plaza Department of Evolutionary Ecology, National Museum of Natural Sciences - CSIC, Madrid, Spain; Juan Moreno Department of Evolutionary Ecology, National Museum of Natural Sciences - CSIC, Madrid, Spain; Alejandro Cantarero Department of Physiology, Veterinary School, Complutense University of Madrid, Madrid, Spain

In many bird species, physical aggression between males become more frequent during the female's fertile period, as female encounters with extra-pair males during this phase are more frequent and can entail paternity losses. Thus, male aggressiveness during this stage has been proposed as crucial for ensuring male reproductive success. In the context of male-male competition, where disputes between males can entail considerable costs, plumage ornaments could represent honest signals of individual quality that could reflect the aggressiveness of paired territorial males. Furthermore, male aggressiveness could be related to mate quality or defensive capacity. We investigated the association of male and female traits with the aggressive behaviour of territorial paired males in a Spanish population of pied flycatchers (*Ficedula hypoleuca*), where territorial intrusions were simulated during the female fertile period by placing a stuffed male close to the nest. We also quantified extra-pair paternity in the broods. We predicted that males with larger white patches and higher UV reflectance of their wing patches (two male plumage ornaments) should respond more strongly to intrusions and that males should be more aggressive when mated with higher quality females. Moreover, in a context of extra-pair paternity, more aggressive males should better protect their mates from intruding males and thereby reduce their paternity losses. We found that the level of male aggressiveness increased with male UV reflectance. Further evidence of the role of male plumage traits in territorial defence was the association between male UV reflectance and control of their territories. Instead, female plumage ornaments were not related to different measures of male aggressiveness. Finally, we found strong evidence that males that responded less intensely to a territorial intrusion suffered a higher paternity loss, which offers strong support to the basic tenet of the theory of territoriality as paternity defence.

**7 Natalia Bezuch** *Developmental and behavioural effects in zebrafish of early-life exposure to conspecific alarm substance from different life stages*

Natalia Bezuch \*, William T. Swaney, Liverpool John Moores University

During early development, animals are highly sensitive to stress and through phenotypic plasticity can respond to the challenges they experience. Predator stress in this period can have developmental consequences, potentially mediated via the HPI axis, however a generalized response to all predator cues may result in sub-optimal phenotypes if those cues are not relevant to the individual.

This study aimed to examine how early-life exposure to predator cues associated with different life stages affect development and behaviour in zebrafish larvae, as well as the molecular mechanisms underlying these changes. We exposed zebrafish embryos over the first 120 hours post-fertilization to conspecific alarm substance (AS) obtained from either other larvae, or from adult fish, to represent the presence of predators of different zebrafish life-stages. We then assessed larval development, measured behaviour in movement and light-dark preference tests, and assayed whole-body cortisol by ELISA and relative expression of key HPI-axis genes by RT-qPCR.

Compared to controls, significantly more AS-exposed larvae hatched by 72 hpf irrespective of AS type, suggesting accelerated development which may enhance fitness in the presence of predators. We also detected subtle morphometric changes in larval AS-exposed fish, indicating that predator stress exposure can alter embryonic development according to predator cue type. Larval AS also induced changes in light-dark preferences which were not seen in response to adult AS, indicating that behaviour is sensitive to the type of predator cue experienced. However, AS exposure did not affect movement behaviour. Cortisol levels were not different between the experimental groups, indicating that other mechanisms may regulate these behavioural and developmental responses. These results suggest that zebrafish embryos respond differently to larval vs adult AS, with effects on both development and behaviour. Such tuning of developmental responses may potentially indicate they are responding differently to signals of immediate vs later predation risk.

### **8 Debottam Bhattacharjee** *Evidence of prosociality in semi free-ranging Japanese macaques*

Debottam, Bhattacharjee\*, Animal Behaviour & Cognition, Department of Biology, Utrecht University, the Netherlands; Eythan, Cousin, Department of Ecology, Physiology & Ethology, Faculty of Life Sciences, University of Strasbourg, France; Lena, Pflüger, Department of Behavioral and Cognitive Biology, University of Vienna, Austria; Jorg J.M. Massen, Animal Behaviour & Cognition, Department of Biology, Utrecht University, the Netherlands.

Prosociality is the tendency or intent to benefit others at a very low or no cost. It was thought to be a unique characteristic of human psychology, consisting of motivational, emotional and normative substrates, explained functionally by reciprocity and reputation building. Recent advancements have shown that species other than humans (such as domestic dogs, meerkats, rats, azure-winged magpies, etc.) can also exhibit prosocial tendencies. However, a considerable gap of knowledge exists regarding prosociality in despotic societies. We studied semi free-ranging Japanese macaques (*Macaca fuscata*), a highly despotic species, in a “group-service paradigm”, to investigate proactive prosociality. In an ecologically valid condition (population of ~170 individuals in 4 hectare area with natural vegetation), we “self-trained” 25 individuals through voluntary participation. Individuals, in the test condition, provisioned food to group members in 72.8% of the opportunities, and on a group level, did so significantly more often than in two control conditions (empty control - no food was placed; blocked control - access to the rewards for the group members was blocked). This is the first experimental evidence of the presence of prosociality in Japanese macaques. We also conducted in-depth analyses on individuals’ diversity and strength of prosociality (i.e. diversity of dyads) taking kin relationships, sex and dominance-rank relationships into account. In highly despotic primate societies, the presence of individual prosocial motivations can be of paramount importance, especially during coalition forming, social bonding and cooperative relationships. We discuss our novel findings along these lines.

### **9 Thibault Boehly** *Individual variation in working memory performance in two archosaur species*

Thibault, Boehly, Lund University\*; Stephan A., Reber, Lund University; Mathias, Osvath, Lund University

Executive functions are cognitive skills which are essential for behavioural control and decision-making. We tested both motor self-regulation and working memory in 6 captive American alligators (*Alligator mississippiensis*) and 6 captive emus (*Dromaius novaehollandiae*). In condition 1 of our setup, we hid a food item behind one of two identical opaque barriers. In condition 2, we hid two food items of different qualities behind two different, opaque and transparent barriers. Each time in full view of the subject, who

could then choose one barrier and eat the food if there was any; the unselected option was removed. We found previously, that both species can solve these tasks by going for the high-quality food item, even when the low-quality food item is visible behind the transparent barrier. For the current study, we introduced a modification: we distracted the subjects after the reward was hidden and they started to approach. The distraction was another food item thrown in their path, reaching for it temporarily broke their visual attention to the barriers. We investigated whether the animals would still find the high-quality food item after picking up the distraction. Results show that both alligators and emus can keep information about the location of the hidden food reward in mind despite being distracted, but also reveal inter-individual variation in performance. Indeed, in condition 1 some individuals show a side preference which is not present when they are tested without the distraction. This suggests the distraction increased memory workload and that not all individuals could cope with it. Moreover, both species being from the clade Archosauria, it could suggest that working memory is a conserved ability which underwent little changes since their last common ancestor, allowing to draw some inferences on the cognitive abilities of extinct related taxa (non-avian dinosaurs, pterosaurs and extinct pseudosuchians).

#### **10 Zsófia Bognár** *Flat-faced dogs' proneness to form eye contact seems not to contribute to their popularity*

Zsófia, Bognár\*, MTA-ELTE Lendület "Momentum" Companion Animal Research Group, Department of Ethology, Eötvös Loránd University, Budapest, Hungary; Enikő, Kubinyi, MTA-ELTE Lendület "Momentum" Companion Animal Research Group, Department of Ethology, Eötvös Loránd University, Budapest, Hungary

Previously we found that brachycephalic (flat-faced) dogs look longer at faces and form eye contact faster with humans than their longer-headed counterparts. We assumed that forming eye contact with humans could be a desired behaviour trait, as it enhances communication and training effectiveness, strengthen bonding and makes dogs look cuter. In this study, we hypothesised that flat-faced dogs' propensity to form eye contact with humans contributes to their growing popularity despite their numerous health problems.

In a questionnaire, we asked people (N=1156) about their most liked and disliked dog breeds and appearance. Then we showed them photo pairs of 25 dogs: in one photo, the dog looked into the camera (formed eye contact), and in the other photo, the dog looked away. Participants could choose a photo from the pair that they liked more or indicate that they liked the photos equally.

In contrast to our hypothesis, we found that those who liked brachycephalism (23.2% of respondents) chose the eye contact photos less frequently than those who disliked brachycephalism (19.8%) or were neutral (57%). In other words, brachycephalic dog lovers seem to be less sensitive to dogs' eye contact. The results suggest that they are less sensitive to dogs' communicative signals and may also pay less attention to dogs' signals of suffering due to health problems.

Consequently, brachycephalic dogs' propensity to form eye contact with humans is probably an unimportant trait regarding their popularity. Perhaps, the brachycephalic dog lovers' lower sensitivity to dogs' signals plays a role in not taking the severity of health problems seriously, and staying loyal to a brachycephalic breed, contributing to the brachycephalic welfare crisis



**11 Lena Bohn** *Cognitive judgement bias in mice: exploring potential causes of «optimism» and its temporal stability*

Lena, Bohn\*, Department of Behavioural Biology, Institute for Neuro- and Behavioural Biology, University of Münster, Germany; Marko, Bračić, Department of Behavioural Biology, Institute for Neuro- and Behavioural Biology, University of Münster, Germany; Marisol, Herrera-Rivero, Department of Genetic Epidemiology, Institute of Human Genetics, University of Münster, Münster, Germany; S. Helene, Richter, Department of Behavioural Biology, Institute for Neuro- and Behavioural Biology, University of Münster, Germany; Norbert, Sachser, Department of Behavioural Biology, Institute for Neuro- and Behavioural Biology, University of Münster, Germany

Individuals differ in how they see the world. The most famous example for this phenomenon is the glass of water: the optimist says it is half-full, the pessimist says it is half-empty. We can find these “optimistic” or “pessimistic” cognitive judgement biases (CJBs) not only in humans but also in other animals, and during the past two decades they have been used to assess the animals’ inner states in animal welfare science.

However, how these differences in CJB arise and how stable they are is not yet fully understood. As one of the most widely used animal in research, we chose the laboratory mouse to tackle these open questions.

By using a 2x2 full factorial design, we aimed to investigate the interactive effect of genotype and environment on CJB: Mice of two genotypes were housed in either of two environments. As another potential driver of differences in CJB, we analysed differential gene expression (DGE) in the amygdala. We determined the mice’s CJB using a fully automated, touchscreen-based active choice test. After the CJB test, half of the mice were used to assess the temporal stability of CJB, by repeatedly testing the mice over the course of seven weeks. The other half was used to analyse the DGE of “optimistic” and “pessimistic” mice.

We did not find a significant influence of genotype or environment on CJB. Similarly, there was no significant difference in the transcriptional profiles between “optimists” and “pessimists”. However, we did find that CJB was repeatable, indicating that CJB is a temporally stable trait in mice. We therefore suggest to continue this research in the framework of animal personality and propose that future work may focus on other genotypes and environmental manipulations, epigenetic factors, or endocrine profiles as potential drivers of differences in CJB

**12 Mirjam Borger** *Rainfall changes the social structure and offspring sex ratio in Seychelles warblers*

Mirjam Borger\*, GELIFES, University of Groningen; David Richardson, School of Biological Sciences, University of East Anglia; Hannah Dugdale, GELIFES, University of Groningen; Terry Burke, Department of Animal and Plant Sciences, University of Sheffield; Jan Komdeur, GELIFES, University of Groningen

Species are facing environmental challenges caused by rapidly changing environments induced by climate change. In tropical regions, climate change causes increasing frequencies of extreme weather, like droughts or extreme rainfall. Natural selection is usually slow and adaptations through phenotypic plasticity are limited, thus species might need more mechanisms to cope with change, like cooperative breeding. Rainfall is an important cue for onset of breeding in many tropical bird species, so young are born when food abundance is highest. We explore the effect of rainfall on the social behaviour and life history of the insectivorous Seychelles warblers (*Acrocephalus sechellensis*), a facultative cooperative

breeder, using long-term data. We expect that with increasing amounts of rain food resources will increase, and thus reproductive output and survival will increase. If so, in dry periods, reproductive output of breeding pairs will be limited, but cooperative breeding may counteract this negative effect because helpers assist with feeding young. We expect that in dry periods breeding pairs produce more offspring of the helping sex, who stay in their natal territory and become helpers in the following year. Rainfall positively affected insect abundance. With increasing rainfall, survival of individuals during the breeding season and reproductive output, especially for cooperatively breeding groups, increased. With more rainfall, also more daughters (the helping sex) were produced, resulting in more group formation the year after. Thus, in contrast to our expectations, Seychelles warblers form social groups in favourable conditions, indicating that group living may be costly and thus not a solution to coping with changing environments. This study showed that the interaction between the environment and life histories, including social behaviour, is complex, and important to consider when studying the impact of changing environments on species survival.

**13 Julie Bosca** *Vocal performance in female songbirds can be as high as in males: a field study in European robin*

Julie Bosca\* (Laboratoire Ethologie Cognition Développement, Université Paris Nanterre, Nanterre, France) ; Guy Jacquin (Laboratoire Ethologie Cognition Développement, Université Paris Nanterre, France) ; Chloris Maury (Equipe Communications Acoustiques, Neuro-PSI, CNRS UMR9197, Université Paris-Saclay, Saclay, France) ; Antje Bakker (Department of Behavioural Neurobiology, Max Planck Institute for Ornithology, Seewiesen, Germany) ; Manfred Gahr (Department of Behavioural Neurobiology, Max Planck Institute for Ornithology, Seewiesen, Germany) ; Thierry Aubin (Equipe Communications Acoustiques, Neuro-PSI, CNRS UMR9197, Université Paris-Saclay, Saclay, France) ; Fanny Rybak (Equipe Communications Acoustiques, Neuro-PSI, CNRS UMR9197, Université Paris-Saclay, Saclay, France) ; Laurent Nagle (Laboratoire Ethologie Cognition Développement, Université Paris Nanterre, Nanterre, France) ; Nicole Geberzahn (Laboratoire Ethologie Cognition Développement, Université Paris Nanterre, Nanterre, France)

Vocal communication plays a key role for social interactions in many animal species. In songbirds vocal signals can serve to attract sexual partners and to defend a territory against rivals. Birdsong is subject to vocal production limits. Certain individuals sing closer to such limits and are said to reach high vocal performance. In some species, vocal performance is related to a singing bird's competitive abilities such as aggressive motivation. Thus, a listening rival can take into account the vocal performance of a singing individual when deciding how to respond. Female birdsong used to be considered as rare and there is a historical research bias towards investigating male song. However, it is widespread and studying female song in comparison with male song can help better understand functions of vocal signals. So far, we know very little about variation in vocal performance of females. In European robins (*Erithacus rubecula*) both sexes sing in autumn and winter to defend individual exclusive territories. This species thus represents a good model to compare the territorial function of male and female song. Here we will present the first results of an experimental study addressing the question whether vocal performance varies with aggressive motivation in female and male European robins. To this end we compare vocal performance in robins of both sexes singing in a context of high versus low aggressive motivation.

**14 Lindsey Broadus** *Investigating individual variation in acute stress response in captive Wood Ducks (*Aix sponsa*)*

Lindsey J. Broadus<sup>1,2\*</sup>, Mitchell G. Hinton<sup>1,3</sup>, Thomas P. Hahn<sup>1,4</sup>, John M. Eadie<sup>1,3</sup>, and Maja M. Makagon<sup>1,2</sup> <sup>1</sup>Animal Behavior Graduate Group, University of California, Davis, CA, USA; <sup>2</sup>Department of Animal Science, University of California, Davis, CA, USA; <sup>3</sup>Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, CA, USA; <sup>4</sup>Department of Neurobiology, Physiology, and Behavior, University of California, Davis, CA, USA

Assessing individual variation in acute stress response can help reveal information on an animal's ability to handle stressors throughout life. Acute stress response has often been linked to morphological phenotype and associated with the allocation of finite energy resources. Here, we evaluated how individual variation in condition, measured as body mass, influences adult acute stress response for 28 captive Wood Ducks (*Aix sponsa*) fed ad-libitum, in and out of the breeding season. Specifically, we predicted that a more attenuated stress response would be inversely correlated with mass as a measure of body condition, and early measurements of body condition would relate to current mass. We collected blood within 3 min of capture, and at 10, 30, and 60 min to analyze for plasma corticosterone and recorded body morphometric data. Area under the curve (AUC) of plasma corticosterone over time was compared to body mass, age, and season using a Generalized Linear Mixed Model. There was a significant relationship between seasons and AUC ( $p < 0.001$ ), with a higher response during the breeding season. No relationships between body mass, age, and AUC were found. Baseline corticosterone levels were consistently low, with 53.3% and 78.5% below the detection limit during and outside of the breeding season, respectively. A regression on preliminary data revealed a correlation between adult body mass and early max growth rates ( $r^2 = 0.71$ ,  $p = 0.001$ ). No association between current body mass and early body mass was identified in this population. Our results highlight possible seasonal variation in captive Wood Duck acute stress response, though more research across multiple seasons is warranted. This study also reveals a relationship between early and adult morphological traits and suggests the need for further investigation of underlying factors affecting phenotypic traits that may be important for coping with changes across life stages.

### **15 Anna Broseghini** *Do dogs (Canis familiaris) recognize a familiar species in cross-modal presentation?*

Anna Broseghini\*, Miina Lööke, Cécile Guérineau, Lieta Marinelli, Paolo Mongillo; University of Padua, Padua, Italy

A recent study has shown that dogs can recognize conspecifics in cross-modal presentations. The aim of the present study was to assess if dogs are also able to recognize other species and if different levels of exposure to them can influence this capability. The designated species was the cat, as it is relatively easy to find dogs with specific degrees of exposure. To this aim, we enrolled 60 pet dogs, half of which had at least one cat in their household, while the other half had never been living with cats. Using a cross-modal audio-video violation of expectancy paradigm, dogs were presented with either a cat or a dog vocalization followed by a cat or a dog video, thus facing either a congruent or an incongruent pair of stimuli. As expected, dogs paid more attention, an indication of surprise, after being presented with the incongruent stimulus of dog vocalization followed by cat video (mean $\pm$ SE=10.91.0) compared to the coherent dog stimuli (10.40.9;  $p=0.015$  GLMM), supporting that they recognized the conspecific's stimuli. However, this was not the case for the cat-related stimuli: the congruent cat stimuli (13.80.9) attracted more attention than the incongruent pair (13.40.9;  $p=0.011$ ). This was likely due to the fact that the cat vocalization did not generate in dogs an expectation that could have been violated, and suggesting that dogs did not recognize the stimuli belonging to cats. In fact, the two cat stimuli might have elicited higher attention for being novel, again supporting the inability of dogs to recognize cats in this type of presentations. There

was no effect of cohabitation with cats on attention paid by dogs ( $p=0.556$ ). This indicates that living with another species in adult life does not seem sufficient to promote recognition with this methodology. This may be due to the exposure to a limited number/variety of cats or to the lack of exposure during the socialization phase.

**16 Lara S. Burchardt** *A novel parameter to analyzing time series: how well do behaviors match an expected time series?*

Lara S. Burchardt\*, Radboud University; Elodie F. Briefer, University of Copenhagen; Mirjam Knörnschild, Museum für Naturkunde - Leibniz Institute for Evolution and Biodiversity Science, Berlin

Many behaviors and physiological functions happen rhythmically, may it be something as essential as heartbeats and respiration or something as elaborate as complex courtship songs or dances. A lot of relevant questions can be asked concerning those temporal patterns stemming from various research fields such as behavioral ecology, animal welfare, biolinguistics, or biomusicology. An important question when analyzing rhythms or temporal patterns in general is, how well a given behavior matches the expected or calculated optimal time series, i.e., the beat or rhythm. Imagine a generally isochronous, that is metronome-like, beat of a communication signal, how well does the animal match the perfect isochronous beat? Or in a more complex time series such as a heartbeat, how well does the actual heartbeat match the expected temporal patterning? This is where the novel beat precision parameter  $ugof$  (universal goodness-of-fit value) comes into play, which will be introduced in this presentation. It is calculating the simple ratio between the absolute deviation of an event to the maximally possible deviation from the expected time point of events. The value is calculated per element and can be summarized as needed per sequence, individual, group, context, or else to find differences and infer reasons for errors as well as possible drivers for beat precision. It could be used to find inaccuracies i.e., in heartbeats, or be used in the quantification of movement errors, possibly serving as a diagnostics tool. By and large, this approach allows a wide range of researchers to answer questions on rhythmic behaviors for example in sleep cycle analysis, finger tapping tasks, circadian rhythms, or various other research areas, possibly even in economics or engineering where temporal structures of processes are of utmost importance as well.

**17 Alvaro L Caicoya** *Giraffes are great statisticians! Big brains are not necessary to make statistical inferences*

Alvaro L., Caicoya\*, 1 Department of Clinical Psychology and Psychobiology, Faculty of Psychology, University of Barcelona, Barcelona, Spain 2 Institute of Neurosciences, University of Barcelona, Barcelona, Spain; Montserrat, Colel, 1 Department of Clinical Psychology and Psychobiology, Faculty of Psychology, University of Barcelona, Barcelona, Spain 2 Institute of Neurosciences, University of Barcelona, Barcelona, Spain; Federica, Amici, 3 Leipzig University, Life Sciences, Institute of Biology, Leipzig, Germany 4 Department of Comparative Cultural Psychology, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Making inferences based on statistical information is an ability thought to require large brains, and thus limited to few species like great apes and keas. Here, we tested for the first-time non-primate mammals on this ability. Following similar studies on larger-brained species, in particular, we tested whether giraffes (*Giraffa camelopardalis*) rely on relative quantities to predict sampling outcomes and whether they also integrate physical information about the presence of a barrier to make their inferences. Giraffes could

make decisions based on statistical information and also integrate physical information to correctly predict sampling information. These results provide the first evidence of true statistical inference outside primates and parrot species, and suggest that the ability to use statistical information to make decisions might be evolutionarily more widespread than previously thought.

**18 Irene Camerlink** *Micro-expressions during social interactions in free-ranging pigs*

Irene Camerlink, Institute of Genetics and Animal Biotechnology, Polish Academy of Sciences, Jastrzebiec, Poland

Animals behaviour involves many micro-expressions, which are actions occurring in fractions of a second, typically up to 4 s. Currently, micro-expressions are hardly applied to the study of animal behaviour, with the exception of facial expressions. Inclusion of micro-expressions in ethograms can further our knowledge of animal communication and emotional state, but may be challenging to record. The aim of this study was to explore the feasibility of recording micro-expressions of social behaviour live in free moving animals. Free-ranging growing pigs (n=32) and sows (n=17) were observed using an ethogram with 25 micro-expressions related to non-agonistic social interactions (e.g., gaze, nose-head proximity, nose-snout contact) and 11 'macro' behaviours (e.g., locomotion, foraging). Continuous live observation for 30 minutes per animal were conducted during pigs' active time of the day. The response of the recipient was recorded as neutral (no response), positive (reciprocating non-agonistically), negative (reciprocating non-damaging agonistic behaviour) or strongly negative (aggressive behaviour). Micro-expressions occurred on average once a minute (1467 micro-expressions in 1470 minutes) and were feasible to record accurately. Most observed were nose-head proximity (24% of observations), nose-snout proximity (16%), sniffing (13%), avoidance (12%) and approach (12%). The response of the recipient was mostly negative (81%) or strongly negative (13%), while less often positive (5%) or neutral (1%). Close proximity towards the head occurred more than touching the head, while touching the body occurred more than just proximity. Hence, pigs were 3 times more likely [OR 3.272; CI 1.808 – 5.919] to touch the body than to touch the head, as compared to remaining with close proximity (p<0.001). This suggests that pigs adjust their behaviour depending on whether they approach the head or body of a social partner. In conclusion, observation of micro-expressions enabled distinction of subtle differences in social interactions, which might be of importance to their communication.

**19 Helen Chambers** *Paws for thought: Problem-solving and spontaneous tool-using ability in socially-housed European brown bears (Ursus arctos arctos)*

Helen, Chambers\*, University of Salford. Dr Sean, O'Hara, University of Salford

Some traditional explanations for the evolution of large brains (e.g., the social brain hypothesis) fail to account for the presence of encephalisation in bears. Ursids have unexpectedly large relative brain sizes, in fact showing similar brain increases to Canids, despite living minimally social lives. Why they have evolved large brains is therefore unclear and this group has been largely overlooked when it comes to testing their cognitive ability. To better understand the proposed benefits afforded by encephalisation, we tested the cognitive abilities of 17 captive European brown bears (*Ursus arctos arctos*). Our aim was to uncover whether bears possess problem-solving and object-manipulation abilities. Two experimental tests, a puzzle box and an object-manipulation set-up, were presented to bears at seven UK zoological collections. Generalised linear mixed models (GLMM) were used to determine which variables, specifically age, sex, motivational levels, behavioural diversity and persistence, influence cognitive

performance. We found evidence of trial-and-error learning; however, two juveniles appeared to acquire a latch association, suggesting some individuals have potential to draw perceptive associations. The bears failed to spontaneously use a tool but still managed to retrieve the food reward, instead using alternative techniques to solve the problem. We found both age and sex to be negatively associated with time-to-solve in our sample, indicating the younger male bears had improved time-to-solve. Brown bears are confirmed to be an excellent model species for testing the cognitive abilities of Ursids, as well as theories of cognitive evolution. Bears remain an outlier in prominent explanations for the evolution of large brains such as the social brain hypothesis, however; selection for enhanced cognitive abilities, specifically in terms of their behavioural flexibility and ability to problem-solve and innovate, offers one explanation for their presence in these taxa.

**20 Aleksandra Chomik** *Cue learning in leopard geckos (*Eublepharis macularius*)*

Aleksandra Chomik\*<sup>1</sup>, Eliška Pšeničková<sup>1</sup>, Eva Landová<sup>1</sup>, Petra Frýdlová<sup>1</sup>, Daniel Frynta<sup>1</sup>

<sup>1</sup> Charles University, Faculty of Science, Department of Zoology, Viničná 7, Prague, Czech Republic

Cue learning is one of the most used navigational strategies in reptiles. Animals use one characteristic landmark in the space to direct themselves. We employed ecologically relevant cognitive test with one available shelter to study learning in leopard geckos. Geckos were placed for 3 minutes into the arena with four shelters (3x white, 1x yellow), but only yellow one was open. We tested 39 same-aged sub-adult animals. They went under 24 sessions in 4 days of testing. Position of the yellow shelter was randomly changed (6 possible ways). We observed the ability of gecko to find a yellow shelter and we counted attempts to the white ones. We measured the latency to find the yellow shelter, the number of correct choices and the number of touches, which we used to encourage the geckos to move into the arena. We also counted how many trials animal need to reach cognitive criterion -three correct choices in a row. We obtained the high repeatability of individual as well, the fact that when only the right choices are made only the influence of the individual is significant. There were animals, which learned quickly the task. Nevertheless, there were also others, which did not: seven individuals didn't reach the cognitive criterion and two of them did not find even once the yellow shelter. The latency to find right shelter decreased with number of repetitions significantly. We did not find any effect of body size and condition, nevertheless the effect of sex and number of touches was highly significant. We conclude from our results that geckos are able to learn and solve this task. However, individuals show different cognitive strategies. Nevertheless, the motivation is crucial. In future we will search for the relationship between personality and cognitive abilities of those animals."

**21 Kareemah Chopra** *Proximity Interactions in a Permanently Housed Dairy Herd: Network Structure, Consistency, and Individual Differences*

Kareemah Chopra\* (University of Essex), Holly R. Hodges (Writtle University College), Zoe E. Barker (Writtle University College; currently University of Reading), Jorge A. Vazquez Diosdado (University of Essex; currently University of Nottingham), Jonathan R. Amory (Writtle University College), Thomas C. Cameron (University of Essex), Darren P. Croft (University of Exeter), Nick J. Bell (Royal Veterinary College; currently Bos International Ltd), Edward A. Codling (University of Essex).

Understanding the herd structure of housed dairy cows has the potential to reveal preferential interactions, detect changes in behavior indicative of illness, and optimize farm management regimes. This study investigated the structure and consistency of the proximity interaction network of a

permanently housed commercial dairy herd throughout October 2014, using data collected from a wireless local positioning system. Herd-level networks were determined from sustained proximity interactions (pairs of cows continuously within three meters for 60 s or longer), and assessed for social differentiation, temporal stability, and the influence of individual-level characteristics such as lameness, parity, and days in milk. We determined the level of inter-individual variation in proximity interactions across the full barn housing, and for specific functional zones within it (feeding, non-feeding). The observed networks were highly connected and temporally varied, with significant preferential assortment, and inter-individual variation in daily interactions in the non-feeding zone. We found no clear social assortment by lameness, parity, or days in milk. Our study demonstrates the potential benefits of automated tracking technology to monitor the proximity interactions of individual animals within large, commercially relevant groups of livestock.

