

# Joint meeting of the BfR and the Ethological Society

Berlin, February 22-24, 2023

An event of the German Federal Institute for Risk Assessment (BfR)



## **Impressum**

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Joint meeting of the BfR and the Ethological Society

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**Welcome to the Joint meeting of the BfR and the Ethological Society!**

We are very excited to welcome you to the first in person meeting of the Ethological Society after two years of 'online only meetings'. More than 100 researchers working in the field of behavioural biology are getting together to discuss their work, present newest results in talks or poster presentations, and to meet again or finally get to know each other.

We will hear about chimpanzees, corvids, bank voles, cotton-top tamarins, fire salamanders, zebrafish, mice, and many other species. Both young and more mature scientists, hailing from many nations, will give presentations; the program thus reflects the broad field of behavioural biology at its best.

We can see that major changes are imminent in our field of research. On the one hand, environmental conditions, which are the basis of the animals' survival, are changing dramatically and rapidly due to anthropogenic influence. On the other hand, societal demands on research with animals are also changing and researchers themselves are under scrutiny. We have to respond to both with good and well-founded research - a particular challenge in times that are not easy, especially for young scientists

This year the German Federal Institute for Risk Assessment (BfR) which has established the German Centre for the Protection of Laboratory Animals (Bf3R, <https://www.bf3r.de>) hosts the conference in Berlin. Behavioural research involves animal experimentation, a topic that is increasingly in the social discourse. The variety of studies presented here directly contributes to a better understanding of the biology, social structures, nature conservation, and the wants and needs of the animals. Therefore, we are confident that this conference will help deepen our understanding of animal welfare and animal behaviour and inspire new approaches to improve the lives of animals in the wild and in human care.

We wish you a productive and enjoyable conference and lively discussions with colleagues while in Berlin,

Lars Lewejohann  
(on behalf of the organisation team)

## 1 Programme

### Wednesday 22 February 2023

3:00 – 6:00 pm

**Registration**  
**Poster mounting**

5:00 - 7:00 pm

**Welcome reception**

### Thursday 23 February 2023

9:00 – 10:00 am

**Registration**  
**Poster mounting**

10:00 – 10:15 am

**Introduction**  
Lars Lewejohann, German Federal Institute for Risk Assessment (BfR)

10:15 – 11:00 am

**Plenary Talk: Animal cognition: from corvids and chimpanzees**  
Simone Pika, University of Osnabrück

11:00 – 11:30 am coffee break

11:30 – 11:50 am

**From nestling to adult: Personality traits are consistent within but not across life stages in a wild songbird**  
Andrew Katsis, Flinders University, Adelaide, Australia

11:50 – 12:10 pm

**Testing the Social Intelligence Hypothesis (SIH) in pair bonds of a wild corvid**  
Luca Hahn, University of Exeter, U.K.

12:10 – 12:30 pm

**Exploring the Emerald Isle: exploration and navigation of non-native bank voles in Ireland**  
Valeria Mazza, University of Potsdam

12:30 – 2:00 pm lunch break

2:00 – 2:20 pm

**Coordinated singing in a pair-living primate: resource or mate defense?**  
Sofya Dolotovskaya, German Primate Center - Leib-niz-Institute for Primate Research, Göttingen

2:20 – 2:40 pm

**Virtual magnetic displacements as a tool to increase conservation translocation successes: A chance for refinement in rewilding projects**  
Oliver Lindecke, University Oldenburg

2:40 – 3:00 pm

**Can AI be used for movement tracking in field experiments?**

Gloria Murari, University of Helsinki, Finland

3:00 – 4:40 pm coffee break and poster session

4:40 – 5:00 pm

**Exploring nuances in enrichment for laboratory housed fish: does type of enrichment or specific dimensions of in-tank structures matter?**

Nick Jones, University of St. Andrews, U.K.

5:00 – 5:20 pm

**Preregistration in animal research – Animal welfare and scientific progress**

Céline Heintz, BfR

5:20 – 5:40 pm

**Changes to the gut microbiota of a wild juvenile passerine in a multidimensional urban mosaic**

Öncü Maraci, Bielefeld University

5:40 – 6:10 pm break

6:10 – 6:30 pm

**Do helpers help? The effect of group size and composition on the reproductive success of cap-tive cotton-top tamarins (*Saguinus oedipus*)**

Michaela Masilkova, Czech University of Life Sciences, Prague, Czech Republic

6:30 – 6:50 pm

**Social structure and helping behaviour in the co-operatively breeding cichlid *Neolamprologus savoryi***

Joachim Frommen, Manchester Metropolitan University, U.K.

from 7:00 pm social evening

**Friday 24 February 2023**

9:00 – 9:45 am

**Plenary Talk**

Alex Kacelnik, University of Oxford, U.K.

9:45 – 10:15 am coffee break

10:15 – 10:35 am

**Outdoor runs for fattening pigs: a place to be and a place to poo**

Ulrike Höne, Friedrich-Loeffler-Institut, Celle

10:35 – 10:55 am

**Can individual characteristics predict problem-solving behavior in common marmosets?**

Marion Varga, University of Vienna, Austria



10:55 – 11:15 am

**The bright, the bold, the toxic? Examining animal personality in fire salamanders**

Max Mühlenhaupt, Bielefeld University

11:15 – 11:45 am coffee break

11:45 – 12:05 pm

**Individual Differences of Female Chronotypes and their Fitness Consequences in Wild Great Tits *Parus major***

Aurelia Strauß, University of Groningen, The Netherlands

12:05 – 12:25 pm

**Personality in groups: Plasticity of common marmoset (*Callithrix jacchus*) behaviour in solitary vs. social setting**

Vedrana Šlipogor, University of South Bohemia, České Budějovice, Czech Republic

12:25 – 12:45 pm

**Effects of food-quality on mouse cognition**

Ekaterina Gorshkova, Christian-Albrechts-University Kiel

12:45 – 2:00 pm lunch break

2:00 – 2:45 pm

**Honorary Membership**

2:45 – 3:05 pm

**What can whole genome sequencing reveal about primate sociality?**

Annika Freudiger, Max Planck Institute for Evolutionary Anthropology, Leipzig

3:05 – 3:25 pm

**Means to succeed in resource competition**

Michael Taborsky, University of Bern, Switzerland

from 3:25 pm

**Awards and Goodbye**

Lars Lewejohann, BfR

## **2 Abstracts - presentations**

### **2.1 Animal cognition: from corvids and chimpanzees**

Simone Pika

Comparative BioCognition, Institute of Cognitive Science, University of Osnabrück, Germany

The evolutionary origins of human cognition have been described as one of the 125 most pressing scientific questions of our time. However, how similar and different cognitive skills of nonhuman animals are is still under much investigation.

Here, I will provide a brief overview of this fascinating research domain by focusing specifically on cognitive skills of one of our closest living relatives, the chimpanzees (*Pan troglodytes*) and a member of the corvid family, ravens (*Corvus corax*). I will present recent observations and behavioural experiments on tool-use and proto-tool use, cognitive performance and insect medication and discuss them in relation to existing findings, future research, and the crucial need to protect species and their natural environments.

## **2.2 From nestling to adult: Personality traits are consistent within but not across life stages in a wild songbird**

Andrew C. Katsis<sup>1,2</sup>, Lauren K. Common<sup>1</sup>, Mark E. Hauber<sup>3</sup>, Diane Colombelli-Négrel<sup>1</sup>, Sonia Kleindorfer<sup>1,2</sup>

<sup>1</sup> College of Science and Engineering, Flinders University, Adelaide, South Australia, Australia

<sup>2</sup> Konrad Lorenz Research Center for Behavior and Cognition and Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria

<sup>3</sup> Department of Evolution, Ecology, and Behavior, School of Integrative Biology, University of Illinois at Urbana-Champaign, Illinois, USA

Personality traits can remain consistent throughout adult life, but it is less clear when these behavioural differences first arise and whether they are maintained across ontogenetic stages. In this study, we measured personality across three life stages (nestling, fledgling, and adult) in a wild population of superb fairy-wrens (*Malurus cyaneus*). We measured (1) boldness (response to human handling, at all three stages), (2) exploration (response to a novel environment, in fledglings and adults), and (3) aggressiveness (response to mirror-image stimulation, in fledglings and adults). Personality differences were often consistent within life stages but never across them: specifically, aggressiveness was repeatable in fledglings and all three traits were repeatable in adults. Exploration and aggressiveness correlated positively in both fledglings and adults, suggesting that behavioural syndromes may remain stable across stages even when traits that comprise them do not. Our results suggest that long-term personality traits may not become entrenched until adulthood.

### **2.3 Testing the Social Intelligence Hypothesis (SIH) in pair bonds of a wild corvid**

Rebecca Hooper, Luca G. Hahn, Guillian E. McIvor, Alex Thornton

Centre for Ecology and Conservation, University of Exeter, U.K.

