Poster presentation abstracts

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'Approach the danger!' Semantic modification in willow tit mobbing calls

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In human speech, words can be strung into larger compositional structures (phrases or sentences), which often provide modified meanings to listeners. Although combinations of meaningful vocal elements have been documented for several birds and nonhuman primates, little is known about how receivers comprehend semantic modification in combined vocal sequences. Here, I report the evidence that birds combine meaningful vocal elements to convey a modified message to receivers. Willow tits (*Poecile montanus*) use combinations of warning and recruitment calls when mobbing a predatory hawk. Playback experiments showed that receiver tits exhibit mobbing-like behaviours (i.e. making hops and flights with calling) when hearing these call sequences. In contrast, separated warning and recruitment calls cause birds to either flee to the cover or approach the sound source. These results indicate that willow tits recognize call sequences as a modified message ('approach the danger'), but not as two separated messages (i.e., 'flee' and 'approach'). These findings provide a novel example of the creation of modified meanings in animal vocal sequences.

A Generalised Multi-Segmented Model to Describe Swimming Kinematics in Fishes

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Undulatory body movements of fishes have evolved to be an effective propulsive method, inspiring many researchers attempts to quantify these complex biological mechanisms. Here, we propose a mathematical model and data processing pipeline to automatically describe the midline kinematics of fishes during steady swimming. Our model consists of a series of rigid segments of variable lengths, with each segment being able to pitch about their joint with their predecessor. We use data-driven approaches to estimate the variables of the model (e.g. number of segments and their lengths, and the amplitude and timing of each segment's movement) so that the difference between predicted and measured midlines is minimised. So far, we tested our approach by attempting to describe the midline kinematics of rainbow trout (*Oncorhynchus mykiss*, n = 2 fish, total body length L 15.5 and 23 cm) over a range of swimming speeds (1 L s-1 to 3 L s-1). Preliminary results from our initial investigation suggest that the model is able to describe the midline kinematics of trout with at least 90% accuracy, as measured by mean absolute error normalised by the maximum tail beat span. The ultimate goal of this research is to develop an analytical tool that can automatically generate midlines that are very similar to those of live fishes. In the future, our model can be used by biologists to evaluate different swimming styles, by roboticists to develop new control algorithms and game designers to generate realistic movements for their fish avatars.

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Achieving cohesive and mobile groups with limited number of neighbours

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Previous swarm research has clearly shown that simple rules of interactions among neighbours can lead to stable movement patterns at the group level, and for this there is no need for a centralized control strategy. To better understand the link between local interactions and emergent collective movements, we ask two questions: i) how many neighbours does each member need to take into account for a swarm to achieve a high performance (n)? and ii) how does n scale with group size (g)? To address these questions, we performed multi-agent simulations in a three-dimensional environment with obstacles. Each agent is programmed to have three behaviours agent/obstacle/tank avoidance, and alignment with and attraction to other agents. A winner-takes-all approach is used for decision making with avoidance and attraction having the highest and lowest priority, respectively. We used two metrics to evaluate the performance of the group; cohesion calculated based on the number of splits occurred within the group and mobility based on the displacement of the group. Our preliminary results suggest that there is a trade-off between cohesion and mobility; when n:g ratio is low, the swarm lacks cohesion but is highly mobile, and when n:g is high, the swarm is highly cohesive but stagnant. We hypothesise that there is an optimum n:g ratio which leads to highly cohesive and mobile swarms.

Acoustic environment affects hormonal level and behavior in mice

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Animals adjust their behavior adaptively under varying environmental conditions, which should require rapid endocrine response for sensory stimulation. However, little is known about whether and how environmental stimuli have an influence on physiology and behavior of animals. In this study, we investigated the influence of the acoustic environment on hormonal state and behavior in the C57BL/6J mouse. In experiment 1, we measured the corticosterone level of mice after 1-hour exposure to two acoustic stimuli: (i) rainforest sounds (n = 8) and (ii) no sounds (n = 8). We found that mice exposed to rainforest sounds showed a lower corticosterone level than those exposed to no sound. In experiment 2, we measured behavioral activities of mice in an open-field in combination with the playbacks of (i) rainforest sounds (n = 13), (ii) reversed rainforest sounds (n = 13), (iii) white noise (n = 12), or (iv) no sounds (n = 12). We found that behavioral activities of mice differed among the four treatments: mice exposed to reversed rainforest sounds showed the highest level of activity, following by those exposed to rainforest sounds, to no sounds, and to white noise. These results show that acoustic environments affect both hormonal state and exploratory behavior of the mice, emphasizing the importance of considering ambient sounds in environmental enrichment.

Age-dependent influences of general anaesthesia on the cognitive abilities of macaques

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Increasing life expectancy and advances in medicine are resulting in a growing number of elderly patients undergoing surgery under long-lasting general anaesthesia. Such long-term anaesthesia may particularly impact the cognitive abilities of aging humans (post-operative cognitive dysfunction, POCD) but until now, the underlying mechanisms remain unclear. The present study aimed to establish a non-human primate model for POCD by testing the physical and social cognitive abilities of young and old long-tailed macaques (*Macaca fascicularis*) before and after general anaesthesia (N = 13). Our study examined if general anaesthesia with isoflurane in the first part and with propofol in the second part of the study influenced cognitive abilities and if these effects were age-dependent. Statistical analysis did not reveal significant effects of age or anaesthetics on performance levels in physical and social cognitive tests which contradicts findings of cognitive impairment after general anaesthesia in humans. Further studies need to clarify whether the test battery may not be suited to detect and quantify impairments, or whether long-tailed macaques are generally less susceptible than humans to such cognitive impairments after general anaesthesia.

Are arboreal frugivores creating food patches for ground-dwelling fruit-eaters?

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Tropical rainforest ecosystems are enriched by a diverse set of complex interactions between plants and animals. Arboreal frugivores may play an important, and little studied role, as they create food patches for ground-dwelling animals. Arboreal frugivores regularly drop fruit from trees before they would naturally fall to ground, potentially facilitating sources of food for terrestrial species to exploit. If these food sources are important, we predict that terrestrial frugivores should eavesdrop on arboreal frugivores to maximise their feeding efficiency and alter their movement in response to cues and signals produced by arboreal frugivores. In this study, we test if interspecific transfer of information about food resources play a role in the structure and assembly of Neotropical frugivore communities on Barro Colorado Island, Panama. During an ecologically simple time-period when only one main tree species is fruiting, a combination of acoustic play-back experiments, remote camera-trap monitoring, and GPS tracking data is used to examine if terrestrial frugivores actively eavesdrop on signals and cues made by arboreal frugivores, are attracted by them, and adjust their food search in response. The preliminary results suggest that terrestrial frugivores are attracted, signifying that arboreal primates may play an important role in Neotropical rainforests. Primates are often the first species to be hunted and the loss of primates could affect food availability for terrestrial mammals, because primates drop partially consumed fruits, sometimes months prior to their availability on the ground when there is little else for terrestrial species to eat.

Camouflage in a dynamic world

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The environment plays a significant role in shaping the visibility of signals both to and from an organism. For example, against a static background movement is highly conspicuous, which favours staying still to optimise camouflage. However, backgrounds can also be highly dynamic, such as areas with wind-blown foliage or frequent changes in illumination. These dynamic features introduce irrelevant visual noise which could serve to mask motion signals. Two forms of illumination change - water caustics and dappled light - are of primary interest and represent dynamic aquatic and terrestrial environments respectively. Using an array of model organisms from both environments, we highlight the extent to which these dynamic features influence behaviour, perception and camouflage.

Cognition and fitness in wild grey mouse lemurs, *Microcebus murinus*

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The fact that neither all species nor all individuals within a given species exhibit the same, unlimited cognitive abilities indicates the existence of proximate constraints and evolutionary trade-offs involving the underlying traits. However, the magnitude and sources of inter-individual variation in cognitive abilities remain poorly known; primarily because only a few studies have linked variation in cognitive abilities to micro-evolutionary processes and fitness outcomes. We tested 90 wild grey mouse lemurs (*Microcebus murinus*) in four cognitive tests, a novel problem-solving, string-pulling and inhibitory control task and a spatial memory test, that showed high variation in the wild primate population. We investigated individual characteristics potentially influencing animals' performance, including sex, age, personality and energetic state, and linked cognitive abilities with monthly survival in the wild. We found that performance in one cognitive task was generally a weak predictor of performance in any other task, providing no evidence for the existence of a general factor explaining cognitive performance in wild grey mouse lemurs. Performance in problem solving efficiency was positively to longevity. However, performance in string-pulling and inhibitory control where negatively related to longevity, whereas performance in spatial memory was not linked to longevity. Hence, our results highlight the need to expand links between cognition and fitness within study species by investigating multiple cognitive abilities addressing fitness-related behaviours in different contexts and various fitness outcomes simultaneously. This will help to detect the complex relationships between cognition and fitness and broaden our understanding how cognition evolved

Determining hazel dormouse distribution at a reintroduction site using footprint tracks

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The hazel dormouse (*Muscardinus avellanarius*) relies on woodland habitat containing wide plant diversity and rarely comes to the ground to cross open spaces. For these reasons, the species has been severely affected by woodland fragmentation and changes in woodland management practices in the UK. Having been lost from over half of its UK range, a series of reintroductions have taken place. To ensure the long-term success of these reintroductions, it will be necessary to understand why some sites are colonised more readily than others, as well as understand the details of the preferred dormouse habitat.

A mixed semi-natural ancient woodland reintroduction site in Cheshire has, in recent years, been finding fewer dormice in nest boxes. We aim to understand the reasons behind this decline, including whether it is a reflection of a local population decline or is a result of local dispersal to more suitable habitat. Here, we use footprint tunnels to determine whether dormice are still present in the woodland and if so, where they are located. This will help to direct future research through understanding specific dormouse habitat preferences and the local distribution of other small mammal species, which may be a source of competition for dormice. It will also be used in planning for future hazel dormouse reintroductions at this site and others.

Development of chromatophore motor control in cuttlefish

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From the time of birth to the stage of reproductive maturity, animals experience a growth in body size. In order to survive through all stages of development, animals must undergo continuous behavioural adaptation. In coleoid cephalopods, one of the most important survival tactics is adaptive camouflage. Unique among animals, they are able to camouflage by dynamically controlling the sizes of the many chromatophores covering their entire skin. Juvenile common European cuttlefish (*Sepia officinalis*) experience dramatic body growth in the first few months of their lives (quadrupling in surface area in 3 months), during which new chromatophores are also emerge. Using video analysis techniques including convolutional neural network, optic flow and template matching, we tracked the activity of individual chromatophores of the same animals for up to 3 months, at 1-week interval. Crucially, the size of chromatophores are controlled by radial muscles that are directly innervated by motor neurons in the brain. Thus, this method not only serves as a quantitative measurement of a complex behaviour during development, but also provides a window into the neuronal remodelling underlying the adaptation of such behaviour, in a non-invasive manner. Here we present findings on the modification of motor control with regard to the physical changes brought about by the dynamic process of growth.

Do conservation translocations influence song diversity: New Zealand Saddleback, a model system.

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One of the most intriguing features of songbirds is in the formation of distinct, geographical song dialects - or cultures. Song learning from conspecifics is a crucial aspect of songbird ecology as song cultures can have important consequences for the survival and reproduction of individuals and potentially contribute to speciation through their influence on mate choice. That being said, conservation translocation procedures commonly measure their success on the preservation of genetic diversity and consequently the impacts of these practices on cultural processes goes largely overlooked. With growing evidence emphasising the importance of preserving socially transmitted song cultures, the conservation tactics employed at Tawharanui Nature Reserve, New Zealand for the North Island Saddleback / Tīeke (*Philesturnus rufusater*) provides us a unique case study.

To maximise song diversity, the group composition of Saddleback selected to be reintroduced into Tawharanui was composed of birds from three culturally distinct island populations. Our research intends to examine how the cultural evolution of the species is affected by simultaneously reintroducing culturally divergent populations into the same area. Indeed, this presents us with the ability to investigate how song dialects permeate through a fragmented landscape and to test the cultural processes that shape/drive the movement. Do increased cultural mutation rates following translocation cause new dialects to rapidly form? Have translocation efforts of the past caused rapid cultural contact barriers to form, thus impacting effective population size? Are there song learning biases? Exploring these questions and their results will have profound impacts on conservation management policies moving forward.

Ecological and evolutionary causes of phenotypic variation in a cooperatively breeding cichlid

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Cooperative breeding is a complex form of social group living, where individuals other than breeders help raising offspring. These subordinate helpers engage in care for eggs and juveniles, food provisioning, and territory maintenance and defence. Such helper investment is expected to be adjusted to the biotic and abiotic ecological conditions of the habitat, like varying predation risk or substrate quality. Ecological factors that are stable over several generations furthermore may lead to morphological adaptations, which may feed-back on the behaviour. The cooperatively breeding cichlid *Neolamprologus pulcher* inhabits a diverse set of ecologically distinct habitats in Lake Tanganyika, in which they express differences in social system and morphology. In this study, we investigate if such morphological variation can be explained by geographic distance or local adaptation to the respective ecological conditions. In order to measure morphological variation in the wild we conducted geometric morphometric analyses of wild caught individuals from eight ecologically distinct populations. We then raised F1 individuals from these populations under common garden conditions in order to disentangle plastic and genetically determined responses. We furthermore used microsatellite markers to analyse genetical differentiation between these eight populations. Results suggest morphological adaptation to predation risk and substrate quality that can neither be solely explained by plastic reactions to the environment, nor by genetic distance. These results indicate that phenotypic adjustment to the respective environment have a heritable component, which has the potential to feed-back on the social system of this cooperative breeder.

Fluctuating selection on spatial abilities over multiple years in a population of pheasants

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Exaggerated cognitive abilities presumably arise because they bring fitness benefits to individuals expressing them. For example, in species where one sex moves further, we expect the fitness of that sex will be more strongly correlated to their spatial ability. Female pheasants disperse further than males so we predicted they would show stronger relationships between spatial ability and survival than males. We assayed the spatial memories of ~200 pheasant (*Phasianus colchicus*) chicks over three years (2015-2017). In 2015, as predicted, females dispersed further and those that had exhibited better spatial memory were more likely to survive, but this did not predict male survival. In contrast, in 2016 although females still dispersed further, the result was reversed: males with better spatial memory were more likely to survive, but this did not predict female survival. In 2017, we found no relationships in either sex. Our results can be interpreted in two ways. Either annually fluctuating selection pressures act on sex differences in spatial ability, necessitating long term studies of fitness outcomes to understand evolution of cognitive abilities. Alternatively, spurious relationships may be detected, even with reasonable sample sizes and clear a priori hypotheses, necessitating extensive replications before we can confirm how selection may act on cognitive traits.

Gibbon's perspective-taking abilities in a competitive task

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The capacity to follow others gaze is a fundamental socio-cognitive ability. However, the psychological mechanisms underlying this capacity might vary between species. In its simplest form, gaze following consists of an automatic response to others' gaze. A more complex variety involves a mentalistic understanding of the content of others' gazes. This second variety has been mainly found in a reduced number of primate species. In our study we explore whether a largely unstudied group of primates, the gibbons, are capable of understanding the content of others gaze. For this purpose, we establish two paradigms in which a human experimenter induces a competitive relationship by preventing the ape to retrieve one of two rewards lying in front of them. To succeed, the ape should infer - based on different cues - the intentions of the experimenter. In study one the experimenter positions himself between the two rewards and orients his body towards one. In study two, the experimenter orients his body to the center of the testing room while only orienting his head towards one of the two rewards. At the same time, he either keeps his eyes open or close. In both studies the apes should retrieve the reward the experimenter does not face. However, in study two the ape should rely on more subtle cues such as the eyes to infer what the experimenter really sees. Overall, we found that gibbons succeeded in a majority of trials but only took into account gross cues such as body or head orientation.

How does social influence affect performance on a human recognition task in wild urban-living cockatoos (*Cacatua galerita*)?

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Human induced rapid environmental change causes not only destruction but also the creation of new opportunities. Some species are better at adapting and surviving in these new habitats than others. Previous work has suggested that cognitive skills could provide an advantage when facing those novel challenges and opportunities. For instance, animals in urban areas live in close proximity to humans. However, people vary considerably in their behaviour towards animals. Therefore, it would be advantageous for urban living animals to learn to distinguish between persons in order to response appropriately towards specific humans (e.g. flight or approach). In addition to individual learning, social information from conspecifics could play a potentially important role in this decision-making. I investigated these questions in the highly social and cognitively-complex sulphur-crested cockatoo (*Cacatua galerita*), a successful invader of urban environments across the Austral-Pacific. The native population of Sulphur-crested (S-C) cockatoos in the Sydney region of Australia, approach people in order to get desirable food, but are also persecuted, for example as crop raiders. Using this population, I first tested whether S-C cockatoos are able to learn to distinguish between individual humans over the course of 14 session over 7 days of a two-choice experiment, where 76 individually-marked birds were randomly assigned to be only fed by one of two people. Second, by manipulating whether how birds were assigned across the two provisioners, I asked whether social influence plays a role individual decision-making; specifically, whether conflicting personal and public information interferes with this learning process.

How the social environment affects competitive signalling by female house mice

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Odour signals used in competition between male mammals are well studied in the context of sexual selection. By contrast, relatively little is known about the use of odour signals in competitive interactions between females, and the conditions that influence female signalling effort. House mice (*Mus musculus domesticus*) are an ideal study species to investigate this. Female house mice live in complex social environments, and previous evidence suggests that urine marking plays an important role in their communication and competitive interactions. Also, the urine of female house mice contains major urinary proteins (MUPs), which can be expressed at relatively high concentrations under naturalistic conditions. Here we present preliminary results from a long-term experiment aimed at understanding how the social environment influences competitive behaviours of female house mice. We manipulated levels of resource competition and relatedness within social groups under controlled naturalistic conditions, performed behavioural assays to record scent marking behaviours, and monitored urinary MUP concentrations. Our study reveals how female house mice flexibly adjust competitive signalling in relation to local resource competition and relatedness of competitors within their social group. This study adds to the growing evidence that female competition is an overlooked but important selection pressure regulating the complex social lives of mammals.

Influence of conflict during consensus decision making in ant colonies

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Social systems can take consensus decisions in a decentralized manner. There are numerous theoretical and empirical studies aimed at understanding the algorithms behind consensus decisions, modes of interaction between individuals, and individual roles in a collective. An interesting question is how conflicting interests are managed when individuals become part of a group. The two commonly provided explanations are; (1) what appears as cooperation is, in fact, individuals furthering their own, often conflicting, interests and possibly yielding sub-optimal collective performance. (2) Due to the increased genetic relatedness between the group members, in eusocial systems, the effect of conflict is negligible. In this study, we aim to quantify the influence of conflict on consensus decisions. Information conflict is induced in an ant colony performing collective behavior. House-hunting experiments were performed in the *Componotus sanctus* colonies reared in lab. The nature and strength of conflict between the individuals are varied using automatic gate control system developed in our lab coupled with individual barcoding of ants. Preliminary results show that consensus decisions are influenced by varying strength of conflict.

Methods for analysing high-resolution collective movement data from the wild

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A wide range of taxa, from bacteria to birds and mammals, exhibit collective behaviour and display fascinating patterns. A novel aspect of emergent properties of collective behaviour is that they are more than just an aggregation of individuals's actions. Most studies on emergent properties of collective behaviour are conducted in controlled laboratory conditions. In natural settings, however, habitat varies in terms of resource distribution, availability of hiding places and substrate for movement. However, very few empirical studies have recorded such fine-scale interactions in animal groups in their natural habitat. One reason for the dearth of such studies might be due to the difficulty in capturing multiple spatial interactions at any single time instant. Recent advances in techniques of aerial imagery allow us to observe and record such interactions.

We are studying the spatial dynamics of blackbuck (*Antilope cervicapra*) herds using high-resolution aerial imagery. We have recorded fine-scale interactions within blackbuck herds using multiple 15-minute aerial videos. In the first part of our work, we investigate which image-processing methods are most appropriate to analyze videographic data of fine-scale movement and interactions. We compare three computer vision techniques, motion detection, colour segmentation, and convolutional neural networks, to get individuals' trajectories in various datasets. Our comparison of the techniques suggests that for blackbuck videos (highly heterogeneous background and group composition) convolutional neural networks provide the most accurate results. We provide a framework to implement customize and implement track multiple objects in a heterogeneous environment.

Quantity discrimination and biases in giraffes (*Giraffa camelopardalis*)

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The evolutionary origins of "number sense" are highly debated, with a lot of research going on. Here we tested giraffes' ability to discriminate food quantities under different conditions. We tested six giraffes at the Barcelona and Leipzig Zoos by presenting them with two sets of carrot pieces. Depending on the task, we first tested them with different quantities of the same food (Experiment 1), and then we varied the size of the rewards (Experiment 2) and the distance between the elements of each array (Experiment 3). In Experiment 1, giraffes performed like other mammal species, showing a significant preference for the set with more pieces of food, and showing a consistently ratio-dependent performance, suggesting that they rely on an Approximate Number System. In Experiment 2, we tested whether giraffes preferentially rely on size rather than number of stimuli, when selecting the larger quantity of food, but giraffes showed no significant preference. Finally, in Experiment 3 we investigated if giraffes prefer sparse over dense arrangements of food pieces. Giraffes showed a consistent bias towards sparse arrays, which may be linked to their foraging style in the wild. Overall, these results provide a first picture of giraffes' ability to discriminate quantities, which may also be useful to better understand the behavior and ecology of wild and captive giraffes.

Motion patterns, predictability and predation responses within a wild, freely moving fish school

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The collective motion of fish schools is well understood on a mechanistic level, however, only few studies can link their findings to individual fitness instead of group properties. Here, a chichlid fish species, *Lamprologus callipterus*, was used as a model system to analyze collective motion patterns in natural environments with respect to individual behavior and interspecific interactions of potential risk. A combination of Structure-from-Motion scene reconstruction and high-resolution animal tracking via deep neural networks allowed detailed trajectory analyses via behavioral decomposition. A time-frequency representation of the animals' motion kinematics via continuous wavelet transformation resulted in a high-dimensional description of continuous behavior, including temporal information. On this basis, a stochastic neighbor embedding was used to reduce the dimensionality of motion data, allowing subsequent clustering. Hence, unsupervised labeling of group states and individual behavior was possible and enabled further behavioral analyses. The key findings suggest that the motion behaviors of individuals within schools of *L. callipterus* are synchronized, even under precarious environmental scenarios such as predation. In contrast, the predictability of individual behavior transitions was found to be reduced under these risky circumstances in comparison to a high baseline predictability. This indicates a behavioral adaptation to predation risk on the individual level that is potentially linked to central hypotheses concerning the evolution of collective systems such as the predator confusion hypothesis.

Bridging the gap between lab and field

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Although methods for tracking animals underwater exist, they frequently involve costly infrastructure investment, or capture and manipulation of animals to affix or implant tags. These practical concerns limit the taxonomic coverage of aquatic movement ecology studies and implementation in areas where high infrastructure investment is impossible. Here we present a method based on deep-learning and structure-from-motion, with which we can accurately determine the 3D location of animals, the structure of the environment in which they are moving. Further behavioural decomposition of the body position and contour of animals subsequently allow quantifying the behavioural states of each interacting animal. This approach can be used with minimal infrastructure and without confining animals to to a fixed area, or capturing and interfering with them in any way. With this approach, we are able to track single individuals (Conger Eel, *Conger oceanus*), small heterospecific groups (*Mullus surmuletus*, *Diplodus sp.*), and schools of animals (*Tanganyikan cichlids Lamprologus callipterus*) in freshwater and marine systems, and in habitats ranging in environmental complexity. Positional information was highly accurate, with errors as low as 1.67% of body length. Tracking data was embedded in 3D environmental models that could be used to examine collective decision making, obstacle avoidance, and visual connectivity of groups. By analyzing body contour and position, we were also able to use unsupervised classification to quantify the kinematic behavioural states of each animal. The proposed framework allows us to understand animal behaviour in aquatic systems at an unprecedented resolution and a fraction of the cost of established methodologies, with minimal domain expertise at the data acquisition or analysis phase required. Implementing this method, research can be conducted in a wide range of field contexts to collect laboratory standard data, vastly expanding both the taxonomic and environmental coverage of quantitative animal movement analysis with a low-cost, open-source solution.