**22 Ricardo Contreras Osorio** *When a forest becomes a city, are hummingbirds enjoying gardens good enough?*

Ricardo Contreras Osorio\*. Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands. Coro Arizmendi, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México. México. Jan Komdeur, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands

Presence data for some hummingbird species demonstrates that cities are good living spaces across the Americas. Monitoring hummingbird populations in big cities shows that some species could be very abundant in highly transformed environments. Individuals are managing to face interaction with human activities. On the other hand, forest specialists or species less tolerant to habitat disturbance have become rare or completely absent from cities or other environments modified by humans, such as peri urban suburbia or agricultural landscapes. Hummingbirds are particularly challenging animals to monitor with marking methods, their metabolic requirements and small bodies can not hold heavy targets or electronic devices for telemetry. Even ring marking could be considered not completely adequate. Xalapa is a medium size city located in central east Mexico where cloud montane forest used to extend. Two hummingbird species (*Pampa curvipennis* and *Saucerottia cyanocephala*) associated with cloud forest are becoming abundant city species and have been observed feeding from several exotic plants and nesting in highly perturbed environments such as human houses. The third aim of my PhD project is to gain a better understanding on how hummingbirds are coping with human environments when forests are highly transformed and cities become attractive providers of nectar. Some research questions to address are: How cloud forest hummingbirds respond to human presence: exotic plants and artificial feeders? Are cities becoming ecological traps? Can we identify if urban populations are behaving differently towards humans than forest ones? (Tolerant to noise, cars or people when feeding). At what point of environmental transformation will species disappear from their habitat forests? Are native individuals from cities also able to return to forest or an ecological segregation could be going on among our backyard gardens? I present preliminary ideas to discuss these topics in order to set a monitoring method to explain why forest hummingbirds are now living in cities.

**23 Tara Cox** *Absence of the pace-of-life syndrome in a territorial passerine, *Acrocephalus sechellensis**  
Tara Cox\* University of Leeds, Alex Sparks University of Sheffield, Terry Burke University of Sheffield,

David Richardson University of East Anglia, Jan Komdeur University of Groningen, Hannah Dugdale University of Groningen

The pace-of-life syndrome (POLS) hypothesis posits that consistent between-individual variation in behavioural traits ('animal personalities') facilitate trade-offs in life history. Individuals who display risk averse behaviours are expected to follow a 'slow' pace-of-life, including short lifespan and delayed reproduction, compared to their risk-taking, 'fast', counterparts. Despite a breadth of empirical research testing the POLS hypothesis, findings are equivocal. This is likely due to core assumptions of the POLS hypothesis not being met, including clear trade-offs in life history, resource limited conditions, and evidence for a functional role of the behavioural trait being investigated. Here, we use long-term data from a closed island population of individually-marked Seychelles warblers to determine the relationship between repeatable exploration–avoidance personalities and an individual's age at first breeding, lifespan and lifetime reproductive success, separately in males and females. In this population, there is a clear trade-off in reproduction and survival: individuals with a higher age at first breeding display delayed survival senescence. Further, high intraspecific competition for breeding vacancies, as well as a functional role of exploratory traits in accessing these vacancies, also exist. Using multivariate models, we found no evidence for covariation between exploratory and life history traits in either sex. We thus found no support for the POLS hypothesis, despite accounting for core components that may have masked the prevalence of POLS. Our results demonstrate that whilst particular behavioural traits may play functional roles in certain aspects of life history, they may not necessarily be influential enough to have overarching effects on an individual's pace-of-life.

**24 Camille-Sophie Cozzarolo** *Don't worry be wormy: no anxiety-like behaviour in amphipods infected by a manipulative parasite*

Camille-Sophie Cozzarolo\*, Marie-Jeanne Perrot-Minnot (Biogéosciences, UMR 6282 CNRS, université Bourgogne Franche-Comté, 6 boulevard Gabriel, 21000 Dijon, France)

Parasites of diverse clades alter their host behaviour in ways that seemingly benefit their own life cycle. However, the cognitive processing and proximate mechanisms underlying parasitic manipulation are mostly unknown. One of the most striking alterations is the reversal of antipredator behaviour induced by some trophically-transmitted heteroxenous parasites in their intermediate host, thereby increasing their chances of reaching their final host. One hypothesis is that parasites alter their host cognitive ability, impairing fear- or more generally stress-related emotions. We tested this hypothesis in a key model system in the study of parasitic manipulation, the fish acanthocephalan parasite *Pomphorhynchus tereticollis* and its intermediate crustacean host *Gammarus fossarum*, using the threat of electric shock paradigm. We exposed uninfected and *P. tereticollis*-infected *G. fossarum* to chronic and/or acute stress and quantified their sheltering behaviour as a proxy for anxiety-like emotional state. The chronic treatment consisted of daily ten-minute sessions of (mild or strong) electric shocks during the six days preceding a refuge use test and the acute treatment was a last session imposed ten minutes before the refuge use test. Uninfected gammarids that received the acute or both the acute and chronic treatments of both voltages, as well as those that received the strong chronic treatment, hid more than their unshocked counterparts. On the other hand, treatments did not influence parasitized gammarids' refuge use. Our results support the hypothesis that acanthocephalan parasites hijack general anxiety-like circuitry of their intermediate host. Further studies are needed to investigate whether it involves inappropriate processing of information, impaired integration, or altered activation of downstream pathways initiating behavioural action.



**25 Danielle Crowley** *Disruption of daily and seasonal rhythms in migrating fish*

Danielle Crowley, Joke Meijer, Hans Slabbekoorn, Christian Tudorache

Virtually all organisms have adapted to day-night cycles by the evolution of endogenous rhythms that regulate most biological processes. The duration and intensity of light during daily and seasonal rhythms is crucial for maintaining the biological clock's "connection" to the external environment, on which fish rely for the functioning of an array of behavioural and physiological patterns, such as orientation, foraging, breeding and migration.

**26 Silvia Damini** *How to cope with others? Inter- and Intra-specific interactions in wild ravens (Corvus corax)*

Silvia Damini<sup>1,2\*</sup>, Petra Sumasgutner<sup>1,2</sup>, Thomas Bugnyar<sup>1,2</sup>; <sup>1</sup>University of Vienna, Department of Behavioral & Cognitive Biology, <sup>2</sup>Konrad Lorenz Research Center

Group foraging can be advantageous, because it allows the application of different levels of producing and scrounging and offers opportunities for social learning. Ravens, typical social scavengers in the Northern Hemisphere, have a high likelihood of encountering heterospecifics when accessing food resources from predators or other scavengers. Heterospecifics can be carnivores, that make food available to the ravens by providing carcasses and opening them up to make meat accessible, or omnivores, that spread the food in the environment, potentially diminishing competition between ravens. These heterospecifics likely defend their food and can impose different levels of risk and gain for ravens. When groups of wild ravens interact with other animals, different scrounging tactics (such as stealing, pilfering and sharing) along the producer-scrounger dynamics can be observed. The tactics used might depend on an individual's abilities and on the level of risk imposed by the foraging environment. Ravens can also manipulate heterospecifics and associate more or less with them during foraging, displaying different antipredator tactics. Heterospecifics can also be used to demonstrate dominance to conspecifics and increase a raven's social status. Thus, for ravens, heterospecifics can be food producers, predators, and occasions to show off to conspecifics. During my PhD, I plan to explore how ravens interact with heterospecifics, both as competitors for resources and threatening predators. Specifically, I will address the following questions: What scrounging tactics ravens use when foraging with conspecifics and heterospecifics? What correlation exists between a raven's personality traits and the foraging tactics it uses? What are the effects of the presence of heterospecifics on ravens' behaviour in different developmental stages? In my presentation, I will describe the methods I will use, and specify hypotheses and predictions for each of these questions.

**27 Hossein Daryabari** *Dose-dependent effects of dexamethasone on hatching sex ratio in Chukar partridge (Alectoris Chukar)*

Hossein Daryabari<sup>1,3\*</sup>, Amir Akhlaghi<sup>1</sup>, Mohammad Javad Zamiri<sup>1</sup>, Zorbakht Ansari Pirsaraei<sup>2</sup>, Mohsen Taghipour<sup>1</sup>, Ton G.G. Groothuis<sup>3</sup> <sup>1</sup>. Department of Animal Science, School of Agriculture, Shiraz University, Shiraz, Iran <sup>2</sup>.Department of Animal Science, Sari Agricultural Sciences and Natural Resources University, Sari, Mazandaran, Iran <sup>3</sup>.Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, The Netherlands

It is well documented that birds are able to manipulate offspring sex ratio in response to different environmental, social, and hormonal factors. However, the literature on the effects of environmental stress and corticosterone (the main stress related glucocorticoid in birds) on offspring sex ratio is inconsistent. These discrepancies may occur because of differences in hormone dosage and application. For example, in contrast to oral administration, implants and injections of corticosterone may result in supra-physiological circulating concentrations followed by strong negative feedback on these concentrations. In the current study, dexamethasone, a high potent synthetic glucocorticoid, was twice daily orally administered for 10 days in different dosages to Chukar partridges (*Alectoris Chukar*), to study its effect on sex ratio of the eggs, as well as on circulating levels of glucose, cholesterol calcium and aminotransferase, which have been directly or indirectly linked to sex ratio. Ninety-six female partridges were randomly assigned to four treatment groups: Intact, Vehicle, DEX-low (1.15 µg/mL), and DEX-high (20 µg/mL). DEX-low females produced more male hatchlings (72.1%) compared to vehicle (40.5%), and intact (50.0%) females ( $P < 0.05$ ), but the percentage of sons in DEX-high birds (52.9%) was not significantly different from the other three groups ( $P > 0.05$ ). No significant differences were found in egg production and hatchability suggesting that sex-specific mortality of embryos does not explain the effect on hatchling sex ratio. Group differences in glucose concentrations showed a similar patterns of statistical significance as that of sex ratio that in turn correlated with glucose and cholesterol. The results show that the glucocorticoid can increase the sex ratio in birds, indicate that such effects can be dose dependent, and suggest that glucose may be part of the underlying mechanism.

Keywords: Sex ratio, Corticosterone, Dexamethasone, Glucose, Partridge

**28 Gabrielle Davidson** *Inhibitory control performance is repeatable across time and across contexts in a wild bird population*

Gabrielle L. Davidson\*, University of Cambridge, UK, University College Cork, Ireland; Michael S. Reichert, Oklahoma State University, USA, University College Cork, Ireland; Jennifer R. Coomes, University College Cork, Ireland, Ipek G. Kulahci, University of Notre Dame, USA, University College Cork, Ireland; Iván de la Hera, University College Cork, Ireland; John L. Quinn, University College Cork, Ireland

Inhibitory control is one of several cognitive mechanisms required for self-regulation, decision making and attention towards tasks. Inhibitory control is expected to influence behavioural plasticity in animals in the context of foraging, social interaction or responses to sudden changes in the environment. One widely used inhibitory control assay is the 'detour task' where subjects must avoid impulsively touching transparent barriers positioned in front of food, and instead access the food by an alternative but known route. However, because the detour task has been reported to measure factors unrelated to inhibitory control, including motivation, previous experience and persistence, the task may be unreliable for making cross-species comparisons, estimating individual differences and linking performance with socioecological traits. To address these concerns, we designed a variant of the detour task for wild great tits (*Parus major*) and deployed it at the nesting site across two spring seasons. We compared task performance of the same individuals in the wild across 2 years, and with their performance in captivity when tested using the classical cylinder detour task during the nonbreeding season. Potential confounds of motivation, previous experience, body size, sex, age and personality did not significantly predict performance, and temporal and contextual repeatability were low but significant. These results support the hypothesis that our assays captured intrinsic differences in inhibitory control. Instead of dismissing detour tasks and 'throwing the baby out with the bathwater', we suggest confounds are likely system and experimental-design specific, and that assays for this potentially fundamental but largely overlooked

source of behavioural plasticity in animal populations, should be validated and refined for each study system.

**28.1 Eva Millesi** *Dietary fatty acids modulate hormone concentrations, social behavior and dominance hierarchies in male guinea pigs*

Eva Millesi\*, Department of Behavioral and Cognitive Biology, University of Vienna, Matthias Nemeth, Department of Behavioral and Cognitive Biology, University of Vienna

In a long-term study we investigated effects of polyunsaturated (PUFAs) and saturated fatty acids (SFAs) on testosterone and cortisol secretion patterns, social behavior and dominance hierarchies in male guinea pigs. Effects of these nutrients were studied in juvenile, adolescent and adult individuals under different social conditions such as group housing in established single-sexed groups or challenging social confrontations with unfamiliar individuals of other diet groups. Social interactions were recorded and individual dominance ranks were calculated based on initiated versus received dominant behaviors. Our results revealed elevated saliva cortisol and plasma testosterone concentrations as well as increased escalated conflicts like fights in SFA-supplemented males during group housing. Dietary SFAs provided in an early developmental state led to aggressive adult phenotypes with limited body mass gain and first-year survival. In social confrontations, however, SFA males lacked acute glucocorticoid responses and became subdominant. In contrast to SFAs, PUFA males established stable dominance relationships in the single sex groups associated with basal cortisol secretion rates. During social confrontations, PUFA males showed increased cortisol concentrations, higher levels of agonistic and sociopositive behaviors and gained higher dominance ranks than SFA males. Positive effects of PUFAs were also reflected in higher body mass, despite isocaloric diets and a longer life span. Our results demonstrate obviously different effects of PUFAs and SFAs on behavior, hypothalamic-pituitary-adrenal-axis functions and energy balance in male guinea pigs. Dietary SFAs increased cortisol concentrations even under non-stressful conditions, while PUFAs counteracted stress-related impairments of social behavior in males.

**29 Corné de Groot** *Ecology and evolution of social impact and responsiveness in a wild sparrow population*

Corné de Groot\*, Rori Wijnhorst, Niels Dingemans

The study of social evolution aims to explain why and how animals behave socially and how variation in social behaviour is maintained. Indirect genetic effects occur when heritable traits respond plastically to heritable traits of conspecifics, which provides an appealing explanation for slower or more rapid evolution than predicted by classic theory. In social behaviour, this form of plasticity is termed social plasticity, and implies that the social environment to which individuals respond is heritable and evolvable. The ecological processes that favour social plasticity remain largely unknown. Therefore a field study focusing on individuality in social responsiveness and social impact in the wild is much needed. The key unstudied questions are: what are the eco-evolutionary consequences of social plasticity and why do individuals differ in their social responsiveness. We use automated high-throughput behavioural screening by conducting producer-scrounger experiments in wild Norwegian house sparrow populations that are loosely affiliated with dairy farms. These populations of sparrows are pedigreed and monitored throughout the year. Our study design integrates quantitative genetics and behavioural ecology theory approaches, in which individual behaviour is assayed under variable social environments. This study system allows us to answer whether individuals differ in average level of producing and scrounging behaviour, social responsiveness and social impact and how selection acts upon these components.

**30 Hannah De Waele** *Artificial selection for predation survival shapes collective motion in guppies (*Poecilia reticulata*)*

Hannah De Waele\*, Wageningen University and Research; Kevin Chou, Wageningen University and Research

Predation pressure exerts a strong selection on the evolution of several traits. For instance, it is assumed to be a major driver of the evolution of collective behavior and a wealth of empirical evidence corroborates this idea. However, such data is often derived by comparing natural populations with associated confounding factors inherent to ecological comparisons. Experimental evidence on how predation impacts collective motion evolution is surprisingly scarce. Here, we experimentally tested how predation impacts the evolution of collective motion in juveniles and adults. We used three replicate lines of guppies (*Poecilia reticulata*) artificially selected for adult predation survival for three generations. We found that the offspring of survivors, both as juveniles and adults, showed an increase in polarization, coupled with increased cohesiveness, compared to fish from control lines. The predation survival fish also adopted faster speeds and formed denser shoals. Our results demonstrate that collective motion can rapidly evolve under strong selection and reveal which social interaction rules are targeted by predation selection.

**31 Ségolène Delaitre** *The impact of mate preference on reproduction: Female Great tits (*Parus major*) select more exploratory males and reproduce earlier with their preferred male*

Ségolène Delaitre\* CEFE CNRS, Montpellier France, Kees van Oers, NIOO-KNAW, Wageningen, The Netherlands, Marcel E. Visser, NIOO-KNAW, Wageningen, The Netherlands, Samuel Caro, CEFE CNRS, Montpellier, France

Mate choice is widespread in the animal kingdom but how it affects reproductive timing, investment and physiology remains poorly understood. Animals evaluate potential mates based on their phenotypic traits, and they may subsequently adjust their level of reproductive investment according to the level of preference for the mate they acquire. We investigated how the degree of preference of 36 captive female great tits (*Parus major*) for their future breeding partner influenced their subsequent reproductive decisions and physiology. Female preference was determined using a carousel-shaped six-choice chamber in which they could assess six males simultaneously. Male breast colour, tail sizes, beak and body sizes did not influence female's preference but females did spend significantly more time close to more exploratory males. Following the mate-preference test, we paired females to one of the six males and allowed them to breed in aviaries. We monitored female reproductive investment (through measurement of plasma 17 $\beta$ -oestradiol levels, first egg date, clutch size, and egg size) and correlated these measures with the degree of female's preference for the male she was paired with. Oestradiol levels were not related to female's preference, but we found that females who showed a stronger preference for the male with which they were paired laid their first clutch earlier, and tended to lay larger eggs. Our results show that mate preference influences reproductive investment in great tits, thereby linking partner choice to bird reproductive success.

**32 Ednei dos Santos** *Song and syllable diversity are thought to be reliable signals of male quality in songbirds*

Ednei\*, dos Santos, Laboratory of Behavioral Neuroendocrinology, GIGA Neurosciences, University of Liege, Belgium; Gregory, Ball, Department of Psychology, University of Maryland, College Park MD, USA; Charlotte, Cornil, Laboratory of Behavioral Neuroendocrinology, GIGA Neurosciences, University of

Liege, Belgium; Jacques, Balthazart, Laboratory of Behavioral Neuroendocrinology, GIGA Neurosciences, University of Liege, Belgium.

Song and syllable diversity are thought to be reliable signals of male quality in songbirds. Females that choose males singing more diverse songs are potentially mating with higher quality males and might obtain greater direct benefits (e.g., better parental care or territories with more resources) from them and/or more indirect benefits in the form of superior genes that improve offspring viability. In turn, males that produce songs with higher diversity might acquire multiple female mates or females of superior quality and have increased reproductive success. We investigated activational effects of sex steroid hormones on song and syllable diversity in male and female Fife fancy canaries. Three groups of castrated males and 3 groups of photoregressed females received Silastic<sup>TM</sup> implants filled with testosterone, testosterone plus estradiol or left empty as control. Songs recorded from 47 individuals (30 songs per individual) after they had been treated with steroids for 6 weeks were segmented and their syllable content was manually annotated. Syllable types were defined as grouped combinations of sounds consistently produced together as a common unit. Annotation of 57,872 syllables allowed us to calculate individual song and syllable type repertoires, quantify syllable and syllable type production rates, and measure diversity in syllable type transitions using the Levenshtein distance. Significant sex differences were identified: males have larger song and syllable type repertoires, produce songs containing a higher proportion of syllable types, produce syllables at a faster rate, and exhibit higher diversity in song type transitions. In contrast, female songs are often highly stereotyped with many repeats of the same syllable types. Surprisingly, females did not differ from males on metrics quantifying syllable production, such as number of syllables per song, which suggest that the sex differences reported here are mainly related to the song syntax and potentially limited by developmental learning processes.

**33 Edneidos Santos** *Can sex differences in syrinx mass limit the effects of testosterone on behavioral sex reversal in canaries?*

Ednei\*, dos Santos, Laboratory of Behavioral Neuroendocrinology, GIGA Neurosciences, University of Liege, Belgium; David, Logue, Department of Psychology, University of Lethbridge, Lethbridge AB, Canada; Gregory, Ball, Department of Psychology, University of Maryland, College Park MD, USA; Charlotte, Cornil, Laboratory of Behavioral Neuroendocrinology, GIGA Neurosciences, University of Liege, Belgium; Jacques, Balthazart, Laboratory of Behavioral Neuroendocrinology, GIGA Neurosciences, University of Liege, Belgium.

Canaries are frequently used to study effects of sex steroids on singing behavior. In a previous study we compared the effects of testosterone (T) on singing activity and on the volume of brain song control nuclei in canaries. We confirmed that these responses to T are sexually differentiated, in that females appear limited in their ability to respond to T in a similar manner as males. Here we expand on these results by focusing on sex differences in the production and performance of trills. Trills, rapid repetitions of song elements, are an important feature of songs in canaries. Females solicit more copulations when exposed to song playbacks including 'special or sexy' syllables (trills composed of two-note syllables with broad frequency bandwidth and repeated at a fast rate). We analyzed more than 42,000 trills recorded over a period of 6 weeks from 3 groups of castrated males and 3 groups of photoregressed females that received Silastic<sup>TM</sup> implants filled with T, T plus estradiol or left empty as control. The number of trills, trill duration and percentage of time spent trilling within a song were all increased by T but remained higher in males than in females. There was also a sex difference in trill performance as assessed by vocal deviations from the trill rate versus trill bandwidth trade-off. Irrespective of the endocrine condition, the orthogonal distance from the performance limit reflected by the trade-off was larger for trills produced by

females than by males. Finally, inter-individual differences in syrinx mass were positively correlated with trill production in males but not in females. Given that T increases syrinx mass in males but not in females, these data suggest that sex differences in trilling behavior are related to sex differences in syrinx mass that cannot be reversed by sex steroids in adulthood.

### **34 Diandra Duengen** *Social learning in a solitary pinniped: the harbor seal*

Diandra Duengen\*, Max Planck Institute for Psycholinguistics, Andrea Ravignani, Max Planck Institute for Psycholinguistics

Social learning is the capacity to learn from others, through observation or interaction with other individuals. This includes vocal usage learning, where an animal learns to produce an existing vocalization in a novel context through experience with other individuals. Social learning has long been considered uniquely human, and common mainly among social animals. However, recent research has identified a few non-social species to show social learning. Within a current study on pinniped vocal learning capacities, a captive female harbor seal was trained to emit previously randomly occurring vocalizations on cue. In the course of this study, three non-focal harbor seals showed surprising behavior: having observed their conspecific receiving a food reward for vocalizing, the seals initiated vocalizations themselves. This suggests a solitary marine mammal to engage in social learning, which has not been reported before. Following these observations, vocal usage learning is tested under controlled conditions in a currently ongoing experiment. Two seals were successfully trained to i) emit two distinct call types on cue, or to refrain from calling. In a subsequent task, varying sets of these calls will be played back to the seals, after which they will be asked to ii) match respective calls accordingly, i.e., produce call A when hearing call A, and B when hearing B. Preliminary results indicate vocal usage learning, as the seals began vocalizing after having observed their conspecific doing so, learned to respond to distinct visual cues with respective calls, and refrained from vocalizing when asked to remain silent (i). The subsequent experiment will verify if vocal usage learning had occurred, and further switching from visual to auditory cues will show if the animals can transfer the concept of vocalizing on cue and distinguish between call types (ii).

### **35 Anna Luise Fabbri** *Ontogeny of individual variation in food calling in the common raven*

Anna Luise Fabbri\*, Department of Behavioural and Cognitive Biology, University of Vienna; Mauricio Nicola Andreani, Department of Behavioural and Cognitive Biology, and Konrad Lorenz Forschungsstelle, Core Facility for Behaviour and Cognition, University of Vienna; Palmyre H. Boucherie, Department of Behavioural and Cognitive Biology, University of Vienna; Mario Gallego-Abenza, Department of Behavioural and Cognitive Biology, and Konrad Lorenz Forschungsstelle, Core Facility for Behaviour and Cognition, University of Vienna; Thomas Bugnyar, Department of Behavioural and Cognitive Biology, and Konrad Lorenz Forschungsstelle, Core Facility for Behaviour and Cognition, University of Vienna; Sonia Kleindorfer, Department of Behavioural and Cognitive Biology, and Konrad Lorenz Forschungsstelle, Core Facility for Behaviour and Cognition, University of Vienna

Non-breeding ravens (*Corvus corax*) use food-associated calls (termed 'haa' calls) when a food source is difficult to access, attracting nearby conspecifics. These 'haa' calls are thought to develop within the first year of life from begging calls, as they are given during early life stages and initially directed at the parents. Previous research found substantial inter-individual variation in both food calling rates and vocal characteristics of food calls. However, it is still unclear whether the individual variation in young ravens'

begging translates into the variation observed in food calls during later life stages. In our study, we investigate whether individual variation in calling rates and vocal characteristics is consistent across life stages. Through focal protocols and audio recordings, we observed the calling behavior and extracted vocal characteristics of 53 ravens during four life stages, from growing up in families to the formation of early peer groups and the integration into non-breeder groups. Observations were conducted first in captivity and later in free flight, as the young birds became part of a group of individually marked free-ranging ravens. Preliminary analysis seems to support our prediction that individual-specific differences in calling rates and vocal characteristics are present and constant over life stages. We further expect that within life stages, calling rates and vocal characteristics of food calls are not affected by context and that throughout development the overall calling rate decreases, and vocal characteristics do not remain consistent due to morphological changes. Our findings shall inform us whether the variation in ravens' food calling qualifies as a consistent personality trait or reflects adaptive behavioral plasticity.

### **36 Tamás Faragó** *Factors influencing longitudinal changes in dogs-owner communication*

Tamás, Faragó, Department of Ethology, ELTE; Zsófia, Bognár, MTA-ELTE Lendület "Momentum" Companion Animal Research Group, Department of Ethology, ELTE; Borbála, Turcsán, MTA-ELTE Lendület "Momentum" Companion Animal Research Group; Dóra, Szabó, Department of Ethology, ELTE; Enikő, Kubinyi, MTA-ELTE Lendület "Momentum" Companion Animal Research Group, Department of Ethology, ELTE

As dogs achieve higher age in modern societies thanks to veterinary care and owners' awareness, accumulating knowledge about the effects of ageing on dogs has significant importance. Communication between owner and dog is a key element of a successful relationship, thus understanding how communicative abilities change through the development and ageing of dogs and what factors might affect the course of these changes have high significance. Recent cross-sectional questionnaire studies identified traits that change over the lifetime of dogs, but longitudinal studies are still rare. Here we report results from a large-scale, long-term data collection covering four years with up to nine responses from the same owner about the same dog (N=1545). Using GLMM, we aimed to identify which demographic (e.g., sex, reproductive status, breed) and individual (e.g., size, body condition, health status, trauma, keeping conditions, training level) factors affect the dogs' owner-reported communicative ability score, and how these factors modify the effect of ageing. Additionally, based on these factors, we explored the predictability of longitudinal changes in communication. Among several demographic and individual effects, we found a quadratic relationship between age and communication score, with a peak at seven years of age. In female and healthier dogs, communicative ability peaked higher and dropped less in older age. Also, in dogs with more opportunities to spend time off-leash, the negative drop after seven years was attenuated. We then built a model based on the first four owners' responses and tested its predictive performance based on the data of 259 dogs having further data from later time points. We found a strong correlation ( $r_W[95\%CI]=0.76[0.72-0.79]$ ) between the model prediction and the actual communicative ability scores suggesting that the involved factors indeed affect the age-related changes in communicative abilities of dogs.

### **37 Tamás Faragó** *Unravelling the interplay of the acoustic codes for emotional and social valence in vocalisations*

Tamás, Faragó\*, Department of Ethology, ELTE; Bence, Ferdinandy, Department of Ethology, ELTE; Enikő, Kubinyi, MTA-ELTE Lendület "Momentum" Companion Animal Research Group, Department of

During social interactions, vocalisations can carry information about the caller's emotional state. These emotional states are commonly described by two dimensions (emotional valence and arousal) encoded in the acoustic parameters of these vocalisations. Although one might expect that the emotional states (positive or negative, aroused or calm) mainly affect the interaction partner's response behaviours, in some cases, they are not sufficient to explain the receiver's behaviour. For example, aggressive and distressed inner states both have high arousal and negative emotional valence, but their vocal expressions are expected to evoke opposite reactions, withdrawal, or approach, respectively. To disentangle how this social valence is acoustically encoded in vocalisations of different species compared to emotional valence and arousal, we created an online questionnaire where human participants had to report their willingness to approach or withdraw from unknown dog and human vocalisers. Using Structural Equation Modelling, we tested how Harmonic-to-Noise ratio (HNR), call length, and fundamental frequency affect social valence and explored its relationship with emotional valence and arousal. We found that HNR only affected social valence: among both dog and human sounds, noisier calls evoked higher withdrawal, while more tonal calls had higher approach ratings. Longer calls were rated as more negative, while higher-pitched calls were rated to be more aroused independently from the caller species. Finally, even though social and emotional valence correlated positively, there were two outlier call types: distress calls evoked approach reactions despite having negative emotional valence, and in the case of human vocalisations, sexual pleasure calls evoked withdrawal contrary to their positive emotional valence. In summary, while the interplay of call length and pitch encodes emotional valence and arousal, HNR has a distinct effect on social valence, clearly differentiating agonistic and distress calls, suggesting that acoustic encoding of social valence might follow the same rules across species.