The Social Intelligence Hypothesis (SIH) posits that navigating a complex social world, e.g. by forming and maintaining differentiated social relationships, acts as a selection pressure on cognitive abilities. Although a lot of evidence has been found to support the SIH, some of its fundamental underlying key assumptions and predictions have not been examined in a single study system. Therefore, we tested four essential predictions of the SIH by investigating pair bonds in one study system, wild western jackdaws (*Corvus monedula*). We found support for three predictions, namely that pair-bond strength is variable between pairs, repeatable within pairs and related to partner responsiveness, i.e. socio-cognitive performance. Our results did not suggest that pair bond strength directly influences reproductive success. Nevertheless, pairs with stronger bonds were better at adjusting hatching synchrony to environmental conditions. Moreover, we subsequently studied another potential indirect fitness benefit of social relationships, social buffering. The presence of or interaction with a bonded partner might buffer an individual against short-term or long-term stress, thereby reducing levels of glucocorticoids as a proxy for stress levels and promoting health. In total, our results support several suppositional predictions of the SIH, including the first evidence that bond strength and socio-cognitive performance could be related in non-human animals. However, more research is needed to better understand the evolution of social relationships and social cognition.

## **2.4 Exploring the Emerald Isle: exploration and navigation of non-native bank voles in Ireland**

Valeria Mazza, Jana Eccard  
University of Potsdam, Germany

Whether introduced into a completely novel habitat or slowly expanding their current range, the degree to which animals can efficiently explore and navigate new environments may be a key component of survival, ultimately determining population establishment and invasion success.

We tested whether spatial orientation and exploratory behaviour are associated with invasive spread in free-living bank voles (*Myodes glareolus*) accidentally introduced to Ireland a century ago. We measured orientation and navigation skills of 43 individuals in a radial arm maze, and behaviours associated to exploratory tendencies and risk-taking in an open-field test, at the expansion edge and at the population source. Contrary to our expectations, bank voles at the expansion edge were more risk-averse and took longer to start exploring both the open field and the radial arm maze compared to conspecifics in the source population, re-visited unrewarded arms of the maze more, and waited longer before leaving it. Taken together, results suggest that for this heavily predated upon small mammal, a careful and thorough exploration strategy might be favoured when expanding into novel environments.

## 2.5 Coordinated singing in a pair-living primate: resource or mate defense?

Sofya Dolotovskaya<sup>1,2</sup>, Eckhard W. Heymann<sup>1</sup>

<sup>1</sup> Behavioral Ecology and Sociobiology Unit, German Primate Center - Leibniz-Institute for Primate Research, Göttingen, Germany

<sup>2</sup> Primate Genetics Laboratory, German Primate Center - Leibniz-Institute for Primate Research, Göttingen, Germany

Coordinated singing, performed by mated pairs and often joined by offspring, is a distinctive behavior of pair-living primates. The functions of coordinated singing, however, remain debated. The main hypotheses to explain coordinated singing are the joint resource defense, where songs advertise ownership of a home range and/or resources to outsiders, and the mate defense hypothesis, where an individual sings to advertise its partner's or its own mated status to outsiders. Here, we analyzed spatial and temporal patterns of coordinated singing in eight wild groups of pair-living Neotropical primates, coppery titi monkeys, *Plecturocebus cupreus*, in Peruvian Amazonia. To test predictions for the joint resource and mate defense hypotheses, we analyzed singing rates in relation to female reproductive state, fruit consumption and group composition using a dataset based on 227 observation days. We also investigated the temporal and spatial distribution of songs using a dataset of 150 songs. We found that titi monkeys sang most frequently when females were likely to be pregnant and least frequently when females were likely to be sexually receptive. Singing rates were slightly higher when fruits were consumed more intensively, although this trend did not reach statistical significance. The duration of songs was not associated with female reproductive state or fruit consumption, but songs produced during inter-group encounters were longer than songs produced in other contexts. Songs were distributed throughout the home ranges in concordance with home-range use instead of being concentrated in the core areas of home ranges. Finally, songs were mostly produced around dawn, when the communication distance is expected to be the highest. Our findings suggest that coordinated singing in coppery titi monkeys functions in joint resource defense and inter-group communication. The function of coordinated singing for male mate defense, on the other hand, was not supported by our results.

## **2.6 Virtual magnetic displacements as a tool to increase conservation translocation successes: A chance for refinement in rewilding projects**

Oliver Lindecke

University Oldenburg, Germany

Conservation translocations, the capture, transportation, and release of wild animals from one place to another, are a common – and currently trending – action to save species and restore ecosystems and their functions worldwide. However, translocation projects are not always immediately successful, sometimes they fail, but in any case, they are highly costly and relatively risky for the individual animals. In most translocation projects, animals are released without a period of acclimation (“soft release”) but instead they are (“hard”) released directly into their new environment. Notably, this approach resembles the traditional experimental procedure of translocation, release and subsequent movement-tracking in animal navigation research. Also here, animals' disorientation (i.e., their “failures”) is studied and commonly observed. In the last twenty years of navigation research, however, so-called virtual magnetic displacements have been used to examine the magnetoreceptive ability and orientation capacity of animals. Changing the local magnetic field to emulate one that exists elsewhere using magnetic coils allows measurements of behavioural responses by subject animals. Here, I will introduce the concept, results and principles of virtual magnetic displacements that could inform conservation translocation attempts, too, and a software tool that we developed (ViMDAL), which allows predicting where animals could move (or not) based on their original habitats. In our view, applying these techniques integrating animal behaviour and sensory ecology could provide a chance for refinement in conservation translocations, i.e. in the early phases of projects, and especially in migratory species that are particularly vulnerable.

## 2.7 Can AI be used for movement tracking in field experiments?

Gloria Murari<sup>1</sup>, Edward Klueen<sup>1,2</sup>, Rose Thorogood<sup>1,2</sup>

<sup>1</sup> HiLIFE Helsinki Institute of Life Sciences, University of Helsinki, Finland

<sup>2</sup> Research Programme in Organismal and Evolutionary Biology, Faculty of Biological and Environmental Sciences, University of Helsinki, Finland

Consistent individual variation in behavioral responses (animal personality) has now been documented in a range of species, from insects to mammals, and is now recognized to be an important factor in ecology and evolution. One of the most frequently measured traits is exploratory behavior, which has been studied for many years using standardized 'open field' tests under controlled settings. Here, movement behaviour is recorded in a standardized arena, usually by manual coding. Artificial intelligence (AI) is widely used in laboratory settings to automate this process and acquire data of greater depth about locomotion (such as speed, direction and distance), but until recently this has required specific and consistent camera setups that are often not feasible in field conditions. Here, we tested whether newly-developed online software 'Loopy' can be used with videos collected previously in the field to measure exploration of wild reed warblers, a small passerine bird, that vary in quality (light conditions, focal depth, camera angle and placement). To train the AI, we used the Object Detector function to annotate videos under a range of settings (e.g. number of videos, training duration), then tested the accuracy of generated predictions by comparing the distance in pixels between manual annotations and Loopy's predictions, and occurrence of false positives and negatives. Accuracy increased as we used more videos and longer training and annotations were correct 97%-98% of the time for the body parts of interest (beak, head, center of mass, belly, and feet on cage). The next step is to integrate other parameters (e.g. network stride and size), to examine if it is possible to further increase accuracy and reduce mistakes. Although the set up may seem long and time consuming, the use of AI in ethology shows great promise for significantly reducing time spent on data collection.



## **2.8 Exploring nuances in enrichment for laboratory housed fish: does type of enrichment or specific dimensions of in-tank structures matter?**

Nick Jones, Mike Webster

School of Biology, University of St. Andrews, U.K

The housing conditions and welfare of animal subjects can be fundamental to the biological validity of experimental studies. One crucial aspect of welfare, which can be easily incorporated into housing and experimental tanks is enrichment. Exactly what to provide as enrichment, however, is an important question that can depend on species, animal size and social condition, amongst other factors. However, for many species this fundamental question is largely unaddressed. Especially so for many fishes despite them being commonly used as experimental subjects in behavioural studies. In the few studies that have focused on the impacts of enrichment in fishes there have been conflicting findings, some studies find positive welfare and behavioural benefits and other not. One potential reason for this is that the effect of enriched aquaria on a species may depend on the fine scale dimensions of the enrichment items provided. The three-spine stickleback is a classic model species in behavioural studies, and one the more common fish subjects, but there are relatively few empirical studies into their enrichment requirements. I will present the results of a study where we conducted three experiments to develop our understanding of three-spine stickleback enrichment requirements. First, we conducted a multi choice preference test using an arena assay with five types of enrichment, in two different social conditions (alone or in groups of five). Second, we attempted to answer the question of whether fish exhibit fine-scale preferences. We did this by running a choice test for individual sticklebacks presented with three PVC tubes with different dimensions. Last, we compared behavioural and cognitive differences in fish that had been housed individually in three different levels of enrichment for six weeks with a T-maze assay.

## 2.9 Preregistration in animal research – Animal welfare and scientific progress

Céline Heinl<sup>1</sup>, Gilbert Schönfelder<sup>1,2</sup>, Bettina Bert<sup>1</sup>

<sup>1</sup> Federal Institute for Risk Assessment (BfR), German Centre for the Protection of Laboratory Animals (Bf3R), Berlin, Germany

<sup>2</sup> Charité-Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Berlin, Germany

Recent studies show that a large proportion of animal experiments is never published. In addition, poor study design, incomplete reporting, and questionable research practices like HARKing (hypothesizing after results are known) and p-hacking strongly impair the validity of published research. This not only slows down the scientific progress it also represents an ethical issue if animal lives are wasted without bringing any knowledge gain.