Multisensory integration of information requires more than one single trial in garden ants

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Several studies showed that ants learn and integrate information from different sensory modalities and that the combined presence of more than one type of information enhances their performance. Such evidence supports the idea of multisensory integration as an optimal strategy for ants to retain information useful to address their own behaviour. Multisensory integration is at the basis of self-experienced memories, which require the integration of information about what-where-which a certain event happened to that individual. Here we investigated whether ants *Lasius niger* can learn what-where-which components in a foraging task. Individual ants where first placed in a Y-maze in which they were exposed to different odours (lemon vs. rosemary - 'what'), direction (left vs. right - 'where') and wall colours (blue vs. yellow - 'which'). Odour information was predictive of the reward by itself, while the other two information were predictive only when combined (e.g. if blue, then go left). After 12 visits, ants where tested by making the what component uninformative (the same odour was present on both arms). In a second experiment, we tested whether ants could learn the what-where-which components within a single experience, using the same maze as in the first experiment but presented only once within a non-relevant training (a single runway). Our results showed that ants succeed in integrating the what-where-which components following repeated experience (Exp.1) but not following a single trial learning (Exp.2). Considering the task did not involve any aversive or unusual event, ants' abilities of multisensory associative learning in a foraging situation appear remarkable.

Nest Population and Excavation Dynamics in the carpenter ant *Camponotus fellah*

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Ants construct their nests according to colony size, however, relationship dynamics between population and nest volume are unclear. We conducted a six-month study in which we followed nest excavation by *Camponotus fellah* in sand-filled 2D vertical nests, from founding queens to mature colonies. Colony and nest development were tracked by simultaneous regular measurement of nest architecture along with colony size and spatial distribution. We found that the ants' density in the excavated nest was maintained within a certain range throughout nest development. Moreover, population increases were generally followed, with some time lag, by significant digging that returned density to its previous level, suggesting the colony regulates nest density. We also found digging to be positively correlated with population growth in the preceding timeframe of seven weeks. Based on these findings, two models are proposed for digging rate. In the first, the colony actively regulates density by responding with accelerated digging to population increases. The model assumes the colony assesses ant density in the nest, however, direct regulation seems unlikely as ants tend to aggregate in specific chambers. The second model does not require the ants to actively sense density or interact, and claims that digging rates depend solely on population growth at a preceding timeframe. This model also supports interpretations based on workers' age and task allocation. To test the models and better understand density regulation, we plan to further analyze collected data by focusing on ants' spatial distribution within different chambers and tunnels, and their responses to collapse events.

Of mongooses and men: how traffic noise differentially affects a social mammal.

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Road networks are a major feature of our global landscape and increasingly recognised for the damage they can inflict on wildlife, as a result of collisions, habitat segmentation, disturbance and pollution. In the last decade, it has become increasingly clear that traffic noise can have a negative impact on animals, but little is known about whether variation in traffic noise characteristics affect behavioural responses. This study experimentally investigated the effects of two types of traffic noise-continuous and intermittent-on the behaviour of dwarf mongooses (*Helogale parvula*) in a wild habituated population. Mongooses showed greater vigilance (increased scan frequency, proportion of time vigilant and time acting as a sentinel), and were more likely to move foraging patches, during traffic-noise playback compared to ambient-sound playback. Even after playback ended, individuals continued to show elevated vigilance compared to in control conditions. However, there was no significant difference between continuous and intermittent traffic noise. A second playback experiment, conducted at the sleeping burrow first thing in the morning, found that continuous traffic noise delayed group emergence and departure to forage. If such noise effects persisted and individuals could not compensate for lost foraging time, there could be detrimental consequences to condition and survival.

Physiological costs of reproduction in female Assamese macaques (*Macaca assamensis*)

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Reproduction is a critical process in mammals and typically triggers pronounced physiological changes in females as they bear the costs of gestation and lactation. While it is established that those physiological costs of females' reproduction cause both an energy deficit and a stress response (through a rise in glucocorticoids (GCs) level), relatively little is known about how fluctuations in food availability, potentially leading to variation in a female's energy balance, impact a female's ability to reproduce and how the physiological costs are distributed over the course of reproduction. Using ecological (monthly phenology records), behavioral (~3,000 focal hours) and physiological (1080 urine samples) data collected on 45 adult female Assamese macaques across 13 months at their natural habitat in Thailand, we investigate the physiological costs of female reproduction under seasonally occurring nutritional constraints. We use urinary C-Peptide (uCP) as a non-invasive marker of energy balance, and urinary GCs as a more general measure of physiological stress and aim at disentangling how these two physiological markers are impacted by reproduction. As data analysis is currently ongoing, preliminary results will be presented on variation of uCP and GCs in relation to overall food abundance in the habitat and individual female reproductive status.

Population Size and Turnover Increase Cultural Selection for Efficiency

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Socially transmitted behaviors are hypothesized to be under cultural selection for adaptive benefit to the organism, with iterated transmission between individuals and the feedback between social learning and innovation generating greater increases in efficiency. While well-studied in humans, there is a lack of experimental evidence for this process in other species. Previous studies in great tits (*Parus major*) have shown that when birds are presented with experimentally presented foraging puzzles, the solving technique will socially transmit with a conformist bias, establishing as new local tradition. Here, we test whether 1) such established traditions will improve in efficiency over time, and 2) whether innovation and subsequent cultural selection is affected by demographic factors such as population size and turnover rate. An automated sliding door foraging puzzle with two solutions of differing efficiency was presented to captive micro-societies of wild-caught great tits, with one demonstrator in each population initially trained to the inefficient solution. Populations were followed over 5 weeks, with population size and population turnover manipulated in a two-way factorial design. Preliminary results suggest that turnover facilitates selection for efficient behaviors: immigrants were more likely to innovate or switch to the new efficient behavior, and a conformist bias did not prevent its emergence or spread. This process also occurred faster in the larger population, although more replications are needed to confirm this. Our results contribute empirical support for the presence of cultural selection for adaptive benefit in animals and highlight the importance of social conditions for cultural outcomes.

Seasonal Variation in Home Range and Sleeping Site Use in Hamadryas Baboons

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Hamadryas baboons are characterized by a four-tiered multi-level social system, which may cleave and coalesce over time in response to seasonality and other ecological factors. Here we explore ranging patterns, sleeping site use, and separation of bands over time in a population of hamadryas baboons in Ethiopia. Between 2015 and 2018, 7 adult males from the same band were outfitted with satellite-linked GPS collars and tracked for periods between 8 and 12 months. We calculated approximate home ranges for the band during each study period using GPS fixes recorded by the satellite collars. We used fixes collected at night to determine sleeping site locations and band separation frequency. The MCP home range for our study group was 115.62 km2 from July 2015 to March 2016 (n = 2350 GPS fixes), 104.83 km2 from October 2016 to October 2017 (n = 1367 GPS fixes), and 96.95 km2 from July 2018 to March 2019 (n = 2195 GPS fixes). There were significant differences in home range size between months, with May, August, and September being significantly larger than average (p = 0.01). Males from the same band slept at different sites 27.1% of all recorded nights (n = 170) in 2015 - 2016, 20% in 2016 - 2017 (n = 336), and 29.7% in 2018 - 2019 (n = 185), with more separations occurring during the transition to the dry season. This study uncovers previously unknown home range and sleeping site use variation in hamadryas baboons, highlighting the adaptive benefits of their multi-level social system.

Serial reversal learning in the young domestic chick

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Intelligence can be broadly defined as a property of an individual to interact with its environment, the ability to profit with respect to some objective and to adapt to new situations. Such definition implies that a wide variety of animal species do exhibit intelligent behaviour. In particular, convincing evidence has been accumulating that cognitive abilities of some avian species are comparable to those of primates. However, inter-species variability and the use of different tasks has made it difficult to measure and quantitatively compare birds' performance. To overcome the species-specific constrains such as differences in motor, visual and other systems, the use of serial reversal learning task has been put forward. This task requires inhibitory and excitatory conditioning, the ability to inhibit the previous responses and to learn the general rule which makes it suitable for measuring the construct of behavioural flexibility with a real strength in a comparative perspective. Here in the attempt to validate this paradigm in young chicks, we tested 6 male domestic chicks (*Gallus gallus*) from 3 to 20 days old in a series up to 10 reversals. Preliminary data suggest that chicks make more errors in the first reversals and reach a very low error rate in the last two, 9th and 10th reversals. Overall, in spite of their early age, domestic chicks seem to outperform other avian species, such as adult pigeons and even adult corvids, which data are reported in previous literature.

Soundscapes on islands and mainland: differences and influences on bird acoustic communication strategies

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On islands, species richness is reduced and interspecific competition relaxed in relation to the mainland, allowing species to use broader ecological niches. These factors can also affect communication and in particular acoustic signalling and niches. (1) To determine to which extent islands present reduced acoustic richness and fewer constraints for singing species, we compared two pairs of insular and continental soundscapes: one in a temperate zone, the other in the tropics (Cameroun and Sao tome). We found ambient noise was louder in the tropics and occupied a wider frequency range, especially on the mainland. (2) We then compared bird way of singing on islands and mainland. In the more crowed and noisy tropical mainland soundscape, species acoustically avoided more each other when compared to the three other communities (higher acoustic turnover, less overlap in time and in frequency between species composing the community). (3) To determine whether acoustic niche was modified on islands compare to mainland, we last worked on 24 species; 12 endemic insular species and their closest mainland relatives, breeding in the above temperate and tropical habitats. We found that insular species spend more time singing alone, sing with less species and that their songs span broader frequency ranges than their mainland counterparts (especially in the tropics). Overall, this study shows that soundscapes impose less constraints on singing species on islands than on the mainland and in tropical than temperate regions. Additionally, it suggests a link between the level of acoustic niche partitioning, frequency ranges and species interferences

Structure and associations within Grevy's and Plains zebra herds during a disturbance

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Social animals living in herds form often specific associations and structures. Analyzing the relationships between individuals within groups and the spatial distribution of groups can reveal how subgroups may affect the herd's ability to detect and respond to disturbances. In our research we focus on the structures and associations of zebras living in herds before, during and after a disturbance. Here we will compare association patterns between two species which use different social organization systems, namely harems versus fission-fusion societies, and investigate their reactions to a disturbance. We used drones to observe wild zebra herds in Laikipia, Kenia, before and after a disturbance caused by us approaching them by foot.

We used deep learning algorithms to extract locations and postures of each individual from our drone footage. 3D habitat maps were constructed to account for the impact of vegetation structures on the zebras' movement and association patterns. Using various metrics, we conducted social network analyses, to detect consistent subgroups and associations between individuals and to investigate the effects of social structure on collective response to disturbances.

The Evolution of Stress-Induced Social Learning Strategies

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It is widely accepted that indiscriminate social learning can be maladaptive, and animals actively pursue adaptive social learning strategies in response to different social and environmental cues. Learning from or imitating parents (vertical social learning) is one way offspring can acquire adaptive, socially-learned behaviors. However, learning from non-parents (oblique social learning) may be preferable to vertical learning, especially in rapidly-changing environments (McElreath & Strimling 2008). Recent experimental studies in birds have shown that internal cues, such as stress, can also favor oblique over vertical learning. Hormone-induced stress may be a cue juvenile zebra finch use to adjust their social learning strategies adaptively (Farine et al. 2015, Boogert et al. 2018), with stressed individuals learning more often from non-parents and non-stressed individuals learning from parents. However, questions remain over whether this effect is driven by an adaptive, condition-dependent social learning strategy on the part of juveniles, or whether parents are simply avoiding their stressed offspring resulting in more oblique learning by default. To help clarify this issue, we present a stage-structured, condition-dependent social learning model that explores the evolution of stress-induced social learning strategies under varying rates of innovation and environmental change. We show that learning obliquely when stressed and vertically when non-stressed is often an adaptive social learning strategy, able to invade and evolve in populations as long as there is a sufficient fecundity advantage associated with adaptive behavior, the environment is reasonably stable, and innovation (i.e. successful individual learning) is sufficiently difficult. Our results provide confirming theoretical evidence that stress can trigger adaptive switching from vertical to oblique social learning.

Serial Reversal Learning in Nectar-Feeding Bats: A Field Study

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Animals are constantly facing changing environments and thus need to modify their behaviour in response to change. This raises the idea that animals can learn, not merely simple associations between stimulus and reward, but can also 'learn to learn', i.e., learn general rules that dictate foraging behaviour in many contexts. The serial reversal learning task is widely used as a way to explore this ability. Animals discriminate between a pair of stimuli until a criterion is reached, and then the reinforcement contingencies of the stimuli are reversed. This can be repeated several times, and it is thus also a way of examining animals' behavioural flexibility. We conducted field experiments with a species of nectar-drinking bat, *Glossophaga commissarisi*, to examine their behaviour in the serial reversal learning task in La Selva Biological Station, Costa Rica. We show that the bats learn the task rapidly, and though they do not quite reach the optimum rule of one error per reversal, come very close to it. We show also that, similar to bumblebees, their errors are almost entirely due to perseveration and not anticipation, and there is a slight increase in error rate in the final trials.

Vocal individuality of Long-eared owl (*Asio otus*)

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Nowadays, individual vocal variability could be used for acoustic monitoring of individuals. Owls seems to be a great model species for acoustic monitoring research. They are nocturnal animals with high developed vocal territorial behaviour. Recording at night provides high quality recordings with minimum masking birds and urban noise. Contrary to passerines, owls have a simple and stable vocalization in time, therefore the temporal stability could allow long-term monitoring of individuals.

In this study we examined vocal individuality of Long-eared owls (*Asio otus*) within each season 2018 and 2019 and the comparison between them.

We recorded spontaneous hooting of an urban population of Long-eared owls in České Budějovice, The Czech Republic, from January to April during two following seasons 2018 (4 males, 6 females) and 2019 (7 males, 6 females). We used Marantz recorder and directional microphone Sennheiser ME67. We were recording as close to the vocalizing owls as possible (3-5 m distance), to get high quality recordings.

These recordings were analysed by using Avisoft SASLab Pro - an automatic parameter measurement function. We measured general vocal parameters: one temporal (duration) and six frequency (minimum, maximum and peak frequency, 25%, 50% and 75% quartiles of the spectrum) of single hoots. Due to very simple shape of single hoots, we measured frequency parameters 4 times: at the beginning, the centre and the end of the hoot as well as their measurement on the mean spectrum of entire element.

Statistical analysis and data visualization were done in R Project. LDA provide individual differences even for the measurement on the mean spectrum of entire element.

We found vocal individuality of Long-eared owl's hooting based on the general vocal characteristics.

Water-crossing behavior of red kites

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Soaring birds are usually reluctant to fly over large water bodies due to the lack of ascending air currents (uplifts). Aerial uplifts reduce the energetic cost of flight allowing to use soaring-gliding flight. Weak or absent uplifts require the use of powered flight, with exorbitant energetic costs for large species; the costs of powered flight proportionally increase with size and weight. Therefore, extended use of powered flight can be exhausting to a point where larger bird species risk drowning while crossing water bodies. As a consequence many species, particularly the large soaring raptors, take long over-land detours avoiding e.g. the open sea. Red kites (*Milvus milvus*) have a plastic flight behavior. Although they usually take advantage of uplifts, they can also perform long bouts of powered flight. On long journeys red kites usually prefer to take over-land detours, but occasionally are observed to fly over water covering distances of up to 410Km over 12h of continuous flight. We found that birds crossing the Adriatic Sea in autumn choose a route with low level of head winds, whereas when crossing in spring preferred tail winds. Nevertheless overall weather conditions on the crossing days was not different to any day within the migration season or outside it. Therefore it seems that the Adriatic Sea has mostly equally good conditions for the red kites to cross. In the future, higher resolution tracking GPS and acceleration data will shed more light on the cost of transport in red kites while crossing large water masses.

A New Non-Invasive Method for Population Monitoring

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Rapid Evaporative Ionisation Mass Spectrometry (REIMS) is a new way of analysing biological material by a very simple treatment. A diathermy electrode is used to burn biological material and generates an aerosol that is highly information rich. REIMS is fast, non-invasive and requires no sample preparation. We have investigated the potential of REIMS to be used as a non-invasive method for monitoring mammals, using faeces as the biological source. We have shown that discrimination between different species is readily achievable in both wild and laboratory species. Changing the diets of house mice in the laboratory did not affect their ability to be classified. The aim of this study is to explore the extent to which REIMS can be used to discriminate donor sex, maturity or genotype. Preliminary analyses have been completed using laboratory strains (BALB/c, BALB/k, ICR(CD-1) and C57BL6) of house mice (*Mus musculus domesticus*) under uniform conditions. Five faecal pellets were burned for 170 individuals and the spectra were analysed by Random Forests using Rstudio within R. The accuracies of assigning faecal pellets to the correct sex and age class were > 80%, suggesting that REIMS has the potential to identify sex and age from faecal material. REIMS could provide a new approach to the analysis of faecal material which will lead to a faster and simpler method for population monitoring that requires no interaction with individuals and therefore increase animal welfare.

A simple rule connects mechanistic and evolutionary models of foraging behavior in *Caenorhabditis elegans*

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An integrative view of behavioral ecology requires connecting different levels of description, from the genetic and neural underpinnings of behavior to its evolutionary consequences. The nematode *C. elegans* offers an opportunity to achieve this aim, being well studied at the level of genetics, development and neuroscience, as well as at the level of its elementary behaviors (i.e. its immediate response to a chemical gradient). Comparatively, we know less about how these elementary behaviors combine to produce the complex outcomes that determine fitness (i.e. finding a profitable food patch in a complex environment). As a first step to fill this gap, we have characterized *C. elegans* distribution across food patches of different qualities. We find a strikingly simple result: the ratio of the number of worms in any two food patches is equal to the ratio of the densities of the two patches. This result holds regardless of the absolute density of the food patches (across two orders of magnitude) and of the number of patches present in the environment -- a robustness that suggests simple underlying principles. From the evolutionary viewpoint, our results match the Ideal Free Distribution (predicted by game theory as the evolutionary stable strategy when animals compete for food). From the mechanistic viewpoint, we find that patch-leaving behavior is the dominant factor, with other factors such as chemotaxis and memory having an almost negligible impact on the observed distribution. These results therefore connect large-scale patterns predicted by evolutionary theory with the behavioral mechanisms leading to them.

Adult contributions to pup care in dwarf mongooses

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Alloparental care (the provision of care to offspring by adults other than the parents) is widespread in social vertebrates. However, there is much unexplained variation in the contributions of different group members to these helping activities. Dwarf mongooses (*Helogale parvula*) live in groups of 5 to 30 individuals, consisting of a dominant breeding pair and subordinate adult helpers of both sexes. All adults contribute to babysitting (supervision of young when the group has left to forage), and to the feeding, movement and grooming of young. We used detailed observations from six wild but habituated dwarf mongoose groups to examine whether factors such as sex, dominance status and age influence variation in alloparental care. Preliminary analyses suggest that there is no variation between males and females in pup investment however adult dominance status and age do influence the level of contributions to different care activities. Our findings will contribute to the rich literature on cooperation, parental care and social living.

Anxiety as a personality trait in zebrafish, *Danio rerio*

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The term 'personality' has been used to describe behavioural variations that are consistent over time and context. There has been much recent interest in these traits and their fitness consequences. At least some of these traits appear to be genetically determined but little is known about how these traits are controlled. Here, I investigate one personality trait, anxiety, in the zebrafish, *Danio rerio*. Three different tests were used to assess anxiety: novel tank diving test, open field test, and light dark test. The repeatability of these behaviours was assessed and the relationship between the different measures of anxiety was determined using PCA. These analyses showed that individuals varied in their level of anxiety but that some tests were more robust than others. This work will increase our knowledge of how this personality trait is controlled and should increase our understanding of how and why variable traits co- exist in populations.

Application of image processing to quantify self-grooming behavior of a prawn, *Macrobrachium lamarrei*

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Self-grooming is a neuro-phenotypic behavior in both invertebrates and vertebrates. Grooming has been established as a behavioral biomarker in assessment of stress and several neurotic disorders. Our target is to establish this behaviour as a marker of sensitivity in aquatic invertebrates.

Macrobrachium lamarrei (Arthropoda: Crustacea: Decapoda), is a commonly found native freshwater prawn species from India and adjacent countries and is abundant in most of the freshwater bodies. Self-grooming is a robust behavior in this species, which involves efficient use of the first and fifth thoracic appendages to clean different body parts. Microscopic analysis indicated adaptive modifications on the surface of the grooming appendages. Detailed assessment revealed a complex patterning of the entire self-grooming activity. The organism takes prominent postures of the body and grooming appendages to clean different parts of the body. Depending on the postures, we have classified the grooming activity in two major groups; anterior and posterior body grooming.

We have used video-based tracking system for identification and accurate quantification of self-grooming behavior in this semi-transparent prawn model. The method of image processing technique has been applied to quantify self-grooming in terms of time spent for each activity. We used a high resolution video camera to record the behavior frontally. A pilot recording of self-grooming was done in two different aquatic conditions (clean water and dirty water) where results show significant difference in grooming activity. Our ultimate target is to use this software for evaluation of stress-induced alteration in self-grooming by invertebrates.

Arctic avian predators follow the northern progression of snow melt during spring migration

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How and to what degree animals adjust movement to environmental conditions is a key question in ecology. Species breeding in the same environment can exhibit contrasting movement strategies due to the predictability of resources. Migratory species, for example, can display irruptive (facultative) or regular (obligate) movement strategies as a proximate response to differences in the availability of resources. In the Arctic resources are limited by snow, therefore arctic breeders might follow the northern progression of snowmelt during spring migration to optimize arrival time. The literature on this topic is scarce and the process of decision-making during migration as a response to snow conditions is largely unexplored. Based on large-scale Argos and GPS movement data, we compared movement decisions among three keystone arctic species, representing a gradient from an irruptive to a mixed to a regular migration strategy (the snowy owl, the rough-legged buzzard and the peregrine falcon respectively). Arctic migrants followed the northern progression of snowmelt during spring migration. However, the irruptive and mixed migrants adjusted their movement decisions more tightly to snowmelt than the regular migrants. Rapid environmental change is expected to shape snow patterns and consequently movement decisions of arctic migrants. Such changing conditions would affect the regular migrants most, resulting in a phenological mismatch. In contrast, irruptive and mixed migrants would adapt more easily. Considering the global climatic changes that the Arctic is undergoing, we expect altered movement decisions to shape movement strategies with cascading effects through the entire ecosystem.

Behavior-based automatic measurement of happiness in both animals as well as humans

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One of the biggest challenges when studying welfare is answering the seemingly simple question: how happy are you? And yet, at the moment, the best tool at our disposal is self-reported surveys that ask exactly that. These surveys are not only inaccurate but they are of no use when dealing with non-verbal individuals such as babies, pets, or farm animals. Instead, we propose a tool that uses high-dimensional behavioral data to measure personal wellbeing in both animals and humans. Our machine-learning based approach quantifies happiness automatically, continuously, objectively, and in real-time. The uniqueness of our model comes from recognizing that happiness means different things for different individuals. What might be a joyful event for an extravert, like attending a crowded party, might leave an introvert feeling miserable. Happiness is really a personal thing and therefore strongly depends on our personality as well as our temperament. This is true for people as it is for animals.

Behavioral and neural correlates of Hide & Seek in rats

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Evolutionary, cognitive and neural underpinnings of mammalian play are not yet fully elucidated. We played hide & seek -an elaborate role-play-game- with rats. Animals did not receive food rewards, but were engaged in playful interactions after finding or being found. All rats acquired the game. Playing the role of the seeker, rats systematically searched for the experimenter in a large 30 m2-room. Rats guided searches by visual cues and memories of past hiding locations. When hiding, rats preferred non-transparent over transparent enclosures. Animals were highly vocal at trial beginnings, when finding the experimenter, during playful interactions and when being returned for a new trial, but were silent during hiding. Rats appeared to enjoy the game itself rather than merely the post-finding-play. Rats played by the rules, i.e. their behavior was highly distinct between hide and seek trials. Neuronal recordings revealed intense activity in prefrontal cortex that varied according to trial events (initiation, finding, being-found etc.). Hide & seek has found little attention in science, but our findings confirm pet-owner-reports that animals enjoy playing hide & seek. Fast acquisition, strategic behavior, game-adequate vocalization patterns and the game-intrinsic reward value - traits, which emerged without specific conditioning - point to an innate preparedness and to elaborate cognitive and neural capacities for hide & seek in rats.

Behavioral tracking gets real in the wild

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Manually labeling videos is a commonly used technique to quantify behaviors, but it requires scientists to observe all recordings. This is useful when the repertoire of behaviors of interest is not fully known, but later is tedious and limits sample size. Deeplabcut is a novel cutting edge deep-learning markerless video tracking toolbox that is transforming how neuroscientists quantify behaviors of model organisms like mice and fruit flies. Nevertheless, behavioral ecologists have been slower to implement a general purpose deep-learning video tracking algorithm in the field with non-model organisms. Our research group has addressed this problem by using cost-effective raspberry pi microcomputers in a robotics design that withstands use in the field, followed by an implementation of Deeplabcut, to monitor experimental bee nests in the wild. We tracked over 400 videos of Megalopta bees coming from different nests which vary in their architecture. We also present results of other non-model organisms whose behaviors can be automatically quantified in the wild using this cost-effective robotics and deep learning workflow. These tools helped us process considerably more hours of videos from more nests than would have been possible manually. We will keep writing detailed behavioral descriptions and tallying notebooks, but it is time for us behavioral ecologists to start writing Deeplabcut-python code in jupyter notebooks.