### **38 Ondřej Fišer** *Too big or too small? The importance of size in predator recognition by untrained birds*

Ondřej Fišer\*, Petr Veselý, Michaela Syrová, Michal Němec, Kateřina Kopecká, Eliška Perlová, Roman Fuchs; Department of Zoology, Faculty of Science, University of South Bohemia in České Budějovice, Czech Republic (all authors)

An integral characteristic of all predators is their size, which affects, among other things, their food preferences, and the ability of their prey to defend themselves. Several studies have already found, unsurprisingly, that birds discriminate between predators of different sizes and respond to them. In our experiments, we exposed red-backed shrikes to size-modified dummies of the same predator species (shrunken carrion crows and enlarged Eurasian jays). The red-backed shrike usually aggressively attacks the unmodified jay, whereas it remains passive towards the unmodified crow. In our experiments, the shrike responded to the enlarged jay with less aggression, indicating that it assessed aggression towards the jay as ineffective. Aggression increased only slightly to the shrunken crow. Thus, the reason why the shrike does not attack the unmodified crow is probably not its size, but it is an alternative antipredation strategy, the analogy of which has already been demonstrated in relation to the Eurasian magpie. However, experiments with jays demonstrate for the first time that the shrike perceives predator size as a separate parameter and responds exclusively to it by changing its behaviour.



**39 Petra Frýdlová** *Snakes as mediaeval knights in ring armour: Antipredatory strategy in sand boas (Erycidae)*

Petra, Frýdlová\*<sup>1,2</sup>, Veronika Janovská<sup>1</sup>, Jana Mrzilková<sup>2</sup>, Jan Dudák<sup>3</sup>, Jan Žemlička<sup>3</sup>, Veronika Tymlová<sup>3</sup>, Petr Zach<sup>2</sup>, Daniel Frynta<sup>1</sup>, <sup>1</sup> Charles University, Faculty of Science, Viničná 7, Prague, Czech Republic; <sup>2</sup> Charles University, Third Faculty of Medicine, Ruská 87, Prague, Czech Republic, <sup>3</sup> Czech Technical University in Prague, Institute of Experimental and Applied Physics, Prague, 110 00 Czech Republic

Sand boas (Erycidae), belonging to the superfamily Booidea, are fossorial snakes native to North Africa and Asia. They have a cylindrical body, a short tail, a blunt head and small eyes. The tail is usually indistinguishable from the head because it has the same shape. Therefore, they are sometimes called two-headed snakes. Caudal vertebrae are enlarged and highly modified. Sand boas are known for their tail displays (i.e., the tail becomes unusually conspicuous in dangerous situations), which are probably an antipredator strategy. The altered shape of the tail, the unique caudal vertebrae and the tail displays suggest that the tail plays an important role in the antipredator repertoire of sand boas. In our study, we examined the tail morphology of 7 sand boa species and 20 other snake species from different families using microcomputed tomography ( $\mu$ CT). We detected the presence of dermal armour (osteoderms) in three sand boa species. This is the first description of dermal armour in snakes. The distribution of osteoderms follows the pattern of the scales. The ancestral state reconstruction revealed one origin of caudal vertebrae modification and up to three independent origins of osteoderms within a single fossorial family of Erycidae. We did not find a similar pattern in any other examined snake species. Nevertheless, similar structures are known from unrelated clades of squamates like gerrhosaurids and geckos. This supports the view of underlying deep developmental homology. Osteoderms support the defence of the sand boas as ring shirt of the mediaeval knights. We interpret it as another component of the rich antipredatory strategy of sand boas. This project was supported by the European Regional Development Fund Project 'Engineering applications of microworld physics' (no. CZ.02.1.01/0.0/0.0/16\_019/0000766)

**40 Manuel Fuertes Recuero** *Do barn swallow nestlings incur an oxidative cost of begging?*

Manuel Fuertes-Recuero<sup>1,\*</sup>, Alberto J. Redondo<sup>2</sup>, Nuria Sánchez-Sánchez<sup>2</sup>, Tomás Redondo<sup>3</sup> and Alejandro Cantarero<sup>1</sup>, <sup>1</sup> Department of Physiology, Veterinary School, Complutense University of Madrid, Avenida Puerta de Hierro s/n, 28040 Madrid, Spain <sup>2</sup> Department of Zoology, University of Córdoba, Córdoba, Spain <sup>3</sup> Department of Evolutionary Ecology, Estación Biológica de Doñana (CSIC), Seville, Spain.

Offspring use begging displays to signal their need for resources to their parents, and such behaviour has been described as an honest system of communication. Given that begging behaviour is a costly activity, the energy used in such displays cannot be allocated to other essential functions. Here we aimed to demonstrate experimentally whether barn swallow (*Hirundo rustica*) nestlings incur an oxidative cost of begging. To that end, we manipulated the antioxidants levels of nestling by increasing them via vitamin E supplementation and decreased them by BSO injection and compared the nestlings' begging displays to parents through video films. Chicks treated vitamin E increased the number of begging bouts whereas BSO did not decreased them, which suggests an absence of oxidative costs of begging displays. Moreover, we found a strong association between the number of begging bouts emitted by a nestling and the number of feedings received. Our study suggests that barn swallow nestlings do not incur an oxidative cost of begging. Studies addressing alternative action pathways of honest signalling of nestlings' oxidative status would provide important insights on the proximate factors affecting offspring behaviour during this critical phase of life.

Keywords: begging; honest signalling; oxidative stress; *Hirundo rustica*; vitamin E; BSO

#### **41 Henrique Galante** *Artificial intelligence unlocks accurate consumption rates of small invertebrates*

Henrique Galante - University of Regensburg\*, Massimo De Agrò - University of Regensburg, Tomer J. Czaczkes - University of Regensburg

Over the past decade the use of advanced computational methods in behavioural ecology has become increasingly predominant. Such processes have allowed for a better understanding of many complex biological systems by adapting to their unique nature. For instance, due to their small size, Argentine ants (*Linepithema humile*) consume incredibly small volumes of food at the individual level. This renders traditional methods, such as weighing individuals before and after food acquisition, prohibitively expensive. Luckily, as these ants ingest food their gaster visibly expands. Previous work has used this feature to indirectly estimate consumption rate by using a 2D projection of the gaster as an approximation of volume. Instead, in the current experiment, we used a 3D reconstruction of the gaster to directly measure volumetric change using the markerless pose estimation software DeepLabCut. This enabled us to uniquely identify 15 gaster points across videos of two differently oriented cameras. By reconstructing the 3D location of these points, we were able to calculate gaster volume during the whole foraging period therefore obtaining a direct continuous measure of consumption rate. Using this newly developed procedure, we presented the ants with a range of sucrose concentrations, as well as a gradient of caffeine-laced sucrose solutions, since we expected different chemicals to impact the total amount of food ingested and its associated consumption rate. Argentine ants, being highly invasive, cause significant ecological and economical damage. Understanding how they react to different food sources could be an important step towards effective control strategies.

#### **42 Jakob Gismann** *Personality-dependent dispersal and breeding success in three-spined sticklebacks*

Jakob, Gismann\*, University of Groningen; Franjo, Weissing, University of Groningen; Ton, Groothuis, University of Groningen; Marion, Nicolaus, University of Groningen

Behavioural ecologists are well aware of the fact that individuals within populations consistently differ in behavioural expression over time and across context (i.e. animal personality). While many studies focused on the proximate mechanisms responsible for such consistent differences in behaviour, empirical investigations of fitness consequences, especially in the animal's natural environment, remain challenging. By investigating how activity and aggression of three-spined sticklebacks (*Gasterosteus aculeatus*), as measured in the lab, correlate with movement behaviour, territory acquisition and male mating success in a semi-natural mesocosm, we aimed to address two typical shortcomings of animal personality studies: 1) we explored the relationship between personality differences and male success in establishing a territory as well egg acquisition, two important proxies of fitness and 2) we investigated whether, and if so how behaviour measured in classical laboratory setups translates to behavioural expression in an ecologically relevant environment.

We found that male phenotype (behavioural and morphological) partially predicted territory acquisition and mating success in the mesocosm and that behaviour measured in the lab correlated with movement behaviour in the mesocosm, but less than expected.

We here shine light on the often unclear relationship between personality differences and fitness and exemplify how the use of mesocosms can be a valuable tool to bridge the gap between behavioural studies in the laboratory and the wild.

**43 Irene Godoy** *Disentangling genetic and non-genetic influences on sociality: results and challenges from a longitudinal study on wild capuchins*

Irene, Godoy\*, Universität Bielefeld; Peter, Korsten, Universität Bielefeld; Susan, Perry, UCLA

In the last two decades various studies have demonstrated links between sociality (e.g., connectedness) and survival/reproduction in mammals. How within- and between-individual variation in social behaviour arise in uncontrolled populations can be challenging to determine but is important for understanding constraints on the evolution of sociality. Using a statistical method known as an 'animal model', we use spatial association data from a wild population of capuchin monkeys (*Cebus capucinus imitator*) to estimate the relative contributions of genetic and non-genetic sources of variation on sociality. Using 20 year of observational data on 376 individuals (range: 6-185 months of data per subject), we find that individuals show moderate long-term (across years) repeatability in the proportion of time spent social (posterior mode: 0.238, 95HPDI: 0.184, 0.284). Conditioned on the effects of age, sex, group size, seasonality, and El Niño-Southern Oscillation phases, we find that repeatability is largely explained by additive genetic variance ( $h^2$ : 0.166, 95HPDI: 0.106, 0.223) and to a minimal extent by maternal effects ( $m^2$ : 0.000, 95HPDI: 0.000, 0.045). Our model captures the majority of variance (latent scale) in our behavioral trait, with most variance explained by temporally changing factors, which may indicate environmental constraints on the evolvability of the trait.

**44 Ana Cristina Gomes** *Long-term associations shape and maintain common waxbill social networks*

Ana Cristina R. Gomes, BIOPOLIS, CIBIO/InBIO, University of Porto \* ; Patrícia Beltrão, BIOPOLIS, CIBIO/InBIO, University of Porto; Neeltje J. Boogert, Centre for Ecology and Conservation, University of Exeter, Penryn, Cornwall, UK; Gonçalo C. Cardoso, BIOPOLIS, CIBIO/InBIO, University of Porto

In gregarious animals, phenotypic differences and past interactions may determine social network position. To evaluate how phenotypic differences and familiarity influence individuals' social network positions, we monitored wild-caught common waxbills (*Estrilda astrild*) with radio-frequency identifiers in a large outdoor mesocosm during the non-breeding and breeding seasons of two consecutive years. We found that the positions of individuals in the social network were repeatable across seasons and years, indicating a stable social phenotype. Nonetheless, there were seasonal changes in social structure: in breeding seasons waxbills associated more strongly with opposite-sex individuals, while in non-breeding seasons they assorted according to dominance rank. We observed stronger assortment between birds that were introduced to the mesocosm at the same time, as opposed to being introduced in different years, indicating long-lasting social bonds among familiar individuals. These results suggest that social networks in common waxbills are shaped especially by long-lasting associations with familiar individuals and, thus, that maintaining long-term associations is important. To further test this, we then conducted an experiment removing a subset of waxbills from the mesocosm temporarily, for three months, and evaluating whether their social connections would be weakened upon returning to the flock. The strength of associations between birds that had been separated remained as stable as those of control birds that stayed together in the mesocosm during the entire experiment. This resilience of long-term associations among familiar birds, despite a prolonged separation, may be important in highly gregarious species like

the common waxbill, whom in nature have fission-fusion group dynamics and vagrant movements. Resuming long-term associations with previously familiar individuals might stabilize social structure in species with fission-fusion dynamics, and increase the benefits of social living.

**45 Julia Victoria Grabner** *Discrimination of familiar and unfamiliar human voices in common marmosets (Callithrix jacchus)*

Julia Victoria, Grabner\*, Department of Behavioural and Cognitive Biology, University of Vienna; Ruth, Sonnweber, Department of Behavioural and Cognitive Biology, University of Vienna; Thomas, Bugnyar, Department of Behavioural and Cognitive Biology, University of Vienna; Michelle, Spierings, Department of Behavioural and Cognitive Biology, University of Vienna/Department of Behavioural Biology, Leiden University

Being able to recognise individuals by their look, smell, and sound, as well as knowing how they behave is crucial for everyday life, especially in group-living animals. Furthermore, when living and interacting closely with another species, it is also useful to be able to differentiate between heterospecific individuals. For animals under human care, differentiating between familiar and unfamiliar humans may have advantages, such as knowing which individuals can pose a certain risk and which may provide care and food. Studies show that common marmosets recognise conspecific individuals by their vocalisations. Whether they are also able to differentiate between familiar and unfamiliar human voices has not been investigated yet.

In this study we tested the behavioural and physiological response of 8 captive common marmosets to standardized recordings of familiar – positively associated – and unfamiliar human voices. We ran the study shortly after the colony was moved to a new building when individuals likely were in a highly aroused and alert state. We predicted that individuals would show shorter periods of freezing before resuming their activities during the playback of the familiar compared to the unfamiliar human voice. Furthermore, we expected less anxiety- and stress-related behaviours during and after the familiar voices condition.

Preliminary analyses indicate that marmosets differ in their attention, vigilance, and activity behaviour during familiar and unfamiliar playbacks. I will discuss how well those patterns fit our predictions and give an outlook to a second part of the study, that will be conducted this fall, one year after the move.

**46 Cécile Guérineau** *Evaluation of classical music as an enrichment in bottlenose dolphin*

Cécile Guérineau\*, Miina Lõoke, Giuseppe Ganassin, Daniela Bertotto, Laura Cavicchioli, Paolo Mongillo, Lieta Marinelli; All from "Dipartimento di Biomedicina Comparata e Alimentazione, University of Padova, Viale dell'Università 16, 35020, Legnaro (PD), Italy"

The purpose of the study was to evaluate if classical music may act as an enrichment for captive bottlenose dolphins (*Tursiops truncatus*). To this aim classical music provision was compared with that of a less complex auditory stimulus (rain-sound) and a visual enrichment (slideshow of photographs). The effect of the enrichments was evaluated by comparing the behaviour expressed by dolphins before the provision of the enrichment (pre-enrichment phase) with that expressed during its provision (enrichment phase). The subjects were five females and one male dolphin housed together in a dolphinarium in Riccione, Italy. All enrichments were novel to these subjects and each enrichment was provided for 20

minutes a day, on 7 days with a randomized schedule. Non-specific effect regarding all type of enrichment was observed on breathing behavior, which increased from  $94.1 \pm 3.6$  events/hr (estimated marginal mean  $\pm$  se) in the pre-enrichment phase to  $98.7 \pm 4.5$  events/hr in the enrichment phase ( $p = 0.022$ , Generalized Estimating Equations model, (GEE)). Specific effects were only found for classical music, which resulted in an increase of two social affiliative behaviours from the pre-enrichment to the enrichment phase, namely synchronous swimming ( $8.9 \pm 1.5\%$  VS  $16.4 \pm 1.7\%$  of observation time,  $p < 0.001$ , sequential Bonferroni-corrected comparisons after GEE) and gentle touches ( $19.5 \pm 3.3$  VS  $47.8 \pm 9.2$  events/hr,  $p < 0.001$ ). The results indicate that presentation of classical music had a positive effect on dolphins' social behavior, with promising capability to act as an effective environmental enrichment in this context. Even if the mechanism by which classical music exerts its effects and which specific acoustical properties are responsible for it are still unknown, the specificity of effects on social behavior suggest that classical music could be particularly useful when an enhancement in social behaviours is needed.

**47 Clinton Haarlem** *Investigating the possible interplay between perception speed, alertness and ecological setting*

Clinton Haarlem, Trinity College Dublin\*

Temporal resolution, the rate at which the visual system can detect changes in luminance, is often quantified by measuring an individual's critical flicker fusion threshold (cff). This threshold can differ significantly between individuals and is known to be affected by factors such as disease, ageing and the use of chemicals. It is however unclear what the basis is for differences in critical flicker fusion thresholds in healthy humans. It is also unknown how an individual's ecological setting and behaviour may influence the trait, and vice versa. Some recent studies have indicated that cff may be related to alertness and may be predicted by an individual's alpha band oscillations in the brain. With an upcoming experiment, I aim to learn more about the interplay between perception speed and environmental interactions by conducting a twofold study. First, I will replicate an experiment that investigated the relationship between alpha-band oscillations and critical flicker fusion thresholds. Second, I will compare cff measurements between individuals who may use their visual perception in different ecological settings, such as athletes versus non-athletes and computer users versus non-computer users. The results of this study may provide more insight into perception speed differences and the behavioural consequences of them.

**48 Luca G. Hahn** *Cooperative nest building in wild jackdaw pairs*

Luca G. Hahn\*, University of Exeter; Rebecca Hooper, University of Exeter; Guillam E. McIvor, University of Exeter; Alex Thornton, University of Exeter

Animals create diverse structures, both individually and cooperatively, using materials from their environment. One striking example is the nests birds build for reproduction, which protect offspring from stressors such as temperature, promoting reproductive success. To construct a nest, birds need to make various decisions, e.g. regarding their time budgets. Research has focused on species where one sex is primarily responsible for building the nest. In contrast, the cooperative strategies of species in which both sexes contribute to nest building are poorly understood. We investigated the role of both sexes in nest building and fitness correlates of behaviour in wild, monogamous jackdaw pairs, *Corvus monedula*.

Both partners contributed to nest building, with females and males present in the nestbox for a comparable duration and transporting material to the nest equally often. However, while females spent

more time constructing the nest, males tended to invest more time in vigilance, potentially to cope with competition for nest cavities. This suggests a moderate degree of division of labour, which may facilitate cooperation. Moreover, some aspects of behaviour were related to proxies of reproductive success. Females that contributed relatively more to bringing material laid earlier clutches and pairs that spent less time together in the nestbox had larger eggs. Thus, selection pressures may act on how nest-building pairs spend their time and divide the labour. Cooperative nest building in birds could be associated with monogamy and obligate biparental care and provides a vital but relatively untapped context through which to study the evolution of cooperation.

**49 Hebesberger Denise Viktoria** *Social Housing Conditions, Social and Repetitive Behaviour in Pet-Chinchillas (*Chinchilla lanigera*) – a Questionnaire Based Pilot Study*

Denise V. Hebesberger\*<sup>1</sup>, Elisabeth M. Gilhofer<sup>1</sup>, Susanne Waiblinger<sup>1</sup>, Cornelia Rouha-Mülleder<sup>2</sup>, Chiara Mariti<sup>3</sup>, Frank Künzel<sup>4</sup>, Ines Windschnurer<sup>1</sup> <sup>1</sup> Institute of Animal Welfare Science, University of Veterinary Medicine, Vienna, Austria <sup>2</sup> Animal Welfare Ombuds Office, State Government of Upper Austria, Linz, Austria <sup>3</sup> Department of Veterinary Sciences, University of Pisa, Italy <sup>4</sup> Clinical Department for Small Animals and Horses, Small Animal Clinic, Internal Medicine, University of Veterinary Medicine, Vienna, Austria

Chinchillas originate from South America, where they live in family groups that can fuse to large colonies. In captivity, individual housing and social stress due to incompatibilities or group-instability can impair their welfare and affect their behaviour. However, systematic knowledge regarding pet-chinchilla's keeping conditions is rare. This study investigated whether social housing conditions and group instability affects pet-chinchillas social behaviour and the occurrence of repetitive behaviours. We distributed an online questionnaire among German-speaking chinchilla owners (Austrian, German, and Swiss). Of 312 respondents 90.7% indicated that they kept their chinchillas together with conspecifics, mostly in pairs (61.2%) or triplets (22.8%). Most animals were intact (97.9% females; 68.0% males). The group composition was predominantly stable (86.2%) over a two-month period prior to data collection. Most owners reported to have never observed agonistic interactions (Median ( $\bar{x}$ ) =1.0, IQR=1.5, 7-point scale from never to several times/day). Affiliative interactions were observed daily ( $\bar{x}$ =6.0, IQR: 0.75). Changes in group composition did not affect the occurrence of observed social interactions. The rate of observed repetitive behaviours was low ('fur biting':  $\bar{x}$ =1.0, IQR: IQR=1.0; 'other repetitive behaviour'  $\bar{x}$ =1.0, IQR: 1.5). A general linear model revealed a small effect that the occurrence of 'other repetitive behaviour', including bar biting, was higher when animals were housed alone, and the younger the animal were. Sex had no effect. These findings suggest that in the German-speaking region, pet-chinchillas are mostly kept with conspecifics, in accordance with their need to engage in social relationships. The importance of social companionship was underlined by the higher frequency of repetitive behaviours in individual housing. The low occurrence of observed agonistic interactions goes in line with anecdotal reports of infrequent aggressive behaviours in chinchillas. In the future, observation of pet-chinchilla behaviour would be desirable to confirm these findings and to determine potential welfare risk for pet-chinchillas.

**50 Youngwook Jung** *Rubbing activity have positive effects both horse and human*

Youngwook Jung\*(Department of Animal Science and Biotechnology, Kyungpook National University, Sangju, Korea), Minjung Yoon(Department of Animal Science and Biotechnology, Kyungpook National University, Sangju, Korea; Department of Horse, Companion and Wild Animal Science, Kyungpook

National University; Research Center for Horse Industry, Kyungpook National University, Sangju, Korea)

Healing programs using interspecific emotional transfer is an emerging field during the COVID-19 pandemic. People felt emotional stability by cuddling or rubbing animals. Knowing the physiological responses with a specific interaction of humans with animals should be defined to provide more effective programs. Rubbing the horses is one of the common ways of human-horse interactions. Thus, the purposes of this study were 1) to evaluate the emotional transfer between humans and horses during rubbing activity by monitoring the hormonal changes; 2) to compare the effectiveness of rubbing activity between males and females. In this study, five mares (mean age  $10.2 \pm 3.77$  years) were used, and three females and three males (mean age  $22.83 \pm 1.72$  years) who had minimal horse experience participated. During three days of the experiment, participants conducted three different activities with horses for 15 min. The three activities include 1) the participant and horse took a rest in separated places (resting); 2) the participant stood beside the horse without touching (standing); 3) the participant gently rubbed the neck and withers of horse (rubbing). Humans' saliva and horses' blood were collected 3 times (0, 15, and 30 min) during the activity. The concentrations of cortisol and oxytocin were measured using ELISA kits. During rubbing activity, the concentration of salivary cortisol in the female group appears to decrease at 15 and 30 min, whereas no change occurred in the male group. In mares, the plasma concentration of oxytocin increased at 30 min in both standing and rubbing activities. In conclusion, rubbing activity diminishes the stress level in females. Also, in horses, rubbing activity by humans increases the level of oxytocin known as influencing prosocial behavior.

#### **51 Sunil Khatiwada** *The interplay between personality and social dynamics*

\*Sunil khatiwada, The interplay between personality and social dynamics, \*Simon Turner, Scotland's Rural College (SRUC), Edinburgh, UK, \*Irene Camerlink, Institute of Genetics and Animal Biotechnology of the Polish Academy of Science, Jastrzebiec, Poland

Animal personality is recorded on the individual level whereas in group living animals social effects may influence behavioural responses. The aim of the study was to test whether a commonly used measure of individual personality (the back test) predicts whether pigs are willing to approach a human alone or only as a cluster of peers. It was hypothesized that pigs in the extreme tails of the BT distribution would show difference in approach pattern. Male and female pigs ( $n=366$ ) of 2 weeks of age were assessed for their coping response in the 'backtest' (BT). At 6 weeks, pigs were in their littermate groups exposed 3 times to a Human Approach Test (HAT). Social effects in the HAT were assessed through the order in which pigs approached (and touched) a novel human, and whether they approached alone or in a social cluster. Data were analysed using mixed models with repeated measurements, taking into account BT response, sex, and birth weight, with individual and group random effect. Pigs showed a greater likelihood to touch the human alone rather than in a cluster on test day 2 [OR= 2.1, CI 1.34-3.34] and day 3 [OR 3.1, CI 1.96–5.04] as compared to day 1 ( $p < 0.001$ ). BT response did not relate to the order of touching the human or whether pigs approached alone or together, but pigs that vocalized strongly during the BT touched the human sooner on HAT day 3 ( $p=0.011$ ). In conclusion, while no effect of coping style was found, social effects are important to consider when recording personality in the presence of peers.

#### **52 Junyoung Kim** *Dogs with low plasma concentrations of serotonin may bite you*

Junyoung Kim<sup>1\*</sup>, Yeonju Choi<sup>1</sup>, Jaemin Kim<sup>2</sup>, Hye-Won Lee<sup>3</sup>, and Minjung Yoon<sup>1,4,5</sup>; <sup>1</sup> Department of

Animal Science and Biotechnology, Kyungpook National University, Sangju, Republic of Korea; 2 Division of Applied Life Science, Gyeongsang National University, Jinju, Republic of Korea; 3 Korean Animal Welfare Research Institut, Namyangju, Republic of Korea; 4 Department of Horse, Companion, and Wild Animal Science, Kyungpook National University, Sangju, Republic of Korea; 5 Research Center for Horse Industry, Kyungpook National University, Sangju, Republic of Korea

Dog bite accident is a serious social problem. Recently, we found that the plasma concentration of serotonin (5-HT) is negatively correlated with the dominance of horses. This fact led us to hypothesize that 5-HT might be an important factor causing dog bit accidents. Thus, this study aimed to identify if the plasma concentration of 5-HT is correlated with the degree of aggression in dogs. Blood samples of 15 dogs were collected at a commercial animal hospital in the Republic of Korea. The concentration of 5-HT was measured in the plasma samples using enzyme-linked immunosorbent assays. The degree of aggression of dogs was scored by the canine bite levels (control and 1 to 4). One-way analysis of variance with the least significant difference post-hoc analysis was used to compare the concentration of 5-HT among control and 4 levels of aggressive groups. The plasma concentration of 5-HT in every aggressive group was significantly lower than that in the control group. However, there was no significant difference in the plasma concentration of 5-HT among the aggressive groups (levels 1 to 4). In conclusion, the 5-HT is a key factor affecting the aggression of dogs, but the canine bite levels are not affected by this factor.

### **53 Magdalena Kozielska** *Modelling the evolution of learning*

Magdalena Kozielska\* & Franz J. Weissing, University of Groningen

The ability to learn from past experience is an important adaptation, but how natural selection shapes learning is not well understood. Here, we present a novel way of modeling learning using small neural networks and a simple, biology-inspired learning algorithm. We used this model to study the evolution of learning under various environmental conditions and different scenarios for the trade-off between exploration (learning) and exploitation (foraging). Efficient learning regularly evolved in our individual-based simulations. However, the evolution of learning was less likely in relatively constant environments (where learning is less important) or in case of short-lived agents (that cannot afford to spend much of their lifetime on exploration). Once learning did evolve, the characteristics of the learning strategy and the average performance after learning were surprisingly little affected by the frequency and/or magnitude of environmental change. In contrast, agent lifespan had a strong effect on the evolved learning strategy. Interestingly, a longer learning period did not always lead to a better performance, indicating that the evolved neural networks differ in the effectiveness of learning. Overall, however, our study shows that even a relatively simple learning mechanism can lead to efficient adaptation.

### **54 Ladislava Krausová** *Red-backed shrike (Lanius collurio) vs. common cuckoo (Cuculus canorus): an example of ineffective cuckoo-hawk mimicry*

Ladislava Krausová 1\*, Petr Veselý 1, Michaela Syrová 1, Kateřina Antonová 2, Ondřej Fišer 1, Vanda Chlumská 1, Markéta Pátková 1, Štěpán Pužej 1, Roman Fuchs 1,2

The red-backed shrike (*Lanius collurio*) used to be one of the most common hosts of the common cuckoo (*Cuculus canorus*). Nevertheless, during the last 30 years, rising evidence from central Europe exists that cuckoo chick in shrike nests are scarcer and, on some locations, they disappeared completely. There are



multiple hypotheses suggested explaining this abandonment. Here, we test the hypothesis that shrikes vigorously attack adult cuckoos, potentially resulting in ineffective parasitism. Adult common cuckoos resemble in appearance Eurasian sparrowhawk (*Accipiter nisus*), a common predator of small passerines. One hypothesis presumes that this mimicry aims to avoid being attacked by small passerines when searching for their nests. Our results show that shrikes defending their nests attacked cuckoos very vigorously, more often and more intensively than sparrowhawk. In the presence of sparrowhawk dummy, parent shrikes only produced alarm calls and flew over the dummy. This suggests that cuckoo-hawk mimicry is ineffective in the case of shrikes and that they attack them much often than any other presented intruder. Therefore, this activity could possibly result in the abandonment of shrike as a potential host for cuckoos.