We propose preregistration of studies involving animals as a powerful tool to encounter questionable research practices and to increase transparency in behavioral research. Thoroughly planned studies, a clear distinction between planned and unplanned statistical analyses as well as reporting of all experiments conducted can improve the validity of outcomes and reduce the number of animal experiments in the end.

We have developed [animalstudyregistry.org](http://animalstudyregistry.org), an online platform for the preregistration of animal studies conducted worldwide. It supports researchers in planning their study by asking detailed questions about the study design, methods, statistics and animals used. The authors have the possibility to choose an embargo period for up to five years during which the study appears in the registry only with the title, name of the institution, short abstract and optionally the name of the author. With registration each study receives a DOI (Digital Object Identifier) making the study plan citable. As a federal institute, the Bf3R can guarantee continuity, data security, and independency of sponsorship.

Preregistration was already shown to be effective in clinical research to improve the quality and reporting of all gained results. Its implementation in animal-based research is currently low, but is starting to be supported by several research institutions, funders and publisher, leveling the way for its broader acceptance in the future.

## **2.10 Changes to the gut microbiota of a wild juvenile passerine in a multidimensional urban mosaic**

Öncü Maracı<sup>1</sup>, Barbara A. Caspers<sup>1</sup>, Marta Szulkin<sup>2</sup>

<sup>1</sup> Department of Behavioural Ecology, Bielefeld University, Germany

<sup>2</sup> Centre of New Technologies, University of Warsaw, Poland

Urbanisation is a major anthropogenic perturbation that progressively alters multiple environmental parameters, thereby presenting novel evolutionary challenges to wild populations. Symbiotic microorganisms residing in the gastrointestinal tracts (gut) of vertebrates have well-established mutual connections with the physiology of their hosts and respond quickly to environmental alterations. However, the impacts of urbanisation on gut microbiota remain poorly understood, especially in early development. To address this knowledge gap, we investigated the gut microbiota in juvenile great tits (*Parus major*) in an urban mosaic. Alpha diversity was influenced by the amount of impervious surface surrounding the breeding location. Alpha diversity was also positively correlated with the tree cover density. Beta diversity differed between urban and rural sites, and these alterations covaried with sound pollution and the distance to the city centre. Overall, the microbial communities reflect and are possibly influenced by the heterogeneous environmental modifications that are typical of the urban space. Strikingly, the choice of framework used to define the urban space can influence the outcomes of studies investigating animal-microbe symbiosis. Our results open new perspectives from which the potential function of microbial symbionts in the adaptation of their hosts to anthropogenic stress can be investigated.

## 2.11 Do helpers help? The effect of group size and composition on the reproductive success of captive cotton-top tamarins (*Saguinus oedipus*)

Michaela Masilkova<sup>1</sup>, Vojtěch Smolík<sup>2,3</sup>, David Boukal<sup>4</sup>, Miranda Stevenson<sup>5</sup>, Jitka Vokurková<sup>6</sup>, Martina Konečná<sup>2</sup>

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In cooperatively breeding species, helpers help the breeders with infant care and are thought to positively affect the fitness of infants and breeders. The reproductive success and infant survival of cotton-top tamarins (*Saguinus oedipus*), critically endangered callitrichid primate, in zoo populations are, however, variable. Using generalised mixed effects models, we examined the effects of the number, sex and age of helpers and other potentially important variables (e.g. experience and age of breeders) on the length of the inter-birth interval, litter size, survival of infants and breeders in a large dataset (3464 infants, 447 breeding pairs) of breeding records of cotton-top tamarins living in 177 European zoos. We detected variable helper's effects on fitness. While inter-birth intervals were shorter, the infant survival and breeding female life expectancy were lower in larger groups. The group size did not affect the number of infants born. The relative number of male helpers positively impacted the life expectancy of breeding males but not breeding females. We further detected the significant effects of rearing, experience and age of the breeding individuals and other variables on reproductive success. The lower infant survival in larger groups might result from overcrowding and increased aggression rates in captive conditions. Our results thus may contribute to managing captive populations of endangered primate species and improving the animal welfare of zoo populations.

## **2.12 Social structure and helping behaviour in the cooperatively breeding cichlid *Neolamprologus savoryi***

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Cooperatively breeding species are fascinating examples for highly derived social systems. Understanding the functions and mechanisms shaping such systems 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. Here, we describe the social structure and fitness benefits of a wild colony of the facultatively harem and cooperatively breeding cichlid fish *Neolamprologus savoryi*, 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. Helpers engage in egg cleaning, territory maintenance and predator defence. Some subordinate males patrol between the females within the harem or defend their own sub-territory, either within the territory of a breeder male or at separate locations within the colony. Relatedness between breeders and helpers declines strongly with increasing helper size, rendering indirect, kin-selected fitness benefits of limited explanatory power. In contrast, helpers gain direct benefits by increasing their survival probability. Male helpers further benefit from receiving considerable reproductive share, while females have high chances to inherit the territory of their mother. Accepting helpers leads to an increased likelihood of successful reproduction as well as workload reduction in territory maintenance and defence, especially for breeder females. These findings elucidate how direct fitness benefits of cooperation and group membership mediate a social system with complex social and relatedness structures.

**2.13 If all data are from behaviour, what's the point of modelling cognition?**

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We all observe and describe behaviour, and often 'explain' it by proposing models of out-of-sight processes that we call 'mechanisms'. Historical debates prove that this is not an easy task, for many reasons. Crucially, for any set of behavioural observations there can be multiple candidate mechanisms that fit, so that discriminating between them depends critically on running research programs where putative mechanisms are repeatedly challenged and models are rejected and/or refined to cope with the accumulating evidence. My colleagues and I aim to pursue this strategy in a limited arena, trying to unravel how experimental animals (especially starlings) form preferences. We argue that the most likely mechanisms involve assignment of value to different options as a function of the outcomes of actions when in different states, and different backgrounds. We further aim to unravel how values translate into choices when more than one alternative is present. One overall conclusion is that preference is not constructed at the time of choice but the result of competition between valuations acquired during serial rather than simultaneous encounters. The generalizable message is that in spite of its difficulties, models of cognitive processes are both testable and useful.

## 2.14 Outdoor runs for fattening pigs: a place to be and a place to poo

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Access to an outdoor run improves housing conditions of fattening pigs by providing contact to different climate zones, an enlarged space allowance as well as the possibility to expand functional areas. Nevertheless, an outdoor run is also a challenge in terms of emissions of greenhouse gases such as ammonia as they cannot be extracted from the outgoing air via air scrubbers. However, by establishing appropriate functional areas in fattening pens, the area soiled by faeces and urine can potentially be reduced.

The aim of the study was to investigate the usage of an outdoor run and to determine the defaecation behaviour and location of organically housed fattening pigs. Therefore, video recordings were performed in eight pens and the respective outdoor runs in three observation periods, at 16, 19, and 22 weeks of age. In each pen ten pigs were housed, i.e. in total 80 pigs were considered.

Usage of the outdoor run was hourly registered at the group level in three observation periods (i.e. 16, 19, and 22 weeks of age). Additionally, in each pen, two focal pigs were individually marked. These 16 focal pigs were continuously observed for 24 hours in each observation period to record defaecation behaviour, and pre- and post-defaecation behaviours, as well as the locations of defaecation events.

The fattening pigs used the outdoor run continuously 24 hours a day, but most often during the daytime, between 08:00 h and 20:00 h. Defaecation behaviour of focal pigs occurred to 99.4 % in the outdoor run, on a comparable small area. On average, the focal pigs defaecated eleven times per pig per day whereby the frequencies of defaecation events decreased during the weeks of age. Fattening pigs defaecated more often during the daytime than the nighttime.

In pens as used in our study, fattening pigs perform nearly all defaecations in the outdoor run and maintain a specific defaecation area during the fattening period. This may enable technical possibilities to reduce ammonia emissions in pig pens with outdoor runs, such as regular cleaning of dunging areas.

## **2.15 Can individual characteristics predict problem-solving behavior in common marmosets?**

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Confronting animals with a novel problem and measuring their behavioral responses is one of the key methods to investigate intra- and interspecific cognitive differences. Previous research suggests common marmosets to be skilled problem solvers in foraging tasks and skilled social learners in simple motor tasks. Still, different individuals may have different preferences and/or problem-solving strategies. In this study, we aimed to explore which individual characteristics (e.g., age, sex, motivation, persistence) influence performance in problem-solving in an asocial setting. We tested 26 common marmosets in captivity with three extractive foraging tasks (sliding door, pulling string, pressing lever) using a puzzle box. We first confronted individuals with one opening mechanism at a time and then with all three mechanisms simultaneously. We predicted that subjects will solve several of the opening tasks but show individual preferences for particular techniques. Across tasks, we predicted younger individuals to be more explorative, but older, more experienced individuals to be more successful in opening the mechanisms. We also expected females (that are more food motivated than males), and subjects with shorter approach latencies and with more persistence, to have a quicker solving time and/or higher success rate than males and subjects with long approach latencies and low persistence, respectively. Contrary to our expectations, only half of the monkeys opened the box by using the “slide” mechanism and only one individual opened it by using the “pull” mechanism. Furthermore, younger individuals had a higher success rate than older ones. We will discuss the found inter-individual variation in problem-solving behavior in relation to methodological constraints of the current set-up and possible effects of personality traits (Boldness-Shyness, Exploration-Avoidance).