Body-shaking: a vibratory indicator of reproductives and eggs presence in a subterranean termite

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In insect societies, one of the several tasks carried out by workers is to take care of reproductives and brood, which underline their central role in colony functioning. In this way, several studies highlighted the effect of social composition on worker physiology and behavior (i.e. presence/absence of reproductives, queen-laid eggs but also the presence of non-nestmate individuals). However, while vibratory behaviors are widespread in those societies, very few studies investigate the influence of social composition, and especially social disturbance, on workers' vibratory behavior. Body-shaking is a vibratory behavior widespread among termites and previously described as an alarm behavior in most species. Here we investigate, in the subterranean termite *Reticulitermes flavipes*, if body-shaking displayed by workers is influenced by social disturbances: presence/absence of reproductives and/or eggs. Our results show that the presence of both reproductives and/or eggs enhance workers' body-shaking, suggesting a potential implication of these vibratory cues in social organization. Because colonial fusions occur in this species, we also tested the presence of unrelated reproductives and/or eggs. Interestingly, the vibratory behavior of workers was not modified by the colony of origin of the reproductives and eggs, raising questions about how worker pursue the presence of non-nestmate reproductives/eggs. This study brings new insights into the opened recognition system of R. flavipes and into the overlooked role of vibratory behaviors in social organization of insect societies.

Can boldness of shoalmate modify personality traits of Deccan Mahseer, a freshwater fish?

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Personality - consistency in the behavioural traits exhibited by an individual across time and context - is known to constrain behavioural flexibility required for adapting with the demands of the contexts. For social animals, living with individuals of similar or contrasting personality traits is unavoidable and limited flexibility in behavioural traits may lead to costly interactions. The present study examined the effect of living with a conspecific similar/divergent in boldness on individual Deccan Mahseer (*Tor khudree*), a freshwater fish, for a period of 15 days. The differences in the nature of social interactions in bold-bold, bold-shy and shy-shy pairs of age-matched individuals and subsequent changes in their propensity to take risk were analysed. The results revealed that the individuals of bold-bold pairs became less bold while members of shy-shy pairs were found to increase their boldness. Interestingly, bold individuals from the bold-shy pairs also became shy, while shy individuals became less timid. Thus, boldness of shoal-mate and resultant social interactions experienced by individuals can modify personality traits like boldness but do not appear to affect other social behaviours such as leadership and sociability in Mahseers. These results could have implications in determining the composition of shoals ideal for cultivation as well as in situ and ex situ conservation of Deccan Mahseers.

Can chimpanzees, capuchin monkeys and children form abstract rules from minimal input?

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The ontogenetic and evolutionary emergence of the ability to form abstract concepts remains highly debated, both because of mixed results and different interpretations of positive results following long training regimens. Kemp et al. (2007) proposed a computational model of abstract knowledge formation from sparse data, which has not been directly tested in children or in any non-human species. We developed an ecologically valid paradigm in three different versions for testing chimpanzees (*Pan troglodytes*, n=30), capuchin monkeys (*Sapajus spp.*, n=22) and 3-5-year-old human children (n=219), and compared it to the model predictions. We presented each species with an evidence phase, in which participants sampled 5-10 items from each of four containers either supporting the abstract rule that each container was filled with a uniform item type or a mix of different types. In a subsequent test phase, participants were presented with two containers simultaneously which only provided low-valued items. As expected for a learner capable of abstract knowledge formation, more children switched earlier in the uniform compared to the mixed condition to the second test box. In the uniform condition, one item is sufficient to predict the content of the first box (all low-valued), whereas in the mixed condition more persistence is expected as there is still a chance for high-valued rewards in the first box. Chimpanzees showed tentative evidence for this pattern in one of three versions but capuchin monkeys' switching behaviour never differed between conditions. This suggests a steep evolutionary increase of abstract concept formation but questions human uniqueness.

Can personality predict survival in the wild of translocated captive-bred Eastern quolls?

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Conservation translocations are sometimes necessary for restoring or re-establishing populations of threatened species. However, they can be expensive and risky to implement. Personality traits of individual animals may be a factor in determining translocation success. Traits such as bold/shy, reactivity/tameness, exploration/avoidance, aggressiveness and sociability have been linked to an individual's response to predators, interactions with conspecifics and their ability to forage and find shelter. For example, in stable environments, bold, aggressive animals are more likely to have better body condition as they are more able to find the best resources. However, in unfamiliar or unstable environments, such as when translocated, the same animals are more likely to encounter novel threats and not survive. Thus, there is a trade-off in being bold for good health and less bold for survival. An understanding of how personality relates to survival and fitness is particularly relevant for the selection of individuals for translocations. We explore whether personalities of captive-bred Eastern quolls (*Dasyurus viverrinus*) can be quantified via observations prior to translocation, and whether individual personality traits are associated with post-release survival and fitness. In May 2019, 40 quolls will be released into an unfenced, predator managed environment on mainland Australia. Our results aim to reveal whether certain personalities of quolls are better suited to translocation. The selection of individuals with such traits could lead to increased survival of founders, and contribute to establishing a secure wild mainland population of Eastern quolls

Chimpanzees predict encounter probabilities with food and conspecifics when they revisit fruit trees

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Here, we investigate which social and ecological variables influence the probability that chimpanzee females (N=5) in the Taï National Park, Côte d'Ivoire revisit a previous feeding tree to monitor or eat fruit within an observation period of 275 days. We find a significant interactive effect of the number of individuals that were with the focal female at the tree during the previous feeding visit and the proportion of fruit that was left in the tree after that visit on the approach probability. The probability decreased when more individuals had been present at the previous feeding visit, and thus could have depleted the tree at subsequent visits, but only when the proportion of fruit left in the crown had been low after departure. Crucially, the probability increased when more individuals had been present, but only when the proportion of fruit left in the tree was high. Furthermore, we find a significant interactive effect of the genera of the fruit tree (Ficus or less ephemeral fruit) and the number of days that had passed since the previous feeding visit at that tree. The probability decreased when more days had passed, but only for trees that bore ephemeral fig fruit. We conclude that these findings are best explained by the possibility that chimpanzees keep track of encounter probabilities with fruit and conspecifics, during their daily foraging and travel decisions.

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Communication and the Coordination of Collective Behavior in Wild Baboons

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Recent theoretical and technological developments have advanced our understanding of collective animal behavior, demonstrating how simple, local behavioral interactions can result in complex and adaptive group-level behaviors. The majority of these studies focus on how individuals respond to visual information about the proximity and trajectories of others when moving in simple environments. However, under more complex social and ecological conditions, we might expect inter-individual distance, vegetation, and/or activity to constrain visual information and favor the use of vocalizations for the coordination of behaviors. We are testing this hypothesis in wild chacma baboons (*Papio ursinus*) in Namibia. The baboons range in an 'open' desert environment containing several 'closed' woodland groves along an ephemeral riverbed. This landscape provided a unique opportunity to study collective behaviors under two contrasting levels of environmental complexity that have previously been shown to alter troop synchrony and cohesion. Furthermore, long-term data on this troop enable investigation of how interindividual social relationships affect responses to one another's behavior. We fitted nine adult baboons with bio-loggers that recorded GPS location, accelerometer data, and continuous audio over 30 days. Here we will present preliminary analyses seeking to determine if and how vocalizations shape individual and collective decisions while 'making a move' and 'on the move'. We will discuss our findings in the context of previous research on animal communication, social, and collective behaviors and highlight our upcoming work studying the role of vocal communication in information flow, coordination and collective decision-making.

Cooperation & Conflict Resolution: my place or yours?

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Group coordination can be difficult to achieve if there is conflict of information between individuals. Although pairs of foraging fish have been shown to resolve directional conflict by turn-taking, it is unclear whether such resolution mechanisms operate among groups. We investigated whether domesticated guppies, *Poecilia reticulata*, resolve directional conflict by turn-taking. Fish were trained to expect food in different zones and tested in different arrangements of sub-shoal size and symmetry. Relative sub-shoal personality differences were also examined to determine whether this difference explained the efficiency of conflict resolution. Our results focus on the role of group size, symmetry and level of 'conviction' in conflict resolution between groups. We discuss the role that individual strength of preference may have, separately from boldness in the resolution of directional conflict.

Czech and Catalonian treecreepers interspecific interactions

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The most common reason of the competition between two well defined species is niche overlap. The genus Certhia, represented by two species in Europe' *Certhia familiaris* (Eurasian Treecreeper) and *Certhia brachydactyla* (Short-toed Treecreeper), is a good example for studying inter-specific competition. Both species are supposed to differ in their habitat demands, which is true in their extreme preferences, but their habitat preferences may overlap remarkably.

Treecreepers respond quite intensively to a conspecific song. Therefore, we used conspecific playback stimulation (a male song) to map an individual's territory. During the experiment we played 4 song playbacks: a conspecific, a heterospecific (the other treecreeper species), and the Eurasian nuthatch and the European robin (*Erithacus rubecula*) as controls, inside the territory. Each playback was played for 15 minutes, in random order, and was accompanied by a dummy (made of hobby mass for artists) of the particular bird. At least one-hour pause was left between each playback trial. We recorded and measured the distance of the treecreeper from the dummy (loudspeaker), number of attacks, voice response of the treecreeper (number of particular call types), and other displays of stress behaviour.

We compared our results from the Czech Republic with the results from Catalonia and we suggest that interspecific agression of both species is low. Short-toed Treecreeper is as much aggressive towards conspecifics as the Eurasian Treecreeper. The vocalisation use of both species differ. We hypothesize the niche breadth to be the main factor affecting the aggression towards the other species.

Do capuchin monkeys avoid areas of home range overlap because they are dangerous?

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The Risk Hypothesis suggests that species that engage in lethal intergroup aggression avoid areas of their home range that they share with neighbors due to a fear of fatal confrontations. White-faced capuchin monkeys (*Cebus capucinus*) appear to challenge this hypothesis, as they avoid areas of home-range overlap, even though their intergroup encounters are rarely fatal. However, even non-lethal encounters with neighbors may be costly enough to discourage the use of shared areas. To investigate this possibility, we compared activity budgets, vocalization rates, and foraging behavior of capuchins in central vs. peripheral areas of their home range. Capuchin monkeys spent less time socializing at the edge (vs. in the center) of their home range, but rates of resting, vigilance, and vocalizing did not differ. Fruit trees near range borders tended to contain more ripe fruit, and groups spent more time in these trees with more individuals entering to feed and obtaining more fruits in trees on the edge compared to the center. However, we did not find evidence that capuchins altered their foraging behavior in potentially risky edge areas in a manner consistent with the predictions of optimal foraging theory. Quitting harvest rates were not significantly lower in potentially risky edge areas, and groups depleted food patches to a greater extent at the edge of their range. These results suggest that while peripheral areas of the home range are perceived as risky and contribute to changes in behavior, they also provide important resources that may outweigh the cost of intergroup encounters.

Do preschoolers and capuchin monkeys infer causes or learn associations?

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The ability to infer unseen causes from evidence is argued to emerge early in development and to be uniquely human (Penn &Povinelli, 2007). We explored whether preschoolers and capuchin monkeys could locate a reward based on a hidden causal event or instead relied on arbitrary associations. Three-five-year-olds (N=68) and capuchin monkeys (N=19) were presented with two cups covered with foil. The experimenter performed two events, first in one order (Test) and then in reverse order (Transfer): 1) She hid a reward behind a barrier, then showed the subject that the foil covering Cup-A was ripped; 2) She poked in downwards motion behind the barrier with a stick, then showed the subject that the foil covering both Cup-A and B was now ripped. If subjects inferred the cause of the ripped foil, they should search in Cup-A regardless of the order of the events; but if they used an arbitrary rule (e.g., choosing the most recently ripped foil), we reasoned that they should make errors when the order of events was reversed in the transfer. Age significantly predicted children's scores: Four- and 5-year-olds performed above chance in both test and transfer. Three-year-olds performed above chance in test but not in transfer. Monkeys performed above chance in both test and transfer, and a follow-up study ruled out reliance on arbitrary cues to solve the task. Our results suggest that by 4 years children used the causally-relevant cue whereas 3-year-olds relied on associations. The role of prior experience on monkeys' performance is discussed.

Familiarity effects on short-term repeatability and changes in behavioural responses in stickleback fish

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Current and recent social environmental conditions can affect the repeatability of behavioural measures. However, the potential effects of familiarity (e.g. associating with a known or unknown social partner) on the repeatability of behavioural measures remain unexplored. This is surprising given evidence for familiarity effects on behavioural expression in response to novel environments and objects. We studied the behaviour of N=24 pair-housed three-spined stickleback fish (*Gasterosteus aculeatus*) and used high-resolution image-tracking from video to assess: (i) total distance travelled, (ii) individual shelter use, (iii) shared shelter use, and (iv) inter-individual distance, for individuals in two observation trials when paired with either a fish from their own tank (familiar) or from another tank (unfamiliar). Distance travelled was repeatable and decreased across trials, and was not influenced by familiarity. Individual shelter use was not repeatable, increased from trial one to two, and was not influenced by familiarity. Shared shelter use was repeatable for unfamiliar but not familiar dyads (which could be a result of the novelty of both the social partner and the physical environment), and increased from trial one to two. Inter-individual distance was not repeatable and increased from trial one to two, and was not influenced by familiarity. Overall, this study indicates familiarity does not affect short-term repeatability and changes in behavioural measures commonly used in animal personality research, and we discuss the implications of our findings for testing fish in behavioural experiments.

Genetics of behavioural isolation in Heliconius butterflies

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The evolution of new species relies on the accumulation of genetic differences that result in reproductive barriers. These barriers frequently act before mating, and many closely related taxa remain separate because they effectively 'choose' not to mate in the first place. Although the significance of behavioural barriers has been recognized at least since the Modern Synthesis, we still know very little about the genetic changes that underlie behavioural divergence in natural populations, or how they are mediated during development. The warning patterns of *Heliconius cydno* and *H. melpomene* are under disruptive selection for mimicry, and are also used during mate recognition. We report a genome-wide QTL analysis which reveals that divergent mate preference between these species has a surprisingly simple genetic basis. Three QTLs explain 60% of the difference in preference behaviour observed between the parental species. One of these QTLs is physically linked to the major wing patterning gene optix, which causes a switch in forewing colour from white to red. By integrating these results with gene expression and population genomic analyses, we identify a candidate gene responsible for shifts in visual mate preference behaviours, specifically a regucalcin, previously implicated in synaptic transmission or plasticity. Genetic associations between loci for ecological and assortative mating traits are predicted to facilitate speciation in the face of gene flow. Our data also suggest behavioural alleles may be acquired through introgression, allowing reassembly of existing genetic variation, further facilitating the rapid evolution of novel behavioural phenotypes and speciation.

Harsh winters influence the success of colony founding in a socially polymorphic ant

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The structure of animal societies often co-varies with altitudinal gradients, suggesting that alternative social forms are adapted to different ecological conditions. The Alpine silver ant has two types of colonies coexisting within populations: some colonies have a single breeding queen (monogynous) and others have several breeding queens (polygynous). Colony social organisation is genetically determined. Across independent elevation gradients, monogynous colonies are more frequent at high elevation, whereas polygynous colonies are more common at low elevation. Here, we experimentally investigated whether social origin and environmental conditions jointly influence the success of newly mated queens during independent colony founding. We hypothesized that queens from monogynous colonies would be more successful at independent colony founding in harsh environments, as they are larger and have more body fat reserves. We placed queens to hibernate in either a 'harsh' or a 'mild' winter and recorded their fecundity and survival for one year. Queens originating from monogynous colonies had higher survival than queens from polygynous colonies after a harsh winter, while both types of queens had similar survival after a mild winter. Queens of monogynous origin were more fecund than queens of polygynous origin, independently of the winter type. Our results suggest that harsh conditions limit the success of polygynous queens during independent colony founding, which may help explain why polygynous colonies are less common in higher-elevation populations.

How do chimpanzees (*Pan troglodytes*) overcome conflicts of interest to coordinate their actions?

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Coordinating decisions and actions is a vital aspect of living in a group for social species such as chimpanzees (*Pan troglodytes*). In many cases successful coordination requires some individuals to pay a cost, e.g. although individuals have differing preferences for the direction of travel, it is necessary to agree on one if they are to travel as a group. The aim of the current study is to understand how individuals resolve these conflicts of interest while avoiding coordination failure and whether they able to use knowledge about other's behaviour to gain strategic advantage. We presented captive chimpanzees with a task based on the Volunteer's Dilemma: highly preferred food was placed out of reach inside boxes (one for each individual), the food could be accessed for a short period of time if one individual paid the cost of volunteering by moving to another location to activate the release mechanism. This individual thus had less time to access the food reward. If no-one volunteered the food remained inaccessible. When there was the possibility of a partner paying this cost, they waited for others to volunteer even when this occasionally resulted in coordination failure (no reward) although all of these chimpanzees were willing and able to use the release mechanism for themselves when tested alone. We also found that chimpanzees adjusted their actions to changes in the costs and benefits of volunteering.

Human attention affects facial expression in dogs

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Most mammalian species produce facial expressions. Historically, animal facial expressions have been considered inflexible and involuntary displays of emotional states rather than active attempts to communicate with others. In the current study, we aimed to test whether domestic dog facial expressions are subject to audience effects and/ or changes in response to an arousing stimulus (e.g. food) alone. We presented dogs with an experimental situation in which a human demonstrator was either attending to them or turned away, and varied whether she presented food or not. Dogs produced significantly more facial movements when the human was attentive than when she was not. The food, however, as a non-social but arousing stimulus, did not affect the dogs' behaviour. The current study is therefore evidence that dogs are sensitive to the human's attentional state when producing facial expressions, suggesting that facial expressions are not just inflexible and involuntary displays of emotional states, but rather potentially active attempts to communicate with others.

Increased terrestriality in a Neotropical primate living on islands with reduced predation risk

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The absence of terrestriality among New World monkeys is notable and raises questions about the ecological pressures that constrain the expansion of platyrrhines into terrestrial niches. We took advantage of a natural experiment to test the hypothesis that terrestrial predators constrain primates' exploitation of terrestrial niches.

We used camera-traps to compare patterns of terrestrial behavior in white-faced capuchin monkeys (*Cebus capucinus imitator*) living on two islands off of the Pacific coast of Panama that lack mammalian predators and at three sites in central Panama with more intact predator communities. We compared detection rates, party size and duration of terrestrial events, and estimated the timing of terrestrial activity.

We found that white-faced capuchin monkeys living on islands exploit terrestrial niches more extensively than their counterparts living in habitats with a more intact predator community. Camera trapping revealed differences in the frequency and timing of terrestrial activity in these capuchin populations, as well as differences in the number of individuals observed on the ground. The range of party size observed was larger and individuals engaged in a wider range of terrestrial behaviors on the islands.

These findings support the hypothesis that predators constrain primates' exploitation of terrestrial niches. They are also consistent with the hypothesis that arboreal locomotion imposes costs that primates will avoid when predation risk is low. Our findings demonstrate that under the right ecological conditions, capuchins can readily expand into terrestrial niches, and suggest that reduced predation risk may be key to the adoption of a more terrestrial lifestyle.

Individual behavioral variation as a tool for conservation? A New Zealand case study

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There is a growing recognition among behavioral ecologists that individuals within species vary in their behavior. Meanwhile, conservation biologists have long considered variation a safeguard against environmental change but have largely focused on genetic differences. As threatened populations continue to shrink, each individual has an increasing impact on its species' survival, and the need for efficient interventions grows more urgent. Understanding the extent to which behavior varies could help us tailor management strategies to the unique needs of these remaining individuals. The hihi (*Notiomystis cincta*), a threatened New Zealand passerine, is one such species for which behavioral variation could have meaningful conservation implications. Following near-extinction around 1890, hihi have been reintroduced to several island and mainland sites, but habitat suitability (including food availability) has proved a major barrier to establishing self-sustaining populations. At the species level, hihi eat a generalist diet, but they meet many criteria predicted to drive dietary specialization: their physiological needs change with age, they exhibit intra- and interspecific dominance hierarchies, and they inhabit heterogeneous landscapes. Here, we assess dietary variation in the Tiritiri Matangi Island population, showing that this generalist species may actually be composed of specialized individuals. We also find that dietary differences link to social interactions among and within species, suggesting possible dominance effects. Finally, as this population is a frequent source for translocations, we discuss whether dietary variation could help us improve reintroduction efforts by identifying individuals that will be more likely to survive and thrive in a new environment.

Individual consistency and social flexibility modulates the waggle dance of honey bee foragers

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Individuals in social groups need to integrate information from social cues and signals into their behavioural responses. At the same time, individuals may also show consistent differences in their behavioural responses. The interplay between social interactions and consistent inter-individual differences within such groups remains largely unexplored.

In eusocial insect groups, social cues and signals play a vital role in ensuring efficient division of labour amongst the workers. Foraging, for example, involves interactions between multiple workers in the hive. The waggle dance behaviour of foragers acts as the main regulatory mechanism of foraging and incorporates cues from the environmental and social context.

In this talk, I will present results from our work on the social modulation of individual differences in the waggle dance activity. Observations of individual foragers over consecutive days revealed consistent inter-individual differences in the probability and intensity of the dance activity. Manipulation of the social environment by removing some foragers led to more active foragers changing their dance activity. This change in activity was greater in the probability than the intensity of dancing. Lab assays and agent-based model simulations provided further evidence that intensity of dancing is a more intrinsic behavioural parameter, whereas the probability of dancing is more flexible with respect to social cues.

Our work reveals a fine scale division of labour within honey bee forager groups. It also reinforces the importance of the social context in task performance in eusocial insects and highlights the role of social interactions in maintaining consistent individual behavioural patterns.

Integrating synchrony, skin and sexual contact to assess pathogen transmission risk in dolphins

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Pathogen and parasite transmission is fundamentally driven by a population's contact network structure, and is further influenced by its demographic composition. Importantly, populations are most often concurrently exposed to a suite of pathogens, which is rarely investigated. Using detailed long-term data of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), we quantify the demography-dependent exposure risk associated with three different transmission routes (sexual contact, skin contact, and droplet contact of respiratory vapour above the water surface), quantify co-exposure risks and relate them to individual sociability. Our results suggest demography-driven disease implications in bottlenose dolphins, with males at greater risk than females. We hypothesize that male alliance-formation and the divergent reproductive strategies in males and females drive the demography dependent exposure risk to pathogens. Our study provides evidence for the risk of co-exposure to pathogens transmitted along different transmission routes and that they relate to individual sociability. Hence, our results highlight the importance of a multi- behavioural approach for a more complete understanding of the overall pathogen transmission risk in animal populations, as well as the cumulative costs of sociality during animal life histories.

Innovation in wild Barbary macaques' inter-individual differences in a novel foraging task.

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The ability to innovate and the social transmission of innovations have played a central role in human evolution. However, innovation may also be crucial for many other species, by allowing them to successfully cope with socio-ecological challenges, for instance, by exploiting novel food resources. In this study, we conducted behavioural observations on a group of wild Barbary macaques (*Macaca sylvanus*) on Gibraltar and presented them with a novel foraging device, which they had to manipulate to obtain food. The device was completely transparent, with the exception of one functional part (i.e. lid, tab or stick). Depending on the condition, food could be accessed by rotating a lid, pulling a tab, or pushing the food out of the box with a stick. More devices were simultaneously present, to also allow access to lower-ranking individuals. Across 400 trials, 14 different individuals participated in this task. We monitored whether individuals preferentially manipulated functional versus non-functional parts of the box, and whether they generalized across conditions by preferentially accessing functional parts. We further assessed inter-individual differences in the ability to solve the task, and which factors best predict these differences. In particular, we analyzed the effect played by sex, age, rank, inhibition, neophobia, persistence, exploratory skills, social centrality and strength, and presence of others on the ability to innovate. We discuss our results in line with existing and novel evolutionary hypotheses on the emergence of innovation, and hint to possible future directions for research.

Insight problem-solving in meerkats (*Suricata suricatta*)

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Insight behaviors are adaptive and innovative solutions to problems in the environment. Such responses arise without explicit training, so are considered evidence of higher cognitive abilities, such as reasoning. For example, after the perceptual experience with the landscape the animal infers the best way to approach the goal, which can be shelter, food or a mate. No test of insight behaviors in meerkats has been reported yet. In our test the meerkats saw the food from the ground, but they only could get it after climbing a ramp and going through a bridge Once at the top of the bridge, if they pulled, in vertical direction, a piece of white net mesh fabric, they could reach mealworms. Fifteen meerkats of the Barcelona Zoo were tested on this task, the objective was to measure their ability to solve it by insight, namely in a spontaneous, continuous and direct way. In an individual pretest, without any prior manipulation, neither meerkat solved the task. Then, after 72 hours-habituation to the apparatus without any food on it, one subject solved the task in an individual test (now with worms), but none of the other did in individual, or in subsequent group tests. Finally, after individual and group training to climb the ramp and to walk through the bridge without the net present, one meerkat solved spontaneously in an individual test, two solved the test spontaneously in the group test, and another one solved it in the group test after several attempts to pull the net without eating the worms. These results suggest that meerkats solved new problems spontaneously. However, exploration of the elements of the problem and knowledge of prerequisite behaviors may be necessary for the appearance of insight in meerkats.