**55 Miriam Kuspel** *Alarm calls in Eurasian magpies: variability, context specificity and function*

Miriam Kuspel\*, Behavioural Ecology Group, Wageningen University & Research; Marc Naguib, Behavioural Ecology Group, Wageningen University and Research; Kat Bebbington, Groningen Institute for Evolutionary Life Sciences, University of Groningen; Sjouke A. Kingma, Behavioural Ecology Group, Wageningen University & Research

Animals in a multitude of species call to alert others of approaching danger, despite the potential risk to themselves. Such calling has been found to be very specific in a variety of species. Those exhibit functionally referential alarm calls that convey information about the type of predator so the receiver can accordingly freeze, fight or flight. Other species, however, use general alarm calls that are not used in only specific contexts and trigger a more general response. It thus remains to be further investigated which species have more general or specific alarm calls, and what exactly the function of general alarm calls is. To this end, we experimentally investigated a) the vocal and behavioural responses to different types of threat and b) the responses to playbacks of alarm calls in Eurasian magpies (*Pica pica*). Since breeding pairs are year-round territorial in a stable neighbourhood of varied density, juveniles usually aggregate in flocks for mutualistic benefits, and fledglings stay with their parents for a prolonged period, social benefits in magpies differ. We will present if the types of magpie calls or graded variation in a call type correspond to different types of threats: directly life-threatening (aerial) or less threatening (terrestrial predators), or threatening to their territory-ownership (conspecifics). We differentiate between different social contexts throughout (presence of offspring/ seasonality). We will further present how magpies respond to variation and overlap in a general alarm call. Together these experiments contribute to the understanding of what factors select for alarm calling and semantic communication.

**56 Océane La Loggia** *Early social complexity influences social behaviour but not social trajectories in a cooperatively-breeding cichlid fish*

Océane La Loggia\*, Institute for Ecology and Evolution, Behavioural Ecology division, University of Bern, Switzerland; Alastair J. Wilson, Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Penryn, UK; Barbara Taborsky, Institute for Ecology and Evolution, Behavioural Ecology division, University of Bern, Switzerland

Social competence, which is the ability of an individual to optimally adjust its social behaviour to the prevailing social information, is influenced by the early social environment in a wide range of vertebrates. Early life also influences other life-history traits like the propensities to provide alloparental care, to disperse or to reproduce. We investigated how rearing group size influences different components of

social behaviour and life-history strategies in the cooperatively-breeding cichlid *Neolamprologus pulcher*. We raised the fish in large social groups of ten individuals or in small groups of three individuals. After 60 days of social experience, fish were kept under identical conditions in sibling groups. At the age of 120 days, we tested two individuals per experimental brood for social competence; we recorded the social behaviours expressed by a focal fish in response to a gradient of conspecific aggression in two tests: (i) towards video recordings of conspecifics and (ii) towards a larger live conspecific intruder. At one year of age, we tested the explorative, helping and dispersal behaviour of the same fish. Fish raised in large groups showed more submission per received aggression from a larger conspecific, they showed submission earlier and exhibited more flexibility in the expression of submissive behaviour compared to fish raised in small groups. Rearing group size did not affect aggressive behaviour at four-month of age in the video test, or exploration, helping and dispersal behaviour later in life. Our results suggest that fish from large groups show higher social competence, which emphasizes the importance of early-life social complexity for the expression of social behaviour. In contrast, our results suggest further that early social complexity did not affect the decision to disperse or show helping behaviour.

**57 Beatrix Laczi** *Can dogs become jealous of robots?*

Beatrix Laczi\*, Judit Abdai, Fábio Faustino Agostinho, Ádám Miklósi

Dogs engage in various social interactions with artificial self-propelled agents (UMO) but based on previous results it is unclear whether dogs recognize the UMO as a 'true' social partner. Jealous behavior emerges when an important social relationship is endangered by a third-party individual. The behavior appears only when the potential rival is a social agent (e.g. dog) but it does not occur in case of non-social objects (e.g. magazine). Here we investigated whether a UMO can elicit jealous behavior in dogs and whether the behavior of the UMO influences the behavior. We hypothesized that dogs display jealous behavior when their owner attends to the UMO, but only if it displayed social or animate behavior before. First, dogs observed the behavior of the UMO which either displayed (a) inanimate motion, (b) animate and goal-directed motion or (c) engaged in an interaction with a human (between-subject design). Following this, dogs were tested in a jealousy-evoking test. Here, the owner engaged in an interaction with the other dog from the household, the UMO and read from a magazine, while ignoring the subject dog (all subjects encountered all potential rivals). We investigate how much dogs show owner-rival-interaction orientation e.g. by looking, orientation and touch, also we analysis the dogs activities by we make difference between moving and standing. The analyses of our data is currently in progress

**58 Sanne Lamers** *Natural variation in sociability among *Drosophila melanogaster**

\*Sanne J. C. Lamers, Gelifes, University of groningen; Tiphaine P. M. Bailly, Gelifes, University of groningen; Michael van Dijk, Gelifes, University of groningen; Jean-Christophe Billeter Gelifes, University of groningen.

Sociability – an individual's propensity to engage in group activities – is a conserved trait throughout most of life. Sociability can be considered as a personality type in humans when showing correlated sociability measures across different assays. Our knowledge of the mechanisms that drive sociability and explain its inter-individual variation is still limited. To enhance our mechanistic understanding, the genetically tractable *Drosophila melanogaster* is increasingly being used as a model for research on social behaviour. High and low sociability phenotypes, indicative of a variation of sociability levels among the population have been documented in this species. However, sociability traits have been measured

through unidimensional assays, which do not allow us to assess whether sociability is a personality type in fruit flies. Here, we present a multidimensional approach to assess sociability, using a combination of three behavioural assays that each captures a different functional feature of social interactions in *D. melanogaster*. We applied our approach to the *Drosophila melanogaster* Genetic Reference Panel (DGRP) lines and revealed continuous variation in the strength of response to others. We found that sociability levels varied between genetically distinct lines, indicative of a genetic component of sociability. The three sociability traits were, however, not correlated, making it questionable whether sociability can be considered a personality type in *D. melanogaster*.

**59 Eva Landova** *Specific antipredatory response of leopard geckos (*Eublepharis macularius*) to the smell of snake and lizard skin*

Eva Landová<sup>1\*</sup>, Petra Frýdlová<sup>1</sup>, Aleksandra Chomik<sup>1</sup>, Petra Hnidová<sup>1</sup>, Veronika Janovská, Daniel Frynta<sup>1</sup> <sup>1</sup> Charles University, Faculty of Science, Department of Zoology, Viničná 7, Praha 2, CZ12843, Czech Republic

Various snake species represent a significant source of predation for geckos. The danger of a snake is determined by several ecological factors, mainly its food specialization and foraging strategy, which are usually shared within monophyletic clades of snakes. Previous research revealed that the antipredatory reaction to the living snake is innate for leopard geckos and that there is no difference in the reaction to sympatric vs allopatric snake species.

In this study, we carried out a confrontational test quantifying the antipredatory response of leopard geckos *Eublepharis macularius* to snakeskin odour in several experiments: 1) we analysed antipredatory reactions to the piece of shedded snakeskin and compared it to the control stimulus (a piece of the plastic bag), 2) we compared reactions to the eight snake predators from the Boidae and Colubridae family to the control stimulus, and 3) we compared the reaction to the snakeskin with the reaction to the skin of non-snake European glass lizard *Pseudopus apodus*.

We found that geckos react by antipredatory response to the snakeskin and lizard skin in comparison to the plastic bag controls. The first reaction to the stimulus was tongue-flicking and its frequency positively correlated with the interest of the animal. Geckos exhibited reaction toward all snake and lizard stimuli but varied in the type and intensity of the reaction. Overall reaction to all snake species (except one, *Eryx colubrinus*) differed from the reaction to non-snake skin. Our study revealed proactive (high posture, attack) and reactive (avoidance, low posture) elements of defensive behaviour towards snake skins. Elevated avoidance reactions were observed towards Indian sand boa (*E. johnii*) species. We did not find any effect of sex of the tested snake on the antipredatory reaction. Geckos reacted to all snake skins, nevertheless they expressed different antipredatory responses to the smell of skin of fossorial snake species

**60 Alexandra Langehennig-Peristenidou** *Variable vocal streams during infancy: ontogeny of the trill call in grey mouse lemurs*

Alexandra Langehennig-Peristenidou\*, Institute of Zoology, University of Veterinary Medicine Hannover; Daniel Romero-Mujalli, Zoological Institute and Museum & Institute for Botany and Landscape Ecology, University of Greifswald; Tjard Bergmann, Institute of Zoology, University of Veterinary Medicine Hannover; Marina Scheumann, Institute of Zoology, University of Veterinary Medicine Hannover

Human infants acquire their language through a period of high auditory-feedback-dependent vocal plasticity, with similar phenomena also described for marmosets and gibbons. Variable vocal streams during infancy have also been reported in grey mouse lemurs. Therefore, this study aims to investigate how these variable infant calling bouts contribute to the development of the trill, a complex advertisement call not present at birth, in grey mouse lemurs.

240 infant calling bouts were utilised (N = 15 families), which were recorded during four age classes representing different infant developmental stages. Furthermore, 50 adult trill calls (N = 39 individuals) were used as reference. To characterise the acoustic structure of the syllables, temporal, tonality-related and spectral acoustic parameters were measured for each syllable of a bout. To define distinctive syllable types, unsupervised cluster analysis was performed, with the results illustrated with the help of dimensionality reduction techniques. Based on the obtained results, transition networks were established to visualise the sequential order of the syllable types for each age class.

Six syllable types were obtained, which differed in their occurrence across age classes. Syllables with almost no frequency modulation occurred mainly around birth, whereas frequency-modulated syllables predominated in the later age classes and in the adult trill calls. With increasing age, the sequential order of the syllable types became more complex, while bearing more resemblance to the adult trill call. Thereby, the first syllable of the calling sequences belonged to several clusters, whereas the middle and the last part belonged to a specific cluster.

Our results suggest that adult trill calls develop during infancy by increasing the frequency modulation of syllables and by combining specific syllable types into complex sequences. Nonetheless, further studies are necessary to investigate whether this is a result of maturation, or whether auditory templates of the parents are imitated

**61 Camille Le Gal** *Female courtship signals in a passerine bird: inter-individual consistencies and individual coding*

\*Camille Le Gal\*, Sébastien Derégnaucourt & Mathieu Amy. Laboratoire Ethologie Cognition Développement, Université Paris Nanterre, France.

Sexually selected signals are often used during courtships which are generally assumed to be mainly performed by males towards females. To date, most research focussed on male signals and on their variations but, in recent years, female signals have become of increasing interest and courtships are more and more acknowledged as reciprocal. For instance, in songbirds, males produce song and females often solicit copulation by combining a display and an acoustic signal. However, few studies have quantified the variability of female signals used during courtship. If individual variation in sexually selected traits is understood to reflect individual variation in quality or motivation, inter-individual variation in signals may also encode individual identity and consistent interindividual differences may also reflect a personality trait. Our study aims (1) to test the existence of stable interindividual differences in the use of female solicitation signals emitted by female domestic canaries (*Serinus canaria*) and (2) to evaluate the potential for individual coding of the FST that their utter during the courtship. To do so, sexually receptive female canaries were daily exposed to two types of male songs (differing in their attractiveness) during a reproductive cycle. Female signals (Female-Specific Trills; FST and Copulation Solicitation Displays; CSD) in response to male songs were recorded. We examined the stability of interindividual differences according to the type of song for several characteristics of the signals produced by females such as the intensity and duration of the CSDs, the average frequency, the rhythmicity (number of note/s) and the

latency of FSTs. Moreover, acoustic analyses were performed to assess which acoustic parameters of the FST are likely coding for individual identity. The results will be discussed with regard to the evolution of secondary sexual characteristics in females.

**62 Saein Lee** *Observational learning from mother in immature wild Javan gibbons (*Hylobates moloch*)*  
Saein Lee\*, Ewha Womans University, University of Lausanne; Rahayu Oktaviani, Yayasan Konservasi Ekosistem Alam Nusantara; Yoonjung Yi, Nanjing Forestry University; Ahyun Choi, Ewha Womans University; Jae Chun Choe, Ewha Womans University; Ani Mardiasuti, IPB University

Immature primates need to develop adult-level of foraging competency for survival during prolonged juvenile periods. Immatures may need to acquire social information from more experienced individuals, such as using observational learning while co-foraging to improve skills and information on food items. Although most studies focused on primate species with extractive foraging skills and large group size, gibbons are placed in an interesting position since they face foraging difficulty and live in a small family group but have prolonged juvenile periods. Therefore, we examined the mother-immature interactions in feeding and non-feeding contexts to investigate social learning in Javan gibbons (*Hylobates moloch*) in Gunung Halimun-Salak National Park, Indonesia (Dec 2019 to Jan 2022). We examined overlap in mother-immature diet composition and co-foraging time change as immatures aged. In general, immatures between 0.9 and 2 years of age spent 61% of their time co-foraging with their mothers. We found that the proportion of diet composition overlap and co-foraging time between mothers and immatures decreased as immature got independent. Then, we tested whether co-foraging time and the frequency of immatures approaching mothers in the feeding context increases with the foraging difficulty level, while one-quarter of food items were categorized as the highest foraging difficulty level. Immature spent more time with mothers and approached more in the feeding context than in the non-feeding context. Co-foraging time and the frequency of approaching mothers increased when immatures could not forage themselves because of the size or hardness of food items. Our results indicate that immature Javan gibbons can socially obtain information on foraging skills and food items by observing their mothers in close proximity during the dependency period.

**63 Lisanne Leenheer** *Social preferences of three-spined sticklebacks – a mesocosm experiment*  
Lisanne M. Leenheer\* (1), Jakob Gismann (1), Franjo J. Weissing (1), Marion Nicolaus (1). (1) Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, The Netherlands

Determining the social structures within populations and identifying the factors that influence them can be of great value for understanding many aspects of behavioural ecology and evolution. Animals often exhibit preferences for joining certain groups and preferentially associate with some individuals over others, resulting in non-random group compositions. Since group composition can affect fitness components such as predation risk and foraging success, it is important to understand how these social preferences arise. Here, we report on an experimental study that strives to identify the role and relative importance of factors that determine shoaling decisions in three-spined sticklebacks (*Gasterosteus aculeatus*). Shoaling behaviour in fish has received ample attention in literature, resulting in the identification of several important characteristics that shape social decisions in highly controlled laboratory settings. The purpose of this study is to investigate shoaling under more natural conditions, where fish are able to assort freely. To this end we raised a cohort of three-spined sticklebacks, for which we manipulated social group size and perceived predation risk following a two-factorial design. We then

introduced PIT (passive integrated transponder) tagged fish from different treatments into a mesocosm system consisting of several connected semi-natural ponds equipped with RFID (radio-frequency identification) antennas. This system allows for remote, continuous, and long-term tracking of the location and movement of each fish, and thus offers unique insights into their social decisions. In this way, we intend to investigate how social preferences and shoaling decisions of sticklebacks are influenced by factors such as body size, prior familiarity, early-life conditions, and personality. We will present the first results of this mesocosm experiment, which should provide better understanding of the organisation of social interactions and their underlying mechanisms.

**64 Silvia Leonetti** *Noise-dependent vocal plasticity in harbour seal and grey seal pups*

Silvia\*, Leonetti, Max Planck Institute for Psycholinguistics, Sealcentre Pieterburen, Hoofdstraat 94- A, 9968 AG Pieterburen, The Netherlands Yannick, Jadoul, Max Planck Institute for Psycholinguistics Wundtlaan 1, 6525 XD Nijmegen, The Netherlands & Artificial Intelligence Lab, Vrije Universiteit Brussel, 1050 Elsene/Ixelles, Belgium Laura, Torres Borda, Max Planck Institute for Psycholinguistics Wundtlaan 1, 6525 XD Nijmegen, The Netherlands & Research Department, Sealcentre Pieterburen, Hoofdstraat 94- A, 9968 AG Pieterburen, The Netherlands Koen, de Reus, Max Planck Institute for Psycholinguistics Wundtlaan 1, 6525 XD Nijmegen, The Netherlands & Artificial Intelligence Lab, Vrije Universiteit Brussel, 1050 Elsene/Ixelles, Belgium & Research Department, Sealcentre Pieterburen, Hoofdstraat 94- A, 9968 AG Pieterburen, The Netherlands Heikki, Rasilo, Artificial Intelligence Lab, Vrije Universiteit Brussel, 1050 Elsene/Ixelles, Belgium Anna, Salazar Casals, Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Wundtlaan 1, 6525 XD Nijmegen, The Netherlands & Research Department, Sealcentre Pieterburen, Hoofdstraat 94- A, 9968 AG Pieterburen, The Netherlands Andrea, Ravnigani, Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Wundtlaan 1, 6525 XD Nijmegen, The Netherlands & Research Department, Sealcentre Pieterburen, Hoofdstraat 94- A, 9968 AG Pieterburen, The Netherlands & Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, 8000 Aarhus C, Denmark

Most social interactions in mammals are mediated through vocal signalling. Mammals show different levels of vocal plasticity, i.e. the capacity to adjust vocalisations in response to environmental noise. However, complex forms of vocal plasticity, such as the modulation of the fundamental frequency ( $f_0$ ), are rare in mammals. Here, we present two studies that investigate noise-induced vocal modifications in two pinniped species: harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*). These phocids are excellent candidates to investigate vocal plasticity, as previous studies have shown that they can imitate human speech sounds.

Using a non-invasive methodology, we tested 1–3 weeks-old pups of both species in a controlled experimental setting. Seals were exposed to low or high-intensity playbacks of bandpass-filtered noise. The filtered noise was designed so as to overlap with the seal pups' typical  $f_0$  range (250-500 Hz). We recorded the pups' vocal responses using a unidirectional microphone and assigned each vocalisation to the correct individual based on video recordings. Our main aim was to induce a shift in the  $f_0$  of their calls.

In the first experiment, by fitting a linear mixed-effects model, we observed that harbour seal pups lowered the  $f_0$  of their calls in response to higher levels of environmental noise. Furthermore, one individual showed a significant increase in call amplitude and a flattening of the spectral tilt. In a second, ongoing experiment, we expect to find similar results after analysing the data collected from grey seal pups. Here, we present both experiments, hoping that this methodology can be applied to test vocal

plasticity in other mammals and to investigate the animal's motivation to avoid acoustic masking in order to achieve accurate communication. Finally, through a comparative approach, findings from our and other such experiments may shed light on the biological bases of this trait

**65 Raffaella Lesch** *Owner perception of companion cat welfare*

Katharina, Galunder, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Vienna, Austria; Raffaella, Lesch\*, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Vienna, Austria; Ines, Windschnurer, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Vienna, Austria; Akos, Pákozdy, Clinical Unit of Internal Medicine Small Animals, University of Veterinary Medicine, Vienna, Austria; Zsófia, Virányi, Comparative Cognition, Messerli Research Institute, University of Veterinary Medicine Vienna, Medical University of Vienna, University of Vienna; Takuya, Yanagida, Department for Psychology of Development and Education, Faculty of Psychology, University of Vienna, Vienna, Austria; Christine, Arhant, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Vienna, Austria

The assessment of pet welfare often hinges on owner reports. While information provided by owners provides unique opportunities, it also comes with the pitfall of not knowing which factors of the animal's life are viewed as especially relevant to welfare. We here provide a first overview of factors heavily influencing the perception of welfare in cat owners. We hypothesised that cat owners would rate pets with medical needs, no access to outdoors, and no opportunity to display hunting behaviour with a lower score in welfare. We also hypothesised that body condition (underweight or overweight) and age would not influence the owner's perception positively or negatively. To test these hypotheses we advertised a questionnaire that was answered by 460 participants. Through full/null model comparisons of linear models, we found that both old age and medical needs were associated with lower welfare scores. Also in line with our hypotheses, we found body condition to not affect the perception of welfare. The data did not support our hypothesis of access to outdoors and hunting behaviour positively impacting the owner's perception. In situations where we rely on owner reports to assess welfare, it is crucial to gather species-specific understanding of factors influencing owner perception of animal welfare.

**66 Kate Lewis** *Systematically documenting equine facial expressions using EquiFACS*

Kate, Lewis\*, Department of Psychology, University of Portsmouth; Matthew, Parker, School of Pharmacy and Biomedical Science, University of Portsmouth; Leanne, Proops, Department of Psychology, University of Portsmouth

In group-living species, the management of individual relationships and social networks is essential for group cohesion. For species such as horses, in which the visual modality plays a significant role in communication, accurate perception and interpretation of facial expressions may produce an evolutionary advantage by providing valuable information about the signaller and their internal state. Feral horse populations live in multi-level societies containing a number of small, relatively stable 'bands' that share space and resources. In order to maintain these complex networks of social relationships, effective communication is essential, and horses are able to recognise conspecifics and discriminate between their facial expressions. However, the full range of equine facial expressions has yet to be systematically documented.

To address this, we collected a bank of over 1200 facial expressions recorded during interactions between 36 domestic horses in two established social groups. These were categorised by the social behaviour of the focal animal during the facial expression (e.g. displace, kick threat) and by the post-interaction behaviour of the focal individual and the receiver. Facial expressions during the exchange were then coded using EquiFACS. Facial Analysis Coding Systems (FACS) provide a reliable, standardised, and systematic framework for recording facial actions, based on underlying facial musculature. The development of EquiFACS for horses revealed a wide range of equine facial movements, but how they may be grouped to form distinct and reliable facial displays, reflecting different social and emotional contexts, had yet to be established. Using Network analysis techniques designed for the analysis of FACS data (NetFACS), we identified clear and discrete combinations of facial movements that were used in different contexts. This systematic documentation of equine facial expressions provides an ideal, standardised framework for future equine behavioural research across a variety of fields such as communication, welfare, cognition, individual differences, and the horse-human relationship."

**67 Miina Lõoke** *Attractive serial dependence in numerosity perception in dogs (*Canis familiaris*)*  
Miina Lõoke\*, Lieta Marinelli, Anna Broseghini, Cécile Guérineau, Paolo Mongillo; University of Padua, Padua, Italy

Recent literature in humans has described a perceptual phenomenon called serial dependence, by which the current stimulus appears similar to the previous one. It has been interpreted as an active stabilization process, integrating stimulus features over time for a stable and seamless conscious experience. Despite the growing number of studies investigating serial dependence across several visual domains in humans, it is not known if the phenomenon extends also to other species.

In the current study we aim to fill this gap of knowledge by exploring the behavioral signature of serial dependence in numerosity perception in dogs. We enrolled 5 dogs, who were trained on quantity discrimination prior to being presented with a set of test trials. Simultaneously presented test stimuli included a variable probe (4-16 dots) and a reference (8 dots), which was preceded by a task-irrelevant inducer stimulus (4 or 16) in the identical location. We hypothesized that if dogs are susceptible to the serial dependence, the reference would be perceived either smaller or larger depending on the inducer numerosity.

For each dog we fitted a psychometric curve based on the probability of choosing the reference and defined the point of subjective equality (PSE) for the reference preceded by either of the inducer, (PSE(4)=7.10; PSE(16)=10.07). To compare the perceptual effect of the two inducers, we performed an ANOVA, which revealed a significant effect of the inducer ( $F(2)=23.87$ ;  $p<0.001$ ), with both of the conditions being significantly different from the control condition ( $p(4)=0.35$ ;  $p(16)=0.02$ , sequential Bonferroni corrections applied).

This result suggests an attractive bias in consecutively presented stimuli in dogs, providing the first evidence that the phenomenon of serial dependence extends also to non-human animals. Moreover, the finding expands the similarities between humans and dogs in processing visual stimuli

**68 Donghui Ma** *How to divide a cake: the impact of resource distribution on life history behaviour of the burying beetle *Nicrophorus vespilloides**



Donghui Ma\*, Long Ma, Jan Komdeur, Groningen Institute for Evolutionary Life Sciences, University of Groningen, The Netherlands

Variation in types and distribution of resources promotes the evolution of competition and cooperation in animals. Small vertebrate carcasses, which are bonanza and unpredictable available for carrion-use insects are essential resources for the survival and reproduction of burying beetles *N. vespilloides*, a facultative communal breeding insect with parental care. Burying beetles bury carcasses for breeding, lay their eggs in or around the buried carcass and hatched larvae are fed by their parents. Resource distribution is related to variation in amount and availability. The aim of the research is to investigate whether resource distribution influences the degree of communal breeding. We expect that centralized resource distribution (i.e. large but less carcasses) promotes communal breeding, while decentralize resource distribution (i.e. small but more carcasses) promotes pair breeding. We constructed four contrast experimental groups at a field site in De Vosbergen, The Netherlands. Each experimental group has access to the same total resource amount in a certain area, however the groups vary in the number and size of resource units (i.e. three 30g dead mice, vs six 15g dead mice, vs one 30g and four 15g dead mice, vs two 30g and two 15g dead mice). We predict that in the group that have access to large but less carcasses: (1) there are no differences in the interspecific competition (i.e. the number and species of competitors) between these four groups, (2) burying beetles will compete more for gaining access to carcasses; (3) communal breeding will be more likely to occur, and (4) the per-capita reproductive output (brood size and mass of the brood) will be lower as a consequence of a more pronounced trade-offs between investment for competition (fighting) and reproduction.

**69 Veronica Maglieri** *Two signals, two functions: Communication and play fighting in Czechoslovakian Wolfdogs*

Veronica Maglieri\*, Unit of Ethology, Department of Biology, University of Pisa; Anna Zanolì, Department of Life Sciences and Systems Biology, University of Turin; Fosca Mastrandrea, Unit of Ethology, Department of Biology, University of Pisa; Elisabetta PALagi, Unit of Ethology, Department of Biology, University of Pisa

Play fighting is the most common form of social play in dogs, and it is often punctuated by specific signals: Relaxed Open Mouth (ROM) and Play Bow (PBOW). Here, we selected as a model breed the Czechoslovakian Wolfdog (CWDs), a recent breed showing some wolf-like traits. We analysed 15 hours of videos frame-by-frame extracting 118 playful sessions from 24 subjects and collected 822 ROM and 76 PBOW events. By the DogFACS we demonstrated that the recruitment of the facial muscular action units was more numerous and stereotyped during ROM than during the preparation phase of the biting action thus suggesting the ritualized nature of this signal. As predicted by the metacommunication hypothesis, ROM anticipated offensive patterns and had a role in balancing playful sessions. If ROM seems to fine-tune the session, our data suggest that PBOW has a different function. PBOW did not anticipate an offensive pattern and had no effect in balancing the session. Instead, the survivor curves analyses clearly indicate that PBOW is mainly performed after a short pause and is effective in renovating the motivation to play in the partner. Consequently, the mismatched number of play bows of the players can be a good indicator of their different motivation to play. In conclusion, the different and complementary functions of ROM and PBOW highlight dogs' ability in perceiving and decoding facial and bodily displays to promptly react with proper motor actions to manage one of the most complex and unpredictable social interaction.

**70 Irene Martínez-Baquero** *Is risk-taking behaviour consistent throughout different threats? Measuring among-individual variation in a population of blue tits*

Irene Martínez-Baquero\* (Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands), Gaoyang Yu (Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands), Xia Zhan (Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands), Atharva Andhare (Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands), Maaïke A. Versteegh (Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands), Jan Komdeur (Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands), Peter Korsten (Faculty of Biology, Bielefeld University, Germany)

Among-individual variation in behaviours closely related to fitness, such as risk-taking behaviours, is found across the animal kingdom. However, its ecological drivers are poorly understood. Theoretical work suggests that individual differences in investment into current versus future reproduction may lead to a “slow-fast” continuum, known as the “pace-of-life syndrome” (POLS) hypothesis. Accordingly, populations may show variation among individuals in the level of risk-taking behaviours (i.e., “fast” individuals tend to take more risks and invest more in current breeding endangering their own survival as opposed to “slow” individuals). In addition, it has been suggested that consistent differences in individual risk-taking behaviours are repeatable across various threatening contexts. Yet, empirical studies in a natural setting remain scarce. The objectives of this study are: (1) to establish to what extent levels of risk-taking are repeatable in blue tits (males and females) across different contexts, and (2) to investigate how the variation in risk-taking relates to levels of parental investment. We will assess this hypothesis in a wild blue tit (*Cyanistes caeruleus*) population using two risky contexts during the nestling stage: (1) presenting a Eurasian sparrowhawk (*Accipiter nisus*) model as a predator stimulus, and (2) temporarily removing one parent bird to simulate a predation event. In both cases, to quantify the variation in risk-taking behaviour, we will use the latencies of birds to resume brood provisioning after having been exposed to the threat. Furthermore, we will collect fitness-related data (e.g., egg-laying date, clutch size, offspring survival) to investigate the fitness consequences of this behaviour. As predicted by the POLS hypothesis, we expect risk-taking behaviour to be consistent and repeatable in the individuals under different contexts. Moreover, we predict individuals that take more risk to have higher breeding success, as they invest more in their current reproduction (at the cost of their own survival).