**2.16 The bright, the bold, the toxic? Examining animal personality in fire salamanders**

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Recent evidence suggests that inter-individual differences in behaviour are consistent (i.e., “animal personality”) across a broad variety of taxa. However, amphibians have been under-represented in animal personality studies. Furthermore, how these consistent behavioural differences arise remains to be further studied. Here, we use the European Fire Salamander (*Salamandra atra*), a toxic amphibian with aposematic black-and-yellow-colouration, to investigate potential drivers of inter-individual differences in behaviour. Over two seasons (spring and autumn), we collected 29 adult fire salamanders from a forest in western Germany. Each individual was tested for activity, exploration, and boldness three times in a standardized trial: immediately after capture, 60 days, and 63 days after maintenance under laboratory conditions. We tested for repeatability of behavioural tendencies and correlations among these behaviours, as well as correlations between behaviour, colouration and toxin gland size.

## 2.17 Individual Differences of Female Chronotypes and their Fitness Consequences in Wild Great Tits *Parus major*

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Diel timing is thought to be an adaptive trait, where consistent diel rhythms facilitate the anticipation of predictable situations such as the start and the end of the day. Individuals can have consistent earlier or later chronotypes compared to their conspecifics. In Great Tit males, early chronotypes seem to gain extrapair paternity improving their fitness. However, between individual variation in chronotypes remains considerable high and little is known about fitness consequences for females. Here, we assess fitness consequences for female chronotypes in Great Tits during the breeding season in a nest box population on the island of Vlieland, the Netherlands. We recorded nest temperature using temperature loggers during incubation and early chick provisioning, when females maximise their time spent on the nest. From these data we extracted the activity onsets relative to the conspecifics to obtain mean chronotypes for 151 known females during three breeding seasons. Chronotype was then correlated to fitness parameters from brood monitoring data. Our data indicates that later chronotypes start breeding later, are more successful in hatching at least one egg, and are more likely to initiate a second brood after a successful first one. However, they did not have more hatchlings or fledglings than the other chronotypes. Chronotype was also unrelated to female weight as well as chick condition, probably due to the many other factors influencing chick provisioning. These results suggest that females with different chronotypes might not differ in their quality but could have different breeding strategies. Further research might investigate fitness consequences beyond the breeding season, as well as life-time reproductive success, to explore fluctuations in selection pressure and potential differences in pace-of-life between females with different chronotypes.

## **2.18 Personality in groups: Plasticity of common marmoset (*Callithrix jacchus*) behaviour in solitary vs. social setting**

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Animal personality has been thoroughly studied in many solitary and socially living taxa. However, little is known whether personality is affected by conspecifics (e.g., shy individuals become bolder with bold conspecifics) and about a phenomenon of group members exhibiting similarity in personality. Further, there is a surprising lack of studies assessing personality on the same animals in both solitary and social settings. Common marmosets, small cooperatively breeding Callitrichid primates native to Brazil, spend their lives in family groups, yet also face problems on their own. They have been shown to display personality both in captive and wild settings. However, whether and how their personality profiles change in the presence of conspecifics is still unknown. In this study we replicated a personality test battery previously done on the same subjects in individual setting. Namely, we tested 27 captive common marmosets in two test sessions in a social setting, assessing their general activity, and their reactions to novel object, food, and predator model, and foraging under risk. Many behavioural variables showed a high degree of both temporal and contextual consistency. We found that the resulting personality structure was strikingly similar to the previously obtained structure from wild monkeys tested in a social setting. We then compared personality scores of the same animals obtained in both solitary and social setting. We will discuss our findings on whether individuals show plasticity in their responses when tested individually or socially, i.e., if and to which extent social environment has an effect on the expression of individual personality traits.

## 2.19 Effects of food-quality on mouse cognition

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Cognition is the main factor that ensures the rapid adjustment of the behavior in accordance with environmental changes, how quickly this change occurs will be determined by the flexibility and difference in the personality of animals. The availability and quality of food has always been the driving force behind these behavioral changes. In our study, we used the problem solving and reversal learning tests to investigate the cognitive flexibility and the novel object test to assess boldness of *Mus musculus domesticus*. In our study, we used 39 mice on two different diets: standard (SQ) and high-quality (HQ). By manipulating the quality of diet in mice across 5 generations, we show that this results in a difference in their personality and results in problem solving and reversal learning. Our results showed that the mice on the SQ diet showed better success in problem solving and solved faster, while the mice on the HQ diet were bolder in the novel object test based on latency to touch. However, parameters such as time and number of interactions in the novel object test were similar. Thus, our study highlights the role of food quality in relation to cognition and personality and therefore we emphasize the role of environmental conditions especially the food in the relationship between cognitive and behavioral flexibility and personality.

## 2.20 What can whole genome sequencing reveal about primate sociality?

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Genetic relatedness plays a central role in the evolution of sociality. For example, biological kinship in primates has long been known to be a key driver of behavioural preferences, with bonds among relatives leading to increased fitness outcomes. However, there is a high variation in the degree of kin bias across primate species, which, to some extent, might be explained by methodological limitations in the estimation of relatedness. In past research it has been challenging to accurately estimate dyadic relatedness among social animals because of locus-to-locus variation resulting from recombination events during meiosis and because of the noise inherent to small genotyping data sets. Whole genome sequencing (WGS) data sets, which cover millions of single nucleotide polymorphisms (SNPs) should allow us to calculate more precise measures of realized dyadic relatedness. Moreover, we can identify high-resolution genomic signals of biological relatedness as the number and length of segments that are identical-by-descent (i.e., IBD due to descent from a recent common ancestor). In this project, we produce WGS data from over 800 rhesus macaques (*Macaca mulatta*) from a free-ranging population on Cayo Santiago island in Puerto Rico. We integrate the resulting estimates of IBD with demographic, behavioural, morphological and reproductive data to assess the influence of variation in dyadic IBD on social preference, phenotypic cues, and kin recognition. Our preliminary results suggest that inferring IBD based on genome-wide resequencing data reveal variation in relatedness within and between kin classes beyond that which can be captured by pedigree estimates alone. This signal will provide us a novel way to understand the role of relatedness in the evolution of sociality in animals.

## **2.21 Means to succeed in resource competition**

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Organisms compete for resources. To succeed in this competition, organisms may either ‘race’ to be quicker than others, ‘fight’ for privileged access, or ‘share’ their efforts and gains. In this talk I discuss how the ecology and intrinsic attributes of organisms select for each of these strategies. Special emphasis will be given to the evolution of cooperation, with examples including a range of different taxa. Here the crucial question is how the conflict of fitness interests can be mediated in order to allow competitors for resources to unite and benefit from collective goal pursuit.

### 3 Abstracts - poster

#### 3.1 Effects of long-term housing in a semi naturalistic environment on female C57Bl/6J mice and advancements of the applied housing system

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Environmental enrichment (EE) is used to minimize negative effects of impoverished, monotonous housing conditions that can be experienced in standard laboratory caging. The environment of laboratory animals can be enriched with objects and a changing supply of nesting and bedding materials to encourage natural behaviors. A major challenge in the use of EE is ensuring standardization and comparability between laboratory studies. There is concern that the emergence of individuality and increasing variability of measurement data may influence the outcome of studies.

To evaluate influences of EE on behavioral and physiological parameters, different housing conditions were provided for female C57Bl/6J mice. As an alternative to standard sized cages with or without EE a group of 20 mice was housed in a large semi naturalistic environment (SNE). The mice were living in the respective housing conditions for a long-term housing period of XX weeks and were analyzed with regard to physiological and musculoskeletal properties. Activity data from animals in the SNE revealed distinct patterns of roaming behavior which stabilized over time indicating the emergence of individual differences. However, this individuality in movement behavior did not correlate with other behavioral or physiological parameters. Notably, measured values of the resting metabolic rate, grip strength and bone density showed no increase in variance in comparison to animals in standard caging. In comparison to standard cage housing SNE animals were longer and heavier. Bone properties of SNE animals appeared to be improved and age-related increased bone resorption was less pronounced. Based on the advantages of the SNE, a further development of the housing system is presented that is also intended to optimize everyday handling in laboratory experiments.

### 3.2 Revisiting the theory of reciprocal cooperation

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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 cannot exchange help reciprocally given its apparent cognitive complexity. Consequently, reciprocity is suggested to have evolved in the human lineage only. In contrast to this, recent findings have demonstrated reciprocal cooperation in various non-human animals. To understand the evolutionary origins of human reciprocity, and whether it is shared with other animals, we examined 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, for example, not confined to unrelated individuals, but that the choice of commodities can impact the likelihood of reciprocation. Based on this, we conclude that reciprocal cooperation is not restricted to humans. How do they do it then? We are proposing reciprocity can be achieved by different psychological mechanisms, varying in cognitive complexity. 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 emerged and how it is maintained.