Investigating how baboon behaviour and ecology contributes to Guinea worm transmission in Ethiopia

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While the use of animal models to examine human disease and the study of animal behaviour in response to disease are widespread, the concept of understanding animal behaviour to inform control of human disease remains largely unexplored. An increasing number of 'human' neglected tropical diseases are being detected in non-human primates, indicating that insights into how wild animals contract and transmit such diseases may be crucial to disease management and eradication. We investigate the behaviour and ecology of a social species, the olive baboon (*Papio anubis*), in Gambella, Ethiopia to test the hypothesis that Guinea worm disease (dracunculiasis) may persist in the region due to human-animal transmission. We combine observations of social behaviour from six focal troops with ranging data over 12 months from manual tracking and GPS collars, and dietary data from stable isotope analyses of whiskers to elucidate how baboon behaviour puts them at risk of Guinea worm infection. By linking these behavioural, dietary and ranging information to data on infection history obtained from serology tests of blood samples from individuals, we assess whether certain individuals are more likely to contract and transmit dracunculiasis due to their social position/rank and associated foraging behaviours and/or access to resources. Information on baboon interactions (drinking, eating fish/frogs) with water bodies also used by humans will be particularly informative for control efforts. Our work provides important evidence to inform the new frontier of Guinea worm eradication, plus broader insights into the role non-human social species may play in transmission of human disease.

Learning and personality: Better to be bold?

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There is a body of evidence to suggest that personality, the study of consistent differences in individual behaviour across time and context, influences learning outcomes in both humans and non-humans. This has important implications on the selection criteria for working animals who are required to perform certain tasks efficiently and effectively. To investigate this relationship, we performed a boldness assay across two contexts (novel object and open field) to determine the individual boldness scores of 30 animals. Scores were then compared to performance in an odour discrimination task. Preliminary results suggest that the less bold individuals learnt the task faster. Previous studies have posited that this relationship may be a result of less bold animals being at an advantage when changes in the environment are relevant to the task. This relationship between personality type and performance should be considered during the selection of working dogs.

Chimpanzee perception of visual communicative signals

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Chimpanzees, in the wild and captivity, are known to distinguish between their various vocal signals. This capacity has been successfully demonstrated by call playback experiments. Although chimpanzees frequently communicate with both facial expressions and gestures, knowledge on how they perceive these visual communicative signals is sparse. To address this issue, we developed a two-pronged approach with eyetracking and match-to-sample touchscreen experiments. In the eyetracking experiments, we used images of chimpanzee facial expressions versus neutral faces and gesturing chimpanzees versus their neutral body states, to test if they look differently at visual signals compared to neutral states. In the match-to-sample experiments we tested if chimpanzees match images of visual signals to other exemplars of visual signals rather than non-matching foils, enabling us to probe how chimpanzees categorise visual signals. These studies are ongoing with the 15 chimpanzees at the Budongo Research Unit of the Edinburgh Zoo, UK. This is the first systematic experimental study, using two different methodologies, to understand chimpanzees' perception of conspecific visual signals.

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Mechanisms and consequences of collective migration in juvenile white storks

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Many migrating animals move together, sometimes in groups of thousands of individuals. Thus, to understand the mechanisms and consequences of these seasonal movements fully, we must explore animal trajectories within their social context. Investigating groups of wild migratory birds empirically is challenging, but with state-of-the-art tracking technology that record the simultaneous movements of multiple individuals at extremely fine spatial and temporal scale it is now possible to connect an individual's behaviour and physiology to its group and environment. Here we describe how collectively migrating white storks use social cues for locating and exploiting thermal updrafts by relying on leading and following behaviour. In addition, we show that collective stork migration involves group cohesion among individuals with variable movement capacities and costs, indicating that group composition is essential for successfully reducing movement costs. By unravelling the use of different collective migration mechanisms in a natural environment, we highlight the importance of combining experimental behavioural research with ecological in situ observations and suggest that integrating intraspecific interactions into migration research will enable a better, more mechanistic understanding of broad-scale ecological processes.

Mixed support for state maintaining risky personality traits in yellow-bellied marmots

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In a variety of taxa, individuals behave in consistently different ways. However, there are relatively few studies that empirically test the potential mechanisms underlying the causes and maintenance of these personality differences. Several hypotheses for the causes and maintenance of risky personality traits have been suggested but all have received mixed support. Two major hypotheses, the pace-of-life and state-dependent safety hypotheses, propose that differences in internal state cause and maintain personality traits. Formally, the pace-of-life hypothesis states that differences life-history strategy including productivity (growth) and residual reproductive value (age) create initial differences in individual behaviour and then positive feedback maintains these differences, while the state-dependent safety hypothesis suggest that body condition (mass) is responsible for causing and maintaining behavioural differences. We tested and evaluated these two hypotheses explaining causes and maintenance of variation in risk related personality traits- defensive aggression, activity and exploration- in yellow-bellied marmots (*Marmota flaviventer*). We found little support overall for these hypotheses in explaining maintenance in activity or exploration. However, for defensive aggression, we found positive feedback for both mass and age.

Cat Fight Amongst the Sexes: promiscuous lionesses win the gender war of fitness

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To maximize individual fitness, males and females of the same species often engage into strategies that are at loggerheads. Sexually selected infanticide is a male strategy that is costly for females, as killing of dependent young by males cause considerable losses to maternal investments. African lions are social, with a group comprising of females, their cubs and a coalition of adult males. Coalition males maintain territorial exclusivity on a group of females and sire all cubs born to a pride during their tenures. Infanticide is prevalent among lions where incoming males kill cubs during a 'takeover', after ousting the resident males. Asiatic lions, living as a single relic population in India exhibit a contrasting social structure with males and females staying separately. In here male ranges encompass multiple female groups and vice-versa. We investigate consequences of such social organisation on the mating strategy of Asiatic lions. Long-term observations on 134 mating events between 21 males and 49 females revealed that lionesses are promiscuous, females readily mating with multiple rival coalitions. However, promiscuity was primarily shown by experienced lionesses who have had litters before. Selective female promiscuity has considerably buffered cub infanticide by confusing paternity amongst males, reduced sexual harassments, and also might have invigorated an inbred population by increasing genetic diversity of litters. This novel mating strategy for lions might have evolved owing to spatial segregation between the genders caused by smaller modal prey in the Asiatic system. Our results thus highlight resource mediated behavioural plasticity amongst territorial species inhabiting diverse eco-regions.

New Technological Approaches to Study Sensory Aspects of Foraging Behavior in Wild Bats

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New technologies allow us to record the location (GPS), movement (accelerometer) and acoustic behavior (microphone) of bats while they are behaving freely in the wild. Here, we present two case studies where we use these technological advances to assess different aspects of bat foraging.

We compared GPS tracks and echolocation of five different bat species. Linking the movement with sound recordings, we evaluated not only the foraging behavior of individual bats, but also recorded the presence of close-by conspecifics. We found that species that search for ephemeral prey, which is hard to predict in space and time, fly together in a group. Listening to their conspecifics' echolocation calls increases their detection range of prey and therefore the likelihood of finding patchily distributed food resources.

For one of those species - the greater mouse-eared bat, *Myotis myotis* - we analyzed the foraging behavior in more detail. GPS tracks informed us on the nightly, stereotypical foraging routes and large-scale strategies that these bats employ. The analysis of body movement and echolocation behavior gave unprecedented fine-scaled insights into the actual foraging behavior of individual captures. Our acoustic recordings described the dynamics of this species' echolocation when listening for prey-generated sounds and hunting airborne prey. Finally, we could not only distinguish between different foraging modes (aerial vs. ground capture), but also evaluate the attack success rate and possible prey type. This kind of data can inform us on important basics of foraging and thereby open up possibilities to estimate optimal foraging strategies.

Can deep neural network score bird song similarity?

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Deep neural network is a machine learning network that can extract higher level features (similarity, identification, etc.) from lower level input (i.e. spectrogram). Due to its strong computational power, it can process a magnitude of multi-dimensional interactions. Therefore, it is suitable to analyze bird songs where the temporal, spectral and sequential features are densely intertwined. Song similarity is an important index to study songbird cognition. We have trained a Siamese network [SongSim], a specific neural network that can learn to calculate similarity, to score similarity between any two given zebra finch songs and evaluated the results by checking how the network scores songs from the same bird.

Shared behavioral mechanisms underlie *C. elegans* aggregation and swarming

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In complex biological systems, simple individual-level behavioral rules can give rise to emergent group-level behavior. While collective behavior has been well studied in cells and larger organisms, the mesoscopic scale is less understood, as it is unclear which sensory inputs and physical processes matter a priori. Here, we investigate collective feeding in the roundworm C. elegans at this intermediate scale, using quantitative phenotyping and agent-based modeling to identify behavioral rules underlying both aggregation and swarming—a dynamic phenotype only observed at longer timescales. Using fluorescence multi-worm tracking, we quantify aggregation in terms of individual dynamics and population-level statistics. Then we use agent-based simulations and approximate Bayesian inference to identify three key behavioral rules for aggregation: cluster-edge reversals, a density-dependent switch between crawling speeds, and taxis towards neighboring worms. Our simulations suggest that swarming is simply driven by local food depletion but otherwise employs the same behavioral mechanisms as the initial aggregation. We further expand our work by examining swarming at very high densities, and using a bioluminescence bacterial system to visualize and quantify feeding.

Old Age Primates (OAPs): Locomotion and musculoskeletal disease in ageing populations of chimpanzees

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Continuous improvements in zoo animal welfare have led to extended lifespans compared to wild conspecifics, particularly for the great apes. With ageing in humans, we commonly see slower more unsteady movement, increased risk and fear of falling, and musculoskeletal disease, namely osteoarthritis. Given the challenging environment that wild apes must move around in, if present, these age-related impacts ought to be more salient. Osteoarthritis in particular is thought to be a disease of sedentary lifestyles, where inactive joints are poorly maintained, and cartilage breaks down. Evidence comparing wild and zoo chimp activity is limited, but suggests captive chimps are more sedentary, ergo prone to osteoarthritis. This research seeks to quantify how chimpanzee positional behaviour and locomotor ecology (movement and posture in a given environmental context) are impacted by ageing, and whether a potentially more sedentary lifestyle has adverse risks to joint and bone health.

Oxytocin increases after affiliative interactions in male Barbary macaques

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Oxytocin (OT) is a neuropeptide hormone implicated in the formation of social bonds. It is often released in response to positive social interactions, though this can be context and/or partner specific. Here, we investigate the effect of affiliation - grooming and triadic male-infant-male interactions - in a non-reproductive context with bonded and non-bonded partners on urinary OT levels in semi-free ranging male Barbary macaques. We collected data on social behavior during full-day focal protocols on 13 adult males and measured endogenous OT levels from 185 urine samples collected after affiliation and non-social control periods during one non-mating season. We used a window of 15-60 min to excretion of OT in urine after a target behavior. OT levels tended to be higher following affiliation with any partner and with bond partners but not after affiliation with non-bond partners compared to non-social controls. Testing grooming and triadic interactions separately, we found OT levels were significantly higher after grooming with any partner and tended to be higher after grooming with bond partners. By contrast, OT levels after triadic interactions with any partner or with bond partners were not significantly different from controls. We could not test for independent effects of grooming or triadic interactions with non-bond partners due to small sample sizes. Our results are in line with previous studies showing that OT levels are increased after grooming, although it is still unclear whether OT release is partner-specific. The lack of an effect of triadic interactions on OT levels is puzzling and will be discussed.

Personality influences breeding response to corticosterone in a long-lived bird

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Carry-over effects occur when energetically demanding events in the past shape future reproductive attempts. Glucocorticoid hormones are important mediators of carry-over effects, with recent work in birds showing that corticosterone in feathers (fCORT) can predict future breeding decisions and success. However, individuals vary widely in how they respond to fCORT, potentially due to the existence of different life-history strategies: the trade-off between investing in current or future reproduction manifests in different life-history strategies at the individual level, which often correlate with personality. Fast-paced, bold animals preferentially allocate resources towards current reproduction, while slow-paced, shy animals prioritise survival. Accordingly, carry-over effects are predicted to vary with personality, with shy individuals responding to stress by reducing allocation to current reproduction more readily than bold individuals. Here, we examine the influence of personality on carry-over effects in a long-lived seabird, the black-legged kittiwake (*Rissa tridactyla*). To assess the strength of carry-over effects, we measured concentrations of the stress hormone corticosterone (CORT) in feathers grown at the end of the previous breeding season. We then examined breeding responses to these CORT levels, specifically focussing on phenology, clutch size, and success, and tested the influence of personality on carry-over effects. We demonstrate carry-over effects of CORT on breeding phenology, and we show that the strength of this effect varies with personality: shy individuals adjusted the timing of breeding in response to stress more strongly than bold individuals. Our results emphasise the importance of considering individual differences when interpreting the effects of environmental stress on fitness.

Personality niches across relationship components of the bottlenose dolphin (*Tursiops truncatus*) social network

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Social structures are critical to the success of gregarious species. Rapid advances are being made in understanding how small scale processes, such as consistent individual variation, impact social structures. Personality similarity predicts dyadic bonds, which are the basis of social structures. Thus, personality should be related to an individual's location in the social network. Boldness predicts network centrality, but other personality factors have yet to be investigated. Additionally, multiple species display evidence of social relationship components, and new analysis methods incorporate information from these components into network models simultaneously. Here we analyzed the social network metrics of individuals with different personalities to determine their role in their social group. A population of bottlenose dolphins (*Tursiops truncatus*) in a naturalistic environment under human care served as an easily observable proxy for wild populations. Personality was assessed using a Five-Factor Model questionnaire. Association was defined as within one body length of at least one other group member. Bond components (termed affiliative support, sociosexual, and conflict play) were determined by grouping interactions recorded during underwater opportunistic focal-follow via exploratory factor analysis. The role of personality types in the social group was determined using a multilayer network, with association and relationship components as layers. Openness and Extraversion were correlated with high centrality within and between layers. Neuroticism had a weak inverse correlation with centrality, but not across all layers. This furthers our understanding of the role personality types play in their social network, and demonstrates variation in these roles between social components.

Proximate mechanisms underlying alternate behavioral strategies in the facultative cleaning goby *Elacatinus prochilos*

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Cleaner fish are conspicuous members of coral reef communities that remove ectoparasites and dead tissue from larger fishes, referred to as 'clients'. In the Caribbean, the cleaning goby *Elacatinus prochilos* is a facultative cleaner that exhibits two alternative behavioral types, which are linked to habitat use. Individuals living in corals or other substrates (coral-dwellers) depend mostly on cooperative cleaning interactions with client reef fishes for feeding. Alternatively, individuals living in basket sponges (sponge-dwellers) feed mostly on micro-organisms living inside the sponges' tissue and only rarely engage in cleaning interactions. Previous studies have shown that obligatory coral-dwelling species prioritize predatory clients and secrete levels of cortisol after facing them. Here, we aimed to investigate how the two behavioral types in the facultative species behave towards predatory and non-predatory clients in controlled laboratory conditions and whether their whole body cortisol levels correspond to their cleaning behaviors. We found that wild coral-dwelling gobies have significantly higher whole-body cortisol levels than sponge-dwellers. Behavioral observations revealed that although the two behavioral types did not differ in their latency to interact with either predatory or non-predatory clients, sponge-dwellers interacted significantly less with clients than coral-dwellers in the lab. These results show that the *E. prochilos* with higher levels of cortisol also exhibit higher frequencies of cleaner interactions. However, these facultative coral-dwellers did not give priority of service to predatory clients as do obligatory coral-dwellers. Further studies should aim to investigate which factors cause the increase of cortisol in coral-dweller types and how it affects individual fitness.

Quantifying social complexity in Lamprologine cichlid species

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The complexity of the social environment has been proposed to be a key driver of the cognitive evolution of animals. Despite recent progress in conceptualizing social complexity, identifying a unifying index that allows comparisons across taxa still remains a major challenge. Here we propose a simulation that employs social network analytical metrics and takes on an information theoretical point of view to provide a quantitative assessment of social complexity. By constructing dynamic social networks of varying size, edge density, interaction density, relationship stability and breadth of behavioral repertoire we assess the relative contribution of these parameters in driving the systemic unpredictability as perceived from the perspective of an individual embedded within the network. In order to illustrate a case example of how our model-based approach could be applied to real-world data, we investigate the social behavior of shell-dwelling Lamprologine cichlid species which exhibit striking ecological similarities, but differ substantially in their social organization. After reconstructing species-stereotypic social networks, we compare the model predictions to estimate the level of complexity that each species is facing in natural contexts. In so doing, we gain insight into the social sources of selection that underlie the evolution of neuroanatomical and socio-cognitive features in a quantitative, comparative framework employing both empirical and theoretical approaches.

Responses of female bank voles, *Myodes glareolus* to male chemosignals

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Female mammals often need to locate and assess potential mates to ensure they reproduce with high quality males. Scents may play an important role in facilitating female location and assessment of males, particularly in solitary species where individuals interact infrequently. Further, female mammals often discriminate between male odours based on social status, territory ownership, health, genetic quality and age. Mammalian odours are highly complex, often containing hundreds of volatile and non-volatile compounds. Male bank voles invest heavily in urinary scent marking and produce a urinary protein, glareosin, which is upregulated during the breeding season, so may function to attract females. Proteins are expensive to produce so urinary protein production may be an honest signal of male quality. Alternatively, such proteins may function to bind smaller volatile ligands slowing their release. Recently, we have identified a volatile ligand present in male urine which may also play a role in sexual attraction in this species. Here, we investigate the response of female bank voles to male chemosignals by combining behavioural tests with molecular analysis of male scents. Combining molecular techniques with behavioural testing has allowed us to determine the functional importance of different components of male scent and has given us greater insight into the mechanism underpinning this important female behaviour.

Reversal learning and cognitive flexibility under realistic conditions of multiple different choices

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The extensive use of reversal learning as a measure of cognitive flexibility is typically based on training an animal to discriminate between rewarding and non-rewarding stimuli, and then reversing their roles. In natural conditions, however, animals are likely to face more than one set of relevant stimuli, which may substantially impact the dynamics of reversal processes and their implications for foraging success. Here, we address this possibility by studying reversal learning in captive socially foraging house sparrows. Sparrows were initially trained to prefer one of two colors or one of two shapes (creating color or shape specialists) and then allowed to forage on foraging grids containing both colors and shapes. We noted that during training, color specialists learned faster to discriminate between the rewarding and non-rewarding stimuli, compared to shape specialists. After the roles of the rewarding and non-rewarding colors and shapes were reversed, shape specialists (including those exhibiting exclusive use of the rewarding shape) quickly reversed their preference to the new rewarding shape. Color specialists, on the other hand, failed to reverse to the new rewarding color but gradually shifted to the new rewarding shape. These results suggest that: a) marked differences in reversal behavior may be explained by the type of learned stimuli rather than by individual differences in cognitive flexibility; b) under realistic conditions of more than two foraging options, strong initial preferences that are difficult to reverse, may drive a flexible shift to a new rewarding stimulus rather than to the previously non-rewarding option.

Risk of dynamic social colours in a tropical agamid lizard

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Across different taxa, there is incredible variation in colour signals of animals. Such variation can result due to differences in sexual selection and predation pressure, such that the benefits of conspicuous colours for social interactions are constrained by the costs associated with high predation risk. However, empirical evidence for the predation cost of conspicuous colour signals, especially those differentially expressed during different social contexts, is limited. In this study, we quantified predation risk on the Indian rock agama (*Psammophilus dorsalis*), a species where males express distinct physiological colours during different social contexts, while females remain cryptic. We first estimated the conspicuousness of the different colours expressed by the lizards to the visual systems of their typical predators. We then deployed wax models of lizards that were painted to resemble males in courtship colour, males in aggression colour, cryptic females, and cryptic males, across multiple sites. We find that not only was the courtship colour most conspicuous, the models bearing this colour were attacked the most by avian (raptors) and terrestrial (dog) predators. Our results suggest that colour change may have evolved in P. dorsalis to balance the benefits of sexual signalling with the risk of predation.

Scrounging enhances the diffusion of a novel foraging behaviour in domestic chicks, *Gallus gallus domesticus*.

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Animals foraging within a group can transfer profitable information, through social learning, about discovered food patches, novel food items and foraging techniques. However, during social foraging, instead of performing the novel foraging behaviour themselves, naïve individuals will commonly adopt a scrounging tactic and acquire food that has been obtained by others, termed producers. It is commonly assumed that social learning of new behaviours is inhibited by the opportunity to scrounge food; a premise supported by multiple laboratory experiments showing learning to occur only when scrounging behaviour is prevented. We investigated the effect of scrounging opportunities on the spread of a socially-learned foraging behaviour through a group of domestic chicks, *Gallus gallus domesticus* using a natural information diffusion approach. We manipulated scrounging opportunity by altering the quantity of food reward while maintaining group sizes and learning opportunities. We found that the opportunity to scrounge food from others was essential for the novel foraging behaviour to spread throughout the group. Furthermore the speed of behaviour spread appears to be directly proportional to the level of scrounging opportunity present. Therefore contrary to previous assertions, scrounging may facilitate the transmission of socially learnt behaviours. The opportunity to scrounge, often determined by the divisibility of the resource in question can determine the learning and spread of new behaviours within a group of animals.

Sensitive periods for personality development in a medium-sized rodent

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The study of consistent individual differences in behaviour, termed animal personality, has flourished over the last two decades because it has been recognised as a major contributor to differences in survival and fitness among individuals. How personality develops during life and how the early environment influences adult personality on the other hand has only started to be investigated. Sensitive periods - developmental stages in which environmental cues shape the phenotype to a larger extent than in other stages - may shape personality characteristics and help individuals to adjust optimally to the environment.

To identify a sensitive period for the adjustment of risk-taking, stress-coping and social personality traits, we experimentally manipulated stress-hormone levels during three life stages (juvenile, adolescent, adulthood) in wild cavies (*Cavia aperea*). We tested immediate and long-lasting effects of the manipulations on expression of personality traits as well as their temporal consistency. While we found an immediate effect of the experimental manipulation in juvenile and adolescent animals, the manipulation only induced permanent changes in personality types in adolescent but not in juvenile animals. Both, juvenile and adolescent cavies with experimentally increased stress-hormone concentrations developed a passive stress-coping strategy but this effect diminished during adolescence in animals treated as juveniles. Neither risk-taking nor social traits were affected by the treatment and adult individuals did not show any alteration of personality characteristics. These results indicate that especially the stage of adolescence is an important sensitive period during which the animals adjust their personality long-lasting to the prevailing environmental conditions.

Social learning strategies and advice giving regulate human collective intelligence

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Why groups of individuals sometimes exhibit collective "wisdom" and other times maladaptive "herding" is an enduring conundrum. Here I present that this apparent conflict is regulated by the social learning strategies deployed. I examined the patterns of human social learning through an interactive online experiment with 699 participants, varying both task uncertainty and group size, then used hierarchical Bayesian model-fiting to identify the individual learning strategies exhibited by participants. Challenging tasks elicit greater conformity amongst individuals, with rates of copying increasing with group size, leading to high probabilities of inflexible herding amongst large groups confronted with uncertainty. Conversely, the reduced social learning of small groups, and the greater probability that social information would be accurate for less-challenging tasks, generated "wisdom of the crowd" effects in other circumstances. Additionally, through a laboratory experiment with 194 subjects where participants could share 5-star ratings about options quality in addition to inadvertent choice-frequency information, I found that, even though the 5-star rating was a useful cue to predicting objective option-qualities, participants performed worse when both types of social information were combined than when only the frequency information was available, resembling the "less-is-more" effect in the judgment and decision making literature.

Social network dynamics and home-range overlap among horses in extremely seasonal habitats

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Feral Retuerta horses in Doñana Biological Reserve experience dry summer and fall and in winter marshes may flood large areas of the reserve. These dramatic environmental changes affect availability of forage and water and may thus affect the social structure of the horses. We tested the hypotheses that during the dry season 1. Groups show a greater overlap in home-range, due to scarcity of patches of food and water and 2. Network modularity will be lower, due to increased opportunities for mixture of groups when using the few available patches. We documented horses' group affiliation between July 2014-Feb 2015, and divided these months to a dry and a wet season, based on monthly rainfall and NDVI. We analysed the weighted social networks separately for the two seasons and compared them.

Ten harems were detected in both seasons and a few of them remained mostly unchanged. However, the composition of some of the groups was very different: a few groups split or merged, and a few horses died towards the end of summer. Group home-ranges overlapped more during the dry season, however, network modularity was higher in the dry season, i.e., groups were less inclined to mix. We hypothesize that in addition to the distribution of resources, the presence of flies may have affected the movement and the cohesion between individuals in summer.