**71 Jim McGetrick** *Do domestic pigs understand the need for a partner in a cooperative task?* Jim McGetrick, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria; Kimberly Brosche, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria; Clémence Nanchen, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria; Jean-Loup Rault, Institute of Animal Welfare Science, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria

Many animal species engage in cooperative interactions in which two or more individuals perform coordinated or synchronized actions to achieve a goal. Such interactions have been studied using experimental tasks, with numerous species displaying successful cooperation. In two recent studies, to gain access to food treats, domestic pigs successfully lifted a log together, in pairs, in the joint log-lift (JLL) task. However, it is unclear whether pigs understand that they need a partner to succeed in this

task. In the current study, we investigated whether pigs would recruit a partner to assist them in the JLL task. Pigs first learned spontaneously how to perform the JLL task, in a group setting. They were then given the opportunity to learn how to open a small door separating two enclosures. In the test phase, 29 subjects were individually faced with the JLL task or a non-cooperative, control version that could be operated alone, and they had the opportunity to open the small door to the adjacent enclosure. The presence of a partner in the adjacent enclosure, and need for a partner to solve the task, were varied across experimental conditions. Pigs generally opened the door in all conditions. Based on the comparison of latencies to open the door or to return to the task after opening the door, there was no indication that the presence of, or need for, a partner influenced the pigs' decision making. Thus, an understanding of the need for a partner was not evident. As with many non-human animal species tested in cooperative tasks, pigs seem to be capable of achieving relatively complex behavioural outcomes in the JLL task without necessarily understanding that a partner is needed.

## **72 Berenika Mioduszevska** *Group foraging on feeding platforms in wild free-ranging Goffin's cockatoos*

\*Berenika, Mioduszevska, Messerli Research Institute, University of Veterinary Medicine Vienna; Alice, Auersperg, Messerli Research Institute, University of Veterinary Medicine Vienna; Dewi, Prawiradilaga, Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences (LIPI); Mark, O'Hara, Messerli Research Institute, University of Veterinary Medicine Vienna

Wild Goffin's cockatoos (*Cacatua goffiniana*; hereafter: Goffins) are opportunistic feeding generalists and are well-known for gathering in large groups on corn fields during harvest. However, the visitation pattern of these social groups on concentrated food sources was so far unknown. In this pilot study, we developed hoistable feeding platforms to continuously monitor visitation rates of wild Goffins groups. The platforms were baited with corn kernels and the group activity was recorded with camera traps. Additionally, playback sessions were conducted to investigate the effect of conspecific loud calls on attracting Goffins to a location. The preliminary results indicate that Goffins do repeatedly aggregate on concentrated high-value food sources and that group presence is influenced by daytime, weather, and corn abundance. These results provide first insights into the temporal distribution and social dynamics of foraging bouts in wild Goffins, which are otherwise challenging to observe in the dense tropical forest. Furthermore, this study presents a methodology for reliably attracting wild psittacines into a standardized and monitored location, which in turn allows detailed behavioural observations of free-ranging individuals.

## **73 Dina Mostafa** *The role of vocal signals in the collective movement of greylag geese (*Anser anser*)*

\*Dina Mostafa - University of Vienna – Cognitive, Behavioural and Neuroscience department - Konrad Lorenz Research Centre for Behaviour and Cognition; Nico M. Adreani, University of Vienna - Konrad Lorenz Research Centre for Behaviour and Cognition; Sonia Kleindorfer - University of Vienna - Konrad Lorenz Research Centre for Behaviour and Cognition

Selection is predicted to favour individuals with traits that allow them to navigate the costs and benefits of group living, including those that maintain group cohesion. Collective movement decisions are reached using a variety of mechanisms, including despotic decisions, quorum via voting, and the participation of particular individuals, while some systems probably utilise a combination of mechanisms. Visual and auditory signalling are used to advertise the motivation to move, but in species that show multimodal movement behaviour the signalling could be more complex – an area that requires study.

The greylag goose (*Anser anser*) belongs to a basal taxonomic lineage that is both highly social and vocal, and engages in daily and seasonal sub-group movement associated with motor signalling and calling behaviour. This study aims to elucidate the structure of departure calls and measure inter-individual differences in call structure, and the associated influence on sub-group movement. Our findings show that 60% of variance in departure calls was explained by caller ID, and that different individuals had different influence on successful sub-group movement and the recruitment of others for flight. Call characteristics did not predict successful flight initiation, and influence was not predicted by age or sex. Causal factors for differences in individual influence thus need to be elucidated. We conclude that the greylag goose is a good system to study leader-follower dynamics and individual influence associated with collective movement, as the birds are terrestrial, aquatic and aerial species, that use complex vocal and behavioural signals to coordinate movement

**74 Gloria Murari** *Effect of food competition on the sex-specific distribution of parental care in common ravens (*Corvus corax*)*

Gloria Murari\* and Elisabeth Svitil, Palmyre H. Boucherie (Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria) and Thomas Bugnyar (1Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria; 2Konrad Lorenz Forschungsstelle, Core Facility for Behaviour and Cognition, University of Vienna, Vienna, Austria)

When taking care of their offspring, parents face a limited quantity of resources that need to be divided between their own maintenance, and the maintenance and survival of the offspring. Parents additionally need to make decisions on how to allocate their resources when rearing multiple offspring, dividing them in the most functional way. Several species, like the common raven, show distinct patterns of parental investment depending on the individual's sex (both of the parent and the chick). A recent study investigating resource allocation in *Corvus corax* indeed found that resources are distributed differently based on the sex and weight of the chicks, with fathers feeding and affiliating more with heavy sons, whereas mothers show no preference. Here, we investigated whether these preferences remain when manipulating the degree of food competition in the family. Using different quantities and distribution (clumped, scrambled) of meat, we analyzed begging, allofeeding, ground proximity, co-manipulation and agonistic interaction patterns between parents and their chicks in five captive families. We found that competition for resources affected both parents and chicks' interaction patterns. Increased competition resulting in: increased aggressiveness and decreased food sharing from fathers with their chicks; and increased begging and gregariousness from chicks to their parents (seeking proximity and soliciting food sharing). With lower competition, chicks initiated less co-manipulation towards their parents. This study highlights the necessity to consider food accessibility when studying parental care, competition between family members affecting parents-chicks interactions over food, and eventually conditioning chicks' growth and fitness. Future studies will aim to integrate another parameter, that is family size, to better illustrate how the natural variations of early conditions can mediate parents-chicks interactions and their consequences.

**75 Jori Noordenbos** *Do dogs know what humans know?*

Noordenbos\*, J.R., Wuisman, J., Herp, A. van, Wouters, L., Beerda, B.

Domestic dogs (*Canis familiaris*) seem to have some understanding of others' visual perspective. They differentiate between others' attentional states and also understand that a human's line of sight can be

blocked by a barrier. Not so much is known about dogs' understanding of others' knowledge. We are running an ongoing study to test if dogs differentiate between persons with relevant knowledge and those without, based on who the dogs look at for help in an 'unsolvable puzzle' set-up. In three increasingly difficult steps, dogs learned to solve different puzzles to access food rewards. Each puzzle was prepared and presented by an experimenter or the dog's owner, both standing opposite to the dog. Only the preparer of the puzzle had eyes on it the entire time and thus possessed knowledge about it. Dogs participated in two trials, with the preparer and puzzle randomly assigned per trial. If the dog solved the puzzle three times, the puzzle was made unsolvable and presented to the dog, which was then observed for help seeking behaviour. We expected dogs to look at the preparer for help if they understood that he/she had the correct knowledge to solve the puzzle. So far 19 dogs participated in the experiment, resulting in 38 trials, of which 32 could be used for preliminary analysis. The dogs' first gaze after they stopped trying to solve the puzzle went to the preparer of the puzzle more often than to the ignorant person, irrespective of who the preparer was (26 out of 32 trials, binomial,  $p < 0.001$ ). Dogs looked longer at the preparer when it was their owner rather than the researcher ( $4.3 \pm 0.9$  seconds of 10 vs  $1.77 \pm 0.808$ , Linear Mixed Model  $p < 0.05$ ). This suggests an understanding of knowledge in the preparer, yet a preference for looking at the owner.

**76 Elisabetta Palagi** *Facial communication in social carnivores: What similarities with primates?*  
Elisabetta, Palagi\*, Unit of Ethology, Department of Biology, University of Pisa

Visual communication in wild social carnivores has been often neglected, with most studies focusing on signals based on different sensory modalities. Here, I will review and present original observational data on some African carnivore and primate species showing how, facial displays are good regulators of social interactions and reliable predictors of behavioural synchrony thus promoting inter-individual affiliation and group cohesion. The relaxed open mouth (ROM) and yawning will be analysed and compared across different species. Despite the presence of some variants, ROM (or play face) is a highly context-specific signal widely shared among mammals. Due to its morphological similarity, yawning is easy to be detected and objectively described in many different vertebrate taxa. Moreover, both ROM and yawning often evoke a mirror response in the observer in the so-called facial mimicry that is an extremely adaptive phenomenon mainly based on the perception-action coupling mechanism mediated by the mirror neuron system. Facial mimicry regulates dyadic relations, promotes behavioural synchrony at group level and favours the formation of enduring social bonds that in turn enhance reproductive success. All these features make ROM and yawning highly good models to study in a comparative way the possible roles of visual communication in managing social interactions. The available data on social carnivores will be discussed and compared with those coming from primates in order to make an attempt in providing an overarching perspective on the possible factors at the basis of the evolution of these facial displays.

**77 Marina Papadopoulou** *The role of individual heterogeneity in collective behavior across species*  
Marina Papadopoulou \* (Swansea University), Ines Fürtbauer (Swansea University), Andrew King (Swansea University)

Computational models of collective animal behaviour usually assume that agents are identical, moving and interacting with each other in the same way. However, through recent advances in laboratory and field observation techniques, there is evidence that individual heterogeneity is present in many collective behaviour systems, with interaction rules of group members differing within and across species and

ecological contexts. Due to this discrepancy between model assumptions and reality, our theoretical understanding of the influence of individual variation on the emergence of collective patterns is still limited. Our new project aims to fill this gap. We first analyse data of collective motion in several social species (schools of fish, flocks of sheep, herds of goats and troops of baboons) focusing on their interaction rules and investigating the presence and role of individual heterogeneity. Based on our findings, we will build a new set of species-specific agent-based models that include individual variation in their local rules of motion and interaction. With our new models we aim to study the effect of heterogeneity on the groups' internal dynamics, patterns of collective motion and decision-making. Finally, we expect our models to inform the engineering of alternative artificial swarm systems which to date, inspired by early models of collective behavior, tend to be decentralized, distributed, and homogenous.

**78 Giulia Pedretti** *Audience effect on domestic dogs' behavioural displays and facial expressions*

Giulia Pedretti\*(1,2), Chiara Canori(2), Sarah Marshall-Pescini(3), Rupert Palme(4), Annalisa Pelosi(2), Paola Valsecchi(2,1) 1-University of Parma, Department of Medicine and Surgery, Via Gramsci 14, Parma, 43126, Italy 2- University of Parma, Department of Chemistry, Life Science and Environmental Sustainability, Viale delle Scienze 17/A, 43124, Parma, Italy 3 - Domestication Lab, Wolf Science Center, Konrad-Lorenz-Institute for Ethology, University of Veterinary Medicine, Veterinärplatz 1, 1210 Vienna, Austria 4 - Unit of Physiology, Pathophysiology and Experimental Endocrinology, Department of Biomedical Sciences, University of Veterinary Medicine, Veterinärplatz 1, 1210 Vienna, Austria"

In the present study we investigated the influence of positive and negative arousal situations and the presence of an audience on dogs' behavioural displays and facial expressions previously identified as stress-related signals as well as appeasement signals. We exposed dogs to positive anticipation, non-social frustration and social frustration evoking test sessions and measured pre and post-test salivary cortisol concentrations. Cortisol concentration did not increase during the tests and there was no difference in pre or post-test concentrations in the different test conditions, excluding a different level of arousal. Displacement behaviours of "looking away" and "sniffing the environment" occurred more in the frustration-evoking situations compared to the positive anticipation and were correlated with cortisol concentrations. "Ears forward" occurred more in the positive anticipation condition compared to the frustration-evoking conditions, was positively influenced by the presence of an audience, and negatively correlated to the pre-test cortisol concentrations, suggesting it may be a good indicator of dogs' level of attention. "Ears flattener", "blink", "nose lick", "tail wagging" and "whining" were associated with the presence of an audience but were not correlated to cortisol concentrations, suggesting a communicative component of these visual displays. These findings are a first step to systematically test which subtle cues could be considered communicative signals in domestic dogs.

**79 Davide Potrich** *Number discrimination by Archerfish*

Davide Potrich\*, Center for Mind/Brain Sciences, University of Trento, Rovereto, Italy; Mirko Zanon, Center for Mind/Brain Sciences, University of Trento, Rovereto, Italy; Giorgio Vallortigara, Center for Mind/Brain Sciences, University of Trento, Rovereto, Italy

Non-symbolic numerical estimation is an important and well-studied cognitive ability that allows humans and other animals to interact successfully with their surroundings. The development of a "sense of number" is associated with fundamental biological needs that in many ecological contexts allow animals

to estimate how many companions or enemies are around, or how much food is present in different patches.

Debates have arisen, however, as to whether animals actually can learn abstract non-symbolic numerosity or whether they always rely on some continuous physical aspect of the stimuli, covarying with number. Here we investigated archerfish (*Toxotes jaculatrix*) non-symbolic numerical discrimination with accurate control and proper randomization for continuous physical stimulus attributes.

Archerfish were trained to select one of two groups of black dots (Exp. 1: 3 vs. 6 elements; Exp. 2: 2 vs. 3 elements); these were controlled for several combinations of physical variables (elements' size, overall area, overall perimeter, density and sparsity), ensuring that only numerical information was available. Training results showed that archerfish are capable of abstract numerical discrimination.

After reaching a learning criterion, generalization tests with novel numerical comparisons (2 vs 3, 5 vs 8, and 6 vs 9 in Exp. 1; 3 vs 4, 3 vs 6 in Exp. 2) revealed a spontaneous choice for the largest or smallest numerical group according to the relative number that was rewarded at training. The use of relative information of numerical groups may have ecological reasons, being more adaptive in a natural environment that constantly requires numerical/quantity judgement. None of the continuous physical variables, including spatial frequency, affected archerfish performance.

In conclusion, our results prove that archerfish spontaneously use abstract relative numerical information for both small and large numbers when only numerical cues are available

**80 Arianna Racca** *Behavioural adaptive responses of mice to changes across the spectrum of gravity*  
Arianna Racca\*, Center for Behavioural Sciences and Mental Health, Istituto Superiore di Sanità, Rome, Italy; Patrizia Pignataro, Department of Emergency and Organ Transplantation, University of Bari, Bari, Italy; Maria Grano, Department of Emergency and Organ Transplantation, University of Bari, Bari, Italy; Daniela Santucci, Center for Behavioural Sciences and Mental Health, Istituto Superiore di Sanità, Rome, Italy

Understanding the phenomena underlying tolerance and adaptation to altered environmental conditions such as un-physiological gravity represents a great opportunity to study coping strategies, mechanisms underlying neuroplasticity phenomena, and the individual vulnerability to stress. In addition, animals are sent into orbit as a useful tool to preserve potential human and animal health, predicting and developing adequate countermeasures in long-term space travel. Ground-based experiments employing animal models to reproduce the effects of altered gravity exposure use the paradigms of the rotation-induced hypergravity (HG) and the hindlimb suspension (unloading model, HU), the latter being highly employed in gravitational physiology and consisting in removing gravitational loading from the hindlimbs by suspending the animal by its tail. The present study was aimed at investigate and compare the neurobehavioural effects in ground-based animal models and to define a detailed HU ethogram in order to identify behavioral biomarkers for individual differences in coping with the suspension paradigm and make progress in the procedure to ensure and improve animal welfare. C57BL6 mice were subjected to rotation induced hypergravity or to tail suspension procedure and their behavioural profile studied before, during the hypergravity or tail suspension exposure, and after. Specific behavioural items, such as vertical movements (rearing and wall rearing behaviours) or novel object exploration, were affected after being exposed to altered gravity conditions. Interestingly, the study of HU ethogram revealed several analogies

with behavioral elements observed in on-orbit mice, confirming that gravitational fields represent a continuum as well as the biological adaptive responses to changes across the spectrum of gravity.

**81 Arianna Racca** *Behavioural indicators of susceptibility to pollutant exposure in commercial seawater fish species*

Arianna Racca\*, Center for Behavioural Sciences and Mental Health, Istituto Superiore di Sanità, Rome, Italy; Francesco Ciabattoni, Department of Experimental Medicine, Sapienza University, Rome, Italy; Giacomo Grignani, Department of Ecological and Biological Sciences, Ichthyogenic Experimental Marine Centre (CISMAR), University of Tuscia, Tarquinia, VT, Italy; Marco Tafani, Department of Experimental Medicine, Sapienza University, Rome, Italy; Claudio Carere, Department of Ecological and Biological Sciences, Ichthyogenic Experimental Marine Centre (CISMAR), University of Tuscia, Tarquinia, VT, Italy; Daniela Santucci, Center for Behavioural Sciences and Mental Health, Istituto Superiore di Sanità, Rome, Italy

Environmental contaminants, metals, pesticides, and other organic products represent a serious risk to many aquatic organisms. Since in aquatic ecosystems there are often conditions where environmental contaminants are present in quantities clearly much lower than those that cause mortality, the study of fish behavior can provide insights with particular preparatory value for understanding pathophysiological and ecological processes affecting commercial species exposed to potentially polluted aquatic environments. The purpose of this study was to assess the behavioural profiles and to validate behavioural indicators of susceptibility to ecologically relevant pollutants in two fish species. Specimens of commercial seawater, gilthead seabream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) were exposed for 4 weeks to an ex-situ environment through sediments and invertebrates taken from Bagnoli-Coroglio, an Italian site currently subjected to environmental restoration due to a previous invasive industrialization process. Spontaneous activity and foraging behaviour were videorecorded three times a week and, at the end of the 4th week, behavioural challenges (i.e., predation, aversive, social and explorative tests) were presented to the subjects. Specie-specific changes in selected behavioural items, such as in swimming, floating, chasing behaviours, and in the habituation profile were observed in both species. Differences in the approach to the prey model were also revealed. Finally, an overview of experimental set-up built to investigate the effects of polluted environment on different behavioural domains in fish will be reported, illustrating also some subtle and relevant differences observed between the two species.

**82 Ella Rees-Baylis** *The evolution of eusociality through maternal manipulation*

Ella Rees-Baylis\* (1), Ido Pen (1), Jan J. Kreider (1). (1) Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, the Netherlands

Eusociality is a fundamental phenomenon in many insects, yet its evolution and underlying mechanisms are still not clearly understood. Many analyses focus largely on worker altruism: offspring may forgo their own reproduction if the costs of this are outweighed by the inclusive fitness benefits of helping to raise close relatives. However, this offspring-centred approach often overlooks the potential fitness consequences to the mother, and thus there is potential to broaden this theory. Maternal effects are rife in nature, and consequently it is plausible that they could play an additional role in facilitating philopatry and helping behaviour, which may ultimately lead to the evolution of eusociality. To elucidate, we implemented an individual-based computational model whereby mothers are able to manipulate the body



size of their offspring by controlling larval diet provisioning. We anticipate that mothers may produce smaller daughters to coerce them into becoming non-reproductive helpers, as a smaller body size reduces their potential success of dispersing and reproducing alone. If such helping behaviour can also be facilitated by the manipulation of the mother's offspring, helping to raise close kin could become less imperative and thus sociality may still evolve under lower levels of relatedness between offspring. To this end, we also investigate whether strict lifetime monandry (and thus higher relatedness between offspring) is a requirement for the evolution of eusociality via maternal manipulation. The results from this model provide key insights into maternal manipulation, a lesser-understood mechanism that can potentially facilitate helping behaviour in offspring and lead to reproductive division of labour, a critical step in eusocial evolution.

**83 Nadieh Reinders** *Horse Power: Social Interactions with Horses in Military Veterans with Post-Traumatic Stress Disorder*

Nadieh Reinders\* 1, Chantal Kapteijn 1, Nienke Endenburg 1, Eric Vermetten 2, Bas Rodenburg 1 ; 1 Division Animals in Science and Society, Department of Population Health Sciences, Faculty Veterinary Medicine, Utrecht University, Utrecht, The Netherlands; 2 Department of Psychiatry, Leiden University Medical Center, Leiden, The Netherlands

Approximately 5% of the Dutch military veterans is suffering from post-traumatic stress disorder (PTSD), which can result from exposure to traumatic events. Conventional types of trauma-directed treatment and medication are not always effective, so additional approaches are needed. Equine assisted interventions (EAI) have become increasingly popular amongst humans with mental health issues, including PTSD. It is important to gain a better understanding on the effects of EAI on the welfare of the humans, but also on the welfare of the horses. Most studies on EAI use psychological parameters such as questionnaires, but few use physiological parameters such as heart rate variability and behaviour to measure welfare. Furthermore, there are several working mechanisms proposed for EAI. Social interactions with horses can offer social support, function as an emotional mirror, help with focusing on the here and now, and improve people's self-esteem, confidence, assertiveness and trust. This study investigates the effects of social interactions through both physiological (heart rate variability) and behavioural (social and stress-related) parameters in both veterans and horses, in addition to questionnaires, and aims to provide more insight into the working mechanisms. Sixteen veterans followed a twelve week EAI program, during which they interacted with horses on a weekly basis. Heart rate variability was measured at baseline and during interactions in both horse and veteran using Polar H10 sensors and M430 receivers, and data was processed with Kubios software. Behavioural data was obtained through analysis of video recordings of the interactions, using The Observer XT 16. It is expected that the social interactions with horses will lead to a decrease in PTSD symptoms and stress and increase social behaviours in humans without negatively affecting the welfare of the horses. Furthermore, it is expected that human and equine stress parameters are correlated.

**84 Alex Rieger** *A selectionist approach to mate choice*

Alex, Rieger\*, TU Braunschweig; Jan, de Haan, TU Braunschweig; Annemarie, Hartung, TU Braunschweig; Frank, Eggert, TU Braunschweig

Recent theoretical approaches linking evolutionary biology and behavioral psychology (Borgstede & Eggert, 2021) based on the Price equation (Price, 1970) are able to formally describe behavioral

selection. We want to apply this model (the covariance-based law of effect; CLOE) to mate choice behavior. In this approach behavioral selection is modeled on two levels - the phylogenetic selection in evolutionary time on the one hand and ontogenetic behavioral selection on the other hand, sometimes referred to as “learning” by mechanisms such as operant conditioning - which are interrelated. One main factor of behavioral selection is the behavior of other individuals, i. e. social influences. These influences can be conceptualized as interaction effects in the formal model.

One possible application of the model is the formal description of mate choice behavior and mate choice strategies. Assuming there are two individuals in a stable relationship. They might be of a species where one sex has to invest (e. g. providing resources) in order to court individuals of the other sex. Possible behavioral alternatives (e. g. foraging, courtship) are linked differentially to fitness predictors (e. g. mating opportunities, continuation of a relationship). These fitness predictors then - due to phylogenetic selection - provide information about the relationship of fitness predictors and an organism’s eventual fitness. One example for expanding the aforementioned scenario by incorporating social influences on mate choice might be a local change in sex ratio. As a consequence, it might be necessary to invest more in order to outcompete competitors of the same sex when continuing a relationship or mating, which is represented in the model as a change in the parameters that link behavioral alternatives, fitness predictors and fitness. Formally, this corresponds to an interaction effect. Hence, mate choice should be regarded as flexible in changing (social) context structures

### **85 Mila Roozen** *The social brain hypothesis and social dysfunction – a Darwinian paradox*

Mila Roozen\*, Groningen Institute for Evolutionary Life Sciences, University of Groningen, the Netherlands; Martien Kas, Groningen Institute for Evolutionary Life Sciences, University of Groningen, the Netherlands

The social brain hypothesis (SBH) states that the evolution of the primate neocortex to levels beyond what is expected based on total brain size is the result of selection pressure for high levels of social complexity. In situations of selection pressure such as the one suggested by the SBH, genetic variants related to the phenotype in question are assumed to eventually either become lost or reach fixation in the population, reducing the genetic variation related to the phenotype. However, variation in social functioning has been found to be related to genetic variation (Bralten et al., 2021) and reduced social functioning is connected to a wide variety of psychiatric disorders (Porcelli et al., 2019) which are assumed to result in reduced reproductive fitness. Although this genetic variation may appear to be an argument against the SBH, this paradox is a commonly known paradox in evolutionary psychiatry, where genetic variation related to severe psychiatric disorders maintained despite the apparent evolutionary disadvantage.

Hypotheses attempting to explain this paradox include ancestral neutrality, balancing selection and mutation-selection balance, which are compatible with the SBH to variable extents. Recent methodological advances have also created many opportunities to use genetic data to examine evolutionary markers (Song et al., 2021). Using methodologies such as selection pressure timelines and cross-species conservation of genetic variants, researchers can now examine the evolutionary processes involved in the continued existence of genetic variation in social functioning. Findings from such analyses may contribute to our understanding of the evolution of the brain and to our understanding of social dysfunction such as that observed in psychiatric disorders like schizophrenia and autism spectrum disorder

**86 Taylor Rystrom** *Social niche shapes social behavior and cortisol concentrations in adolescent female guinea pigs*

Taylor, Rystrom\*, University of Münster; S. Helene, Richter, University of Münster; Norbert, Sachser, University of Münster; Sylvia, Kaiser, University of Münster

For social animals, the environment is highly influenced by interactions among conspecifics. These social interactions lead to the formation of individualized social niches, shaping phenotypes such as behavior and glucocorticoid (e.g. cortisol) concentrations. However, it is not well-understood how flexible phenotypes are when the social niche changes, especially during adolescence, a sensitive phase for the development of social behavior. Using female guinea pigs, we investigated the relationship between the social niche, social behavior, and cortisol concentrations (baseline and response to challenge) during adolescence. Since female guinea pigs form dominance hierarchies, we used dominance rank as a measure of the individualized social niche, with females filling the dominant or subdominant social niche. Females were pair-housed upon weaning, and dominance rank was determined by the outcome of social interactions in the home enclosure (early adolescence phase). Dominance rank was later manipulated by replacing the housing partner with either a larger or smaller female, forcing the focal female to become dominant or subdominant (late adolescence phase). We show that the social niche shapes cortisol concentrations during adolescence, and social behavior is flexible but not completely reshaped when the social niche changes. Baseline cortisol was shaped by the social niche in early adolescence with higher concentrations in dominant females. After the social niche manipulation, cortisol responsiveness significantly increased for the females who were forced to become subdominant. With regard to behavior, dominant females were consistently more aggressive than subdominant females, but there was a persistent effect of early dominance rank on submissive behavior in the late adolescence phase. Previously dominant females were less submissive to their new partner than the previously subdominant females were, regardless of their current dominance rank. These findings demonstrate that for adolescent females, behavioral and hormonal phenotypes can be adaptively shaped and reshaped to match changes in the social environment.

**87 Tommaso Saccà** *Male intrasexual aggression and partial dominance of females over males in vervet monkeys*

Tommaso Saccà\* University of Groningen; Erica van de Waal, University of Lausanne; Charlotte K Hemelrijk, University of Groningen

Females dominate a subset of the males in a minority of mammalian species despite male-biased sexual dimorphism. How this may arise is suggested by a computational model, DomWorld. The model represents male-biased sexual dimorphism through the males' greater initial dominance and higher intensity of aggression, meaning that fights initiated by males have a greater impact than those by females. The model shows that female dominance over males increases with a greater proportion of males in the group. This happens because when males are involved in a larger fraction of fights this results in greater hierarchical differentiation (i.e., steepness). This causes rank overlap between the sexes (i.e., partial female dominance). We test the validity of these processes in vervet monkeys (*Cercopithecus pygerythrus*), a primate species with partial female dominance. We confirm that the proportion of males in the group is significantly positively correlated with the degree of dominance by females over males and with the steepness of the hierarchy among males exclusively, but not with the steepness of the hierarchy among all adults of the group. The steepness in male hierarchies correlated

positively with female dominance over males in these groups. We show that steeper hierarchies among vervet males resulted from (1) males directing a larger proportion of their severe aggression to other males and (2) male-to-male fights being a larger proportion of the fights among all adults of the group. We conclude that the higher frequency and greater intensity of male intrasexual aggression favours female dominance in vervet monkeys. We also show that females received coalitionary support when they were in conflict with a male, mainly from other females, and that this favours female dominance in this species, but this does not explain why partial female dominance increased with the proportion of males in the group.