### 3.3 Analysis of zebrafish larval behaviour as model for analgesic drug screen

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In the past decade, the zebrafish (*Danio rerio*) has been established as an efficacious model organism for a broad spectrum of research in the biomedical field. Its attractiveness is due to its high fecundity and offspring numbers, rapid development and a broad repertoire of behavioural responses to various stimuli. These advantages make the zebrafish model well suited for high throughput screenings of drugs or toxins.

In consequence of the rising popularity, a greater need to improve animal experiments in accordance to the 3R principle for zebrafish arose. Especially in the area of pain management, additional research is needed to reduce side-effects in known analgesics and to identify alternative treatments.

Therefore, the aim of this study was to investigate whether larval zebrafish can be used as a model for analgesic drug testing. For this a model to analyse larval behaviour has been established, where swimming activity is video recorded and automatically analysed in a 24well plate format. Algogenic substances such as cinnamaldehyde or hydrogen peroxide elicited changes in mean velocity and total distance travelled. These effects were normalized by addition of the opioid buprenorphine and nonsteroidal anti-inflammatory drugs (NSAIDs) such as acetylsalicylic acid or diclofenac were tested as alternatives.

In summary, this demonstrates that assessment of larval behaviour is a promising approach to screen for effective analgesic treatments in zebrafish.

### 3.4 Human food waste consumption and health of eastern gray squirrels (*Sciurus carolinensis*)

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Urban habitats provide wildlife with easy access to high-caloric human food waste, and its consumption can have both positive and negative effects on health. This study assessed the effects of living in proximity to humans and consumption of human food waste on eastern grey squirrel (*Sciurus carolinensis*) health. We expected that urban squirrels would use trash bins more often during periods of high human presence, would consume more anthropogenic food during winter when natural food availability is low, and would have a larger body mass compared to rural squirrels due to their access to anthropogenic food items. We hypothesized that the measured health parameters of urban squirrels would differ from those of rural squirrels. We assessed trash bin usage and food waste consumption via direct observation (total of 160h) of five trash bins during four study periods spread throughout the year on an urban university campus in North Carolina, USA. We also trapped squirrels in both an urban (N=45) and rural (N=11, control) habitat. Squirrels were anesthetized for collection of body mass and a blood sample to determine blood cell counts, hematology, and biochemistry including assessment of kidney and liver values, blood lipids and glucose. Results revealed that trash bin usage increased with human presence. Squirrels retrieved 60% of all anthropogenic food items during the coldest study period and 76% of items were starchy foods (e.g., fries, bread). Urban and rural squirrels did not differ in body mass, white blood cell counts, blood lipids, blood urea nitrogen, potassium or sodium. Red blood cell indices were higher in rural squirrels, and ionized calcium and glucose were higher in urban squirrels. Our results support previous findings of increased carbohydrate consumption in urban environments, but squirrel health was comparable between both environments, suggesting that urban habitats are relatively benign for gray squirrels.

### **3.5 Rise and fall: The influence of temperature on aggression in a tropical ectotherm across a broader range of thermal conditions.**

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Aggression in ectotherms is correlated with temperature. However, most studies exploring this relationship and its consequences normally use a small number of specific temperatures and this may limit our understanding of the relationship between aggression and temperature. We tested levels of aggression across a range of temperatures in a tropical cichlid species using a mirror aggression assay. We found that, as predicted based on physiological response to temperature (thermal performance curves), that while rates of aggression do initially increase with temperature this does not hold. There is a nonlinear relationship, and after reaching a peak, any further increase in temperature results in decreased aggression. Additionally, we found that the intensity of aggression changes across temperatures. In the first five minutes on exposure to an opponent (mirror image) the frequency of aggression increases linearly with temperature, however these levels of aggression are not sustained at high temperatures. Within 20 minutes levels of aggression in the higher temperature conditions dropped. Suggesting that the drop in aggression at higher temperatures may be driven by greater fatigue through a decrease in physiological performance. These findings contribute to our understanding of behavioural impacts of climate change induced warming and rapid thermal fluctuations. Especially for our study species *Neolamprologus pulcher*, where aggression is used as a mechanism for mediating social hierarchies, and other tropical ectotherms more generally. Our results also have methodological implications. The selection of specific temperatures when conducting studies of aggression temperature must take into account the possibility of bias introduced by selecting small numbers of temperatures or explicitly test for potential changes in aggression over the thermal tolerance range of their subject species. Our results can hopefully aid future research by highlighting the importance of considering the full thermal ranges when selecting specific temperatures in future work on aggression in ectotherms.

### 3.6 Serial reversal in ravens (*Corvus corax*)

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Learning flexibility has been previously linked with ontogenetical and social factors enabling animals to adapt and increase their chance of survival. Understanding the cognitive requirements and ensuing abilities is, however, often obscured by associative alternatives. This study aims to get a closer look at the factors playing a role in the abilities of learning and relearning patterns and the connected capabilities in the common raven (*Corvus corax*). Through a serial reversal task in which the subjects, upon learning a certain rewarded stimulus, needed to switch to the opposite of the two presented colours, forms of generalisation and learning abilities were measured according to the amount of needed trials and errors until reaching the learning criterion. Confounding factors such as age, experience, sex, stress, and breeding status were subsequently excluded to be of a significant influence on the learning outcome. However, the mean improvement over the trials and the number of errors linearly decreased over the session of the experiment. This proves that all ravens were able to successfully master the experiment and, hypothetically, were able to generalise a pattern over time. As a social complex species with a comparably large brain, the individuals still presented a strong individual difference. Further research into the effect of personality, such as fast and slow learners, would be needed to gauge the exact factors for the found variance.

### **3.7 Artificial selection for predation survival shapes life-history traits and collective motion in guppies (*Poecilia reticulata*)**

Hannah De Waele<sup>1</sup>, Regina Vega-Trejo<sup>2,3</sup>, Kevin Chou<sup>1</sup>, Jori Noordenbos<sup>1</sup>, Alexander Kotrschal<sup>1</sup>

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Predation pressure exerts strong selection pressure on many traits. For instance, it is likely a major driver of the evolution of life-history traits and collective behaviour. 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 evolution is surprisingly scarce. Here, we experimentally tested how predation impacts the evolution of life-history traits and collective behaviour in juvenile and adult guppies (*Poecilia reticulata*). We used three replicate lines of guppies artificially selected for adult predation survival for three generations and compared them to three control lines. We found that predation selected fish had larger, and more offspring, particular early in life, than controls, while several other traits were remarkably unaffected by selection. Additionally, we found that the offspring of survivors showed differences in polarization and cohesiveness, compared to fish from control lines. Our results demonstrate which aspects of life-history are shaped by predation and show that collective motion can rapidly evolve under strong predation selection.

### 3.8 Effects of early social experiences on exploration and foraging in juvenile ravens (*Corvus corax*)

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Social experiences during early development are known to strongly shape the ontogeny of social behaviour, but less is known about their impact on the development of other behavioural responses such as exploration and foraging. In the current study, we subjected 61 juvenile ravens (*Corvus corax*) to a novel environment test (NE; an established method to measure individual responses to novel environment exposure) after brood sizes had been experimentally manipulated. Using exploratory factor analysis, we identified three latent behavioural variables (Exploration-Latency, Exploration-Activity and Foraging) in the NE. We now asked if these can be predicted by an individual's early social environment (specifically family size and sex ratio in the brood). We hypothesized that increased stress, induced through competition during early development, may lead to heightened exploration and foraging in the NE, as chicks might adapt their life-history strategies to cope with suboptimal resource availability in their early lives. We predicted that chicks from families with large broods would be subject to increased sibling competition, showing increased exploration and foraging in the NE. Since males are more resource-demanding than females, we similarly predicted that families with a higher percentage of males would face heightened resource competition and therefore show increased exploration and foraging in the NE. We found that family size was not a predictor of behaviour in the NE. Sex ratio in the brood significantly predicted Exploration-Activity, it was however female-biased broods that explored most. This observation runs contrary to our prediction. A possible explanation is that parents invest more heavily into male chicks, therefore subjecting female-biased broods to heightened resource competition and developmental stress.

### **3.9 The Open Science Toolbox for animal experimental research – Advancing research transparency and quality**

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Open science has become a slogan in the scientific community that too often fails in its practical implementation. Here we provide an overview of practices that can be applied throughout the research process to help scientists improve the transparency and quality of their work. As open science practices continue to evolve, we also provide an online toolbox of resources that we will continually update. This toolbox can be accessed through Zenodo (DOI: 10.5281/zenodo.6497559).

Animal experimental research has a special responsibility to be transparent and of high scientific quality, as it still relies on animal testing and is the basis for clinical trials that may potentially put patients at risk. However, animal research still lags behind other fields in implementing open science practices. In addition to deep-rooted problems in the scientific incentive system, this deficit may also be due to a lack of information. Animal researchers can already choose from a variety of tools to increase the transparency of their scientific work. We provide an overview on the tools that can be used throughout the research process, from planning to conducting and analyzing a study to publishing it.