Song syllable sharing in male and female New Zealand bellbirds

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An understanding of spatial patterns of song sharing and sex differences in song diversity can reveal insights into the function and evolution of bird song. In systems where males and females are territorial, sedentary, and sing complex song, there is an opportunity to explore how sex differences in song sharing may influence the formation and maintenance of song dialects. In this study, we examine male and female song syllable diversity in an island population of the New Zealand bellbird (*Anthornis melanura*). Male and female bellbirds use song for resource defence against intra-sexual rivals, including mates and territories. However, females have a smaller syllable repertoire compared to males. This indicates that there may be sex differences in patterns of song sharing and diversity.

We propose that proximity predicts syllable sharing for both males and females, so that birds in adjacent territories share more syllable types with each other than with birds from distant territories. This would infer that bellbirds have micro-geographic song dialects, and it's possible that this pattern may be more apparent in males than in females since females sing fewer syllable types. Alternatively, bellbirds may show no differentiation in syllable types across the island if syllable sharing with neighbours is comparable with birds from distant territories. This would infer that bellbirds do not display song dialects at this spatial level. Examining micro-geographic spatial patterns of syllable sharing for both sexes provides further understanding on song sex differences and the roles of sex and social dynamics in shaping song dialects.

Squirrel monkeys individuate object based on spatio-temporal information

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Human infants, apes, macaques, and capuchin monkeys can individuate objects, namely identify and track objects, based on spatio-temporal information. The current study further investigates the evolutionary origins of object individuation by testing squirrel monkeys (*Saimiri sciureus*). In Experiment 1, the subjects manually or visually accessed a box to find a surreptitiously pre-baited food item after seeing either one (expected condition) or two (unexpected condition) food item(s) dropped into the box. Squirrel monkeys (n=19) didn't look longer (Wilcoxon signed-rank test, z=0.980, n=18, p=0.327) nor search more (z=1.222, n=17, p=0.222) when the outcome violated their expectation. Experiment 2 investigates squirrel monkeys' competence with a more sensitive design, in which the monkeys searched food behind two small barriers rather than in a large box. The monkeys watched food item(s) being moved around two barriers along continuous path (suggesting one object) or discontinuous path (suggesting two objects). Then they could knocked down the barrier(s) to find the hidden food. The squirrel monkeys (n = 16) searched both locations within 20 seconds regardless, showing a ceiling effect on total searching behaviour. However, in the continuous/one-object trials they preferred to knock down first the last barrier where the food item disappeared, while they chose randomly in the discontinuous/two-object trials (main effect of path continuity: $F_{(1, 15)}=33.601$, $p<0.001$, $p2=0.691$). This result reveals squirrel monkeys can demonstrate the ability to individuate objects with spatio-temporal information only when testing their preference but not their searching time, supporting the notion that spatiotemporal object individuation is likely a primate primitive trait.

Sympathy in wild corvids: do jackdaws console stressed partners?

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Consolation behaviour is a type of sympathetic concern, where individuals attempt to decrease the stress levels of a conspecific through affiliation after a stressful event. It is often measured in a post-conflict context, where elevated affiliation from a bystander to a participant in a fight is interpreted as consolation. Understanding whether the bystander is truly showing consolation requires that the individual's own stress level is known (i.e. could the bystander merely be alleviating its own distress?) and that directionality of the interaction is known (is the consolation event unsolicited by the other individual?). Many studies only partially meet these criteria. Furthermore many studies, especially those on birds, are conducted in captivity, leaving a gap in knowledge about consolation behaviours in the wild. In this study, we used a ringed population of wild jackdaws to test whether individuals who had not experienced a stressor showed consolation behaviours to a stressed individual. To do this, we exposed incubating female jackdaws to a mild and ecologically relevant stressor while their male partner was absent from the nestbox. We then measured the level of affiliative behaviour directed from the male to the female upon his return, and compared this to baseline levels of affiliation. If consolation is found to occur, this will be some of the first evidence to show sympathetic concern in birds without the potential caveats of solicited affiliation and self-comforting behaviour. If it is not found, this study will nonetheless add valuable information about the function of consolation in wild animals. (Results due in June 2019)

Individual differences in spatial memory predict changes in speed and straightness of transitory paths in the pheasant

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Spatial memory has been hypothesised to be an important determinant of an animal's movement decisions. Utilising memory allows an individual to build more efficient trajectories and reduce time in areas with high predation risk or low energetic yield. Yet individuals can differ in their ability to collect, store and utilise information about their environment. Although work on species with obvious sex differences in their spatial ecology indicate a strong, positive link between performance on cognitive tasks and space use and/or environmental complexity, individual level differences have had surprisingly little attention. We assayed the cognitive ability of 62 pheasant chicks using an associative learning task and a spatial memory task. We then released the birds at 10 weeks old into a woodland/grassland area in rural South-West England and monitored their movements with a reverse-GPS system. Using a hidden Markov model, we classified movement trajectories into three classes: resting/vigilant, foraging and transit between patches. We found that the proportion of time in transit per day is a repeatable within an individual and we discuss the potential for individual movement specialisations in pheasants. We then assessed whether an individual's performance on abstract cognitive tasks predicted temporal or spatial aspects of their movements. The implementation of state-of-the-art tracking technology on a large sample of individuals allows us to develop a deeper understanding of the interplay between spatial ecology and cognition.

The genetics of visual preferences in a hybrid species

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Speciation in the face of gene flow is facilitated by linkage of traits under divergent ecological selection and those that contribute to assortative mating. The Neotropical butterfly *Heliconius heurippa* is one of the best-known examples of hybrid speciation. Specifically, its combined red-yellow forewing pattern is thought to have arisen as a result of hybridisation between the red patterned *H. m. melpomene* and yellow patterned *H. timareta linaresi*. The warning patterns of *Heliconius* are also known to act as mate recognition cues. We present data from mate preference experiments including over 1000h of video footage processed with a novel video analyses pipeline. Our data reveal that *H. heurippa* males show a preference for females that share its own red and yellow colour pattern, over that of *H. timareta linaresi* (which lacks the red forewing band). Preliminary analysis also provide evidence that a locus underlying this behavioural shift is physically linked to optix, which is responsible for the presence or absence of the red forewing band. This mirrors previous work showing the existence of a major preference allele for red patterns associated with optix in *H. melpomene*. Together, these data suggest that during the evolution of *H. heurippa*, both colour pattern and preference alleles were acquired through introgression from *H. melpomene*, which would facilitate hybrid speciation.

The History of the Handicap Principle

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The most cited explanation for the evolution of honest signaling is Zahavi's Handicap Principle, and yet there is no consensus for how to define or test this idea. We provide a critical overview of the theoretical development of the Handicap Principle to show how it has generated confusion. Zahavi originally argued that honesty signals evolve because they are costly to produce. He also argued that honest signals evolve because they are wasteful, and that they evolve through signal selection, which favors wastefulness rather than efficiency. Zahavi's proposals for his Handicap Principle would have been rejected, except that he also suggested a logical explanation for reliable signals: he proposed that signals are honest because high-quality signalers pay lower viability costs for signalling compared to low-quality signalers. His two hypotheses were widely confused with each other and equated to good-genes models of sexual selection. Grafen's strategic choice model provided support for Zahavi's second hypothesis, but rather than being recognized as a Darwinian alternative to the Handicap Principle, it was misinterpreted as validating this illogical proposal. This model is neither a handicap model, nor a general principle for honest signalling. It is better interpreted in the framework of evolutionary life-history theory, and the Handicap Principle should be ushered into an "honorable retirement".

The role of relatedness and familiarity in the social relationships of male Assamese macaques

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Male Assamese macaques are unusual among dispersing male primates as they form strong stable bonds with a few of their competitors in the group. Closely bonded males can act as allies during conflicts, allowing them to raise in dominance rank, which in turn increases their reproductive success. Here we assess the effect of relatedness (both maternal and paternal) as well as familiarity on the social behavior of wild adult male Assamese macaques at the Phu Khieo Wildlife Sanctuary, Thailand. We genotyped all 136 adult individuals of four multimale-multifemale groups at 17 microsatellite loci to assign kinship. This was combined with two years of observational data (4543h) on affiliative and agonistic social behavior for the up to 31 adult males of the groups. We find that strong bonds are not limited to closely related males, a pattern that has been reported in males of several other primate species. Since males leave their natal group before reaching sexual maturity, they also leave the majority of their close kin behind, which could explain why they turn towards unrelated individuals. Moreover, the coalitions that bonded males form benefit both males mutually, making the indirect benefits of bonding with kin of secondary importance to the direct benefits they get out of it. Overall, these results show that close affiliative relationships observed among male Assamese macaques are equivalent to human friendships in the sense that they develop between unrelated males.

Tolerant birds: Testing for inequity aversion in four parrot species

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Inequity aversion, the negative reaction to unequal treatment, is considered a basic mechanism of cooperative behaviour. However, this might only be adaptive for species, which can easily change cooperative partners. Utilizing a comparative approach, inequity aversion has been assessed in many mammalian species and recently also in corvids and a parrot species, revealing mixed results.

We tested four parrot species in a token exchange paradigm, in which we varied the quality of rewards delivered to the birds, as well as the effort required to obtain a reward. Results reveal that blue-headed macaws and African grey parrots did not show any reaction to being rewarded unequally. In contrast, the bigger macaws refused to exchange tokens, if their partner received a reward of better quality than they did. While the behaviour of the blue-throated macaws can be explained by motivation effects, as they refused to work for the LQR altogether, the great green macaws exchanged fewer tokens in the unequal compared to both equal conditions. Nonetheless, they also refused to exchange in a non-social control, in which the high-quality reward was delivered to their empty neighbour compartment; thus, indicating that frustration over not getting the better reward might be the underlying motivation for their refusal to exchange, rather than social comparison. None of the species were sensitive to inequity in terms of effort. Potentially, parrots do not exhibit inequity aversion due to interdependence on their life-long partner and the high costs associated with finding a new partner.

Traffic disturbance on the personality of tungara frog (*Engystomops pustulosus*) tadpoles in Trinidad

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Investigating how urban and disturbed environments impact key behaviour traits is important in understanding how animals will continue to cope with ongoing urbanisation. This is especially important in tropical habitats with high rates of development. Human disturbed environments place novel selection pressures such as habitat transformation, vehicle traffic, chemical pollutants and increased episodes of physical disturbance on animals. Increased levels of disturbance can impact on the personality (consistency of a behavioural trait) of animals. For example, individuals of the same species inhabiting high disturbance areas show increased levels of aggression and boldness. High disturbance locations have also been associated with individuals displaying increased flexibility in their behaviour, reducing how consistently the level of a behaviour will be displayed in an individual. However previous research has focused on adults which have developed within disturbed habitats and there has been limited research on whether differences in personality traits develop when individuals are reared outside their site of origin. In this study we looked at the impact traffic disturbance had on *Engystomops pustulosus* tadpoles in Trinidad. We collected eggs from 39 high or low traffic disturbed sites and raised the tadpoles within a field station under common conditions. We recorded activity, exploration and neophobia behaviours in 129 tadpoles and investigated how the disturbance levels from a tadpole's site of origin impacted these behavioural traits. We repeated each assay six times to additionally identify how consistently these behaviours were expressed in tadpoles from high and low disturbance areas.

Wavering Behaviour in Chimpanzees

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As humans, we are aware of when we find things difficult. Although these experiences are not directly measurable, there are certain signature behaviours which coincide with self-reported task difficulty, such as motor hesitation and increased response latencies (Questienne, Atas, Burle, & Gevers, 2017). In non-human primates, metacognitive appraisals of this kind can only be assessed with purely non-verbal measures, such as choosing to opt-out of difficult trials and seeking additional information (Beran, Smith, Redford, & Washburn, 2006; Call & Carpenter, 2001). Such behaviour may indicate monitoring of task difficulty. In the current study we pursue a complementary approach by investigating whether objective task difficulty was related to hesitation behaviour ("wavering"), one of the behavioural correlates of difficulty experience in humans, in a sample of three chimpanzees who completed a serial learning task. After learning to clear five items in the correct order on a touchscreen, subjects were presented with subsets of two items from the list to see if they could infer their correct order. Previous research has established that these subsets vary in difficulty based on the items' positions in the original list (D'Amato & Colombo, 1988). All chimpanzees showed longer reaction times and increased frequencies of wavering behaviour in trials that were objectively more difficult. Chimpanzees therefore demonstrated a signature behaviour which is associated with humans' subjective experiences of difficulty and demonstrated this behaviour more often in trials of greater difficulty.

A look in the mirror: What's this uncanny pigeon doing?

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Mirror self-recognition is a characteristic of higher intelligence, hence limited to a few animal species. Compared with humans and some great apes, monkeys fail at mirror self-recognition tests, and perceive their reflection as an 'uncanny' individual rather than a congener. Uncanniness results from the perfect synchrony between the monkey's movements and its reflection. Pigeons also have no self-recognition, but how they perceive their mirror image is unknown. Our study examined pigeons' responses to a mirror image versus a real pigeon. In both cases, the pigeons were exposed to two conditions: one consisted of approaching a feeder placed in front of a mirror or in front of a real pigeon behind a Plexiglas panel; the other consisted of approaching a feeder placed on the opposite side of the mirror or of the real pigeon. Our results show that the time latency to reach the food was significantly increased when the feeder was placed in front of the mirror rather than the real pigeon. Additionally, the number of pecking bouts and the total number of pecks at the feeder were considerably smaller in front of the mirror rather than the real pigeon. In conclusion, pigeons seem to be afraid by their mirror image, suggesting that they perceive, like monkeys, their reflection as an 'uncanny' individual rather than a congener.

A new note in an old tune: Drosophila song and the drivers of behavior

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Deciphering how brains generate behavior depends critically on an accurate description of behavior. If distinct behaviors are lumped together, separate modes of brain activity can be wrongly attributed to the same behavior. Alternatively, if a single behavior is split into two, the same neural activity can appear to produce different behaviors.

Here, we address this issue in the context of acoustic communication in Drosophila. During courtship, males vibrate their wings to generate time-varying songs, and females evaluate songs to inform mating decisions. For 50 years, *Drosophila melanogaster* song was thought to consist of only two modes, sine and pulse, but using unsupervised classification methods on large datasets of song recordings, we now establish the existence of at least three song modes: two distinct pulse types, along with a single sine mode.

We show how this seemingly subtle distinction affects our interpretation of the mechanisms underlying song production and perception. Specifically, we show that visual feedback influences the probability of producing each song mode and that male song mode choice affects female responses and contributes to modulating his song amplitude with distance. At the neural level, we demonstrate how the activity of four separate neuron types within the fly's song pathway differentially affects the probability of producing each song mode. Our results highlight the importance of carefully segmenting behavior to map the underlying sensory, neural, and genetic mechanisms.

Criss-crossing the frontier between behavioural game theory and conservation ecology

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Understanding the causes of the structure and dynamics of food webs is crucial for developing policies to halt the loss of biodiversity. Game theory could enable the prediction of links in webs as the outcomes of competitive games among species, and thereby help understand the consequences of environmental change. I focus on one example: the potential for loss of nest sites to cause great variation in the declines of closely-related species. I used a mathematical model to predict how a reduction in nest sites would affect species of different sizes and timing of nest establishment, and found that data on 43 bumblebee species and 221 bird species worldwide agreed with the model's predictions. This means that behaviour that evolved when nest sites were not hard to find could result in some species may be driving others to extinction due to habitat loss. This phenomenon – anthropogenic competition – is likely to occur for any formerly abundant resources that suddenly, on an evolutionary timescale, are now limiting population sizes. Furthermore, these data provide rare quantitative support for the predictions of the theory of animal conflict, revealing the benefits of criss-crossing frontiers between ecological disciplines.

African grey parrots behave more pro-socially when not rewarded themselves

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Prosociality is defined as a voluntary, typically low-cost behaviour that benefits another individual. Parrots are interesting models to study such other-regarding behaviours, given their social complexity, their enlarged brains and their surprising cognitive capacity. We assessed African grey parrots' prosocial tendencies in dyadic settings implementing two different methodologies. In the prosocial choice task based on token exchange, an increasingly widely used comparative paradigm, the parrots only behaved prosocially, choosing a prosocial token (rewarding both birds in the dyad) over a selfish token (rewarding only the actor), when they were tested in the active and passive role alternatingly. The birds also increased their willingness to provision food to their partner, if it was of higher quality than that the actor obtained. Nonetheless, the control conditions suggest that the parrots had not fully understood the task's contingencies. When tested in a token transfer paradigm, in which the subject had tokens that only its neighbour could exchange for food, the grey parrots actively transferred tokens to their partner. In control conditions, in which no partner was present (non-social control) or in which the partner was present but could not exchange either, they transferred significantly less tokens into their neighbour's compartment than in the test. The results of the two studies raise the possibility that other-regarding tendencies may be partially masked if the subjects need to consider their own and another's payoff simultaneously. This confounding effect may similarly apply to other species and should be examined and considered by future comparative studies.

Androstenone induces submissive behavior of horses thorough OR7D4 expressed in VNO and nasal cavity tissues

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Androstenone is a steroidal pheromone found in the saliva of boars. Androstenone is an intermone that elicits a response in different species. OR7D4 is an odorant receptor that responds to androstenone. The main objectives of this study were 1) to investigate expression of OR7D4 in horse vomeronasal organ (VNO) and olfactory epithelium tissue and 2) to evaluate the effect of androstenone on horse behavior. Tissue samples were collected from VNO and nasal cavity of two Thoroughbred horses. The expression of OR7D4 was determined using immunohistochemistry and western blot. For the 1st behavior test, 15 horses were used with 3x3 Latin square study design. For each group of horse, 2ml of 0.1 or 1 ug/ml of androstenone diluted with jojoba oil or oil only (control) were applied around muzzle of horses. Five mins after application, a handler slightly push down horse's head under horizontal level and timed for 5 secs (submissive behavior). The time for showing the first submissive behavior was recorded. For the 2nd test, 15 horses were used to test the effect of 10 ug/ml of androstenone in submissive response of horses with cross-over study design. Neurons and cells of VNO and nasal cavity tissues were immunolabeled with OR7D4 antibody. Treatment with 10 ug/ml of androstenone applied 30 min prior to the test significantly decreased time to show submissive behavior compared with control. In conclusion, androstenone appears to induce submissive behavior of horses throughout OR7D4 receptor expressed in VNO and olfactory epithelium tissues.

Animal habitat networks: why should we care and how can we model them?

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Animals live on habitats, the physical configuration and structure of which can shape individual movements thus can mediate the downstream ecological and evolutionary processes. Network theory has long been applied to discuss habitat connectivity and animal movements across contexts, but there is still a lack of a general framework for modelling the physical configuration and structure of animal habitats using networks. Animal habitat networks are abstractions of habitat entities, and their properties are expected to be shaped by features of physical environments; yet the properties of animal habitat networks remain largely undiscussed. We propose a general framework for modelling the physical structure and configuration of animal habitats using networks and a general model for depicting animal habitats; then we explore the properties of animal habitat networks with our model. We highlight the application of our framework and model for explicitly describing the physical configuration and feature of animal habitats in studies of animal ecology, evolution and conservation.

Anti-predator behavior in male bushcrickets is adapted to threat and age to optimize reproductive success

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Animals regularly trade off vital activities, such as attracting potential mates against avoiding predators. Many males attract females by species-specific calls, which also attract eavesdropping predators. Males are thus under strong selection pressure to trade-off singing (mate attraction) with stopping to sing (predator avoidance). Moreover, the life of many animals is short, and the likelihood to obtain a future mating decreases over a mating season. We thus hypothesized that male decision making changes over the lifespan to optimize reproductive success: males should prioritize predator avoidance over mating effort early in the mating season, yet accept higher predation risk towards the end of the mating season. We tested this hypothesis in singing male *Tettigonia viridissima* bushcrickets (Orthoptera: Tettigonidae), whose song attracts both females and eavesdropping predatory bats. We conducted playback experiments with individual wild caught male *Tettigonia viridissima*, testing each male twice during the mating season. Our playbacks mimicked three levels of bat predation threat by varying the sound level and call repetition rate of the presented bat echolocation calls. We recorded the bushcrickets' song and analyzed the proportion of reacting males, the time until and duration of song cessation as a function of simulated predation threat and male age. At high and intermediate predation threat, young and old males reacted very similar. At low predation threat, however, old males stopped singing less often, and stopped later and for shorter periods than young males. Decision making in bushcrickets is thus adapted to predation threat and age, to optimize reproductive success.

Bats integrate information about species identity, conspecific activity, and prey abundance when eavesdropping

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Animals can use Inadvertent Social Information (ISI) to improve fitness-relevant decisions. Since bats emit high-amplitude species-specific echolocation calls when flying, they provide a constant flow of ISI to others. Of particular interest is the feeding buzz rate - characteristic call sequences preceding any prey capture - which correlates with insect abundance. Our goal was to systematically test which ISI bats integrate when eavesdropping on others and how this integration affects space-use and interactions, respectively.

We used a community-wide approach and investigated the effects of a broad range of playback feeding buzz rates and conspecific activity on eavesdropping responses in 24 bat species combinations in the wild.

For the first time, we reveal that finely graded and density-dependent eavesdropping responses are not limited to particular foraging styles or call types, but instead are ubiquitous among insectivorous bats. All bats integrated ISI about calling species identity, prey abundance, and conspecific activity to estimate the cost-benefit ratio of prospective interactions, yet in a species-specific manner. The effect of buzz rate was multifaceted, as bats responded differently to different buzz rates and responses were additionally modulated by heterospecific recognition. Conspecific activity had a negative effect on the eavesdropping responses of all bats.

These findings can explain the inconsistent results of previous studies and advance our understanding of the complex nature of con- and heterospecific interactions within bat communities. A comprehensive understanding of how bats incorporate social information into their decision-making will help researchers to explain species distribution patterns and eventually to unravel mechanisms of species coexistence.

Behavioral pattern of unique and only Black Colored meat variety of India (Kadaknath)

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Kadaknath is only Black Meat Chicken (B.M.C.) Breed of India also called as Lamborghini of chicken birds. It is a native bird of Madhya Pradesh, reared mainly by the tribal communities of Bhil and Bhilala. The Kadaknath is, of course, not the only black chicken in the world. China has the Silkie chicken and Indonesia the Avam Cemani. Adult plumage varies from silver and gold-spangled to bluish-black without any spangling. The skin, beak, shanks, toes and soles of feet are slate like in colour. The comb, wattles and tongue are purple. Most of the internal organs show intense black coloration, which is pronounced in trachea, thoracic and abdominal air-sacs, gonads and at the base of the heart and mesentery. The blood is darker than normal. The black pigment is the result of melanin deposition. Kadaknath has special medicinal value in homeopathy and a particular nervous disorder and have lowest cholesterol level than any other chicken variety. The study was carried out to understand the behavior pattern of these unique birds in open and closed shed system. The birds were divided in to 3 groups of 50 birds each. T1 birds were reared in shed for whole time,T2 birds were kept open during day time and kept in shed at night,T3 birds were kept in open condition throughout the day and night. A number of behavioral and production pattern were studied like pecking, foraging, cannibalism, egg production, weight gain, sunlight exposure, effect of feeding time, feed consumption, feed conversion ratio. It was observed that birds kept in open during day and then kept in cages at night gave best production results like egg production, weight gain, age at first laying etc. Cannibalism and Pecking was most common in T1 group kept in sheds and was least in T3 birds. It was also observed that women farmers are best suited for backyard poultry farming and if Kadaknath birds are given proper popularization they can prove to a be good source of income generation for the poor women farmers because of their unique colour and taste. These birds can generate a price of about 300 times more than normal birds

Behavioural ecotoxicology of colour change

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The brown shrimp, *Crangon crangon* utilizes chromatophores (specialized cells containing pigments) to match its background, changing its colour from pale (pigments contracted) to dark (pigments expanded) to become almost invisible in its environment. Chromatophores also protect the shrimp (at least in the larval stages) from UV light. The control of pigments depends on hormones, secreted by the shrimp as a response to different stimuli (e.g., light, temperature and colour of substrate). Heavy metals are found often and consistently in estuaries, due to human activities along the coasts and can potentially affect behavioural responses, acting as anthropogenic stressors. Detecting the concentration of pollutants in the aquatic environment is challenging (because of spatial and temporal variation) and often not sufficient to assess the actual effects on marine organisms. The use of colour change as a behavioural marker of pollution can become an effective tool to assess the initial stages of biological alteration in aquatic organisms. To test the efficiency of this novel technique, brown shrimp have been treated with non-lethal concentrations of heavy metals. Shrimp subjected to cadmium became darker, suggesting a stress response. Arsenic did not produce such effect, possibly due to the ability of marine organisms to biotrasform inorganic arsenic into the less toxic organic form. Thus, colour change can be a promising effective tool for behavioural ecotoxicology studies.