**88 Tommaso Saccà** *Reducing the bias due to unknown relationships in measuring the steepness of a dominance hierarchy*

Tommaso Saccà\*, University of Groningen, Gerrit Gort, Wageningen University, Erica van de Waal, University of Lausanne, Charlotte K Hemelrijk, University of Groningen

Measuring the steepness of a dominance hierarchy is important for classifying a social system in a continuum between egalitarian and despotic. For this, often the steepness-slope from de Vries and colleagues (2006) is used. It compares the cardinal and ordinal dominance rank of each individual using the slope of the linear regression. The disadvantage of this measure is that the slope becomes lower the higher the proportion of unknown relationships (dyads without interactions). In the present paper, we investigate what causes this bias, and propose a solution. We show: (1) that the bias is due to the treatment of unknown relationships by the dominance index currently used in this methodology, the David's score (namely by assuming, among other things, an equal number of wins and losses for both members of the pair). (2) Instead, using the Average Dominance Index (the average proportion of wins by each individual from all its opponents) reduces the bias due to unknown relationships, because it excludes unknown relationships, and (3) the standard error of the steepness slope based on the Average Dominance Index is smaller. (4) The two indices (David's score and Average Dominance Index) result in similar steepness-slopes when all relationships are known. For comparing the two indices we use empirical data (from four group-years of wild vervet monkeys) and data from a computational model on dominance interactions in a group (DomWorld). We conclude that the Average Dominance Index (compared to the David's score) is preferable for measuring the steepness-slope.

**89 Iago Sanmartín-Villar** *Social buffer or avoidance depends on the similarity of stress between queen ants*

Iago Sanmartín-Villar\*, Universidade de Vigo, ECOEVO Lab, Escola de Enxeñaría Forestal, Campus Universitario A Xunqueira, 36005 Pontevedra, Galiza, Spain

The association of unrelated ant queens (pleometrosis) is supposed to improve nest foundation and competitiveness under environmental stress, but its evolutionary maintenance is difficult to explain because only one of the queens survives after nest foundation. My aim was to test the potential effect of queen association as a social buffer, i.e. as a mechanism reducing stress and improving fitness due to the benefits of social contact. I analysed the survival, fecundity, and behaviour of isolated and paired *Lasius flavus* queens exposed and not exposed to stressors (disturbing environmental conditions). I found no difference in survivorship between isolated and paired queens or between stressed and unstressed isolated queens. Groups in which one or two paired queens were stressed showed higher mortality. Unstressed queens died similarly to their stressed nestmates, suggesting stress transmission. A trend

suggested that paired queens produced eggs more quickly, but eggs were produced similarly between isolated and paired queens. Social avoidance was observed in groups with one stressed and one unstressed queen. However, the groups with two stressed queens showed the expected behaviours according to social buffering: lower mobility and more interindividual inspection. My findings suggest the synergistic effect of pleometrosis and stress and the dependence of stress level similarity between nestmates on social buffering or rejection on ant queens.

**90 Iago Sanmartín-Villar** *Direct and cross-generational effects of reproduction on fitness and behavioural variability in male-biased environments*

Iago Sanmartín Villar\* Universidade de Vigo, ECOEVO Lab, Escola de Enxeñaría Forestal, Campus Universitario A Xunqueira, 36005 Pontevedra, Galiza, Spain; Xin Yu, College of Life Sciences, Chongqing Normal University, Chongqing, China; Adolfo Cordero-Rivera, Universidade de Vigo, ECOEVO Lab, Escola de Enxeñaría Forestal, Campus Universitario A Xunqueira, 36005 Pontevedra, Galiza, Spain

Population structure determines individuals' interactions and trade-offs with evolutionary consequences. Male biased populations increase intrasexual competition and intersexual harassment, reducing female resource acquisition and thus, resources availability for the following generation.

We analysed direct and cross-generational effects of male harassment two generations of damselflies (Odonata). We exposed adult females to treatments with different sex-ratio and density (balanced and male-biased) to modify the male harassment level. We analysed female fecundity, fertility, and number of faecal deposits as indirect measure of resources acquisition. We studied female flight performance after repeated exposures to males. We analysed survivorship, development, exploration, thigmotaxis, and feeding latency of larvae produced by the experimental females. In both generations, we analysed behavioural mean level, interindividual differences in plasticity, intraindividual unpredictability, and repeatability.

Mating duration increased in male-biased treatment while female resources acquisition and fertility decreased. Females that mated longer showed higher fecundity when they were exposed to balanced treatment, but not if they were exposed to male-biased treatment. Females from the male-biased treatment showed interindividual differences in plasticity and no repeatability in flight performance. Offspring showed balanced sex-ratio and similar survivorship, development, and feeding latency independently of the parental treatment; however, females exposed to male-biased treatment produced offspring with higher differences in exploration plasticity and daughters less explorative and with higher unpredictable thigmotaxis. We propose that female guarding as in-copula courtship at balanced sex-ratio but a cost to females under male-biased sex-ratio. Cross-generational effects in behavioural variability may be a mechanism to cope with predicted future environments

**91 Adithya Sarma** *The interplay of sociability and social exposure on sleep rebound in *Drosophila melanogaster**

Adithya Sarma, Paula Kirmis\*, Robbert Havekes, Jean-Christophe Billeter, Affiliation: Department of Neurobiology, GELIFES, University of Groningen

Sleeping and engaging in social interactions are widely conserved phenomena crucial to the well-being of all animals. Impairments in both these processes are associated with negative outcomes such as severe

cognitive decline and shortened lifespan. Moreover, in species as distant as humans, mice, and *Drosophila*, both sleep and social interactions influence each other. For example, the frequency of social interactions dictates sleep need and conversely, sleep loss causes social withdrawal, indicating an ancient and fundamental link.

Interestingly, a number of studies have also revealed that humans might display differences in their intrinsic need to engage in social interactions, also known as sociability. This is relevant because the sociability of an individual might eventually determine the frequency of social interactions, thereby jointly influencing traits such as sleep. However, these studies remain correlational leading to the untested hypothesis that the sociability trait of an individual in conjunction with the amount of social exposure might determine the objective need for sleep and associated vulnerability to sleep loss.

The conservation of fundamental aspects of sociability and sleep allows the use of *D. melanogaster* to dissect the intimate connection between sociability and sleep. Recent studies in our lab have showed a wide spectrum of sociability in inbred lines, with some lines having high sociability and others having low sociability. In our present study, we therefore quantified sleep and determined whether prior exposure to a social interaction in high and low sociability flies influences sleep rebound differently. Using this approach, we attempt to discern the interplay of sociability and social exposure on sleep in fruit flies opening avenues to investigate this interaction at the molecular level and in higher organisms."

**92 Yohan Sassi** *Relative importance of contextual drivers in thermal change decisions of a soaring bird*  
Yohan, Sassi, CEFE\* ; Olivier, Duriez, CEFE

When deciding where to go, animals rely on a mixture of public and personal information. In group-living animals, pre-existing social relationships play an important role in these decisions as well. Animals that live in stable groups tend to travel with their preferred affiliates during collective movements. However, such highly stable groups are relatively rare in nature; it remains therefore unclear whether such process could be as predominant in more fluid social systems. Here, we investigate the extent to which social relationships, public and private information predict leader-follower events in a colonial central-place forager, the griffon vulture (*Gyps fulvus*). To evaluate the strength of social association with conspecifics, we calculated inter-individual distances of a group of 6 captive vultures using a camera trap system during the wintering period. The following summer, we equipped these 6 birds with GPS tags to reconstruct leader-follower events during free flights in group. This allow us to record how vultures choose a thermal column and change to another to gain altitude. We predicted that this decision would be firstly driven by conspecifics climbing rates (used as public information) as it would indicate where vultures can find the strongest thermal. A second hypothesis could be the use of memory (i.e. personal information) to locate the best thermals, although the variability and lability of thermals make this hypothesis less likely. A third hypothesis would be the use of social relationships, with individuals following their preferred affiliates. This could ultimately be beneficial around carrions due to reduced aggression levels through familiarity. We will present the first results of this experiment and discuss how these results can help understanding the formation of flight groups in social birds.

**93 Theresa Schabacker** *Intraspecific individual differences in vocal behavior*

\*Theresa Schabacker, Free University & Natural History Museum Berlin; Lysanne Snijders, Wageningen University; Mirjam Knörnschild, Free University & Natural History Museum Berlin

Animals use vocalizations for communication, orientation or expression of emotional valence, and links to personality-related differences have been demonstrated. For example, certain songbirds exhibit consistent individual differences in vocalization during exploration. However, our current understanding of consistent individual differences in vocalization is primarily based on avian studies. This limits our understanding of how individual differences in vocalization may affect certain life history traits, as, for example, most songbirds do not use vocalizations for orientation. Moreover, most bird studies are carried out during the day, while vocalizing can be an especially functional behavior in the dark. Thus, we here investigated individual vocal behavior in bats, a nocturnal mammal that uses vocalizations in a wide variety of contexts. We repeatedly assessed exploratory behavior of two wild-caught bat species, *Pipistrellus nathusii* and *Glossophaga soricina*, through standardized personality tests involving the exploration of a maze-type arena (*P. nathusii*) and a flight cage (*G. soricina*). In the first species, we tested repeatability of vocalization as a cue sampling response, while in the second species we focused on vocalization as a cue sharing response. When introduced to the maze *P. nathusii* exhibited consistent intra-specific differences in spatial activity as well as echolocation call activity, given their spatial activity, a behavioral response we term 'acoustic exploration'. Acoustic exploration, a direct reflection of the level of environmental cue sampling, may provide a new measure when assessing intra-specific variation in exploration behavior in actively sensing species. *G. soricina* exhibited consistent intra-specific differences in social call production when exposed to novel environments or objects. This type of social call, termed 'alert call', has been previously observed when bats behaved warily or vigilantly. Thus, these preliminary results suggest that vocal production rate reflects individual levels of nervousness or alertness. Our results provide evidence for consistent intra-specific variation in the degree at which wild bats 1) collect information from a novel environment and 2) potentially express experienced levels of nervousness. Furthermore, we highlight the importance of vocalization as an additional relevant factor when assessing animal personality.

**94 Alexander Schlatmann** *Olfactory kin discrimination in begging blue tits nestlings?*

Alexander A. Schlatmann \* (University of Groningen), Stephen M. Salazar (University of Groningen & Bielefeld University), Gaoyang Yu (University of Groningen), Koen B. Baas (University of Groningen), Maaïke A. Versteegh (University of Groningen), Jan Komdeur (University of Groningen), Barbara A. Caspers (Bielefeld University), and Peter Korsten (Bielefeld University)

Animals rely on their senses to adaptively respond to their social and non-social environment. In many animals, olfaction plays a key role in modulating social behaviour. Olfactory cues are, for example, used to discriminate kin when expressing kin-biased behaviours. Surprisingly, however, in birds the importance of olfaction in mediating social behaviour remains largely unknown, even though they are a key model in sensory ecology. Recently, there has been growing evidence suggesting that birds use olfactory cues in a range of social and non-social contexts. Furthermore, first empirical evidence suggests that competing young in the nest can recognise kin using olfactory cues. A recent experiment on wild blue tit (*Cyanistes caeruleus*) nestlings has shown that they beg more intensely when presented with olfactory cues from unfamiliar nestlings from a different nest compared to familiar nestlings from the same nest. Such modulation of begging behaviour in response to olfactory cues could potentially cause kin-biased begging behaviour when relatedness among competing nestlings varies due to the frequent occurrence of extra-pair paternity. However, while in natural broods nestmates may differ in relatedness due to extra-pair paternity, they are always equally familiar. Therefore, we repeated the odour discrimination experiment using cross-fostered nestlings which allowed us to test whether blue tit nestlings can also discriminate between odours of related versus unrelated conspecific nestmates which are both familiar. Focal nestlings did not beg longer to the odours of unrelated nestmates than those of related nestmates.

Hence, we found no evidence for olfactory kin discrimination. Before the start of the experiment, we preregistered our hypothesis, study design, and analysis with the Open Science Framework (OSF; <https://osf.io/mghr8>).

**95 Sandro Sehner** *Group problem solving in common marmosets (*Callithrix jacchus*) is more than the sum of its parts*

Sandro Sehner<sup>1\*</sup>, Erik P. Willems<sup>1</sup>, Lucio Vinicus<sup>1</sup>, Andrea B. Migliano<sup>1</sup>, Carel van Schaik<sup>1,2</sup>, Judith M. Burkart<sup>1,2</sup>; <sup>1</sup>Department of Anthropology, University of Zurich, Switzerland; <sup>2</sup>Center for the Interdisciplinary Study of Language Evolution (ISLE), University of Zurich, Switzerland

Collective problem solving is a key human trait, and is best described as the ability of groups to outperform the summed performances of separate individuals. Further, groups solve tasks more reliably than even the best individuals and are in general more likely to solve more complex tasks. Human hyper cooperativity and the emergence of division of labor allows us to not only solve problems effectively within a group but also collectively. However, it remains unclear whether this ability is uniquely human or to what extent precursors to collective problem solving exist in non-human animals. We understand the evolution of problem solving in a group as a continuum rather than a dichotomy with true collective problem solving at its tip. Here we tested common marmosets (*Callithrix jacchus*) on a series of problem-solving tasks, either individually or in a social environment. To avoid sampling biases, we compared real groups to virtual groups, where virtual groups reflect the summed performance of the solitary tested animals. Animals in real groups were both more likely to solve problems than animals within the virtual groups and to do so faster. Although individuals within real groups approached the problem faster, a reduction in neophobia was not sufficient to explain the greater success. Success within real groups was best explained by a higher perseverance. This perseverance was socially induced as members of the real groups increased their exploration after a fellow group member had solved a problem. These results indicate that human collective problem solving is the endpoint of a continuum, with performance improving beyond baseline as societies move from social tolerance to opportunities for diffusion of information to active exchange of information. We suggest that increasing interdependence and the adoption of cooperative breeding pushed our ancestors up this scale.

**96 Yara Silberstein** *Development and encoding of arousal in Mongolian gerbil infant vocalisations* Yara, Silberstein\*, Institute of Zoology, University of Veterinary Medicine Hannover, Germany; Marina, Scheumann, Institute of Zoology, University of Veterinary Medicine Hannover, Germany

Acoustic communication is essential to coordinate animal social interactions. Especially the communication between pups and their parents is important for their survival. Previous studies in several mammalian species showed that pups signal their emotional state vocally. As single vocalisations of adult Mongolian gerbils have been described, vocalisations in their pups or their ontogenic development have not been focused on yet. Therefore, we compared the encoding of arousal in vocalisations in four different age groups in an experimentally-induced separation paradigm.

Vocalisations of 28 (14 ♀, 14 ♂) Mongolian gerbil pups were recorded in a semi-soundproof chamber. We applied experimental conditions suggested to induce different arousal levels. In the low arousal condition a single pup was placed in an arena isolated from its siblings and parents. In the high arousal condition a single pup was additionally stressed by simulating a predator. The recordings were scanned for infant



vocalisations and call rates were calculated for each subject and context. Additionally, we performed a multiparametric sound analysis of the produced infant calls.

A cluster analysis revealed that Mongolian gerbil pups produced three distinct call types: ultrasonic (USV), audible calls (ADV) and transitions between USV and ADV (USV-ADV). The USV and USV-ADV rate showed an age-dependent decrease, in contrast to an age-dependent increase of the ADV rate. During the first two age groups, before eye opening, the pups produced mainly USV calls in the experimental conditions, which showed only minor differences in their acoustic parameters comparing the two conditions. After eye opening pups decreased their USV call rate in both conditions and switched to ADV calls in the high arousal condition. Our results showed that during the first four weeks of development a vocal reaction to the same conditions can differ, indicating that a greater independency of pups might affect the significance of the condition."

**97 Gabriella Smith** *Explanation seeking in kea parrots (Nestor notabilis)*

Gabriella E. Smith\* (VetMedUni), Megan L. Lambert (VetMedUni), Christoph Völter (VetMedUni), Jan Engelmann (UC Berkeley)

Explanation-seeking—the search for ‘why’ in a gap in knowledge—is a special class of information-seeking. Known for their sophisticated problem-solving abilities, kea parrots (*Nestor notabilis*) are also an exceptionally curious species. Equipped with such cognitive and behavioral traits, kea are thus a well-suited nonhuman animal model to examine the phenomenon of explanation-seeking. This study aims to examine whether kea trained to insert a block into one box resulting in a reward arriving in another are more likely to seek an explanation (peek inside) when the mechanism fails (reward does not arrive after block insertion and is instead provided by researcher). This study offers one of the first formal examinations of explanation-seeking in a nonhuman animal species, and holds promise for future comparative studies in animal cognition and developmental psychology.

**98 Rolf Storms** *Patterns of collective escape of bird flocks under predation by a RobotFalcon*

Rolf F. Storms\*, Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, the Netherlands. Claudio Carere, Department of Ecological and Biological Sciences, University of Tuscia, Viterbo, Italy. Simon Verhulst, Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, the Netherlands. Charlotte K. Hemelrijk, Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, the Netherlands.

Collective behaviour often functions to avoid predation, and is therefore especially conspicuous and complex in flocks of birds under attack by raptors. However, studying collective behaviour experimentally in natural conditions is challenging. Here, we used an artificial predator, the RobotFalcon, developed after a peregrine falcon, a cosmopolitan raptor hunting a wide variety of birds. We hunted with the RobotFalcon flocks of corvids, gulls, starlings and lapwings in an agricultural area in The Netherlands, while recording the collective escape responses of the flocks with a camera. We compared collective escape responses from the RobotFalcon with those from a drone. Flocks of all species responded to the RobotFalcon most often by collectively turning, compacting and splitting in subflocks. The frequency of collective escape was highest in starlings and corvids and lowest in gulls. For starlings only, we also compared their response to a live peregrine falcon using observational data. Similar to hunts by the real falcons, the collective escape response depended on the level of predatory threat. Flocks of all species except

starlings responded less often and less intensively to the drone compared to the RobotFalcon. These results give novel insights in the predator-prey dynamics between raptors and bird flocks, and illustrate how artificial predators can be used to study prey-predator interactions experimentally in the field.

**99 Elisabeth Suwandschieff** *Replication of the two-action-task for testing imitative and nonimitative social learning in kea (*Nestor notabilis*)*

Elisabeth Suwandschieff\*, VetMed Vienna

Humans learn many of their skills by imitating others in their environment. Motor imitation, the copying of physical movements or interactions with objects, has been shown in a few species, although often under very specific conditions. Here we tested the kea parrot (*Nestor notabilis*) of New Zealand on their ability to imitate the actions of another kea. We replicated a 2002 study on motor imitation in budgerigars (*Melopsittacus undulatus*) conducted by Heyes and Saggerson. In our study kea that observed a trained demonstrator remove a stopper from a test box showed (1) faster response duration in session one and (2) faster latency to remove a stopper in session one, than non-observing control group individuals. In contrast to the budgerigars (Heyes and Saggerson, 2002) the present study could not find evidence of motor imitation in kea. The results do suggest however, that there were strong social effects on exploration rates pointing towards motivational and attentional shifts in the observer birds. We measured clear signs of social facilitation, general stimulus enhancement and affordance learning. In line with previous studies our findings further suggest that kea have a propensity toward emulation learning in contrast to faithfully copying any model behaviour and hence engaging in motor imitation.

**100 Will Swaney** *Multigenerational effects of paternal environmental enrichment on multiple traits in larval zebrafish (*Danio rerio*)*

Mike, Green, University of Chester; Will, Swaney\*, Liverpool John Moores University

Transgenerational effects can be an important influence on offspring phenotype, and the experiences of preceding generations may influence different traits in different ways. We examined how variation in the physical complexity of the environment experienced by male zebrafish influences multiple early-life traits in subsequent offspring and grand-offspring. Adult male zebrafish were exposed to either standard or highly enriched housing for 4-weeks prior to breeding, and the resulting F1 offspring were tested for changes in morphology after hatching, and in locomotor activity at the larval stage. We found that swimming behaviour was increased in F1 offspring whose fathers experienced enrichment, and that F1 larval body shape was also different depending on the fathers' environmental experience. These offspring were then reared to adulthood and given the same 4-week manipulation of either standard or enriched housing before breeding. The resulting F2 offspring had paternal and grand-paternal backgrounds made up of the different combinations of standard and enriched housing, enabling us to examine the persistence of effects, and how matching and mismatching environmental experience in preceding generations influences phenotypes. We found that different components of swimming activity are differentially sensitive to the experience of previous generations, and we also saw changes in both swimming behaviour and morphology that seem to be driven by whether paternal and grand-paternal environments were matched or mismatched. As we focused on effects via the male lineage and given that zebrafish are an externally-fertilising species with no parental care, our results are strongly suggestive of non-genetic inheritance of environmental information via the sperm influencing both larval behaviour and morphology in zebrafish across multiple generations.

**101 Sandra Trigo** *Sex differences in common waxbill social behaviour following mesotocinerpic manipulation*

Sandra Trigo\*; Paulo A Silva; Gonçalo C. Cardoso; Marta C. Soares. CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Campus de Vairão, Universidade do Porto, 4485-661 Vairão, Portugal BIOPOLIS Program in Genomics, Biodiversity and Land Planning, CIBIO, Campus de Vairão, 4485-661 Vairão, Portugal

The neuropeptide oxytocin is implicated in the regulation of sociality across vertebrates. Non-mammalian homologs of oxytocin, such as isotocin in fish and mesotocin in amphibians, reptiles and birds, all play crucial roles modulating social and reproductive behaviour. In this study, we exogenously manipulated the mesotocinerpic system in a highly social bird, the common waxbill *Estrild astrild*, and tested the effects on affiliative and aggressive behaviour by performing tests of competition over food. Birds treated with mesotocin showed a sedative state, decreasing all the behaviours we studied (movement, feeding, aggression, allopreening), while birds treated with an oxytocin antagonist showed a decrease only in social behaviours (aggressions and allopreening). We also found two sex-specific effects: mesotocin reduced allopreening more in males than females, and the oxytocin antagonist reduced aggressiveness only in females. Our results suggest sex-specific effects in the modulation of affiliative and aggressive behaviours by the mesotocinerpic system.

**102 Borbála Turcsán** *The relationship between body size, behavioural, and cognitive aging* Borbála Turcsán<sup>1,2\*</sup>; Enikő Kubinyi<sup>1,2</sup>; 1: MTA-ELTE Lendület "Momentum" Companion Animal Research Group, Budapest, Hungary; 2: Department of Ethology, Eötvös Loránd University, Budapest, Hungary

In dogs, larger individuals have an accelerated rate of physiological aging, and thus die younger than smaller individuals. It is yet unclear whether this increased physiological aging also manifests in an earlier onset and/or in a faster rate of behavioural and cognitive deterioration. In this study, we used survey data of >15.000 pet dogs to explore the effect of body size on the lifelong age trajectory of different behavioural characteristics and the age-related prevalence canine cognitive dysfunction symptoms.

We used the R package segmented to analyse and extract the break points in the aging trajectories of the dependent variables (indicating the onset of decline), as well as the slopes before and after the break point (indicating the rate of decline), separately for six weight groups.

Regarding the break points in the aging curve giant dogs (> 40 kg, N=1161) had the onset of cognitive decline earlier than in all smaller size groups (~8-8.5 years vs. 10.2-11.7 years). Regarding the slopes of the age trajectories, we found no difference between the size groups before the onset of decline; however, after the onset, giant dogs showed a slower rate of decline (had less steep slopes) than all smaller size groups.

Thus, while age-related cognitive decline starts sooner in giant dogs, its rate (both the speed and the amount of change) is much slower than in smaller dogs. These results suggest that physiological and mental aging do not follow the same trajectory in all dogs. Although giant dogs (in general) show cognitive decline symptoms at an earlier age, they do not live long enough for the biological processes of aging to manifest in severe behavioural and cognitive deteriorations."

**103 Chris Tyson** *Optimizing location estimates using automated radio tracking systems*

Chris, Tyson\*, Wageningen University & Research; Rita, Fragueira, Wageningen University & Research; Sjouke, Kingma, Wageningen University & Research; Marc, Naguib, Wageningen University & Research

Automated radio tracking systems offer wildlife researchers the ability to continuously track the location of small, free-living animals using lightweight tags. To estimate the location of a tagged individual, it is common to use the relationship between tag signal strength and distance. Since the received signal strength (RSS) of a tag decreases with distance, when a tag is detected by multiple receivers at different locations, multilateration can be used to estimate the location of a tagged individual. Due to the exponential decrease in RSS with distance, however, the relationship between RSS and distance is highly variable. This is especially problematic in heterogeneous environments where multipath propagation and signal bounce further obscure the relationship. These factors can create large uncertainty in location estimates when using multilateration since RSS may be an unreliable indicator of distance. An alternative method developed for the purpose of indoor localization is to generate a map of RSS patterns, which can then be used to estimate the location of new RSS patterns. Here, we present a comparison of these methods for application in wildlife tracking and discuss the costs and benefits of each.

**104 Menno van Berkel** *How do sex-differences in cooperative nest-building affect the morphology and insulation of nests built by monogamous jackdaws (*Corvus monedula*)?*

Menno van Berkel

While cooperation in the parental care of birds is widely studied due to its effect on reproductive success, little attention has been given to how parents cooperate in the construction of the nest, despite the importance this structure has on the insulation and development of eggs. Measuring cooperation in bi-parental care can therefore be considered incomplete without considering nest-building. We investigated how cooperative nest-building in the Eurasian jackdaw (*Corvus monedula*) affects the morphology and insulation properties of the nest. We investigated nest building behaviour inside standardised nest boxes by measuring the time each sex spent building, the time they spent on each nest component, and what material they used. Differences in building effort between sexes were related to nest morphology: 3D models of the nest created from photogrammetry allowed us to measure the diameter-, symmetry-, and depth of the cup, the volume of the nest, and the proportion of soft nest material used on the surface. Finally, the functional impact of morphological differences in the nest structure was identified by relating these measurements to the cooling rate of eggs in the nest, in turn calculated from their surface temperature. We found differences in the amount and timings of building behaviour between sexes, which in turn primarily affected the morphology of the nest cup. We suggest that sex-specific roles and energy requirements, such as nest-defence and egg-laying, are responsible for the observed differences in building effort and their timing in the nest-building season. Our study has demonstrated that the social dynamics in cooperative nest construction alters the nest morphology and its insulating properties. Nest construction can therefore be considered another domain in which cooperation can influence reproductive success and as such an extension of bi-parental care.

**105 Marion Varga** *How to get to food? Individual differences in solving foraging problems in common marmosets (*Callithrix jacchus*)*

Marion, Varga\*, Department of Behavioural and Cognitive Biology, University of Vienna, Vienna, Austria; Vedrana, Šlipogor, Department of Behavioural and Cognitive Biology, University of Vienna, Vienna, Austria/Department of Zoology, Faculty of Science, University of South Bohemia, Budweis, Czechia; Thomas, Bugnyar, Department of Behavioural and Cognitive Biology, University of Vienna, Vienna, Austria

One of the most fundamental ecological challenges that animals must face daily is finding and getting access to food. Confronting animals with a novel problem and measuring their behavioural responses is one of the key methods to investigate intra- and interspecific variation in a foraging context. In this study, we aimed to explore individual differences in problem solving by testing 26 common marmosets with three extractive foraging tasks (sliding door, pulling on string, pressing lever) of a standardized test battery apparatus (TBA). We first confronted individuals with one opening mechanism per session and then gave them the choice between all three mechanisms simultaneously. We recorded the monkeys' approach latencies, stress- and attention-related behaviours, and amount of time manipulating each mechanism. We expected subjects to solve all three problems but to be the most successful, and to have a preference for, opening the simplest mechanism (i.e., "slide"). We further predicted that females (that are more food motivated), older (that are more experienced) and more persistent individuals (that show a higher motivation) will have higher success rates and shorter opening latencies irrespective of the opening mechanism. Contrary to our expectation, we found that only half of the monkeys opened the TBA by using the "slide" mechanism, only one individual opened with the "pull" mechanism and none of the monkeys opened with the "lever" mechanism. The observed floor effect in two out of the three tasks restricted further analyses of the preferred technique. We discuss the found inter-individual variation in opening success in relation to other findings on the same subjects in personality tasks (Boldness-Shyness, Exploration-Avoidance) and in respect to methodological constraints of the current set-up.

**106 Marijke Versteven** *The neurobiology of social context-dependent stress responses*

Marijke Versteven\*<sup>1</sup>, Afroditi Tzepakadaki<sup>1</sup>, Jean-Christophe Billeter<sup>1</sup>, <sup>1</sup>GELIFES, University of Groningen, NL

Sociability, an individual's tendency to engage in group interactions, is a fundamental property of life. Recently, sociability has been identified as a strong mortality predictor in humans. Although affecting health, we lack an understanding of the biological mechanisms underlying sociability. I here propose that the presence of others modulates an individual's response to a stressor. Being an evolutionary conserved trait, I am investigating the sociability neurocircuitry in the model system *Drosophila melanogaster*. Our first observations point towards group size dependent sex dimorphic differences in heat resistance to noxious temperatures. Females benefit from being included in larger groups than males in terms of reaction speed, temperature of Vmax and survival when being exposed to harmful temperatures. Furthermore, flies show sex specific social leg interactions when being subjected to a temperature gradient up until the point of conspecifics' heat paralysis, implicating sex-specific cooperation in heat resistance. As social interaction requires conspecific recognition and context, I will further explore the importance of various sensory modalities underlying social context-dependent sex dimorphic heat stress and resistance responses.