Open science practices not only raise the profile of individual scientists, but can also initiate a change in the research culture towards greater transparency and quality. There are early indications that open science is increasingly being adopted in animal experimental research as key players in the scientific incentive system, i.e., funders, publishers, and research institutions, support and, in some cases, already require the implementation of open science practices. However, scientists do not have to wait for the slowly evolving incentive framework to change their research habits; they can take initiative and start using open science tools for more collaboration, transparency and reproducibility today.

### **3.10 Impact of three commonly used blood sampling techniques on the welfare of laboratory mice: Taking the animal's perspective**

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Laboratory mice are the most frequently used animals in biomedical research. In accordance with guidelines for humane handling, several blood sampling techniques have been established. While the effects of these procedures on blood quality and histological alterations are well studied, their impact on animal welfare has not been extensively investigated. Thus, our study aimed to compare three commonly used blood sampling techniques regarding their effects on different animal welfare indicators, including physiological and behavioural stress parameters, e.g., pain measures, home-cage and nest-building behaviour and exploratory activity.

Male C57BL/6J mice were subjected to a single blood collection from either the vena facialis, the retrobulbar sinus or the tail vessel or were allocated to the respective control treatment. While all blood sampling techniques led to an acute increase in plasma corticosterone levels, the response was strongest in mice that underwent sampling from the vena facialis and the retrobulbar sinus. Similar results were observed when the time-course of adrenocortical activity was monitored via corticosterone metabolites from faecal samples. Blood collection from the vena facialis and the retrobulbar sinus also decreased nest-building activity and induced higher scores on the Mouse Grimace Scale. Moreover, locomotor activity and anxiety-related behaviour were strongly affected after facial vein bleeding. Interestingly, tail vessel bleeding only induced little alterations in the assessed physiological and behavioural parameters. Notably, the observed effects in all treatment groups were no longer detectable after 24 hours, indicating only short-term impacts.

Thus, by comprehensively assessing the severity of the particular sampling procedures, the results of our study contribute to Refinement within the 3R concept and allow researchers to objectively select the most appropriate and welfare-friendly blood sampling technique for a given experiment.



### 3.11 Ontogeny of individual variation in food calling in the common raven

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Non-breeding ravens (*Corvus corax*) give food-associated calls (termed 'haa' calls) when a food source is difficult to access, attracting nearby conspecifics. These 'haa' calls develop within the first year of life from begging calls, and previous research found substantial inter-individual variation in both calling rates and vocal characteristics of food calls. However, it is still unclear whether the variation in young ravens' begging translates into the individual variation observed in food calling in later life stages. In this 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 captive-bred ravens across 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. Calling behavior differed between individuals but was affected by different factors depending on the life stage and became more individual-specific during later life stages when birds moved from captivity to free flight. Overall food calling rate decreased across developmental stages and calling rates during early life stages did not predict calling rates in later life stages. Our study also found individual-level differences and age-associated changes in the acoustic structure of begging calls in raven fledglings. Our results provide insights into how ravens adjust their calling behavior to different contexts and flexibly use information encoded in food-associated calls to locate and make decisions about accessing food sources.

### **3.12 In search of a conditioned place preference test for mice to assess the severity of experimental procedures**

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To compare the severity of experimental procedures and behavioral tests from an animal's perspective novel methods are needed. In theory, one feasible approach could be the use of a conditioned place preference test (CPP). In this test the preference for a certain area in a test apparatus is associated with an experimental treatment. Usually, the CPP is used to investigate, for example, the effects of drugs. Here, we wanted to develop a protocol, which instead would enable us to compare the effects of different experimental procedures conducted with mice.

Nine experiments with C57BL/6J mice were performed, varying the setup, the procedure duration, the neutral to be conditioned stimuli (NS->CS; visual and/or textual), and the unconditioned stimuli (US; fixation, food reward, or weighing as it is conducted during the weekly cage cleaning routine) as well as the presentation order (NS before, after, or parallel to US).

Unfortunately, none of the tested protocol resulted in a distinct preference. Moreover, even simple protocols using food reward as a treatment failed to result in a conditioned place preference. Overall, none of the protocols was sufficient to form a reliable association between NS and US. We have scrutinized the experimental setup in detail, and although we cannot present a solution yet, hopefully, our findings will help to create a working CPP to compare the severity of different experimental procedures for mice.

### **3.13 The power of a touch: Regular touchscreen training but not its termination affects hormones and behaviour in mice**

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The automated assessment of cognitive function via touchscreen-based tasks has become an increasingly applied procedure in animal research. However, besides many advantages of touchscreen tasks (e.g. high translational value, automated data acquisition, reduced experimenter effect), they often require long and intensive training phases, sometimes lasting up to several months of daily training. First studies revealed increased adrenocortical activity and anxiety-like behaviour in touchscreen-trained mice. At first, this points towards a negative effect of touchscreen training. However, also enrichment effects of touchscreen training have been discussed. In the present study, we aimed to disentangle these effects further, focusing on the question whether an abrupt termination of the training schedule could pose a loss of enrichment for mice. Therefore, we assessed faecal corticosterone metabolites and anxiety-like behaviour in touchscreen-trained, mildly food-restricted, and ad libitum fed mice, since a restricted diet constitutes an integral part of training. To address the effect of training termination, we compared these parameters between mice that were continuously trained, and mice whose training was terminated two weeks earlier. Our results confirm previous studies reporting increased adrenocortical activity and anxiety-like behaviour in touchscreen-trained mice. However, there was no significant effect of the termination of training, contrasting the hypothesis that training termination might constitute an enrichment loss. We discuss two alternative explanations for our findings. Yet, at the current state of knowledge, no final conclusions can be drawn, which is why further research is necessary to more accurately estimate the severity of touchscreen procedures in the future.

### **3.14 Do females keep the sweetest buns in their oven? The role of male quality in pregnancy turnover**

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Sexual selection theory predicts conflict between the sexes regarding investment into offspring, and this investment is specifically unbalanced in mammals. To choose an attractive male can be beneficial for a female's fitness, considering that the genes that a male possesses could increase offspring viability and/or mating success. 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. The terminated pregnancy is usually followed by a new pregnancy sired by the invader, and may thus be referred to as a "pregnancy turnover", in the context of sequential mate choice. In this experiment, we investigated pregnancy turnover as a form of sequential mate choice by manipulating the quality of the first versus the second male. We use bank voles (*Myodes glareolus*) as a study system since it has been shown that 50% of females exhibit turnover of pregnancies after male turnover in the field and lab. For this experiment we chose males of different qualities perceivable to human observers, i.e., experimental dominant males (or high quality, "HQ") will have a higher UMV, will be larger, and bolder than experimental subordinate males (low quality, "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. Our results suggest that, as predicted, the pregnancy turnover rate was higher when the second male was dominant.

### 3.15 Mouse lock box—sequential problem solving in mice

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Against the background of studies demonstrating sequential problem solving in cockatoos (1), we developed complex mechanical puzzles, so-called lock boxes, for mice (young adult female C57BL/6JCrI) and investigated their problem solving strategies. To motivate the animals to open the lock boxes, the puzzles were baited with a food reward. We designed two lock box sets, each consisting of four 1-step lock boxes that were combined as a 4-step lock box. For the latter, a sequence of four locks blocking each other had to be removed in the correct order. The 1-step lock boxes were presented to the mice in preparation for the 4-step lock box. While manipulating the lock boxes, the mice were video-recorded from three perspectives allowing accurate behavioral annotation. Data analysis is currently in progress. The lock box sessions are analyzed both manually and automatically to derive the pose of the lock box parts and mice, and to classify their behavior. Besides the problem solving strategies of the mice, another outcome was of interest: Since laboratory mice often live in an impoverished environment, the presentation of lock boxes may serve as cognitive stimulation and, therefore, the impact of the lock box enrichment on the phenotype of the mice was investigated using an extensive test battery (i. e., home cage activity, anxiety-related behavior, stress levels, the response to stressful situations, calorimetric measurement, adult neurogenesis). These data are compared between mice housed under standard laboratory enrichment (n=12), super environmental enrichment (n=12), or lock box enrichment (n=12) and will reveal whether lock boxes have the potential to improve the animals' affective state.

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(1) Auersperg AMI, et al. (2013). Explorative Learning and Functional Inferences on a Five-Step Means-Means-End Problem in Goffin's Cockatoos (*Cacatua goffini*). PLoS ONE 8(7): e68979.

### **3.16 Biological variation accounts for most of the variation in a multi-laboratory study**

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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.

### **3.17 Boldness, parasite load, and space use correlations in bank voles (*Myodes glareolus*)**

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Animal behavior and parasite infection are inextricably linked at phenotypic, ecological, and evolutionary levels. Previous research indicates personality complexly interplays with parasite load, nevertheless it often remains unclear how these are expressed and correlate with space use under natural conditions. Therefore, we aimed to study among-individual correlations between boldness, tick load, and microhabitat use in wild populations of bank voles (*Myodes glareolus*), a species for which among-individual differences in spatial competition and movement are predicted by boldness. In this study, we repeatedly assessed boldness in emergence tests and ear tick load in bank voles ( $n = 34$  to  $65$ , depending on analysis). We determined microhabitat use based on capture-mark-recapture data and quantified vegetation height and cover in each individual's microhabitat. We found repeatable variation in boldness and sex-dependent tick load, with males carrying a higher tick burden than females. Additionally, we found positive correlations between tick load, vegetation height, and vegetation cover. In contrast to our prediction, we found only weak among-individual correlations between boldness, tick load, and vegetation cover. Overall, our results suggest non-random distribution of parasites among wild bank voles related to personality and microhabitat, which may have further effects on the distribution of ticks and tick-borne diseases in the landscape and potentially affect disease outbreaks among humans.