Behavioural repertoire and associated vocalizations in a social passerine, Jungle Babbler (*Turdoides striata*)

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Animals display a wide variety of behaviours across different environmental and social contexts within their lifetime. In this regard, long-lived social birds with their vast repertoire of solitary as well as interactive behaviours, provide a fascinating system to study the ontogeny, function and evolution of behaviours. Social birds also show well-developed vocal communication between group members. As communication plays a critical role in maintaining social bonds, examining the diversity and function of these vocalizations helps in achieving a better understanding of the organism's social complexity. This study aims to describe the behavioural and vocal repertoire of a social passerine, Jungle Babbler (*Turdoides striata*). Jungle Babblers (JB) are a cooperative breeding bird found in groups of 3-20 individuals. The present study describes 13 distinct behaviours in JB wherein some behaviours showed a specific temporal pattern of occurrence at both diel and seasonal scales, while foraging occurred throughout the day and year with similar frequency. In addition, ten different calls associated with different behavioural contexts were recorded and characterised acoustically. This study presents the first quantitative description of the calls of this social passerine. It also lays the foundation for further studies examining the role of social complexity in the evolution of acoustic complexity.

Bird flight speed depends on the climb rate

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The extent to which animals modulate their movement decisions to minimise their energy expenditure remains an active area of research. This has been tested widely for flying animals, because the power curve leads to specific predictions about the flight speeds that animals should adopt in different scenarios. Nonetheless, this model is designed for level flight and does not explain the high variability in flight speeds often observed in powered flight. We equipped homing pigeons (*Columba livia*) with 1 Hz GPSs to examine the extent to which flapping birds vary their flight speed in relation to their climb rate and the influence of environmental factors on their flight altitude. We found that the airspeed was extremely variable, with a range of 10.9 m s-1 within flights. Airspeed was negatively correlated to the climb rate, increasing during the descent and decreasing during the ascent. However, birds were not maintaining a constant power output across periods of ascending and descending flight. This was evident as the slope of the relationship between the power required to climb and the power required to change speed was less than one, and furthermore, the slope was greater during periods of descent. The flight altitude depended on the topography of the route. Overall, this demonstrates that the vertical flight path has an important influence on speed selection in birds and that this must be considered when modelling the implications of flight speed for energy expenditure.

Born to be asocial: Newly-hatched tortoises spontaneously avoid unfamiliar individuals

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Individual recognition is important for modulating social interactions, but it is not clear whether it is innate or to what extent it depends on experience, and whether it is present in species with limited social habits, such as tortoises. In wild tortoises, evidence of social interactions is limited to behaviors performed years after hatching, in the context of mating. To investigate the presence of abilities of individual recognition at the onset of life in tortoises, we used hatchlings of two species (*Testudo marginata*, *Testudo graeca*) reared with a single conspecific as unique social experience. When located in a novel environment together with the familiar conspecific, tortoises reached the average distance expected by random trajectories. On the contrary, tortoises tested with an unfamiliar conspecific first explored the mate, then actively kept a distance significantly larger than expected by chance. These results show spontaneous abilities of individual recognition in a non-social species at the onset of life, and active avoidance of unfamiliar conspecifics. We suggest that this predisposed behavior might be adaptive for young tortoises' dispersal and that evolutionary pressures for social behavior might be relevant for non-social species even at the onset of life.

Bottlenecks in juvenile snapper (*Chrysophrys auratus*).

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Sparid Snapper (*Chrysophrys auratus*) are in important commercial and recreational species in New Zealand that have been under intense fishing pressure over many decades. Adult stocks are now well under fisheries targets: In this study we hypothesize that this, in part, may be due to habitat bottlenecks acting within the critical first few months of life when juveniles are reliant on sheltered nursery habitats and particularly structured environments. This study investigates how the territorial behavior of juvenile snapper may set a carrying capacity on nursery habitats that is well below any upper limits set by availability of food or shelter. Here we investigate firstly the stability of dominance hierarchies within groups of juveniles, and secondly the factors driving such dominance hierarchies. Specifically, we address the relative importance of size, prior residency, and personality (boldness) in determining the outcome of paired contests between juveniles. We further discuss the relevance of these findings in terms of fisheries and environmental management.

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Collective decision making by rational individuals

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The patterns and mechanisms of collective decision making in humans and animals have attracted both empirical and theoretical attention. Of particular interest has been the variety of social feedback rules and the extent to which these behavioural rules can be explained and predicted from theories of rational estimation and decision making. However, models that aim to model the full range of social information use have incorporated ad hoc departures from rational decision-making theory to explain the apparent stochasticity and variability of behaviour. I will describe a model of social information use and collective decision making by fully rational agents that reveals how a wide range of apparently stochastic social decision rules emerge from fundamental information asymmetries both between individuals and between the decision makers and the observer of those decisions. Using this model I will show how rational decision making creates complex dependencies between the environment, experimental conditions, population structure and observable social behaviour.

Communicative value and intentional use of facial expressions in red-capped mangabeys (*Cercocebus torquatus*)

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Facial expressions in primates have often been qualified as involuntary markers of emotional state. While the dual intentional and emotional use of facial expressions has been recently suggested for the apes, the question whether monkeys produce facial expressions intentionally to communicate remains open. Here, we tested whether red-capped mangabeys (*Cercocebus torquatus*) use facial displays socially and concomitantly to behavioural markers of intentional communication commonly used in gestural studies. These intentional markers are based on the assumption that a signal produced intentionally in dyadic communication would (i) be directed to a recipient, (ii) have the function to reach a specific goal, and (iii) lead to a change in the recipient's behaviour. We described six facial expressions that were used in social contexts by captive red-capped mangabeys. Those implied ears, eyebrows and mouth movements, that could be graded in intensity and produced either independently or combined with one another. We found that five of the facial expressions described could be associated in some cases to all the behavioural markers of intentionality. However, only "open mouth" displays, produced in playful contexts, were found to be associated to intentional markers in most of the cases. Other facial expressions were at least directed to a recipient, except for yawns, that seemed to be disentangled from dyadic communication. Taken together, these results suggest a communicative value of some facial expressions in red-capped mangabeys, but reveal substantial variability in their intentional use.

Comparative Acceleration Study Across Fish Phylogeny

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Undulation of the axial body is the fundamental motor pattern in vertebrates that predates the origin of paired fins and jaws, and it has powered the locomotion of the earliest animals with backbones. Over the past several decades, a number of studies on fishes have investigated the kinematics, physiology and hydrodynamic mechanisms of undulatory locomotion during steady swimming. In contrast, far less is known about how these mechanisms apply to unsteady locomotion; for instance, when fishes accelerate quickly to catch a prey or avoid predators. Here, we leverage a multi-disciplinary approach to study forward acceleration. Our initial flow tank experiments using live rainbow trout showed that during acceleration tail beat amplitude is approximately 30% higher than during steady swimming. To uncover how elevated tail beat amplitude relates to thrust production and propulsive efficiency we used a combination of flow visualization experiments on trout and soft-bodied biomimetic models. Our results reveal that by increasing tail beat amplitude fish are able to enhance thrust production through alteration of the vortex ring geometry generated by the caudal fin. We suggest that this phenomenon is generalized to all fishes, given that we later observed similar acceleration kinematics in more than 50 species with vastly different body shapes, swimming modes and ecological habitats.

Collective action modulates androgen levels in shoaling fish

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Androgens, traditionally viewed as hormones that regulate reproduction in male vertebrates, are often modulated by social stimuli. High levels of the 'social hormone' testosterone (T) are linked to aggression, dominance, and competition. Low T levels, in contrast, promote prosocial behaviours such as affiliation, social tolerance, and cooperation, which can be crucial for group-level, collective behaviours. Here, we test the hypothesis that, in a collective context, low T levels should be favourable, using male and female stickleback fish (*Gasterosteus aculeatus*) and non-invasive waterborne hormone analysis. In line with our predictions, we show that the fishes' T levels decreased significantly during shoaling, with high-T individuals showing the largest decrease. Ruling out stress-induced T suppression and increased aromatase activity, we find evidence that shoaling directly inhibits androgen responsiveness. We also show that groups characterized by lower mean T exhibit less hierarchical leader-follower dynamics, suggesting that low T promotes egalitarianism. Overall, we show that collective action results in reduced T levels, which may serve to promote coordination and group performance. Our study, together with recent complementary findings in humans, emphasizes the importance of low T for the expression of prosocial behaviour in vertebrates suggesting a deep evolutionary history.

Considerations used by desert isopods to assess scorpion predation risk

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Animals adjust behaviors to balance changes in predation risk against other vital needs. Animals must therefore collect sensory information and use complex risk assessment process that estimates risks and weigh costs and benefits entailed in different reactions. Studying this cognitive process is challenging, especially in nature because it requires inferring sensory abilities and conscious decisions from behavioral reactions. Our goal was to address this empirical challenge by implementing psychophysical principles to field research that explores considerations used by desert isopods (*Hemilepistus reaumuri*) to assess the risk of scorpions that hunt exclusively from within their burrows. We introduced various combinations of chemical and physical cues to the vicinity of isopod burrows and recorded their detailed reactions upon first encountering the cues. The isopods reacted defensively to scorpion odor but only when accompanied with excavated-soil or other odors typically found near scorpion burrows. Isopods also reacted defensively to piles of excavated soil without scorpion olfactory cues, suggesting that isopods take precautions even against physical disturbances that do not necessarily reflect predator activity. Simultaneous presence of different cues provoked graded responses, possibly reflecting an additive increase in risk estimation. We conclude that wild isopods use defensive reactions toward environmental signals only when the integrated perceptual information implies an active scorpion burrow, or when they lack data to refute this possibility.

Cooperation of shrikes and barred warblers during the nest defence?

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The barred warbler has been repeatedly shown to nest in the proximity of shrikes. We tested the hypothesis that barred warblers breed close to shrikes to profit from their very active nest defence against predators. Moreover, we tested if they consider shrikes to be potential predators of barred warblers as well (umbrella protection). We presented dummies of avian predators differing in the threat they represent to the nest and to adult barred warblers, at nests of barred warbler, which do and do not breed in association with shrikes. We showed that the intensity of the antipredatory behaviour of barred warblers is equal to all predators (jay, magpie, sparrowhawk), but they tend not to approach the sparrowhawk, which is capable of catching the adult bird. Barred warblers intensively warned also in the presence of magpie, which is never attacked by shrikes. The dummy of shrike elicited less alarm calling than the control pigeon, barred warblers commonly approached it and provided food to chicks. Barred warblers obviously do not considered the shrike to be a potential predator. The close presence of shrike nest did not affect the barred warbler alarm calling to any dummy. Even the presence of adult shrikes at the barred warbler nest during the experiment did not induce a more intense alarm calling of the barred warblers. We may conclude that we were not able to confirm any adaptive function of the close breeding of these two species.

Coping with habitat uncertainty: a case study with pond breeding dragonflies

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The Guiana shield is one of the most ancient bedrock formations on Earth that houses a variety of ecosystems including forests, floodplain savannas, and granite outcrops (inselbergs). On these inselbergs, eroded depressions house temporary rock pools. The fauna of these habitats in South America is just recently described and the underlying processes that determine survivorship of species in this changing habitat are not well understood.

For these reasons, we are investigating some important behavioral adaptations that can explain the survival of odonate larvae in the unpredictable environment of temporary rock pools. We are using common garden experiments to test the relative importance of water level reduction and increased conductivity (due to evaporation in natural conditions) as cues that can stimulate faster development and shorter times to metamorphosis of last instar larvae. We test whether this type of phenotypic plasticity is more developed in species from the family Libellulidae, comparing between them, and with Aeshnidae species, which have longer aquatic life phases. We have also established species life cycles timing, rearing individuals from earlier stages using controlled conditions with aquatic parameters measured from their natural environments; then, we also include the effect of average larvae survival without any treatment. As an additional means to escape from drying ponds, we investigate the ability of these dragonflies' larvae to reallocate in inundated pools when their habitat dries out. Using experimental arenas, we test to what extent visual cues, chemical cues, moisture, or terrain slope, can help them to find new suitable habitats.

Development of an assessment tool to understand canine and feline behaviour and personality

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Understanding canine and feline behaviour and personality has important welfare implications. First, behaviour-related problems are major reasons for relinquishment and euthanasia. Second, environmental factors largely affect behaviour and thus, changes in daily lifestyle could improve welfare. Third, breed differences in behaviour and personality suggest genetic contributions that can reveal genes and molecular pathways to advance breeding programs and improve the treatment of problematic behaviour. Fourth, metabolomics studies could unfold metabolic fingerprints for diagnostics of behaviour problems. Finally, pets can serve as spontaneous models for human anxieties. A welfare assessment tool should be quick, reliable and user-friendly. As a part of our large pet behaviour project, we introduce here a novel interactive behaviour and personality survey for dogs and cats. With this tool we aim to collect a large epidemiological data (up to 100k) with a specific focus on the identification of potential behavioural indicators of welfare. Our survey has an automatic reporting system which gives immediate results to participants by generating a behavioural profile. This profile can be compared to other pets in the database. The breed organizations can utilize the breed-wide data for breeding. The current participation rate is > 1100 answers per month. Preliminary analysis of the data suggests breed differences in behaviour and personality, and high prevalence of behavioural problems. We expect to identify various environmental and lifestyle contributors affecting pet welfare.

Directionality of heterospecific sociality in mixed-species flocks of songbirds

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Mixed-species groups are common among fish, birds, and mammals, and are generally thought to provide their members with anti-predator benefits and increased foraging efficiency. The evolutionary explanations for interspecies sociality focus on group-level benefits and species-level interactions, thus neglecting the potential for uneven competitive interactions and individual social preferences to play an important role in shaping mixed-species social structure. Here, we investigate how individual and social factors affect heterospecific mixing in winter foraging flocks of three tit species (*Paridae spp.*). We used a unique experimental setup that allowed us to manipulate foraging associations and to analyse active preference for potential flock members. We analyse individual grouping decisions of more than 400 PIT-tagged birds in different social scenarios. Individuals from all three species predominantly foraged in mixed-species flocks, instead of smaller single-species groups. Social choice data suggest that preferences for heterospecific flock members is predicted by dominance relationships between species, with more dominant species joining more individuals from more subordinate species. We discuss the mechanisms underlying individual social decisions, and their importance for understanding the organisation of heterogeneous groups and evolution of interspecies sociality.

Distortion of perceived value perception in insects

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Making value judgements is critical to choosing between options. Traditional economic theory assumes that the value of an option depends solely on the state the option brings an actor to, and traditional theories of animal decision-making have followed this assumption. However, deviations from economic rationality have repeatedly been described in both human and animal behaviour. Rather than being fixed, value may be relative. We have found that value perception in insects can be distorted in many of the same ways as it is in humans and other vertebrates. Ants (*Lasius niger*) are shown to make value judgements relative to expectations. This demonstrates cognitive, not physiological, incentive contrast effects. We further show that perceived value can be affected by changes in expectation which are not related to option quality. Finally, we show that working harder for a reward makes the reward seem more valuable to foraging ants. Taken together, we show that many apparently irrational behaviours described from behavioural economics, consumer psychology, and vertebrate behaviour are mirrored in the behaviour of insects, raising questions about the evolutionary and neurological origins of these behaviours.

Does sociality affect reproductive timing in a cooperative nursing system?

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We aim to understand whether social interactions prior to breeding determine female reproductive timing in a species that may breed year-round and with alternative female breeding tactics (solitary versus communal nursing). It is well understood that animals "match" the timing of when their resource requirements are highest (e.g. peak lactation) to the timing of when the quantity and quality of resources available also peaks (e.g. food availability). In social animals, the availability of social partners, particularly those that contribute to an individual's fitness by helping to rear young, may be considered an essential resource. Here, we analyzed whether social partner choice among adult females prior to breeding influences the timing of reproduction. Using RFID readers and genetic data from a long-term monitoring project on house mice (*Mus musculus domesticus*), we examined whether characteristics of a female's social group and potential female nursing partners influence the timing of birth and, as a result, a female's lifetime reproductive success.

Ecological and Environmental Drivers of Polydomy in Ants

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Living in groups can improve a species' defence against predation. Polydomy, the state in which ants of a single colony occupy two or more nests, is hypothesised to have some defensive benefits in the face of predation. These benefits are hypothesised to be due to the persistence of the colony after the destruction of a nest (hypothesis 1), improved retaliation (hypothesis 2), the presence of nests to flee to if one nest is destroyed (hypothesis 3). I am investigating whether the proportion of polydomy in a model increases in relation to monodomy (the state in which a single colony occupies a single nest) under different predation regimes. These include varying numbers of ants lost by a predation event, and different preferences on the part of the predator for large or small nests.

Escaping from a predator: run for your life or take another look?

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It is now well understood that prey assess the risk levels associated with an approaching predator to make informative decisions on when to escape. However, little is known about subsequent decision-making process. For filling that knowledge gap, we approached corvids until they escaped, and then measured escape time. When birds were being followed during escape, escape times were the longest, escape trajectory was modified the most during escape, and a larger proportion of individuals changed from terrestrial to aerial escape type compared to observations where birds were not followed. While there were some interspecific differences, the general patterns indicated that birds dynamically assess risk during escape to find an optimal balance between being depredated and spending too much time and energy on escaping.

Evolution of personality in cooperative breeders: boldness, prosociality and social strategies

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In cooperative breeders, subordinates may increase the dominants' reproductive success while reaping only limited direct fitness benefits. Crucially, not all subordinates benefit the breeder to the same extent because of between-individual variation in helping contributions, which may be linked to personality differences. Consequently, breeders should not only attempt to control the number of subordinate individuals joining their group, but should also be sensitive to their individual characteristics and to the current environmental conditions. Empirical studies have revealed variation within species in the caring effort of subordinate joiners and the rate of acceptance by the dominant. However, little is known about the link between personality traits and the social strategy of cooperative breeders. Using an individual-based model, we investigated the co-evolution of the two personality traits boldness and prosociality in populations of cooperative breeders where nest sites are limited. We assume that boldness increases the probability of subordinates to leave an occupied nest (thus looking for an opportunity to become dominant in the next season) and to engage in a fight. Prosociality increases helping effort as a subordinate, increases the probability to accept a submissive floater and decreases the probability to engage in a fight. We systematically varied the information available to the breeder, creating uncertainty about the efforts of others. Our results highlight the importance of taking into account individual variation, showing that the information animals process and the behavioural phenotypes influence group- and population-level phenomena.

Features orienting motor activity of rats after ligation of the common carotid arteries and intranasal application of stem cells

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The goal is to analyze the characteristics of the oriental motor activity of experimental animals after ligation of the common carotid arteries and the intranasal application of stem cells.

The experiments were performed on male Wistar rats (n = 15). The parameters of the tentative-motor activity of rats were assessed in an elevated plus maze using the ANY-Maze software package before ligation and 3 and 7 days after surgery. The general mobility, the motor activity of animals in open and closed sleeves, and the average speed of movement in the maze were recorded.

It was established that in animals on the third day after obturation of the common carotid arteries, the total distance covered (three times) and the distance covered in a closed area (twice), the number of mobility episodes (twice), the number and the duration of acts of verticalization (twice), the total distance covered in a closed area (twice), the average speed of movement in a closed area (twice), the total time of mobility in a closed area (three times), there was no visit to open areas the maze . The data obtained indicate a decrease in the orientational motor activity in laboratory animals after ligation of the common carotid arteries. These changes are saved both in the acute period (the third day) and in the more distant period (the seventh day) after the modeling of ischemic stroke. A different picture was observed in the group of animals that were obtruded by the common carotid arteries and intranasal administration of mesenchymal stem cells (MSC). On the third and on the seventh day after ligation of the common carotid arteries and the intranasal administration of MSCs in this group of animals compared with the initial value, there were no significant differences in the estimated motor activity in the elevated plus maze.

Thus, the introduction in the acute period after occlusion of the common carotid arteries the introduction of mesenchymal stem cells is accompanied by a more rapid recovery of the oriental-motor activity in experimental animals.

Floater strategies in the spotless starling

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Nest-site limitations are an important constraint for hole-nesting birds. We studied a spotless starling (*Sturnus unicolor*) population in which the number of floaters exceeds nest site availability. By providing extra nest-boxes we found that floaters search for a nesting place throughout the breeding season until the very end of the second-broods, even though the chances of raising young successfully at that time are greatly reduced. Female floaters showed evidence of increased follicular development around the population laying peak, showing reproductive synchronization with female nest-owners, and suggesting a brood-parasitism strategy. We further studied movements of floaters by radio-tags and transponder readers, finding that they show limited home areas. This suggests that floaters settle in reduced areas within the colony, possibly as a way of acquiring public information about available nesting sites.

Foraging efficiency of a bat predator in acoustically complex environments

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Prey aggregates tend to attract predators as they become more conspicuous with increase in number. Such grouping however may benefit prey through a predator confusion effect, in which predators fail to efficiently single out a prey from an aggregate. Most studies across different taxa, including fish, reptiles and primates, have examined the confusion effect in the visual context, and not in the auditory context. Gleaning bats such as the lesser false vampire bat, *Megaderma spasma* that rely predominantly on prey-generated sound cues for localization, are appropriate model systems to test for an auditory confusion effect. We first examined if *M. spasma* was attracted to calling prey aggregates in a choice experiment, and then tested if the bat showed difficulty in localizing prey in an aggregate, using different experimental tasks. Habitat complexity via leaf clutter was also included to assess how vegetation might affect the bat's foraging efficiency. Preliminary results show that bats approached calling prey aggregates more often than prey calling alone indicating predator's preference to aggregate prey. In the experimental tasks, the bats took the least time to localize a lone calling prey. Increasing auditory complexity with calling aggregates, increased the average time taken to complete the foraging tasks suggesting an auditory confusion effect. These results also suggest a preference-complexity trade-off in bats when attacking calling prey aggregates.

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Genetic variation in plastic response to predation and its cost to reproduction

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Several studies have shown that genotypes differ in their phenotypic expression in different environment (G:E). This means that there is among-genotype variation in the level of plasticity, allowing for selection on plasticity. It also means that no individual is fully plastic, indicating that there are costs to plasticity. However, there is a lack of empirical data showing any cost of developing a plastic machinery. Moreover, the few studies that have tested for cost have tested the cost for differential expression of a trait rather than the cost of different investment in the plastic machinery. Here, I used multiple isogenic lines of *Gryllus sigullatus* to investigate the genetic variance in plasticity for response to predators and how level of plasticity affected reproductive output. Crickets from each line were run through an open field behavioral assay with and without predator cues present, where change in activity level between the two trials was used as a measurement of plasticity. Crickets with higher levels of plasticity were predicted to have lower fitness. Understanding the costs of plasticity can help us predict a population's ability to adapt to a changing environment.

Horses are able to recognize a familiar human face in a photograph

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Facial recognition has been widely studied in primates, and also recently in other species such as dogs. In this experiment, we investigated whether horses could recognize the face of humans they were familiar with from their photograph. Eleven female horses were trained to recognize the faces of four people (recurrent faces) from novel faces displayed on a screen. They were rewarded when they touch the recurrent faces but never when they touched a novel face. These four people were unknown to the horses in real life, but their faces had become familiar during the training sessions. When horses choose the recurrent faces for more than 75% of the trials over two consecutive days, we tested whether they could spontaneously recognize the photograph of the face of their current handler. Horses recognized her in 0.71+0.18% of the trials without pre-training (comparison with chance level: t=3.65; p<0.004). The final test involved recognizing the photograph of a person the horses had not seen for 6 months. They recognized her in 0.77+-0.14% of the trials (comparison with chance level: t=6.24; p<0.0001). During a control trial, we also checked that animals did not use cues other than familiarities in real life when responding correctly. Overall, these results show that horses have advanced facial recognition abilities, and are able to recognize a face in a photograph, even when the face is not of their species. Moreover, they demonstrated a long term memory of human faces.

How do seabirds prospect before establishing a new reproductive habitat?

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Territorial animals are permanently analyzing the neighbouring areas, looking for areas with high density of food, quiet areas to rest or potential reproductive habitats. From these, the latter becomes extremely important in scenarios where the current reproductive habitat is in risk due to internal or external perturbations.

We study this problem for the case of a seabirds colony in La Banya, Delta de l'Ebre. There, multiple factors as the intrusion of new predators or the modification of the territory have perturbed the colony. We analyze different features of the trajectories and model them to study which relevant magnitudes give us insights about the prospection of new reproductive habitats.

Interactions between individual variation in behaviour and group performances in House Sparrow

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Social living strongly influences selection on individuals' traits, which in turn evolve to shape the social environment. Individuals in a group vary, and this variation creates social groups that differ from one another with respect to their collective performance and the distribution of resources and fitness of their members. Using captive house sparrows (*Passer domesticus*) we performed a series of experiments investigating the feedback between individual and group traits in situations particularly crucial to survival and fitness. i) Using a novel experimental design we investigated how two groups with different characteristics would exploit limited resources in a novel environment, i.e. if the amount of resources each individual consumed was going to depend on the groups' attributes. We discovered that belonging to the group of the first individual to exploit the resource was critical in determining the amount of resource consumed. ii) We tested house sparrow dyads during an open-field test and during a simulated predator attack. We discovered that individuals assuming the position of leaders and producers during the open-field test switched to being followers during the attack.