**107 Alexandros Vezyrakis** *Into the reptilian Umwelt: the effect of chemical versus visual information on learning performance of lizards*

Alexandros Vezyrakis\*, Max Planck Institute for Evolutionary Biology, University Potsdam; Gilles De Meester, University of Antwerp; Raoul Van Damme, University of Antwerp

Within cognitive research, there exists the danger of designing experiments that fit our anthropocentric world view but fail to fully consider a species' ecology and life history. Proper cognitive tasks using a species' sensory ecology are necessary to fully understand the extent of its cognitive abilities and their ecological relevance. In reptiles, most studies have been limited to learning visual discriminations. However, olfaction is an essential sense for reptiles, with important ecological implications as many species are likely to use both chemical and visual cues in their natural habitat. In fact, chemical cues are hugely important for reptiles in many contexts. Hence, the exclusive use of visual cues in previous studies may have led to underestimations of reptilian cognitive abilities.

In this study, we aimed to test how cue type would affect the learning success of common lizards (*Zootoca vivipara*) in a discrimination task. The lizards were given one type of cue (colour or odour) and after learning to make the correct choice, the test was repeated using the other cue type. Our results show that lizards were able to learn both using visual and chemical cues and switch between them. To our knowledge, this is the first evidence that associative learning is possible with olfactory cues in lizards. Our animals performed better when given colour cues compared to when given odour cues, suggesting a complex link between sensory perception and cognition. Further research is required to diminish human biases and improve our insight into the effects that a species' Umwelt has on their perceived cognitive abilities

**108 Ernő Vincze** *Urbanization's effects on problem solving abilities: a meta-analysis*

Ernő Vincze\* (Lund University, Lund, Sweden; University of Pannonia, Veszprém, Hungary); Bálint Kovács (University of Pannonia, Veszprém, Hungary; Eötvös Loránd University, Budapest, Hungary)

Cognitive abilities are often assumed to be advantageous in urban habitats, but relatively few studies tested this assumption. In a meta-analysis, we tested whether urban animals have better problem-solving abilities compared to their less urbanized conspecifics. After screening 210 papers we collected by keyword search and forward search, we found 12 studies that compared the ability to solve food-extraction or obstacle-removal problems between urban and non-urban populations of the same animal species. These studies were published between 2009 and 2021, and were performed mostly on birds, whereas a quarter of them used mammals as study species. We found a statistically non-significant trend that urban animals are more successful and faster problem-solvers compared to their less urbanized conspecifics. However, both solving success and solving latency effect sizes were highly heterogeneous, therefore hard to generalize. Though the sample was too low to test the factors explaining this high heterogeneity, we suggest that it may be explained by variation in task types, study species, definitions of urbanization, whether the study was performed on captive or free-living animals, geographical location, or publication bias in both directions. Altogether, more studies are needed to either confirm or disprove this trend.

**109 Kamil Vlček** *An afternoon nap helps in navigation using orientation marks*

Kamil Vlček\*, Institute of Physiology, ASCR, Praha; Stefanie Marková, National Institute of Mental Health,

Klecany; Jana Kopřivová, National Institute of Mental Health, Klecany; Daniela Urbaczka Dudysová; National Institute of Mental Health, Klecany;

Sleep is known for its positive effect on memorizing information. Especially the non-REM sleep supports consolidation, i.e. strengthening the memories, and also improves the learned material organization. In several studies, sleep has been shown to enhance orientation in a new environment and finding shortcuts.

In this study, we focused on its influence on the two most important strategies of navigation in space: egocentric, relatively to subjective position, and allocentric, relative to landmarks.

To our aim, we created an experiment in the real-space analogy of Morris's maze, which allowed us to distinguish these two strategies.

Our participants were a group of healthy students (n = 20) balanced in gender.

First, they learned the position of six targets on the floor: three allocentric targets, defined by the landmark on the arena wall, and three egocentric targets, defined by the starting position at the arena wall. This session was followed by a 90 minutes afternoon nap or wake-up in the sleep laboratory. We monitored each participant by polysomnography and EEG. Subsequently, their task was to repeatedly find learned places either by starting position (egocentric) or orientation marks (allocentric). Each volunteer participated in the experiment for two days, sleeping on one day and awake on the other day.

We analyzed the target estimation error during the test in a two-by-two design: depending on sleeping/being awake and on allocentric/egocentric target type. We found a significant interaction between the two factors using a two-way ANOVA. After the sleep, the participants estimated better the positions of targets only allocentric type.

Our results show the different effects of sleep on these two navigation strategies related to their brain location. Sleep consolidation helps allocentric navigation connected primarily with the medial temporal lobe, similarly to declarative memory

**110 Lea Vodjerek** *Do females prefer more confident males? The role of male quality in pregnancy turnover*

Lea Vodjerek\*, Animal Ecology, University of Potsdam, Potsdam, Germany; Jana Eccard, Animal Ecology, University of Potsdam, Potsdam, Germany

Sexual selection theory predicts conflict between the sexes about investment into offspring. Parental investment is specifically unbalanced in mammals. The Bruce effect, i.e., the termination of a pregnancy sired by the former breeding male after the invasion of a new breeding male, is often seen as a counterstrategy to infanticide. Meanwhile, pregnancy termination is usually immediately followed by a new pregnancy sired by the invading male in many species and may thus be considered a pregnancy turnover in the context of sequential mate choice. Pregnancy turnovers have been documented for numerous rodent species in captive pair studies. In this experiment, we will investigate pregnancy turnover as a form of sequential mate choice and manipulate quality of first versus second male offered to the female. We use bank voles (*Myodes glareolus*) as study system, since it has been showed that 50% of females exhibit turnover of pregnancies after male turnover in the field and lab. For this experiment we will choose males as different as possible combining different qualities perceivable to human observers,

i.e., experimental high-quality males (HQ) will have a higher UMV, will be larger, and bolder than experimental low-quality males (LQ). The second male will be offered one week after the first one, and females can only achieve a trade-up of sire quality by terminating the first pregnancy. We hypothesised that the occurrence of late pregnancies, an indicator of pregnancy turnover, is higher in LQ-HQ than in HQ-LQ treatments.

**111 Vanessa von Kortzfleisch** *Biological variation accounts for most of the variation in a multi-laboratory study*

Vanessa Tabea von Kortzfleisch\*, Department of Behavioural Biology, University of Münster; Sylvia Kaiser, Department of Behavioural Biology, University of Münster; Norbert Sachser, Department of Behavioural Biology, University of Münster; S. Helene Richter, Department of Behavioural Biology, University of Münster

In light of the ‘reproducibility crisis’, huge emphasis has been put on the identification of potential confounding factors in animal research. Divergent findings between replication studies are often attributed to different experimenters or the influence of different laboratory environments. To exploratory dissect how much variation is introduced by such confounding factors, we used the data of a previously conducted multi-laboratory study. Originally, this study was conducted to investigate the reproducibility of behavioural strain differences between two inbred strains of mice (C57BL/6J and DBA/2N) comparing two alternative experimental designs. In each of three laboratories, four experimenters conducted the same animal experiment under highly standardised conditions, resulting in 12 experimenters testing 288 animals in 3 laboratories. By applying a component of variance analysis, we assessed the influence of the different laboratories and experimenters and other often discussed sources of variance, such as for example the cage. Our results revealed that the variation introduced by the ‘experimenter’ was much smaller than the variation introduced by the ‘laboratory’, which explained on average 25% of the total variation. Even more interestingly, for the majority of outcome measures, the remaining residual variation was identified as the most important source of variance accounting for 41% to 72% of the observed total variance. This is particularly alarming as standardisation is assumed to create controlled and homogeneous conditions for animal studies that are characterised by minimal random variation (i.e. ‘noise’). Therefore, our findings serve as an impressive example of how much biological variation exists despite strict standardisation regimes. Instead of trying to eliminate this variation in animal studies, better strategies are needed to integrate this variation in our experimental designs in a controlled way.

**112 Mukta Watve** *Climate variability, helper number and maternal investment in a cooperative breeder*  
Mukta Watve\*, University of Exeter; Andrew F. Russell, University of Exeter

Theory proposes that parental responses to helper presence in cooperative breeding systems, wherein helpers paradoxically forego personal reproduction to assist breeders, depends on nestling survival probability. Comparative evidence in birds shows that breeders maintain high levels of provisioning with helpers in species with low levels of nestling starvation but reduce provisioning rates with helpers in those species with high nestling starvation, relative to levels in the absence of help. A powerful test case, however, would be to investigate parental responses to helper presence as a function of variable climatic conditions: when conditions are unfavourable and nestling mortality is high, we would expect parents to maintain investment, and then reduce investment when conditions are favourable. However, studies have yet to investigate helper effects on breeder provisioning rates within a species breeding in variable



environmental conditions. Further, it is unknown whether such predictions also hold at the pre-natal investment stage, and how pre-natal investment affects post-natal investment levels. Here we investigate the interplay between helper number and climatic conditions on pre-natal investment by mothers, and the post-natal investment by breeders as well as helpers. Our model species is the chestnut-crowned babbler (*Pomatostomus ruficeps*) from the climatically stochastic arid zone of Australia which breeds over highly variable conditions within and among years, and for which parental provisioning rates and nestling survival probabilities vary markedly. The results of our study will not only contribute to our limited understanding of socio-ecological drivers of maternal effects in cooperative breeders, but their potential to influence our understanding of the evolution of cooperative breeding systems now and under a changing climate.

**113 Amelia Wein**      *Validation study: measuring dominance rank in kea parrots*

Lucie, Gudenus\*, MEI:CogSci Middle European Master's of Cognitive Science; Denis, Kovalenko, Comparative Cognition, Messerli Research Institute; Amelia, Wein, Comparative Cognition, Messerli Research Institute In this study, we attempt to validate a method of measuring dominance rank in kea parrots using a tournament methodology. 14 captive kea subjects participate in dyadic tournament tests, in which two subjects are separated from the group and given simultaneous access to a monopolizable food reward. The subject which succeeds in displacing the other from the reward, or preventing it from obtaining the reward in the first place, is coded as the winner of that dyad, and thus the more dominant of the pair. All combinations of dyads are tested one time in this manner, and the resulting winner/loser matrix is used to calculate the dominance hierarchy. The tournament method is a quick way to generate a dominance hierarchy, as each dyad is tested only once, and multiple tests can be performed each day. However, it is unclear whether the hierarchy resulting from the tournaments corresponds to how subjects interact when they are in a group setting. Therefore, the same 14 subjects are observed during mealtimes at a foraging area, and all dyadic, agonistic encounters with a clear winner and loser are noted. From the group data the hierarchy is calculated a second time and compared with the one resulting from the tournament. We predict that the tournament hierarchy will correspond to the hierarchy generated from the group interactions.

**114 Amelia Wein** *Does demonstrator dominance affect observer success in a social learning task?*

Amelia Wein, Comparative Cognition, Messerli Research Institute, University of Veterinary Medicine Vienna\*, Lucie Gudenus, Middle European Interdisciplinary Masters in Cognitive Science; Raoul Schwing, Comparative Cognition, Messerli Research Institute, University of Veterinary Medicine Vienna

In research on social learning and imitation, the question often arises of how learners choose reliable models to copy. Here, we investigate the effect of dominance in a social learning task in captive kea parrots. First we establish a dominance hierarchy for 14 kea subjects using a tournament methodology. In the tournament, two kea are simultaneously given access to a monopolizable reward, and the one that succeeds in displacing the other to eat the reward is considered the winner of that tournament and the dominant of the pair. This is repeated until all pairings have been tested, and the results of the tests are calculated into a dominance hierarchy using David's score. Using the established dominance hierarchy, we choose the most dominant and least dominant individuals to serve as demonstrators for the test subjects. The demonstrators are trained to open a box in a two-step process, which they demonstrate for an observer. Observers are divided into two groups: one group observes the dominant demonstrator, and the other group observes the subordinate demonstrator, after which the observer is given access to the

box to solve on its own. A third control group is given access to the box with no prior demonstration, to determine the baseline time it takes for kea solve the task. The task is exactly the same for all three groups, with the only variable being the demonstrator. We will measure 1) how quickly subjects approach the box, and 2) how long it takes for subjects to solve the task. If dominance is a cue for demonstrator reliability in kea, we predict that subjects who observed the dominant demonstrator will approach the box more quickly, and solve it in less time.

**115 Steve Whalan** *“Hearing“ without ears: sponge larvae detect and respond to sound*

Steve Whalan, Southern Cross University.

The capacity to communicate is tightly coupled to animal behaviour. Communication can rely on the use of chemicals, visual signals, or sound, all broadly contributing to inter and intra specific behaviour. Relying on sound to communicate requires an initial capacity to detect sound. There is a remarkable diversity of auditory sensory systems in animals, but all rely on a capacity to detect and process sound, routinely through an “ear” and coupled sensory (nervous system). But what about animals that don’t exhibit obvious auditory systems, and indeed for sponges that have no nervous systems at all? With no known information of sponges responding to sound this study addressed a fundamental question: do sponges have any capacity to detect and respond to sound? The motile larval phase of two coral reef sponge species was targeted because their larvae show behavioural responses to other environmental stimuli. Larvae were placed in experimental aquariums, exposed to pre-recorded reef sounds projected from one end of an aquarium, and positions of larvae noted over time. To understand if larvae can discern different sounds a quasi- control treatment included punk rock music, a sound source that larvae should have no innate or experienced reference to. Scanning electron microscopy (SEM) of larvae was also used to visualise external morphologies that may be indicative of an “auditory system”. Both species showed clear responses of larvae moving to reef sounds. Larvae also showed equally consistent responses to punk rock music, suggesting a non-discerning movement response to sound in general. SEM showed larvae exhibit ciliated external surfaces, and conspicuous posterior ciliated tufts, which may facilitate the detection of vibrations (sound). This study provides a first step in our understanding of the role of sound for sponges and is a catalyst for further work.

**116 Rori Wijnhorst** *Data simulation and statistical methods for estimating variation in social responsiveness and social impact*

Rori Wijnhorst, LMU\*; Corné de Groot, LMU; Jonathan Wright, NTNU; Yimen Araya-Ajoy, NTNU; Niels Dingemanse; LMU

Indirect genetic effects (IGE's) occur when individuals display heritable traits that respond plastically to heritable traits of conspecifics, meanings that the expression of a phenotype is indirectly determined by the genes of others. Consequently, IGE's may increase or decrease the amount of variation available for selection, thereby enhancing or constraining the speed of evolution. The study of indirect genetics effects in the field and in laboratories is rapidly developing and a profound understanding on how to reveal indirect genetic effects is lacking. We know that estimating between and within-individual variation requires multiple measurements of individual behaviour. Within-individual variation may arise from a change in internal state of the individual. However, adaptive theory suggest that within-individual variation can also be explained by an individual's ability to adapt to a changing environment. In the case of indirect genetic effects, the changing environment consists of conspecifics. Thus, a focal individual may be

affected by its social environment and adjusts its behaviour accordingly (social responsiveness). Simultaneously the focal individual may influence its social environment by eliciting certain behaviour in conspecifics (social impact). Disentangling the cause from effect may become highly complex when individuals adjust their phenotype plastically in changing social environments. It is therefore important to develop methods that allow partitioning of individual trait variation into an individual's personality, its social responsiveness and its social impact. Using simulated data and statistical analyses, I will demonstrate the optimal study design for estimating indirect genetic effects. This study will provide the necessary guidelines for researchers in the field and in the lab on how to research indirect genetic effects in animal populations.

**117 Bing Xie** *Vocal communication in groups, the case of the plains zebra*

Bing Xie\*<sup>1</sup>, Amanda Kjersner<sup>1</sup>, Virgile Daunay<sup>1</sup>, Stine Kjær<sup>1</sup>, Josefine Brask<sup>2</sup>, Elodie Mandel-Briefer<sup>1</sup>, <sup>1</sup> Behavioural Ecology Group, Department of Biology, University of Copenhagen, Copenhagen, Denmark, <sup>2</sup> Department of Applied Mathematics and Computer Science, Technical University of Denmark, Denmark

Living in groups results in various conflicts due to the different needs of each individuals. In order to maintain group cohesion, group-living animals thus need to synchronize and coordinate their activities. A notable way to achieve this aim is through auditory signals, which, because of their loudness, conspicuousness and long-range travelling abilities, can be perceived by more than one individual. Though acoustic communication between one signaler and one receiver has been widely studied (e.g. individual recognition, mother-infant interactions), in social groups, communication occurs in a network composed of many potential signalers and receivers. The project uses the plains zebra as model, for its unique and stable multilevel societies, frequent and multi-meaning calls, migration habits and naturally individually labeled stripes that can be used for individual identification. The goal of the study is to revisit the vocal repertoire of this species using advanced acoustical and statistical analyses, and test the potential for each type of call to encode information about the individual identity of zebras, their gender, and social features extracted from social network analyses. We collected audios and individual data from Pilanesberg National Park in South Africa, as well as Givskud SafariPark and Knuthenborg Safaripark in Denmark, resulting in around 80-hour audios and the recognition of 1000 individuals from 370 groups. We employ unsupervised clustering approach of machine learning to estimate the most likely number of distinct call types after extracting thirteen acoustic features. We also use supervised classification to investigate vocal individuality and gender categorization. Moreover, we apply social network analyses to build a zebra network and extract social features. The relationship between vocal and social features is also investigated. The study provides a broad overview of vocalization and their potential function in a wild ungulate, as well as a glimpse into how vocal communication interacts with social networks.

**118 Gaoyang Yu** *Intruder sex and breeding stage influence territorial aggressiveness – but only in male not female blue tits (Cyanistes caeruleus)*

Gaoyang Yu\*, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands; Koen Baas, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands; Alexander A. Schlatmann, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands; Stephen Salazar, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands, Department of Animal Behaviour, Bielefeld University, Germany; Maaïke A. Versteegh, Groningen Institute of

Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands; Jan Komdeur, Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands; Peter Korsten, Department of Animal Behaviour, Bielefeld University, Germany.

Aggressive behaviour is common in nature and may be closely linked to individual fitness (i.e., survival and reproductive success). Aggressive individuals may gain priority access to resources such as food and mates. At the same time, they may also bear costs, including energy expenditure, risk of injury, exposure to predation, and physiological stress. At present, research on individual differences in aggressiveness and its ecological causes and consequences remains scarce. Moreover, much research has focused predominantly on aggressiveness in males rather than females. In this study, we tested the repeatability of aggressiveness in both sexes in a nestbox-breeding blue tit (*Cyanistes caeruleus*) population using simulated territorial intrusions. We investigated female and male aggressiveness towards intruders of both sexes during different breeding stages (nest-building and egg-laying), and with different modes of song playback (paused and continuous). We found that aggressiveness was repeatable in both sexes. Male blue tits showed greater aggressiveness towards male intruders than female intruders, and their aggressiveness levels decreased in the egg-laying stage compared to the nest-building stage. In contrast, we found no significant differences in female aggressiveness between female and male intruders or different breeding stages. As for song type, paused song triggered more aggressiveness in each breeding stage in both sexes. Furthermore, focal bird age influenced aggressiveness — first-year breeders showed stronger aggressive responses than older ones, but only in the nest-building stage. Our results show that intruder sex and breeding stage relate to male but not female aggressiveness, suggesting different ecological trade-offs may underlie the observed variation in female and male aggressiveness.

**119 Jeroen Zewald** *Monopolizability affects cooperation and partner preference in long-tailed macaques (*Macaca fascicularis*) without evidence for coordination or communication*

Jeroen Zewald\* 1,2 ; Nina van Oordt 1 ; Lisette van den Berg<sup>1,3</sup>; Elisabeth Sterck 1,4 ; 1 Animal Behaviour & Cognition, Utrecht University, Utrecht, The Netherlands 2 Unit of Comparative Cognition, Messerli institute, University of Veterinary Medicine Vienna, Vienna, Austria 3 Apenheul, Apeldoorn, The Netherlands 4 Animal Science Department, Biomedical Primate Research Centre, Rijswijk, The Netherlands

An advantage of group living is cooperation, yet cooperation depends on many facets. Cooperation requires tolerance and may be better coordinated among bonded group members. However, when resources are monopolizable, dominant individuals may limit access and only dominants, not bonded individuals, may get access. This predicts that cooperation by bonded individuals is more often found when resources are more dispersed. In addition, synchrony due to concerted action and communication may enhance cooperation. We assessed cooperation in a group setting with the loose string paradigm in captive long-tailed macaques (*Macaca fascicularis*), offering them one, three or five cooperation locations. Even though we did not find evidence of coordination or communication, we did observe high levels of cooperation. We also found a strong influence of monopolisation, especially between the one location condition compared to the three and five locations conditions. Contrary to our prediction, bonds were only relevant in the one table condition, which was mainly driven by one male dyad that was very successful with one location, but hardly cooperated when several locations were available. In conclusion,

we show that monopolizability of cooperation locations influences the cooperation distribution and partner preference, without a need of communication and coordination.

**120 Xia Zhan** *Competition as a driver of eco-evolutionary dynamics: linking individual aggression and environmental quality to reproductive performance—A project plan*

Xia Zhan 1\*, Gaoyang Yu 1, Maaïke A. Versteegh 1, Jan Komdeur 1, Peter Korsten 2. 1. Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, The Netherlands 2. Faculty of Biology, Bielefeld University, Germany

Aggression is expressed during intraspecific competition over finite resources (food, territories, mates) essential for survival and reproduction. Aggression likely increases individuals' resource-holding potential. However, there are still knowledge gaps in our understanding of the trade-offs governing the eco-evolutionary causes and consequences of aggressive behaviour. Given that natural environments are typically heterogeneous, with high and low-quality patches in terms of their resources, correlations are expected between the competitiveness of individual phenotypes that may be related to their aggressiveness, and the quality of their breeding environments. Such phenotype–environment correlations may challenge the partitioning of phenotypic and environmental contributions to among-individual variation in fitness (reproductive performance) and drive the dynamics of dispersal and settlement within population. In this PhD project, we will investigate the combined effects of phenotype (aggression) and environmental quality in driving dispersal, settlement and fitness using a long-term individual-based population study of blue tits (*Cyanistes caeruleus*). The study has four main objectives: (1) Testing for phenotype–environment correlation between aggression and territory quality; (2) Assessing the role of individual aggression in mate selection and the fitness consequences for each sex; (3) Documenting the links between individual aggression, environmental quality and breeding dispersal; (4) Providing a meta-analysis on the trade-off between resource acquisition and resource utilization.

**121 Paolo Panizzon** *Effect of the environment on the development of laterality and personality in the Three-spined Sticklebacks*

Paolo Panizzon(1,2)\*, Jakob Gismann(1), Flavia Berlinghieri(1,2), Bernd Riedstra(1), Marion Nicolaus(1), Culum Brown(2), Ton Groothuis(1), 1) GELIFES, University of Groningen, Groningen, The Netherlands; 2)Department of Biological Sciences, Macquarie University, Sydney, Australia

Laterality of brain and behavior has been found to be widespread among animal species. Recently, laterality has been found to be correlated to personality. In addition, the development of both personality and laterality in fish can be influenced by environmental factors: e.g., high perceived predation leads to bolder and more lateralized individuals. Also, in fish, bolder and more lateralized individuals tend to swim in a safer and energetically more favorable position than other individuals while schooling. However, whether this correlative evidence indicates a causal relationship between laterality and personality is yet unclear. Such a causal link will have consequences for evolution, as selection on one may constrain evolution of the other.

The aim of this experiment was to manipulate rearing conditions to see to what extent both laterality and personality are affected together, which would indicate a causal relationship between the two. Three-spined stickleback larvae were therefore reared under predation cues or in the absence of it in small or large groups for 3 months in a two-by-two design, after which their behavior during schooling, social

interacting, and predator inspection was recorded in standard tests. We expected that the fish reared under high predation perception and/or in large groups will show a higher tendency to school, a bolder behavior and more lateralized behavior than the control group reared under low predation pressure and small group size. The results are currently being analyzed.

**122 Marina Papadopoulou** *Disentangling patterns of collective escape in starling flocks*

Marina Papadopoulou \*(Swansea University, University of Groningen), Hanno Hildenbrandt (University of Groningen), Charlotte K. Hemelrijk (University of Groningen)

Complex patterns of collective behavior may emerge through self-organization, from local rules of interactions among individuals. The relation between local rules and global patterns is not trivial; computational models have been proven necessary for tracing emergent properties in animal groups. One of the most complex patterns in nature is the collective behavior of European starlings under attack, with their large flocks changing shape and internal structure rapidly and continuously. Even though their collective behavior is well studied, our understanding of how patterns of collective escape emerge is still limited; models of collective escape are rare. Here, by qualitatively analyzing footage of starling flocks pursued by a robotic predator, we observe that some patterns of collective escape often co-occur in a single flock (more than one pattern arise simultaneously at different parts of the flock). This phenomenon has never been studied before. Aiming to understand how this co-occurrence emerges, we develop a new three-dimensional agent-based model, inspired by our empirical observations. Our simulated flocks resemble large flocks of starlings in both the rules of motion and coordination at the individual level, as well as properties of the flock, its density and internal dynamics and structure. Patterns of collective escape emerge from one or few individuals performing a discrete escape maneuver (turning or diving) away from an attacking predator, and from their neighbors copying their behavior. We study the co-occurrence (in a single flock) of patterns such as vertical shape, collective turns, splits, and cordons. Our model is the first to realistically simulate several patterns of collective escape in bird flocks, enabling the future study of these patterns in detail across species.

**123 Elke Molenaar** *Stopover decisions of migrating white stork (Ciconia Ciconia) in Egypt – the role of sewage ponds.*

Khaled Noby (1,2) , Elke Molenaar (2) , Marc Naguib (2)

1) Nature Conservation Egypt, Cairo, Egypt

2) Behavioural Ecology Group, Wageningen University, Wageningen, The Netherlands

Migratory properties differ among species, individuals, and regions, and are influenced by many factors, of which ecological barriers and weather can have major impacts. Especially long-distance migrants, such as white storks (*Ciconia ciconia*), make crucial decisions along the way between their breeding grounds in the Northern Hemisphere and wintering grounds in sub-Saharan Africa. Resource availability, such as freshwater bodies and foraging sites, affect stopover decisions that are crucial to rest and refuel before continuing. Habitat selection during stopovers can therefore be expected to have strong fitness effects. Since the use of stopover sites can vary drastically over time and in space, it is important to identify those sites to be able to determine the stopover preferences as well as to identify associated threats. From multiple areas throughout Europe, observations indicate that white stork make frequent use of garbage dumps and wastewater treatment plants (WWTPs),

which can have both positive and negative effects on individuals. Yet, this phenomenon has barely been studied in arid areas along migratory routes such as in Egypt, where sewage ponds can be the only freshwater source and least disturbed wetlands. Moreover, Egypt is at a key geographic location being the flyway for millions of birds on their journeys between their breeding grounds in Europe and their wintering grounds in sub-Saharan Africa. Thus, here we show results of GPS-tracking data from migratory storks which we used to identify stopover sites along with satellite image analyses of landscape characteristics and proximity to WWTPs. Understanding the effect of WWTPs on stopover decisions by birds is important since the reliance upon WWTPs could have impacts on both bird and human health, by for example death through plastic and poisonous material ingestion and disease transmission. Thus, identifying the characteristics of WWTPs as stopover sites could have strong conservation implications.

**124 Kyriacos Kareklas** *Social brain and stress response: phenotypic components and conserved mechanisms in fish*

Kyriacos Kareklas\*, Gulbenkian Institute of Science, Portugal; Ibukun Akinrinade, University of Calgary, Canada; Claudia Gonçalves, Gulbenkian Institute of Science, Portugal; Magda Teles, Gulbenkian Institute of Science, Portugal; Giovanni Petri, ISI Foundation, Italy; Susana Varela, Gulbenkian Institute of Science, Portugal; João Costa, Gulbenkian Institute of Science, Portugal; Ricardo Leite, Gulbenkian Institute of Science, Portugal; Thiago Paixão, Gulbenkian Institute of Science, Portugal; Michael Glikberg, Weizmann Institute Of Science, Israel; Hansjoerg Kunc, Queen's University Belfast, UK; Gil Levkowitz, Weizmann Institute Of Science, Israel; Gareth Arnott, Queen's University Belfast, UK; Rui Oliveria, ISPA - Instituto Universitário & Gulbenkian Institute of Science, Portugal

The social brain plays a key fitness role in stress response. On one hand, it enables behavioural adjustments to external pressures that minimize costs and improve decision-making in vital social behaviours, such as resource-attaining contests. On the other hand, stress can be better anticipated and managed by the social transmission of information. The basis of these processes is cognitive assessment and the motivation to interact with others, while overall susceptibility to stressors can be defined by trait anxiety. Therefore, understanding the mechanisms by which the social brain organises stress response requires the characterisation of these components and their interplay, which is an underexplored approach that we adopted in fish models. In earlier work on territorial contests in Siamese fighting fish, *Betta splendens*, stress from noise and nesting success was found to elicit marked changes in strategy, but, contrary to theory, cognitive assessments were only partly mediated by agonistic motivation. In zebrafish, we recently demonstrated that cognitive and motivational modules have some distinct effects, generalised across social and non-social contexts, but also partly relate with anxiety ( $r > 0.4$ ). Single-nucleotide polymorphisms in neuroplasticity and reward-pathway genes were implicated across modules, but dominant effects were also exhibited by the oxytocin-ligand gene and Shank3, a synaptic plasticity and leading autism-pathology gene. We thus investigated the role of these systems in the social transmission of alarm-induced stress, using a video-playback approach for quantifying behavioural contagion, cognitive discrimination of distress from neutral states and effects on approach motivation. Using genetic models, the oxytocin pathway was found necessary and sufficient for stress contagion, recognition and the approach of stressed others, while mutation to the Shank3 gene elicited deficiencies across these phenotypes. These findings demonstrate the implication of motivational and cognitive components in social stress response and reveal the role of conserved neural mechanisms and pathologies.