### 3.18 Do common marmosets respond to self-live video differently? A multiple video stimuli comparison

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Individual recognition among conspecifics has been found in a variety of non-human primates and is the ability to discriminate among members of their own species. In contrast, self-recognition is the ability to recognize one's own body (e.g., in a reflection) and has been found in great apes but in monkeys it is still in debate. This ability is assessed through the Mark Test, which consists of marking a body part visually inaccessible without a mirror and measuring subjects' mark directed behaviors. The modern video applications are a robust tool in social cognition among. Common marmosets (*Callithrix jacchus*) are a monkey species with a high degree of cooperation, striking social cognitive abilities and have shown positive results in video experiments. The aim of this study was to find out whether the test subjects discriminate between the video content (from themselves, conspecifics or an object). We tested 13 common marmosets in four experimental video conditions: 1) Moving Object (object resembling a marmoset in color, pattern and size), 2) Conspecific (unfamiliar individual of same sex), 3) Pre-recorded Self (recording of the same subject), and 4) Self-live video (mirrored live video of the same subject). After analyzing the behavioral reactions, we found a degree of discrimination in the highest fear response in front of the Self-live video; the highest attention to the Moving Object video; the most aggressive reactions to the Conspecific video; and most contact calls vocalized during the Self-live video. Here, we will discuss the avoidance of visual gaze and interest in the novel object as main possible factors. Additionally, territoriality and discrimination of social vs. non-social content will be further discussed. These findings support the use of video as a remarkable tool for the exploration of individual- and self-recognition in primates.



### 3.19 What is exploration behaviour?

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Exploration plays a central role in the interaction of organisms with their environment. Therefore, it has a clear functional link to survival and is of major interest to animal cognition and ecological research. As one of the main animal personality dimensions, among-individual variation in exploration has been extensively studied. However, are researchers studying exploration in different contexts and fields really addressing the same behaviour? Using a systematic review approach, we aim to clarify apparent heterogeneity in terminology and methodology to define and measure this behaviour across taxa and research fields. Key aspects diverging and interacting within exploration behaviour appear to be response to novelty, spatial movement and information gathering behaviour. Here, we present an outline of our systematic review on the distinctions and connections between different focal points of exploration behaviour. It will consist of a scoping review on how exploration has been defined in high impact research and a meta-analysis on the methodology used to study it. Using the current body of work on exploration test validation, we aim to investigate if exploration is a distinct trait, part of a behavioural syndrome or an umbrella term for multiple closely linked traits. With this review, we want to work towards a more unified perspective on what is meant and measured with the study of exploration behaviour. We hope that this will aid discussions on exploration across fields and research contexts and could ultimately lead to more informative comparative studies.

### **3.20 Assessing Implicit Intergroup Biases in Lemurs**

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Primate species display the ability to distinguish between members of their own social unit and neighboring social units. The behaviors shown toward neighboring groups depend on several ecological factors such as group density, predation pressures, resource availability, and the species. However, the effect of psychological phenomena on intergroup dynamics has largely been unexplored in non-human primates. For nearly three decades, the Implicit Association Test (IAT) has been an important metric in assessing implicit, unconscious biases between specific groups in humans. While the IAT has been replicated reliably for over two decades in humans, few studies have investigated whether the outcome of the test is generalizable to other species. This present study aims to use a similar paradigm to the IAT to assess the impact of implicit biases on intergroup dynamics in two species of lemurs: black-and-white ruffed lemurs (*Varecia variegata*) and ring-tailed lemurs (*Lemur catta*). Performing the experiment with nonhuman primates can indicate whether the association between social constructs is a feature unique to humans, developed through the social environment, or has evolutionary roots, providing fitness benefits.

### **3.21 A Modified Open-Field Test for Rodent Behavior: The Transit Test vs the Traditional Open-Field Test**

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In behavioral research the Open-Field test (OFT) has paved the way for analysis of consistent behavior over time, especially in rodents. Here, we propose a modified version of the OFT, the Transit test, with the goal of decreasing human interference and subsequently, reducing handling-time, stress and enabling “in-the-field” testing of rodents directly at the capture site. The experiment is an ongoing long-term field study on common voles spanning over one year, which allows the investigation of an effect of seasonal dynamics in weather and population density on measured behavioral variables as well. Since common voles are short-lived rodents the study setup further allows to observe the behavior of individuals throughout their entire life span (about 3 month). We focused on autumn-born and spring-born individuals and test for within-individual repeatability of behavior between the two tests, by letting each individual run through both tests separately. With the help of mixed models, we will analyze the effects of factors such as population density, season and age on within-individual repeatability. We predict that individual behavior shows high repeatability across both tests but will vary due to age and population density, with older individuals and individuals from a low density population being more repeatable compared to younger individuals and individuals from high density populations. With our results we hope to introduce the Transit test as an additional behavioral test for common voles, by providing strong evidence for its validity and reliability as a tool for future research on rodent behavior.

### **3.22 Think first, then Eat – Feeding Enrichment for Spider Monkeys at Osnabrück Zoo**

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Environmental Enrichment is designed to promote natural behaviours in captive animals. In addition, it can help to avoid stereotypies or reduce other atypical behaviour. Hence, the aim of our study was to evaluate the suitability of different feeding enrichment designs (three puzzle-feeders) for black-headed spider monkeys (*Ateles fusciceps rufiventris*) housed at Osnabrück Zoo.

The study group consists of one adult male and six females of different ages. The three different feeding enrichments were mounted above ground in the monkeys' indoor enclosure in order to promote foraging behaviour. The enrichment items were accessible from all sides and presented for four consecutive days each. The enrichment consisted of (i) bamboo tubes with holes, (ii) balls made of cane filled with wood wool, and (iii) wooden shaking boxes with holes. After exposing the animals to the three enrichment items consecutively, a preference test was conducted for four days in which the monkeys were provided with one model of each feeding enrichment simultaneously. All enrichments were stocked with treats the animals preferred over their regular food. During the observation times (in total 32h), the activity of the monkeys at the enrichment items was quantified using continuous recording.

Clear individual differences between the spider monkeys in the duration of foraging at the enrichment items was observed. However, the preference test revealed no clearly favoured design of the three enrichment items. Moreover, the results showed that the feeding enrichments did not lose their appeal over the time course of exposure. It can be concluded that all three enrichments were well accepted by the spider monkeys and can be considered a positive addition to their housing environment, thus promoting animal welfare and natural behaviours in captivity.

### **3.23 Social Learning in Social Networks**

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Inferring the expertise of others from observed actions is central for social learning. It enables individuals to decide from whom to learn, because the information provided by others can be either useful – e.g., when the other has expertise that the agent itself does not have – or not useful –e.g., because it is outdated or maladaptive. Interestingly, recent studies indicate that observed experts can also become more valuable social partners in the short term. Hence, the expertise of others, may predict social partner choice beyond other intrinsic traits, such as kinship or personality. In this project, we will combine detailed behavioural observations of social interactions with social learning experiments in several groups of wild redfronted lemurs. We will conduct a series of social learning experiments in which we will manipulate the expertise of learners and demonstrators, document the spread of these techniques among group members and track subsequent changes in their social networks. With this approach, we will investigate whether innovators of a solution of an experimental task receive more affiliation, and how their social network subsequently changes over time.

### 3.24 Phenotypic plasticity under urbanisation: A meta-analysis

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Human-induced rapid environmental change (HIREC) is a major concern of the last decades due to the many perturbations it generates in ecosystems. Urbanisation is a widespread and common HIREC which involves disturbances such as fragmentation of habitat, noise pollution or pollutants. A key area of current research is studying how animals cope with these new challenges. Yet, much research performed till now, investigates patterns and changes of individual average responses to face urbanisation. These studies showed that individuals seem to have different ecotypes between rural and urban habitats, but it often remains unclear whether this pattern is due to an adaptive process (e.g., local adaptation) or results from phenotypic plasticity, such as reversible individual flexibility. The aim of this study is to test the hypothesis that individuals of urban populations are more flexible than those of rural populations. Using a meta-analysis approach, we aim to (i) summarise studies that have measured individual variation at the within- and between-individual level under urbanisation for labile traits (behaviour, physiology, life-history), (ii) quantify the proportion of within- and between-individual variation and (iii) test whether the degree of urbanization explains differences for each partition of individual variation. We expect that urban individuals express higher levels of phenotypic plasticity across all types of labile traits although the clearer differences should be present in behavioural traits since they are the most flexible. Specifically, we test three predictions (i) within individual variation (i.e. reversible flexibility) is higher in urban compared to rural populations. (ii) between-individual variation (i.e. indicating individual specialisation) is lower in urban compared to rural populations and, therefore, (iii) urban populations have lower traits expression consistency (i.e. lower repeatability) than rural populations. We hope that our study will help to clarify the mechanisms driving adjustment to urbanization and particularly by revealing how individual variation in the form of reversible plasticity or increased generalisation play a role to mitigate the effects of urbanisation.