Intraspecific movement specialisations and their implications for personality and movement ecology research

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Many animal personality traits have implicit movement-based definitions. It has therefore been proposed that movement studies could benefit by acknowledging and studying consistent individual differences, and, conversely, animal personality studies could adopt a more quantitative representation of movement patterns. We used high-resolution image-tracking to repeatedly record the movements of individual free-swimming three-spined stickleback fish (*Gasterosteus aculeatus*) in a simple environment that had either two, three or five shelters present. For each fish in each trial we investigate and link three standard movement parameters adopted from random walk theory and two broad movement descriptors used in animal personality studies. We found that all of our fish movement measures were highly consistent within individuals, but highly variable between individuals, representing intraspecific movement specialisations. Environmental differences did not explain variability in our sample. Fish movement parameters predicted personality measures. Movement parameters can therefore be viewed as "micro-personalities", representing the building blocks (behavioural mechanisms) that give rise to personality differences. For personality traits that have implicit movement-based definitions this finding suggests that standard movement parameters represent a short-term, easy assay of personality differences. The inter-individual consistency we observed in movement parameters and their links to personality have implications for understanding and modelling how individual movements scale to group-level processes, and future works should attempt to include individual heterogeneity in movement models.

Jackdaws learn socially about dangerous people

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Social information can help animals to learn about novel threats without direct encounters with predators. If predators vary in their level of threat, discriminating between individual predators may be beneficial. Humans often vary in their response to wildlife: discriminating between dangerous and non-threatening people may allow individuals to avoid danger while exploiting anthropogenic resources. Corvids are abundant in urban and agricultural habitats, are persecuted as pests, and show remarkable discrimination and learning abilities during encounters with people. Here, we investigated whether wild jackdaws (*Corvus monedula*) use social cues to inform their response to unfamiliar humans. Jackdaws were presented with an unfamiliar person alongside playbacks of conspecific alarm calls or contact calls. Birds presented with alarm calls exhibited a stronger fear response in subsequent trials than birds presented with contact calls. This suggests that jackdaws use social cues to learn about individual predators that vary in their level of threat, and provides a mechanism by which information about dangerous people may be transmitted through populations in the wild.

Large-billed crow fledglings learn a novel foraging technique from parents inside their natal territories

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An isolated population of large-billed crows (*Corvus macrorhynchos*) on Shickotan Island is characterized by several foraging traditions which have been persisting for at least the last five decades. We introduced into the population a novel foraging technique. As a result, we observed how it has been socially transmitted from parent crows to their youngsters while they were so young as to stay inside their natal territories.

The experiments were carried out during the large-billed crows' breeding period, when each crow's breeding pair occupies and protects their nesting territory. Three breeding pairs of crows have been taught to open (remove a lid) a red one of four boxes differing in color while their chicks were in the nests. The fledglings began to follow their parents through their natal territories as old as 60-65 days and from then they could observe what parent crows were doing at the experimental tables. At the age of 91-92 days old all the youngsters first flied up to the experimental tables without parents. They all removed the lids from the boxes on the first try. However, only one of them opened the red box. Like their parents they had learned to choose the correct box after 7-13 trials.

Male trajectory as a reproductive strategy in the sexually cannibalistic spider *Nephila clavipes*

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Sexual cannibalism is the ultimate sexual conflict in a mating system. It is a rare phenomenon in nature, but common in some spider families. The fitness consequences for male spiders depends on when cannibalism occurs, with pre-copulatory cannibalism being the most costly since males would forfeit reproduction. Due to this sexual conflict, it is predicted that males have evolved traits to avoid pre-mating cannibalism and ensure reproductive success. A recent study showed that males settle near females in spatial hierarchies that appear to balance the benefits of proximity to the female with the costs of being so close as to risk death. Yet, this study only provides an end-point estimate of the behaviour that males show, and information on how males move, compete, and settle disputes is missing. We therefore lack a clear picture of how selection may have operated to shape this behavioural trait and how the interactions between males and females, as well as between males (e.g. with respect to prior residence effects), influence the success of reproductive strategies. Therefore, in this project I will employ machine-vision based automated tracking to quantitatively describe and compare males' trajectories as they approach a female and simultaneously use laser vibrometry to measure vibrations emitted by the female and male as a direct metric of social interaction. My study will provide a greater understanding of the interactions that occur between sexes in a dangerous and competitive mating system using *Nephila clavipes* spiders.

Meaning, cost and convention: how signaling costs can shape the meaning of signals.

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Conventions determine the meanings of words in human language. Do conventional meanings exist in non-human communication? If so, game theoretical tools would give us a powerful tool to analyze meaning. Yet, early behavioral ecologists (e.g Zahavi & Maynard Smith) rejected the idea of conventionality in non-human communication because they argued that conflicts of interest nearly always exist between non-human signallers and receivers. It is difficult to fully understand this argument because these early behavioral ecologists had a fairly primitive understanding of conventions. We re-consider their argument using a modern definition of signalling conventions, and doing so we develop a more nuanced version of the Zahavi-Maynard Smith argument. We consider a situation with two possible signal systems, such as long tail means good or short tail means good. In the absence of conflicts of interest, both are stable equilibria of the signalling game; so the meaning of tail length is, by definition, conventional. We show that introducing conflicts of interest causes both signalling systems to destabilize, so we lose not only signalling conventions, but all signalling. Additionally, earlier investigators have famously shown that 'honesty' can persist in the presence of conflicts of interest when dishonest signallers pay marginally greater costs. We show that when two signalling equilibria are possible, any sufficiently large cost differential can stabilize signalling, but the direction of the cost difference determines which signalling system persists.

Meta-analytic insights into state-dependent effects on risk taking behaviour

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Different behavioural responses expose individuals to differing levels of risk, particularly in contexts involving novelty and predation. Contrasting hypotheses suggest that the physical condition of individuals influences their readiness to take risks, based on the costs and benefits of risk-taking behaviours. For example, the asset protection principle proposes that higher condition animals have more to lose in terms of future reproductive potential, and thus, should be more risk averse. In contrast, the state-dependent safety hypothesis suggests that high condition individuals may be more likely to survive risky situations, so may be willing to make riskier choices. In this pre-registered study, we quantify the links between individual condition and risk-taking across species. First, we systematically review studies that manipulate individuals' nutritional-/energetic-state across ontogeny, and subsequently measure risk-taking behaviour across a range of experimental contexts (n = 5453 abstracts, 639 full-texts screened). We then use a phylogenetic meta-analyses to test whether the condition-risk relationship (1) is context-dependent (e.g. between contexts involving predation, novelty, risk-sensitive foraging etc.); (2) is sex-dependent; and/or (3) varies when the condition manipulation is applied in juvenile or adult life stages. This meta-analysis provides insights into the roles of state-dependency and developmental plasticity in driving behavioural variation.

Navigation capacities of the kinkajou (*Potos flavus*)

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The emerging movement ecology paradigm proposes that navigation capacity is one of four fundamental properties that drive and define animal movement (Nathan et al., 2008). The primary goal of the research I will present at the ASAB 2019 summer conference is to determine whether and how kinkajous (*Potos flavus*) use memory to navigate efficiently between important feeding locations. The presence of high-use routes in kinkajou movement (Crofoot, unpublished data) suggests they may use episodic-like memory to anticipate the locations of fruiting trees and move directly to them. Because kinkajous are arboreal and frugivorous but minimally social, knowledge of their navigation capacities will help elucidate the roles of diet (Milton, 1981) and sociality (Reader & Laland, 2002) in the evolution of elaborated cognitive systems. I will travel to Barro Colorado Island, Panama from May through mid-August, equip six kinkajous with GPS collars, and set up an array of feeding stations within their home ranges. I will actively track and observe kinkajous for four-hour periods throughout the study. By identifying the impact on kinkajou movement and behavior of experimental changes in the availability of food at each station, I will test whether their use of routes can be sufficiently explained by alternative hypotheses: the structural constraints of the canopy, the ability to detect perceptual cues of food from long distances, and/or the establishment of scent-marked trails. At ASAB I will present initial findings from changes in movement characteristics over time and a multinomial logistic regression of feeding station choices.

Nature calls: does ecology explain abnormal behaviour and breeding problems in captive psittacines?

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Psittaciformes are popular pets and aviculture species. However, in captivity they show species variation in susceptibility to problems such as stereotypic behaviours and poor breeding. For example, feather-damaging behaviour (e.g., self-plucking) is prevalent in African grey parrots, *Psittacus erithacus*, but rare in Senegal parrots, *Poicephalus senegalus*; while monk parakeets, *Myiopsitta monachus*, breed readily, yet blue-throated macaws, *Ara glaucogularis*, do not. Comparing species using phylogenetic comparative methods can unpick fundamental bases of problems; thereby identifying species pre-disposed to be good pets and informing captive breeding management. We investigated relationships between species-typical biological traits proposed to influence welfare, and three welfare-sensitive captive outcomes: feather-damaging behaviour (FDB), other stereotypic behaviours (SB), and hatch rates (HR). Prevalences of FDB and SBs for 53 species (~1,380 birds) were gleaned by surveying pet parrot owners. Captive HRs (chicks hatched/breeding pair/p.a.) for 122 species came from Allen and Johnson (1990 Psittacine Captive Breeding Survey). Using phylogenetic generalised least squares regressions, we assessed effects of the following aspects of species-typical biology on welfare: sociality (maximum group size, communal roosting); foraging effort; ecological flexibility (diet and habitat breadth); intelligence (innovation rate, relative brain volume); and IUCN conservation status. Effortful foraging modes ($T3, 34=-2.25, P=0.03, \lambda=0.88$) predicted FDB. Relatively large brain sizes predicted SBs (whole body: $T3, 36=2.84, P=0.01, \lambda=0.29$; oral: $T3, 37=3.62, P=<0.01, \lambda=0$). More threatened species had lower captive HR ($T5, 75=-2.18, P=0.03, \lambda=0.39$). These traits can thus be considered species-level risk factors for poor parrot welfare, providing an evidence-based platform to inspire ways of tackling these problems.

Population- and age-specific migration landscape of the European honey buzzard

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Birds of prey are morphologically adapted to energy-efficient soaring flight, which allows them to use upward moving air currents to gain height and consequently cover long distances while expending little energy. This leads to the trade-off of poor powered flight and causes a general avoidance of flying over water-bodies where updrafts are weak or absent. Adult European honey buzzards *Pernis apivorus* breeding in the Netherlands show this pattern very well on autumn migration to sub-Saharan Africa, as they circumvent the Mediterranean Sea by flying through the strait of Gibraltar. Juvenile and adult honey buzzards from Finland, however, show much more spatial flexibility on autumn migration and in crossing the Mediterranean Sea. Juveniles are especially more likely to undertake long flights over the Sea. We used GPS-tracking data to investigate the variations in migration ecology between the two populations (the Netherlands and Finland) and between the two age groups of the Finnish population. We analyzed the data at the intercontinental scale along the complete migration routes and at the regional scale over the Mediterranean Sea. We found that at the large scale, the response of each group to wind conditions shapes its migration landscape. At the small scale, juveniles benefit from stronger updraft over the sea due to later migration onset than adults, hence their ability to perform longer water-crossing. This study demonstrates the importance of remote-tracking data sharing in advancing our understanding of intraspecific differences in migration ecology and behavior.

Predation as a personality trait in a wild fish population

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Consistent behavioural differences between individuals (i.e. personality variation) can influence a range of ecological and evolutionary processes. Variation between individual predators in commonly measured animal personality traits, such as boldness and activity, has previously been linked to the risk these individuals pose to prey. By studying wild piscivorous fish (pike cichlids, *Crenicichla frenata*) in their natural environment using experimental presentations of prey and control stimuli, we present the first evidence for a 'predator personality trait' that is independent of the correlation between predator boldness (and/or neophobia) and encounter rates with prey. Individual predators differed consistently in the amount of time spent near a stimulus prey shoal, but there was no evidence of consistent differences between individual predators in the control (the same apparatus lacking prey). Crucially, variation in the response to prey could not be explained by the response of the same individuals towards the control, suggesting that the differences between individuals in responding to prey could not be attributed to individual traits or environmental factors that determine encounter rates. By revealing a novel trait which differs consistently between individual predators, these results suggest that the risk posed by individual predators cannot be adequately predicted from typical axes of personality variation, and highlights the importance of inter-individual variation in traits with direct ecological relevance.

Prospecting behaviour in wild jackdaws

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Prospecting behaviour serves as a tool for gathering information about potential future breeding sites for the prospector. It has been observed in not only jackdaws but other birds such as black-legged kittiwakes, cormorants and house sparrows. When prospecting, birds are looking for cues and public information such as the provisioning rate by the parents, egg number in a nest or parasite load. Birds use this information to decide on a higher quality breeding site which can be crucial to their success. It is thought that younger birds and failed breeders are more likely to exhibit this behaviour as they stand to gain more by using their time to prospect. However, little is known about prospecting in wild birds. Interestingly, jackdaws have been seen to prospect not only before and during the breeding season, but immediately after it as well. With this in mind, I hope to answer three main questions with my masters by research project. Firstly, why are jackdaws prospecting immediately after the breeding season? Secondly, who is exhibiting this behaviour? Is it an age/ sex biased trait? And thirdly, what do these individuals stand to gain? To answer these questions, I am working with the Cornish Jackdaw Project, which has been running since 2013. Over 2100 birds have been ringed with unique colour ring combinations. Each combination includes an RFID (radio frequency identification) tag which will allow identification of individual birds at each of the 80 nest boxes used by the project.

Proteomic stress responses vary with personality in the beadlet sea anemone (*Actinia equina*)

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Within species, a key determinant of the ability to cope with anthropogenic environmental change is the magnitude of phenotypic variation within a population. An important aspect of this is repeatable behavioural differences among individuals, termed personality. However, few studies have investigated the molecular mechanisms underpinning personality variation and how these could relate to differing individual responses to environmental perturbation. Intertidal species are particularly vulnerable to climatic shifts as they already spend much of their time living close to their environmental limits. Here, we aimed to assess variation in the proteomes of bold and shy beadlet anemones under different stressors. We allocated anemones of each personality type to four treatments, exposing individuals to an acute stimulus, chronic high temperatures, both, or no stressors, and assessed their proteomic expression. In the 'no-stressor' treatment, PCA analysis showed clear differences between the proteomes of personality types. After an acute stimulus, shy individuals up-regulated proteins involved in mediating stress responses more than bold individuals. Under chronic temperature stress, bolder individuals exhibited a clearer change than their shy counterparts, up-regulating structural proteins, likely to mitigate for the loss of structural integrity experienced at thermal extremes. Our research suggests that personality is intrinsically linked to proteomic expression in this species. It further indicates that different personality types may be subject to trade-offs in their susceptibility to different types of stress. Regular exposure to high temperatures, of the type which might be brought about by climate change, may impose greater selective pressure on some personality types than others.

Pushing the switch: lionfish show adaptive foraging behaviour under multiple resources scenarios

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Biodiversity is declining on a global scale, and the spread of invasive alien species (IAS) is one major driver. Effective means of assessing the consequences of IAS on native prey population stability remains a vital goal to invasion ecology. Here we use two classic ecological concepts, functional responses and prey switching, to assess the impacts of the Red lionfish (*Pterois volitans*), a notorious invader that has spread over the Western Atlantic and Caribbean, and most recently the Mediterranean Sea. For three prey species (*Palaemon varians*, *Gammarus oceanicus* and *Artemia salina*), when present individually, destabilising Type II functional response (FR) curves were found, owing to high resource acquisition at low densities. Maximum feeding rates were highest towards *A. salina*, whilst *P. varians* and *G. oceanicus* were more similar. However, when multiple prey types were presented simultaneously, the proportion of specific prey items consumed was reliant on the proportion available in the environment, indicative of prey switching behaviour by lionfish. Giving the central role of switching in stabilising predator-prey dynamics, the displayed switching propensity by lionfish may remediate their in-field impacts, by offering low density prey refuge in biodiverse communities via frequency-dependent predation. In turn, this may drive stabilising Type III FRs empirically upon prey, in contrast to consumptive traits exhibited in single-prey systems. We thus highlight opportunities to further impact prediction in invasion science using FRs and prey switching and argue for the explicit incorporation of such methodologies into the assessment and prediction of established, emerging and future invasive alien species.

Quantifying echo detection rates in the sonar cocktail party nightmare

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Active sensing animals detect their surroundings by emitting probes of energy and analysing how the environment has altered the probe's spectrotemporal characteristics. However, active sensing animals like echolocating bats can be 'jammed' by the probes of conspecifics. Echolocating bats detect their surroundings by emitting loud ultrasonic calls and listening for the returning echoes that are reflected off objects around them. In the presence of loud sounds, such as the calls of other bats, they are unable to detect their own echoes. This is known as the cocktail party nightmare. Despite this problem, many bats fly and echolocate in groups and roost socially.

We present for the first time a biologically driven theoretical framework to estimate the sensory detriment a bat may experience in the cocktail party nightmare. By incorporating known psychoacoustic and acoustic phenomena of bat echolocation, we quantify the echo detection rate in the presence of loud conspecific calls. We show that a bat detects the majority of echoes within two emitted calls, all echoes once within six emitted calls, and all echoes twice within eight emitted calls. These results indicate that bats obtain frequent but partial 'glimpses' of their surroundings even under apparently difficult sensory conditions. Our results show that the sonar cocktail party may be more of a 'challenge' than a nightmare.

Quantifying the acoustic parameters of overlapping echolocation calls in free-flying horseshoe bat aggregations

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Many animals are social, often moving, interacting and vocalizing in dense aggregations. Understanding their behavior and vocalizations pose a challenge, particularly if recorded calls overlap in time and frequency. Like many echolocating bats, horseshoe bats fly and echolocate in dense groups. They emit calls at high duty cycle and with a constant frequency (CF) part sandwiched between frequency-modulated (FM) parts. This call type poses a particular challenge for systematically analyzing multi-bat situations, as call recordings suffer from spectrotemporal overlap and Doppler shifts. Our study fills the gap in understanding how horseshoe bats vary their echolocation call parameters when flying alone and together with conspecific or heterospecific bats. We predict that bats will alter their call parameters in multi-bat contexts by increasing CF and FM bandwidths to avoid spectral overlap. We recorded synchronized video and audio data of horseshoe bats flying in a natural cave habitat, and developed a method to quantify their call parameters in single-bat and multi-bat situations. We first obtained independent estimates of the number of simultaneously flying bats based on the video data, peaks in the call spectra, and visual screening of call spectrograms. We then automatically analyzed the call recordings in regular time intervals matched to the bat counts to quantify average call parameters such as CF peak frequencies, CF and FM bandwidths and terminal frequencies. Our study presents a novel approach for studying echolocation in groups of CF bats.

Response towards heterospecific non-alarm signals in social passerines

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Animals with overlapping habitats are more likely to have common predators and a multitude of studies spanning different model organisms have shown eavesdropping of alarm signals among heterospecifics. This is unsurprising as alarm calls provide direct information about the presence of a predator and recognition of these calls from conspecifics and heterospecific may be under strong selection. However, not many studies have looked at the extent of eavesdropping on non-alarm signals, especially in closely related sympatric species. We examined interspecies communication using contact call (a type of call use to communicate between group member over long distance) between two sympatric congeneric social passerines, Jungle Babblers (*Turdoides striata*) and Large Grey Babbler (*Turdoides malcolmi*). We exposed wild population of both species with three playback stimuli; congeneric sympatric species as experimental stimulus, conspecific call as positive control and call of sympatric non-congeneric species as negative control. Our results show that significant response is shown by both species towards experimental stimuli as well as to conspecific calls. On the other hand no response is shown towards the call of non-congeneric species. We also demonstrate that the nature of response towards conspecific call and to that of the heterospecific is dissimilar. From this study we show that there is heterospecific signal recognition of non-alarm signal between two congeneric babbler species which could, through future studies, provide interesting insights into the information content of signals and also on the evolution of signalling systems in these social birds.

Responses of nesting Arctic terns (*Sterna paradisaea*) to disturbance by human

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Nesting birds often respond to human disturbance as to a predatory act. In the case of the high Arctic, the disturbance of incubating birds may be fatal if they do not return to the nest in time. In addition, it is assumed that birds in the high Arctic are not shy and do not respond to human presence fearfully. We tested how quickly the Arctic terns nesting in two colonies in Svalbard return to the nest after human disturbance. One colony was situated inside a town where the terns were regularly harassed by human presence. The second colony was on a glacial foreland where breeding terns have limited experience with humans. We found that terns without frequent experience with humans returned to the nest about five minutes after disturbance, while urban terns habituated to the human presence returned within a few tens of seconds. The urban terns in this way likely solve the risk of spending too much time off the nest, which could lead under the conditions of the high Arctic to stopping embryogenesis. Terns from a remote colony do not show lower hatching success of their eggs than the urban ones, however, incubation and the whole population of terns could be threatened when there is more frequent disturbance by researchers or tourists.

Seasonal adjustment of heart rate and body core temperature in free-living greylag geese

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Animals adaptively regulate their metabolic rate and hence energy expenditure over the annual cycle to cope with energetic challenges. We studied energy management in greylag geese. We describe profound seasonal changes of heart rate (fH) and body temperature (Tb), with distinct peaks in summer and troughs during winter. Next to seasonal variation, we also found significant daily modulation of fH and Tb. Daily means of Tb together with those of air temperature and day length were the most important predictors of daily mean fH, which was further modulated by precipitation, reproductive state, and, to a minor degree, social rank. Peaks of fH and Tb occurred earlier in incubating females compared to males. Leading goslings increased daily mean fH. Our results suggest that in greylag geese, pronounced changes of fH over the year are caused by photoperiod-induced changes of endogenous heat production. Similar to large non-hibernating mammals, tolerance of lower Tb during winter seems the major factor permitting this. On top of these major seasonal changes, fH and Tb are elevated in incubating females.

Sex Pheromone Makes Sense (in Moth)

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Sex pheromone have primarily evolve for the sake of reproduction, thus a high specificity is required to avoid mating with a wrong species.

Typically, sex pheromones are specific blend of a few components, but difference in both the combination and their ratio of the pheromone components provides a range of possible species specific pheromones. The cost of mating with the wrong species is expected to promote a direct selection to reduce sex pheromone's variation among females within a species. Nevertheless, an existing variation was found in the ratio of the pheromone components in moth species that had been tested.

This research aimed at testing whether sex pheromone blends provide information regarding the female's quality. We used the pink bollworm (*Pectinophora gossypiella*) as our animal model. From the laboratory colony, we selected females representing different phenotypic conditions as size and age. We removed the female glands at calling time and analyzed the pheromone amount and ratio. We found significant differences in the pheromone ratio of components but not in their amounts. We than tested if male moths can distinguish between females' quality through their pheromone characteristics. In a wind tunnel assay we introduced each male to two groups of females that differ in their phenotypic conditions and recorded their choice of mate. Indeed, males showed a significant preference for females in better conditions. These findings strongly suggest that female sex pheromones provide information regarding the quality of the female as a mate.

Size as the Attributes Used by Birds for Predator Recognition

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It has been repeatedly proven that birds use simple morphological characteristics of raptors for predator recognition. These traits include the curved beak, hooked claws and supraorbital ridges common to all birds of prey or an undulated belly and yellow eyes typical for most members of the genus Accipiter. However, those so-called sign stimuli never occur in isolation. Another characteristic that may affect predator recognition is body size, which can be a determining factor in the size of the preferred prey. During winter feeder experiment, we tested the effect of the body size and overall coloration of dummies mimicking a Eurasian sparrowhawk (*Accipiter nisus*) on its recognition as a threat by songbirds. All dummies were provided with typical raptors sign stimuli (curved beak, talons) as well as with one specific characteristic of the genus Accipiter (yellow eyes). Two dummy sizes (a real-life size of a sparrowhawk and a size reduced to that of a great tit) and four types of coloration (sparrowhawk/pigeon/European robin/great tit) were used for the experiment. A dummy mimicking a pigeon (normal pigeon size) was used as a control.

Birds approaching the feeder were less afraid of all downsized dummies than of any dummy in the size of a sparrowhawk, including the control pigeon dummy. They did not perceive them as a threat, regardless of any potential sign stimuli. Of the dummies in the size of a sparrowhawk but with modified coloration, only the dummy with the coloration of the European robin (a small songbird, only rarely present at the feeder) caused greater fear than the control pigeon dummy. The effect of coloration we observed is concordant with previous cage experiments. However, the effect of the size is quite different. In the cage experiment, tits reacted to the downsized and life-sized dummies in the same way. The most likely reason lies in the different size perception in a cage and feeder experiments.