**125 Elisabeth HM Sterck** *Gaining and maintaining friends: a computer model of primate bonding*

Elisabeth HM Sterck<sup>1,2</sup>, Han de Vries<sup>1</sup>, Tonko W Zijlstra<sup>1,3,4</sup>

1. Animal Behaviour & Cognition, Utrecht University; Utrecht, the Netherlands; 2. Animal Science Department, Biomedical Primate Research Centre, Rijswijk, the Netherlands; 3. Cognitive Psychology Unit, Institute of Psychology, Leiden University, Leiden, the Netherlands; 4. Leiden Institute for Brain and Cognition (LIBC), Leiden, the Netherlands

Bonds (or good relationships or friendships) are long-term mutually friendly interactions among specific group members. Bonds are found in many primate species and have been shown to provide fitness benefits. At the proximate level, this begs the question how these bonds are gained and maintained. To this end, agent-based computer models are an excellent tool, since these allow the exploration of the link between internal emotional processes and behavioural outcomes. With the agent-based EMO-model, we explored the connection between two types of internal emotional processes directing grooming partner choice which in turn determine group level patterns in gaining and maintaining of bonds. The internal processes that at a low bond strength do not promote partner choice of recent grooming partners, but that enhance such partner choice at high bond strength, lead to stronger and more differentiated bonds than the internal process that is neutral to bond strength. Bond formation is especially strong and stable when these internal processes do not quickly update partner choice preferences. Thus, bonds are strongest and most differentiated when friends are gained slowly, but are long remembered. PLoS ONE 16(4): e0249519. <https://doi.org/10.1371/journal.pone.0249519>

## 126 Salamatu Abdu

**127 Simon Turner** *A central play fighting social network position does not reduce injuries from later aggression between pigs*

\*Simon P. Turner, Scotland's Rural College, Edinburgh, UK; Jennifer E. Weller, Agri-Food and Biosciences Institute, Hillsborough, UK; Irene Camerlink, Polish Academy of Sciences, Jastrzębiec, Poland; Gareth Arnott, Queen's University Belfast, UK; Taegyu Choi, University of Edinburgh, UK; Andrea Doeschl-Wilson, University of Edinburgh, UK; Marianne Farish, Scotland's Rural College, Edinburgh, UK; Simone Foister, ITL Scotland Ltd., Edinburgh, UK

Play fighting is common in young mammals. Proposed functional benefits include enhanced motor, social and cognitive development, leading to improved physical skill and opponent assessment. This could reduce social conflict later in life and improve fitness and welfare. Using pigs (*Sus scrofa*), we examined whether variation in play fighting involvement before weaning predicted the number of injuries received from aggressive interactions when older. Piglets ( $n=239$ ) experienced pre-weaning socialisation ( $n=135$ ; joining two neighbouring litters at 2 weeks old; 'socialised') or remained in their litter group ('control';  $n=104$ ). Socialisation aimed to replicate the age of integration of wild boar litters. Play fighting interactions were recorded between 14-26d of age. Social network analysis quantified pigs' position of centrality in the play fighting network of their pen using degree centrality, Eigenvector, betweenness and clustering coefficient. The number of skin lesions at 11 weeks old was assessed 24h after pigs were mixed into new groups ( $n=8$  socialised groups; 94 pigs; 5 control groups; 63 pigs) and at 3 weeks post-mixing (14 weeks old). Assortment analysis showed that in 2 out of 6 socialised groups, piglets had a strong preference to play with littermates ( $P<0.001$ ). At the pen level, play network structures were similar in socialised and control groups. Large variation existed in play fighting engagement and individual network position between pigs. Pigs with many play fighting partners had more lesions at 14 (mixed models,  $F_{1,46}=4.11$ ,  $p=0.05$ ) but not 11 wk. The individual animal's position within its play network did not affect skin lesions ( $F_{1,88}=0.06-1.76$ ;  $p=0.18-0.95$ ). These results suggest that play fighting does not reduce costs of fights in



immature pigs. Future work should explore if it promotes social cohesion or reduces conflict between adults where fitness costs of aggression may be higher. The work was approved by the UK government and institutional ethical review panel.

**128 J.Fransje van Weerden, University of Groningen** *Agent Based Model of observational and emotional learning processes in groups suffering disturbances -*

Is adapting behaviour always better? Using an ABM model to simulate a group of foragers - with low cognition, they do not recognize others as being in a similar situation, but do not know them as individuals - under predation or other disturbance, makes it necessary to think hard about the assumptions used in modelling, especially when the model is supposed to be a general model for a wide variety of species. For instance, detection of a disturbance would always be some sort of sigmoid, and sudden fleeing behaviour in one individual makes others flee to by contagion. Making the behaviour slightly more sophisticated, widespread forms of adapting behaviour are added : experience gain or a change in fear levels for certain recognized patterns. When one also realizes that the initial setting for fear levels for instance represent the group being dumped in a new environment with a certain ratio of predator attacks to innocuous disturbances, one can simulate and evaluate what happens to groups that do or do not have these adapting behaviours, in the long term, but also in the short term in Rapid Ecological Changing environments. This model gives rise to many testable predictions for empirical observations and vice versa.

**129 Harrington Katie** *Bringing the falcon family into comparative cognitive research: striated caracara as a model*

Katie Harrington, Messerli Research Institute, University of Veterinary Medicine, Vienna\*; Laura Biondi, Universidad Nacional de Mar del Plata; Ulises Balza, Centro Austral de Investigaciones Cientificas (CADIC-CONICET); Megan Lambert, Messerli Research Institute, University of Veterinary Medicine, Vienna

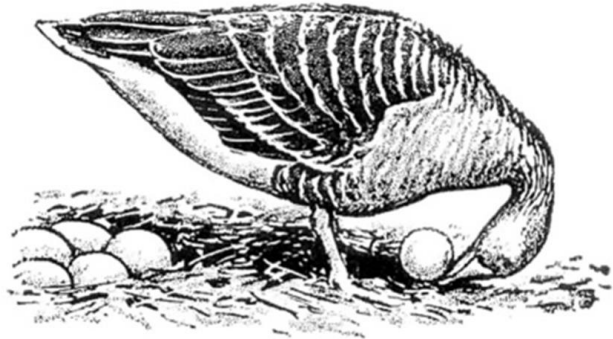
The social brain Comparative cognitive ecologists aim to understand the selective pressures that give rise to cognitive abilities. In mammals, a wide range of distinct taxa have been investigated, while most avian cognitive work has been limited to passerines (e.g., corvids, parids) and parrots (e.g., kea). Despite modern gene sequencing that has revealed falconids are a sister clade to parrots and songbirds (i.e., proposed clade Eufalconimorphae), falconids have not yet been widely considered as candidates for cognitive research. Striated caracara (Falconiformes, *Phalcoboenus australis*) are a little-studied, near-threatened species of conservation concern that inhabit the outer Falkland Islands and the southern tip of South America. The species exhibits many of the life history traits typically correlated with cognitive capabilities, including extended juvenile period, delayed sexual maturity, and long lifespan. They also share behavioral characteristics that have long been suggested as preconditions for cognitive abilities, including a fission fusion social system, cooperative behavior, and a generalist-opportunist foraging strategy. Moreover, they are island-restricted and have adapted to survive in a harsh sub-Antarctic environment, contexts that has been hypothesized to favor cognitive abilities. They are widely recognized by falconers and conservationists as social, intelligent, approachable, and inquisitive birds. In the species stronghold of the Falklands, individuals can be easily trapped, individually marked, and relocated over time. To expand our understanding of the socioecological conditions necessary for specific cognitive abilities to emerge across taxa, we therefore propose striated caracara as a model system for future cognitive ecology research. In this poster, we review in detail the ecological pressures and behavioral characteristics of striated caracara that have been long suggested for cognitive abilities.



Sponsors

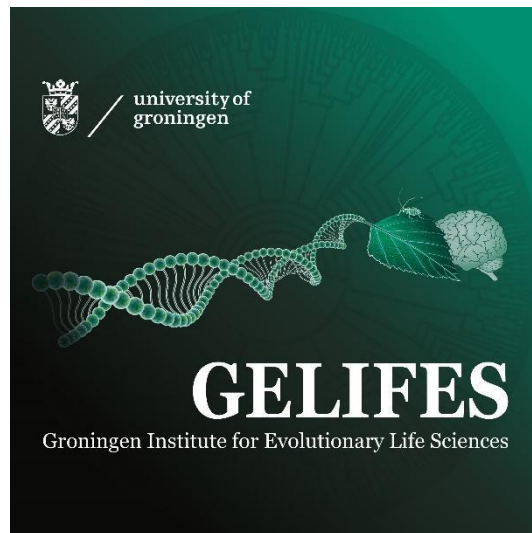


Association for the Study of  
Animal Behaviour



German Ethological Society

*Nederlandse Vereniging voor*  
**Gedragsbiologie**



**rijksuniversiteit  
groningen**

**groninger universiteitsfonds**

List of participants by surname in alphabetical order

Judit	Abdai	MTA-ELTE Comparative Ethology Research Group	Hungary
Salamatu	Abdu	Max Planck Institute of Animal Behaviour	Germany
David	Anderson	California Institute of Technology	USA
Atharva	Andhare	Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands	The Netherlands
Kateřina	Antonova	Charles University in Prague	Czech republic
Josh	Arbon	University of Exeter	United Kingdom
Saskia	Arndt	Utrecht University, Faculty of Veterinary Medicine	The Netherlands
Kerstin	Auer	Vetmeduni Vienna	Austria
Cedric	Aumont	Freie Universitat Berlin	Germany
Tiphaine	Bailly	University of Groningen	The Netherlands
Theo C. M.	Bakker	Institute for Evolutionary Biology and Ecology, University of Bonn	Germany
Sanne	Bal	Groningen Institute for Evolutionary Life Sciences, University of Groningen	The Netherlands
Awani	Bapat	University of Vienna	Austria
Irene Martinez	Baquero	University of Groningen	The Netherlands
Kat	Bebbington	University of Groningen	The Netherlands
Matteo	Beccardi	Institute of Avian Research "Vogelwarte Helgoland"	Germany
Veronika	Beeck	University of Vienna	osterreich
Chiara	Benvenuto	University of Salford	United Kingdom
Flavia	Berlinghieri	University of Groningen and Macquarie University	The Netherlands
Natalia	Bezuch	n.e.bezuch@2018.ljmu.ac.uk	United Kingdom
Debottam	Bhattacharjee	Utrecht University	Netherlands
Jean-Christophe	Billeter	University of Groningen	The Netherlands
Thibault	Boehly	Lund University	Sweden
Zsofia	Bognar	MTA-ELTE Lendulet "Momentum" Companion Animal Research Group, Department of Ethology, Eotvos Lorand University	Hungary
Lena	Bohn	University of Munster, Department of Behavioural Biology	Germany
Turcsan	Borbala	Department of Ethology, Eotvos Lorand University; MTA-ELTE Lendulet "Momentum" Companion Animal Research Group	Magyarorszag
Mirjam	Borger	GELIFES, University of Groningen	The Netherlands
Julie	Bosca	Laboratoire Ethologie Cognition Developpement, Universite Paris Nanterre	France

Marko	Bracic	University of Münster	Germany
Lindsey	Broadus	University of California, Davis	United States
Anna	Broseghini	Università degli Studi di Padova	Italy
Thomas	Bugnyar	University of Vienna	Österreich
Lara Sophie	Burchardt	Radboud University   Donders Center for Cognition	The Netherlands
Irene	Camerlink	Polish Academy of Sciences	Poland
Alejandro	Cantarero	University Complutense of Madrid	Spain
Helen	Chambers	University of Salford	United Kingdom
Violette	Chiara	University of Vigo	Spain
Aleksandra	Chomik	Department of Zoology, Faculty of Science, Charles University, Prague	Czech Republic
Kareemah	Chopra	University of Essex	United Kingdom
Jen-Yun	Chou	Teagasc/Vetmeduni Vienna	Austria
Ricardo	Contreras Osorio	Groningen Institute for Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen	The Netherlands
Tara	Cox	University of Leeds	UK
Camille-Sophie	Cozzarolo	University of Burgundy	France
Danielle	Crowley	Leiden University	The Netherlands
Silvia	Damini	University of Vienna	Austria
Ines Marguerite	Daras	GELIFES	The Netherlands
Hossein	Daryabari	University of Groningen	The Netherlands
Eve	Davidian	Ngorongoro Hyena Project	Germany
Gabrielle	Davidson	University of Cambridge	United Kingdom
Carsten	De Dreu	Leiden University / University of Amsterdam	The Netherlands
Corné	de Groot	Ludwig Maximilian University	Germany
Jan	de Haan	Technische Universität Braunschweig	Germany
Selvino	de Kort	Manchester Metropolitan University	United Kingdom
Hannah	De Waele	Wageningen University and Research	The Netherlands
Tobit	Dehnen	University of Exeter	United Kingdom
Segolene	Delaitre	CEFE CNRS	France
Niels	Dingemanse	Ludwig Maximilian University of Munich	Germany
Ednei	dos Santos	University of Liege	Belgium
Nicolas	Dobovetzky	Groningen Institute for Evolutionary Life Sciences, University of Groningen	The Netherlands
Cato	Drion	University of Groningen	The Netherlands
Diandra	Duengen	Max Planck Institute	The Netherlands
Sandra	Düpjan	Research Institute for Farm Animal Biology (FBN)	Germany
Audrey	Dussutour	University Paul Sabatier	France
Jo	Edgar	Bristol University	UK
Ahmed	El Hady	Max Planck Institute of Animal Behavior	Germany
Paula	Escriche Chova	Utrecht University	The Netherlands

Anna	Fabbri	Department of Behavioral and Cognitive Biology, University of Vienna	Austria
Tamás	Faragó	MTA-ELTE 'Lendület' Neuroethology of Communication Research Group; Department of Ethology, Eötvös Loránd University	Hungary
Claudia	Fichtel	German Primate Center	Germany
Lisa	Fijn	Utrecht University	The Netherlands
Jasmin	Firozpoor	Universität Potsdam	Germany
Stefan	Fischer	Konrad Lorenz Institute of Ethology	Austria
Ondřej	Fišer	Department of Zoology, Faculty of Science, University of South Bohemia	Czech Republic
Victoria	Franks	University of Chester	United Kingdom
Elisa	Frasnelli	University of Trento	Italy
Joachim	Frommen	Manchester Metropolitan University	United Kingdom
Petra	Frydlová	Charles University, 3rd Faculty of Medicine	Czech Republic
Dr Ines	Fürtbauer	Swansea University	United Kingdom
Roger	Fusté	Museo Nacional de Ciencias Naturales (MNCN)	Spain
Manfred	Gahr	Max Planck Institute for Ornithology	Germany
Henrique	Galante	University of Regensburg	Germany
Diego	Gil	Museo Nacional de Ciencias Naturales	Spain
Jakob	Gismann	University of Groningen	The Netherlands
Irene	Godoy	Universität Bielefeld	Germany
Ana Cristina	Gomes	CIBIO/InBIO	Portugal
Wolfgang	Goymann	Max Planck Institute for Ornithology	Germany
Julia Victoria	Grabner	Department of Behavioural and Cognitive Biology, University of Vienna	Austria
Klara	Grethen	University of Bern	Switzerland
Lucie Marie	Gudenus	University of Vienna	Austria
Anja	Guenther	MPI for Evolutionary Biology	Germany
Cécile	Guérineau	University of Padua	Italy
Clinton	Haarlem	Trinity College Dublin	Ireland
Luca	Hahn	University of Exeter	United Kingdom
Katie	Harrington	Messerli Research Institute	Austria
Rachel	Harrison	University of Lausanne	Switzerland
Sophie	Harrower	University of St Andrews	Scotland
Mark	Hauber	University of Illinois at Urbana-Champaign	United States
Denise Viktoria	Hebesberger	University of Veterinary Medicine	Austria
Matjaz	Hegedic	University of Vienna	Austria
Carla	Henriques	IGC - Instituto Gulbenkian de Ciência	Portugal
Friederike [freddy; she/her]	Hillemann	Max Planck Institute for Evolutionary Anthropology	Germany
Jerry	Hogan	University of Toronto	Canada
Oliver	Höner	Leibniz-IZW	Germany

Lisa	Horn	University of Vienna, Department of Behavioral and Cognitive Biology	Austria
David	Hosken	University of Exeter	UK
Kingsley	Hunt	University of Exeter	United Kingdom
Christos	Ioannou	University of Bristol	UK
Anne	Jansen	Gelifes, University of Groningen	The Netherlands
Alex	Jordan	MPI Animal Behavior	Germany
Youngwook	Jung	Kyungpook National University	South Korea
Arne	Jungwirth	Konrad Lorenz Institute of Ethology	Austria
Peter	Kappeler	University of Göttingen	Germany
Kyriacos	Kareklas	Instituto Gulbenkian de Ciência	Portugal
Sunil	Khatiwada	University of North Carolina	US
Junyoung	Kim	Kyungpook National University	South Korea
Andrew	King	Swansea University	United Kingdom
Paula	Kirmis	University of Groningen	Netherlands
Philip	Kohlmeier	Gelifes, University of Groningen	Netherlands
Peter	Korsten	Bielefeld University	Germany
Alexander	Kotrschal	Wageningen University	Netherlands
Magdalena	Kozielska	University of Groningen	The Netherlands
Pleunie	Kraak	University of Groningen	The Netherlands
Sven	Krackow	Universitätsspital Zürich	Switzerland
Ladislava	Krausová	Faculty of Science, University of South Bohemia in České Budějovice	Czech Republic
Jan	Kreider	University of Groningen	The Netherlands
Menno	Kruk	Medical Pharmacology LACDR Retired	The Netherlands
Martje	Kruk-de Bruin	Lorentz Center Leiden Retired	The Netherlands
Bram	Kuijper	University of Exeter	United Kingdom
Ralf	Kurvers	MPI for Human Development	Germany
Miriam	Kuspiel	Behavioural Ecology Group, Wageningen University & Research	The Netherlands
Océane	La Loggia	Institute for Ecology and Evolution, University of Bern	Suisse
Eva	la Peña	Institutional affiliation:University of Córdoba	Spain
Beatrix	Laczi	Eötvös Loránd University	Hungary
Sanne	Lamers	Gelifes, University of Groningen	The Netherlands
Eva	Landová	Department of Zoology, Faculty of Science, Charles University, Prague	Czech Republic
Alexandra	Langehennig-Peristenidou	Institute of Zoology, University of Veterinary Medicine Hannover	Germany
Suzanne	Lanooij	Gelifes, University of Groningen	The Netherlands
Camille	Le Gal	Laboratoire Ethologie Cognition Développement, Université Paris Nanterre	France
Elli	Leadbeater	Royal Holloway University of London	UK
Adria	LeBoeuf	University of Fribourg	Switzerland
Saein	Lee	Ewha Womans University	South Korea

Lisanne	Leenheer	Groningen Institute for Evolutionary Life Sciences, University of Groningen	The Netherlands
Silvia	Leonetti	Max Planck Institute for Psycholinguistics	Netherlands
Raffaella	Lesch	Institute of Animal Welfare Science, University of Veterinary Medicine Vienna	Austria
Kate	Lessells	None	The Netherlands
Joel	Levine	University of Toronto	USA
Kate	Lewis	University of Portsmouth	UK
Quanxiao	Liu	Leiden University	Netherlands
Hugo	Loning	Wageningen University	The Netherlands
Miina	Löoke	The University of Padova	Italy
ALVARO	LOPEZ CAICOYA	Universitat de Barcelona	SPAIN
Donghui	Ma	Gelifes, University of Groningen	The Netherlands
Martine	Maan	University of Groningen	The Netherlands
Veronica	Maglieri	Università di Pisa, Pisa, Italy	Italia
Lieta	Marinelli	Università degli Studi di Padova	Italia
Irene	Martínez-Baquero	Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen, the Netherlands	The Netherlands
Jorg	Massen	Utrecht University	Netherlands
Valeria	Mazza	University of Potsdam, Germany	Germany
Jim	McGetrick	University of Veterinary Medicine, Vienna	Austria
Eva	Millesi	Department of Behavioral and Cognitive Biology, University of Vienna	Austria
Berenika	Mioduszezwska	Messerli Research Institute, University of Veterinary Medicine Vienna	Austria
Paolo	Mongillo	University of Padua	Italy
Sanne	Moorman	Utrecht University	The Netherlands
Dina	Mostafa	University of Vienna	Austria
Gloria	Murari	University of Wien	Austria
Marc	Naguib	Wageningen University	The Netherlands
Nicola Clayton	Nicola Clayton	University of Cambridge	UK
Sabine	Noebel	Institute for Advanced Study in Toulouse	France
Jori	Noordenbos	Wageningen University	The Netherlands
Mark	O'Hara	Messerli Research Institute, University of Veterinary Medicine Vienna	Austria
Lucy	Oldham	SRUC	United Kingdom
Rui	Oliveira	ISPA	Portugal
Charlotte-Anaïs	Olivier	Institut Pluridisciplinaire Hubert Curien - CNRS	France
Clémence	Orsini	Wageningen University & Research	The Netherlands
Elisabetta	PALAGI	Dept. Biology, University of Pisa	Italia
Paolo	Panizzon	University of Groningen	The Netherlands
Marina	Papadopoulou	Swansea University	United Kingdom
Giulia	Pedretti	University of Parma	Italy



Luca	Pedruzzi	Università di Pisa	Italy
Tereza	Petrusková	Charles University	Czechia
Davide	Potrich	University of Trento	Italy
Arianna	Racca	Istituto Superiore di Sanità	Italy
Aparajitha	Ramesh	University of Groningen	The Netherlands
Apu	Ramesh	University of Groningen	The Netherlands
Tom	Ratz	ratz@bio.lmu.de	Germany
Jean-Loup	Rault	University of Veterinary Medicine, Vienna	Austria
Iraida	Redondo García	Museo Nacional de Ciencias Naturales - CSIC	Spain
Ella	Rees-Baylis	Groningen Institute for Evolutionary Life Sciences, University of Groningen	The Netherlands
Nadieh	Reinders	Department of Animals in Science and Society, Faculty of Veterinary Medicine, Utrecht University	the Netherlands
Katharina	Riebel	Leiden University	The Netherlands
Alex	Rieger	Technische Universität Braunschweig	Germany
Mila	Roozen	Groningen Institute for Evolutionary Life Sciences	The Netherlands
Frederica	Rossetto	Universidad de Oviedo-Campus de Mieres	Spain
Taylor	Rystrom	University of Münster	Germany
Tommaso	Sacca	University of Groningen	The Netherlands
Stephen	Salazar	Bielefeld University	Germany
Beatriz C	Saldanha	BIOPOLIS/CIBIO-InBIO-Research Centre in Biodiversity and Genetic Resources	Portugal
Iago	Sanmartin	University of Vigo	Spain
Marianne	Sarfati	Royal Holloway of London	United Kingdom
Adithya	Sarma	Department of Neurobiology, GELIFES, University of Groningen	The Netherlands
Yohan	Sassi	Centre d'Ecologie Fonctionnelle et Evolutive (CEFE)	France
Theresa	Schabacker	Free University & Natural History Museum	Germany
Alexander	Schakowski	Center for Adaptive Rationality, Max Planck Institute for Human Development	Deutschland
Alexander	Schlatmann	University of Groningen	The Netherlands
Manon	Schweinfurth	University of St Andrews	United Kingdom
Raoul	Schwing	Messerli Research Institute, University of Veterinary Medicine Vienna, University of Vienna, Medical University Vienna	Austria
Lauren	Seex	University of Groningen	The Netherlands
Sandro	Sehner	University of Zurich	Switzerland
Piuli	Shit	University of Regensburg	Germany
Yara	Silberstein	Institute of Zoology, University of Veterinary Medicine Hannover	Germany
Michael	Siva-Jothy	University of Sheffield	UK
Gabriella	Smith	Messerli Research Institute, VetMedUni Vienna	Austria

Lysanne	Snijders	Behavioural Ecology Group - Wageningen University	The Netherlands
Frigg	Speelman	Groningen Institute for Evolutionary Life Sciences	The Netherlands
Michelle	Spierings	Leiden University	Netherlands
Liesbeth	Sterck	Utrecht University	The Netherlands
Paula	Stockley	University of Liverpool	UK
Rolf	Storms	University of Groningen	The Netherlands
Aurelia	Strauss	Groningen Institute for Evolutionary Life Sciences, University of Groningen, and Animal Ecology Department, Netherlands Institute of Ecology	The Netherlands
Elisabeth	Suwandschieff	Messerli Research Institute, VetMed Vienna	Austria
William	Swaney	Liverpool John Moores University	UK
Tamás	Székely	University of Bath	UK
Fanni	Takács	University of Debrecen	Hungary
Sabine	Tebbich	University of Vienna	Austria
Rose	Thorogood	University of Helsinki	Finland
Sandra	Trigo	CIBIO, University of Porto	Portugal
Fritz	Trillmich	University of Bielefeld	Germany
Christian	Tudorache	IBL, Leiden University	Netherlands
Simon	Turner	SRUC	UK
Chris	Tyson	Wageningen University & Research	The Netherlands
Utku	Urhan	NIOO-KNAW	The Netherlands
Maria	Valbuena	Congress by design	The Netherlands
Menno	van Berkel	University of Exeter	United Kingdom
Marrit	van der Bruggen	University of Groningen	The Netherlands
Michael	Van Dijk	University of Groningen	Netherlands
Edwin	van Leeuwen	Utrecht University	the Netherlands
Bryndan O.C.M.	van Pinxteren	German Primate Centre	Germany
J.Fransje	van Weerden	GELIFES	The Netherlands
Marion	Varga	Department of Behavioral and Cognitive Biology, University of Vienna	Austria
Vera	Vasas	Queen Mary, University of London	United Kingdom
Ariane	Veit	University of Veterinary Medicine Vienna	Austria
Simon	Verhulst	University of Groningen	The Netherlands
Tim	Vernimmen		The Netherlands
Marijke	Versteven	GELIFES, RUG, University of Groningen, NL	The Netherlands
Alexandros	Vezyrakis	University of Potsdam; Max Planck Institute for Evolutionary Biology	Germany
Ernő	Vincze	Lund University	Sweden
Kamil	Vlcel	Institute Physiology, ACSR	Czech Republic
Lea	Vodjerek	University of Potsdam	Germany

Tiffany	Volle	Laboratoire Éthologie Cognition Développement, Université Paris Nanterre	France
Vanessa	von Kortzfleisch	Department of Behavioural Biology, University of Münster	Germany
Sophie	Waasdorp	Utrecht University	The Netherlands
Yuqi	Wang	University of Groningen	The Netherlands
Mukta	Watve	University of Exeter	UK
Jary	Weerheijm	Utrecht University	Netherlands
Franjo	Weissing	University of Groningen	The Netherlands
Amy	West	University of Portsmouth	United Kingdom
Steve	Whalan	Southern Cross University	Australia
Andrew	Whiten	University of St Andrews	United Kingdom
Rori	Wijnhorst	Ludwig Maximilian University (LMU)	Germany
Anna	Wilkinson	University of Lincoln	UK
Elodie	Wilwert	University of Groningen	The Netherlands
Bing	Xie	Behavioural Ecology Group, Department of Biology, University of Copenhagen	Denmark
Minjung	Yoon	Kyungpook National University	Republic of Korea
Gaoyang	Yu	Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen	The Netherlands
Jeroen	Zewald	University of Veterinary Medicine Vienna	Austria
Xia	Zhan	Groningen Institute of Evolutionary Life Sciences, Faculty of Science and Engineering, University of Groningen	The Netherlands
Lisheng	Zhang	GELIFES of University of Groningen	The Netherlands
Tianhao	Zhao	University of Groningen	The Netherlands
Jia	Zheng	University of Groningen	The Netherlands
Dian	Zijlmans	Biomedical Primate Research Centre	The Netherlands