### **3.25 Effects of social environment on personality in goldfish**

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Numerous studies of fish species have shown the effects of consistent individual differences in behaviour on evolutionary trades, such as mate choice, learning capabilities or group decisions. However, little is still known about the influence of social environment on temporal plasticity of fish behaviour.

Using goldfish (*Carassius auratus*) as a highly social fish species, we conducted repeated open field experiments to measure a combination of variables, such as travelled distances, entering latencies and detention times as a proxy of boldness. In order to investigate hypothesized effects of group composition, 74 goldfish were tested after being housed in two different group contexts. In a first step, fish were grouped randomly in three identical tanks and individually ran through repeated open field tests. Using multiple factor analysis (MFA) on the recorded variables, each fish was assigned a boldness score that referred to one personality type of „bold“, „intermediate“ or „shy“. According to those scores, three novel groups were formed in a second step, consisting of bold, intermediate and shy fish only. After three weeks, all fish ran through a number of experimental trials as before to see if their recorded behaviour changed. In a last step, all fish were put back into their original groups and open field tests followed once more.

Preliminary results indicate no effect of homogeneous groups on exploratory behaviour. Still further analyses have to follow to underline the role of a changing social environment on goldfish.

### 3.26 Insights into novel object tests

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A widely used method to study the personality of animals is the novel object test. It is assumed that the shorter the latency to approach an unfamiliar object, the less neophobic the animal. This implies a fear response to the novel object, while it usually does not take into account whether the unfamiliar object triggers a motivation to explore.

Novel object tests often differ in both methodology and interpretation of the behaviours measured. To get a deeper insight into what is actually measured with the novel object test, we have performed different versions of this test with zebra finches (*Taeniopygia guttata*). We repeatedly performed novel object tests in a familiar and an unfamiliar environment. Besides the behaviour towards the unfamiliar object, we also measured the activity of the animals during the tests. In addition, we took blood samples to determine the plasma concentration of corticosterone, the most important stress hormone in birds.

An increase in corticosterone in combination with aversion to the new object would indicate that birds are neophobic. Our results show that zebra finches hesitate to approach a new object, particularly when they are in an unfamiliar environment. We found little variation or repeatability of behaviour towards the new object in both situations. However, there were different patterns of activity. Moreover, we found a clear avoidance of preferred water baths in combination with increased stress hormone concentrations in the presence of a new object, suggesting that the birds were neophobic rather than showing a lack of interest in exploration.

Taken together, our data provide a detailed overview of zebra finch behaviour towards novel objects.



### **3.27 Personality-dependent use of social information during foraging in common voles**

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Individuals use sensory information to make decisions about how and where to forage. The previous presence of conspecifics at a foraging patch, for example, may indicate increased competition for resources and/or suggest that the particular resource has already been exploited. However, previous presence of a conspecific may also confer positive information about the quality of the resource patch itself and attract other conspecific foragers. In social species, the value and reliability of information obtained from conspecifics may further depend on the identity of the conspecific itself. Cues from known conspecifics may be perceived as more reliable than cues from unknown conspecifics. Thus even for individuals in social species that forage alone, information from known or unknown conspecifics may influence foraging behaviour. We investigate how the previous presence of either known or unknown conspecifics at artificial foraging patches influences individual foraging behaviour in 40 common voles (*Microtus arvalis*). Individuals are tested under risky and safe conditions to assess potential context-dependent value of conspecific cues. Giving up densities (GUDs) and video behavioural analysis are used to measure foraging behaviour at patches. Additionally, individuals are tested for personality traits to determine if conspecific information use is personality dependent. Preliminary results are discussed in the light of personality-dependent use of social information.

### **3.28 Role of personality in pathogen community compositions: a study on wild rodents**

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Personality in rodents can have several ecological consequences and has been linked to differences in fitness. For example a more active rodent might benefit from this behaviour when searching for food or mates when predation risk is low, but suffer from it when predation risk is high. Given the ubiquity of rodent habitats within and adjacent to anthropogenic settlements, personality traits like boldness and activity might influence which individuals are more likely to interact directly or indirectly with humans and/or domestic animals. Since rodents are reservoirs of numerous zoonotic agents, understanding what mechanisms might influence the likelihood of these interactions is thus a challenging issue concerning public health. We tested whether rodent personality is associated with the composition of their pathogen communities, or more precisely whether diversity of pathogenic bacteria differs in bolder and more active/explorative rodents. In urban and forested green areas around the city of Potsdam we captured 91 rodents during two seasons and measured directly in the field behaviours linked to exploratory tendencies and risk-taking through a combination of an open-field test and dark-light test. Captured rodents belonged to three species: bank vole, striped-field mouse and yellow-necked mouse. Individuals were screened for pathogens with 16S rRNA amplicon sequencing and results were assessed to identify patterns of presence and associations between pathogens. Through ordination analysis the role of personality, species, sex, season, and body condition will be explored in relation to the pathogenic presence and diversity.

### **3.29 The virtual magnetic environment: Towards a fast and robust behavioural assay to study magnetoreception in subterranean mole-rats**

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Multiple subterranean mammals possess a magnetic sense, but how the perception works is yet to be elucidated. Much of our knowledge is obtained from the Ansell's mole-rat, *Fukomys anselli*, which builds nests in the magnetic South-East region of an open field arena. The nest-building assay has become the standard paradigm to study magnetoreception in rodents, but it has major limitations. The data collection is slow and temporally imprecise, which renders it inefficient in the study of acute sensory perception.

We, therefore, went on a hunt for a fast, simple and replicable behavioural assay to demonstrate the perception of magnetic fields. We hypothesised that mole-rats primarily use their magnetic sense during exploration, i.e. tunnelling and foraging. Using automated closed-loops between live animal tracking and a magnetic coil system, we created a virtual magnetic environment that responds to the position of the animal. This enables us to test multiple behavioural paradigms within the same coil setup, under controlled conditions. Here, we present data from two explorative paradigms, novel object and maze exploration. We provide a comprehensive analysis of the efficiency of these paradigms for characterising the magnetic sense in Ansell's mole-rats.

### **3.30 On the importance of differentiating between selfless and mutualistic prosocial behavior**

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Prosociality, as a behavior intended to benefit another individual, has a very important role in human society. In spite of extensive research on this topic, lately focused on the cooperative breeding hypothesis, contradictory results still arise. Inconsistent experimental approaches, incomplete testing combinations and confusing terminology hinder us in our understanding of prosociality. To overcome this obstacle, we have carried out a token prosocial choice test with four possible outcomes (selfish, selfless, mutualistic and spiteful). We have tested one cooperative breeder (common marmosets) and two non-cooperative breeders (ring-tailed lemurs and black-and-white ruffed lemurs) in a free-choice experiment and a subsequent forced choice experiment. In the free-choice design, all species selected the selfless token the least often. Interestingly, common marmosets chose the selfish option more often and the mutualistic option less often than either lemur species. In the forced-choice paradigm, although common marmosets chose selfless more often than both species of lemur, they did it less often than by chance and less often than selfish or even spiteful. Moreover, although all three species chose mutualistic above chance, common marmosets did it less often than both species of lemur. The fact that common marmosets showed more prosociality than lemurs in the selfless condition but not in the mutualistic condition challenges the notion that prosocial tendencies are per se more pronounced in cooperative breeders. The findings of the current study highlight the importance of distinguishing and incorporating both selfless and mutualistic prosocial options when studying prosocial behavior since it becomes apparent that individuals differentiate between those two kinds of prosociality.

### 3.31 Personality- and state-dependent space use: Find food or avoid becoming food?

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In the field of animal behaviour, individual differences in behaviour are often explained through animal personality. One aspect of animal personality often studied is boldness. Boldness is considered to be a measurement of risk-taking, however this has only rarely been ecologically validated. When moving through space animals encounter areas of different perceived risk, suggesting that use of these areas differs between individuals of differing boldness. Optimal-foraging theory suggests that individuals with differing energetic state should also differ in the way they optimise their foraging, as they balance the risk of predation with the rate of food intake. State-dependent safety suggests individuals in higher state to be more risk-taking as the chances of surviving an encounter with a predator may be higher. The asset-protection principle however, suggests individuals in lower state to be more risk-taking as starvation risk may be larger than predation risk.

To study the effects of personality and energetic state on space-use I conducted an enclosure study in bank voles (*Myodes glareolus*). Bank voles were behaviourally phenotyped using an open field test and a dark-light test and kept in an enclosure with heterogeneous risk for five days. After recapture individuals were tested in the dark-light test again after the enclosure experiment. Individuals' space use was observed using RFID loggers and camera traps. As risk levels in this study were very high they did not elicit differential use of the enclosures. While differences in animal personality did influence some aspects of space use, space use was mostly explained through differences in energetic state. Individuals in higher state took less risk by having smaller home-ranges and moving through the enclosures less frequently, thus lending support to the asset-protection principle. Trajectories in energetic state however, suggest further effects of differences in metabolism or behaviour.

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