Stereotypic pacing and faecal corticosterone metabolites as non-invasive indicators of stress in rehabilitating green turtles (*Chelonia mydas*)

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Species of marine turtles are experiencing large population declines, and there are many conservation projects worldwide which aim to rehabilitate and release sick or injured turtles. Whilst in captivity, turtles will inevitably experience unnatural conditions and large amounts of human interaction, both of which may cause stress to the animal. Green turtles (*Chelonia mydas*) are believed to travel 5-10km per day, and animals with a similarly large range area have been shown to develop stereotypic behaviours such as pacing whilst held in a captive environment. However, there is both limited research of stress in marine turtles, and a lack of subjective method to quantify the locomotion of pacing. Here we trialled a new method of incorporating transition probability to identify repeated pathways. The results of which were correlated against a biological marker of stress in the form of faecal corticosterone metabolites (FCM), as a non-invasive alternative to the classical use of blood sampling which can itself induce stress.

The aim of the study is to develop our ability to identify stress in real-time and non-invasively, in order to improve recognition and influence best practice for the welfare of captive marine turtles. This may reduce any chronic effects of stress such as immunosuppression, inappetence and impaired reproductive function, which could subsequently support the success of rehabilitation efforts and other conservation interventions. It is hoped the successful application of the methods will advocate their use within future research and captive care of green turtles.

Stereotypy found in budgerigar song using ideas from linguistics and human speech

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Studying the communication systems of non-human animals is difficult because we are missing knowledge about both meaning (top-down approach) and fundamental units (bottom-up approach). Most efforts to study the units comprising non-human animal vocalizations have focused on elements of sound separated by silence. This has been successful in some species, where elements separated by silence are easily identifiable because of their stereotyped nature. However, in other species' song, such as budgerigar warble, elements rarely repeat. Budgerigar warble contains long units separated by silence that have low degrees of stereotypy. This has parallels to human speech where often multi-word utterances are produced without any intervening silences, and many of these utterances never repeat. Instead of silence, rapid changes in the signal structure indicate that a unit type has changed (e.g., transition from 'p' to 'o'). Here we show that breaking up an acoustic signal based on rapid transitions may be useful in identifying basic units in vocal communication in budgerigars as well. This discovery has led us to observe other structural parallels to human vocalizations. These findings suggest that budgerigars may be an ideal model species for human language because we can begin to tease apart what aspects of human language are cultural phenomena and what aspects are the result of widely-shared sound production biases. In addition, by using what we know about the species that has been most studied in terms of vocal behavior, namely the human, we can potentially crack the code of unstereotyped non-human vocalizations.

The ability of breeding titmice to recognize a predator and nest parasite.

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The common cuckoo (*Cuculus canorus*) is a common nest parasite of small passerines. Its visual appearance importantly resembles the Eurasian sparrowhawk (*Accipiter nisus*), and it is supposed that this similarity protects cuckoo from attacks of adult host birds. Previous studies showed that titmice (namely Great tit - Parus major), which are usually not parasitized by cuckoo as they breed in tree hollow, commonly attack cuckoos when encountered. We decided to test the theory that titmice mistake the cuckoo for the sparrowhawk and therefore try to chase it away. We presented stuffed dummies of cuckoo and sparrowhawk at the nest boxes, where titmice (great and blue tits - *Cyanistes caeruleus*) are laying their eggs. As a control we presented also the dummy of great woodpecker (*Dendrocopos major*) a common nest predator preying on eggs and chicks of titmice, rufous form of cuckoo, which does not resemble sparrowhawk, but represents equal danger as the grey form and a harmless feral pigeon (*Columba livia. f. domestica*). We showed that responses of titmice to sparrowhawk and cuckoo importantly differ. Titmice usually approached the sparrowhawk and mobbed it. On the contrary, titmice were further than 10 meters from the nest, when there was a dummy of cuckoo (both forms) as well as woodpecker, which correspond to low interest in the dummy. We can conclude that titmice are able to recognize cuckoo from sparrowhawk and the birds that decide to attack the cuckoo do this intentionally.

An agent-based model to simulate the formation of self-assembled structures in army ants

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Army ants of the genus *Eciton* join their bodies together to create self-assembled structures that are responsive to traffic and environmental conditions, and function as a kind of living infrastructure for the colony. Here I present an individual-based model that simulates the formation and growth of two kinds of structures, bridges and flanges. These two structure types form under different conditions in nature, and the model reproduces both cases, as the same underlying set of individual-level rules results in different structures depending on the geometry of the environment. In the model, ants interact with the environment by detecting the surface ahead (either a void, solid surface, or an ant structure), and the concentration of pheromone deposited by other ants. Mobile ants interact with others encountered within a sensory zone representing the antennae and legs, and ants within a structure can sense contacts from other ants passing over the structure. The model takes three inputs corresponding to variables measured from experimental data: the overall rate of traffic flow; the proportion of ants carrying prey; and the proportion of bidirectional traffic. With these inputs, I test the model under different environmental conditions corresponding to two different experimental setups, for bridges and flanges. Within certain ranges of behavioral parameter values, structures of similar size, geometry, and growth dynamics emerge for both bridges and flanges when compared to experimental data given the same traffic conditions, and I show which parameters appear to be important for the formation of stable and responsive structures.

The role of memory in foraging efficiency under uncertainty: ant trajectories and beyond

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Exploring how animals orchestrate their (individual or collective) foraging excursions in time and space when facing unknown environments represents a way to test their cognitive capacities under uncertainty. However, the corresponding (trajectory, space-use, etc) dynamics can be often complex to analyze and understand. In this contribution we will present some results obtained by (i) tracking ant (*Aphaenogaster senilis*) trajectories in arenas with different topological properties, so involving different levels of organization, and (ii) using methods and ideas borrowed from statistical physics to analyze the patterns observed. In particular, we want to understand how individual and/or collective 'memory' could be a driving force for the generation of these patterns. Moreover, we will discuss these results in connection to other experiments we are carrying out in which we study the navigation and exploration abilities of higher organisms (e.g. humans). As a whole, we will try to show that a combination of multispecies experiments and a mechanistic (random-walk) treatment could represent a promising approach to understand the role that cognitive memory/prospection play in animal response under these and similar scenarios.

Think before you speak! Using thermal imaging for detecting intention and preparation to vocalize.

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Acoustic signals play a role in numerous aspects of animals' lives and are extensively studied across multiple taxa on structural, combinatorial and functional levels. However the signal production phase is the terminal stage of a signaling event. Preceding the audible vocalization, there is stimulus processing, decision making and preparation for sound production. These often non-detectable stages are integral to the dynamics of signaling, as any of them might result in a vocalization not being produced. Monitoring the stages preceding vocal production will allow us to answer questions related to signal planning and the dynamics of signaling motivation.

One way to assess the intention to vocalize is by looking at the preparation of articulators. In human conversations the next speaker identity is predicted by changes in breathing, with participants motivated to speak next taking deeper breaths. Additionally deeper inhales were associated with longer sub-sequential speaking, indicating an early planning of a conversational turn.

We examine if similar phenomena exist in vocal interactions of wild meerkats (*Suricata suricatta*). For working with free ranging animals we are developing a noninvasive procedure, using thermal imaging for breathing depth and rate detection, as expiration and inspiration are associated with surface temperature changes in the animals' nasal region. Synchronization of breathing curves with audio recordings can expose stereotypic breathing patterns, preceding vocalization events. Detection of preparation for calling might indicate to what extent animals plan the timing and duration of their vocal bouts and potentially show if external stimuli can negatively affect calling motivation, suppressing the planned vocalization.

Using deep learning to study collective behavior

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Deep learning is a powerful way to learn from data. We have used it to develope a tracking system for up to 100 animals and to model behaviour. For behaviour, we have found that modular deep nets allow for both a high predictive power and for insight. I will also discuss applications for behavioural classification and for finding interaction rules consistent with collective patterns using inverse Reinforcement Learning.

Vocal mimicry in budgerigars does not depend on octave equivalence

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The behaviour of vocal mimicry - copying of allospecific vocalizations or sounds from the environment - is rare among animals, and its preconditions remain unclear. In this study we hypothesized that vocal mimicry may be supported by perception of octave equivalence. Octave equivalence is the perceived similarity of notes separated by an octave, that is, a doubling in frequency. Humans use octave equivalence perception in vocal learning as it enables young children to approximate adult vocalizations where the pitch lies outside their vocal range. Specifically, children shift the fundamental frequency of the adult vocalization upwards by an octave when reproducing it. This behaviour is rooted in physics: The octave is also the first harmonic of any tonal sound including the human voice. We hypothesized that non-human animals may use octave equivalence in a similar way when vocally mimicking sounds outside their vocal range. In this study, we tested whether a vocal mimicking species, the budgerigar (*Melopsittacus undulatus*), perceives octave equivalence. Budgerigars were trained on and tested for octave equivalence in a go/no-go operant task. In contrast to humans tested using the same paradigm, budgerigars showed no evidence of octave equivalence perception. This result suggests that vocal mimicry does not necessarily depend on perception of octave equivalence. However, the responses of the budgerigars were highly similar to those of black-capped chickadees in a previous study using the same paradigm. This suggests that there may be a common tone grouping mechanism among avian species that is different than that of humans.

Weaver ant-inspired rules for self-assembly and swarm robotics

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Weaver ants (*Oecophylla smaragdina*) dominate their ecosystem by combining the best aspects of small individual size with coordinated collective power. They are one of only a few ant genera that can join their bodies together to create self-assemblages that perform vital functions for the colony. These structures include rope ladders that extend their reach, bridges that act as highways for ant traffic, and pulling chains to roll leaves together for nests. Ant self-assemblages are formed using simple agents and interaction rules, yet the emergent structures are sophisticated, forming when and where required, adapting to environmental conditions, and self-repairing when damaged. Our project induces colonies to self-assemble pulling chains, bridges and hanging chains in the laboratory, performing detailed behavioural analyses to work out the simple rules used by individuals to decide when and where to join or leave a structure. Individuals will be uniquely marked and tracked using state-of-the-art technology to provide the first comprehensive quantification of behaviours during self-assembly, allowing us to statistically link individual-level behaviours to group-level functional outcomes. These data will be combined into a computer modelling framework that will demonstrate how to build things that build themselves. This knowledge may be applied to many other complex systems, from manufacturing to health, where benefits could include efficiently manufacturing nanomaterials or predicting tumour formation. This project will directly demonstrate a swarm robotics application, producing control algorithms that allow robot swarms to emulate ants, self-assembling into useful structures that greatly enhance their capabilities, especially in unknown or dangerous environments.

Stress resilience, methylation, and the dynamic regulation of glucocorticoids

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There is often remarkable variation in how individuals cope behaviorally with similar challenges. Although this variation can have fitness consequences, the mechanisms that generate it remain poorly understood. Recent findings from research in a large population of free-living tree swallows (*Tachycineta bicolor*) has identified global patterns of DNA methylation as a predictor of the behavioral response to stressors. At the same time, work is showing that the response to challenges is influenced by individual variation in the regulation of glucocorticoid hormones. Birds that both mount a strong glucocorticoid stress response and are able to rapidly and effectively terminate that response through negative feedback cope better with stressors. Experimental work has also found that exposure to a few brief, acute increases in glucocorticoids can have long-term impacts on parental behavior and offspring phenotype in free-living birds. These and other experiments are providing insights into how physiological differences, in combination with experiences, can shape future behavior and fitness.

Active smelling in the American cockroach, *Periplaneta americana*

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Olfaction has traditionally been studied as a slow and static sense, even though it is clear that animals actively enhance odour perception with specific behaviour (sniffing, flight manoeuvres, antennal movements, etc.). We use the American cockroach (*Periplaneta americana*), which actively oscillates its long and highly mobile antennae during search, to study active olfactory sensing strategies. We hypothesize that the animals adapt their movements to changing characteristics of a complex olfactory environment in order to extract relevant information and make decisions. Using behavioural wind-tunnel experiments that include antennae and body tracking and odour-plume manipulations, we study the relationship between odour encounter, movement decisions and plume structure. Our first results show that both odour onset and offset affect antennal movement patterns in an odour-specific manner and that these movements are used in locating an odour in space. We are further investigating how antennal movements affect the plume structure and reception of the odour.

Collective Inversion of Individual Preferences in cockroaches

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Decision making is modulated by both environmental and social cues. For example, when choosing shelters, cockroaches respond to both food and social odors. We study the interactions between these components in the American cockroach, *Periplaneta americana*. Individually, cockroaches show attraction for a vanillin odor. However, in groups they display a change in preference; aggregating at a control rather than a potential food odor site. The aim of the study was to investigate this further and elucidate mechanisms underlying this change in preference. Specifically, we tested how much the social shift is mediated by olfaction by testing individuals in the presence of both food and social odors. When presented independently, both vanillin and a feces extract odor are attractive for isolated individuals. However, when these same odors are presented simultaneously, isolated cockroaches show no preference for the mixture over a control. Our results show that individual preference to vanillin changes in a group context, including conditions in which an odor is the only signal for group presence. In order to reveal whether perception of the two attractive odors concurrently induce modulation at the olfactory centers, we monitored brain activity of cockroaches exposed to different concentrations of vanillin, feces extract and a mixture of the two odors. By monitoring calcium levels in the in the antennal lobe, our preliminary results suggest modification in sensory perception already at the primary olfactory center. We observe a partial overlap in response patterns for both odors with a reduced response to vanillin when applied simultaneously with feces extract. Further experiments are planned to test whether the behavioral change is the result of competition avoidance and outline its neural basis.

Decision-making efficiency in wild great tits, with real world consequences

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In animals that provide care for their young, choosing the right offspring to feed is a crucial decision, and the speed at which parents make that decision can substantially impact fitness. Signalling theory suggests that offspring signals for food may have evolved because signals increase parental decision-making efficiency—essentially, the less time parents spend choosing whom to feed, the more time parents have to gather food. However, whether offspring signals really do boost the efficiency of parental decision-making is still untested. Furthermore, while neuroscience laboratory studies have identified many factors that influence decision-making speed, these studies typically take place under very controlled conditions that may not be reflective of animals' evolutionary context. We therefore conducted a study on wild great tits, *Parus major*, where we experimentally manipulated ecological conditions as well as the stimuli information provided to parents from offspring. We then measured how long it took parents to decide which offspring to feed under naturalistic conditions. We found that ecological conditions, the information provided by offspring, the final choice of offspring, and parent sex influence decision-making efficiency. In contrast to expectations from lab studies, we did not find an effect of stimuli noisiness. Our results suggest that efficiency in parent-offspring communication may be more strongly affected by the individual and ecological context than by the actual signals. More generally, our study highlights the importance of expanding the field of animal cognition from the lab to the field.

Generalized rule learning and social tool use in cleaner fish

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Generalised rule application promotes flexible behaviour by allowing individuals to quickly adjust to environmental changes through generalization of previous learning. Here, we show that bluestreak 'cleaner' fish (*Labroides dimidiatus*) use generalized rule application in their use of predators, which act as social tools, in order to evade punishing fish clients. Such punishment occurs as cleaners do not only remove ectoparasites from client fishes, but prefer to feed directly on client mucus, which constitutes cheating and often results in aggressive chasing from the cheated client. We tested for generalized rule application in a series of experiments. First, we trained cleaners to approach one of two fish models in order to evade punishment (i.e. chasing) from a 'cheated' client model. Cleaners learned this task only if the safe haven was a predator model. During consecutive exposure to pairs of novel species, including exotic models, cleaners demonstrated generalization of the 'predators-are-safe-havens' rule by rapidly satisfying learning criterion in significantly fewer number of trials. However, cleaners were not able to generalize a 'one-of-two-stimuli-presents-a-safe-haven' rule, as they failed to solve the task when confronted with either two harmless fish models or two predator models. Our results emphasize the importance of ecologically relevant experiments to uncover complex cognitive processes in non-human animals, like generalized rule learning in the context of social tool use in fishes.

Sharing the burden: on the division of parental care and vocalizations during incubation

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In species with biparental care, individuals only have to pay the costs for their own parental investment, whereas the contribution of their partner comes for free. Each parent hence benefits if its partner works harder, creating an evolutionary conflict of interest. How parents resolve this conflict and how they achieve the optimal division of parental tasks often remains elusive. In this study, we investigated whether lesser black-backed gulls (*Larus fuscus*) divide parental care during incubation equally and whether this correlates with the extent of vocalizations between pair-members during incubation. We then investigated whether pairs showing more evenly distributed incubation behavior had a higher reproductive success. To this end, we recorded incubation behavior and vocalizations for 24-h time periods. Subsequently, we experimentally increased or decreased brood sizes in order to manipulate parental effort, and followed offspring development from hatching till fledging. Although incubation bouts were, on average, slightly longer in females, patterns varied strongly between pairs, ranging from primarily female incubation over equal sex contributions to male-biased incubation. Pairs contributing more equally to incubation vocalized more during nest relief and had a higher reproductive output when brood sizes were experimentally increased. Thus, vocalizations and a more equal division of parental care during incubation may facilitate higher levels of care during the nestling period, as suggested by a greater reproductive success when facing high brood demand, or they indicate pair quality.

Effect of Personality on the Response of Great Tits (*Parus Major*)

to Social Perturbation

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Achieving stability in a social group despite demographic variation enables individuals to better benefit from sociality. Social network theory highlights the importance of the role and position of individuals in ensuring robustness and resilience of animal social networks. Previous work has also demonstrated that individual-level traits can articulate the structure of the network. However the relationship between such traits and the ability of individuals to cope with perturbations at the network level remains to be explored. Here, we investigated the correlation between exploratory personality and individual reaction to changes in group composition in captive populations of great tits (*Parus major*). We found that birds facing such perturbations exhibited the same trends as described in previous studies. The birds increased their connectedness just after the perturbation, what seemed to hamper the pruning and structuration of the network over longer time period. Further, the consistent correlation between personality and social phenotype was disrupted by the perturbation. Although differences in the response to social disturbance were not significant, bold birds seemed to react quicker and to be less resilient than shy birds. The observed tendencies open intriguing avenues in understanding the mechanisms of social resilience and how individual variation may mediate group-level processes.

A new technique to measure anticipatory behavior and future applications

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Anticipatory behavior describes the actions taken to prepare for an upcoming event. In this study we tested the anticipatory behavior to distinguish different levels of interest inside the same event. We measured the intensity of anticipatory behaviors with two different techniques. We started by studied the dolphins' (*Tursiops truncatus*) interest for twenty game objects, then we took the objects with the highest level of interest (HLI) and those with the lowest level (LLI). In this way the event: interaction with objects, has been divided in two levels of interest according to which objects we gave to the dolphins. We trained dolphins to associate the arrive of different objects with different visual signal, then, for the first technique we measured how much time each dolphin showed anticipatory behaviors during the five minutes from the beginning of the signal to the arrive of the objects. For the second technique we analyzed the spatial behaviors in the same sessions use for the first technique and we measured the dolphins' distance from the starting point (the point of the pool where the objects were introduced into the water). Analyzing this data, using a general linear model, we found that, for all two techniques, anticipatory behavior was higher before the arrive of objects with HLI's than those with LLI. This means that all two techniques are able to study the anticipatory behavior and can be used to discriminate different levels of interest inside the event.

Effect of competitive environment on female scent marking in house mice

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Competition for resources is a key driver of animal behaviour. Since direct aggression can be costly, signals of competitive ability may be used to minimise the need for escalated conflict. Among mammals, competitive ability is often signalled via scent marking to mark a territory and through the deposition of expensive scent mark components that can indicate an individual's condition. For example, house mice (*Mus musculus domesticus*) deposit expensive urinary proteins when scent marking their territory which can indicate condition and also increase signal strength and longevity of male territorial scent marks. Although most studies of competitive scent marking to date have focused on males, females also invest in competitive signalling, and investing in proteins may come as a trade-off particularly in relation to resources needed for successful reproduction. Here, we employ an experimental approach under controlled naturalistic conditions to test if female house mice adjust their investment in the production of urinary proteins used for scent marking, according to social conditions. For subjects established in breeding kin groups, we compare investment in urinary protein production and scent marking behaviours in the presence or absence of rival groups living in neighbouring territories. We would expect females that are exposed to rival groups to invest more in urinary proteins than those without rival groups to help reduce the likelihood of rival intrusions. Preliminary results of this long-term study will be presented.

Get back to home: Homing behavior in the rubí poison frog *Andinobates bombetes*

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Homing is the behavior exhibited by individuals of diverse animal species when they return to their territory after having displaced to areas far from it. In anurans, little is known about homing in Neotropical species whose reproduction consists in terrestrial oviposition and the individuals call from territories dispersed in the habitat. The rubí poison frog *Andinobates bombetes* is a diurnal and territorial species, whose reproduction is not associated to large bodies of water. In a forest remnant located in the department of Quindío, Central Andes of Colombia, we performed translocation experiments of individuals at distances between 5 and 90 m outside their territory. Of 105 displaced individuals, 31 returned to their territory. The probability that an individual exhibit homing was negatively related with distance, but was not related with body size and sex. Similar results have been reported in other poison frog species. Apparently, homing is widely distributed in the family Dendrobatidae, being *Andinobates* the fourth genus of this family where this behavior has been corroborated experimentally.

Homing and parental care in the glassfrog *Centrolene savagei*: fathers come back more than singles

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Homing, the behavior of returning to a specific place (e.g. territory) after moving or being displaced out from it, is present in diverse species of invertebrates and vertebrates. In anurans, homing has been studied in species whose individuals have terrestrial habits, but little is known about such behavior in arboreal species; additionally, the relationship between homing and parental care have been poorly studied in vertebrates. Obtaining empirical evidence about homing behavior in arboreal anurans species, and mainly about the relationship between homing and parental care it is an important approach for understanding the evolutionary behavioral ecology of vertebrates. The glassfrog *Centrolene savagei* offers us a great opportunity to explore homing behavior in arboreal species and its relationship with parental care. In this species, adult males exhibit high fidelity to the calling place, and eggs clutches are laid by females in the upper surface of leaves overhanging streams. The care of such egg clutches is performed by males (fathers) and consists in brooding behavior and defense against predators. Between October 2017 and – October 2018, we realized 32 field trips, one-two nights each one, to a population in the Central Andes of Colombia. Along a transect of 420 m in a stream, we translocated 23 males (16 caring eggs, 7 singles) at distances between 5–80 m from their calling or breeding place to test whether the former males tends to exhibit more homing than the latter males. We also, registered the distribution pattern of males and egg clutches along the stream, and compared the mortality of embryos in egg clutches with and without a male caring them. Seven of the males caring egg clutches and one single male exhibits homing. Results of a binary logistic regression analysis indicate that homing probability is significantly higher in males caring eggs (i.e. fathers) than in single males. The distribution pattern of males and egg clutches is clustered, which, points out that adequate places for attracting females and breeding are located in specific places on the stream. Mortality was lower in egg clutches with parental care than in egg clutches without it. Altogether, our results suggest that homing in males of *C. savagei* is a behavior that offers adaptive benefits to them. By one side, single males could recover a calling place that is important to attract mates; on the other side, males with egg clutches return and reassume a parental care behavior which increase offspring survival chances.

A forked relationship - understanding the acoustic communication strategies in sympatric drongos

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The primary function of acoustic signals is to communicate information over optimal distances to their intended receiver, for various contexts. This is subjected to changes and distortions imposed by the physical structure of the habitat, as well as masking interference from co-occurring signals of other vocal species, especially from congeners. Passerine birds in particular, owing to vocal learning and mimicry, are highly vocally plastic, and have been relatively little studied in this regard. However, they pose interesting possibilities because of this, as this plasticity expands the range of possible behavioural and physics-based strategies they may employ to "get the message across" in an acoustically crowded environment.

Drongos (Dicruridae) are a group of highly vocal passerines known for their vocal plasticity. In this (ongoing) comparative study of four sympatric drongo species, we aim to understand the breadth of communication strategies used by these birds in presence of other congeners.

Carried out in a lowland tropical evergreen forest in Assam, India, we use active recording of focal drongo individuals. Perch heights of both calling and non-calling individuals were recorded. passive acoustic recorders were used to estimate diel activity patterns. Spatial information was collected along with abundance estimation. Through preliminary analysis, we found significant overlap in their acoustic space. A linear discriminant analysis was done, and a resulting confusion matrix also showed that the model could not accurately distinguish the calls of one species from another. A randomization test revealed that there is significantly higher overlap than is expected by chance. We present evidence of difference in song perch heights in the drongo species, with *Dicrurus hottentottus* occupying the highest perch and *Dicrurus paradiseus* the lowest. There is high overlap in vocal activity time suggesting no temporal partitioning. Further analysis will provide interesting insights into how sympatric drongos coexist in a similar habitat.

Being flexible in a rigid trait: modulation of Lévy walks in termite workers under distinct social encounter context

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Movement is a crucial element of behaviour: animals displace themselves in space in search of suitable conditions for survival and reproduction. It is hence expected that movement patterns in animals will be determined by the way they efficiently balance (i) their intrinsic individual displacing abilities with (ii) the spatial distribution of food, enemies, mates, etc. However intuitive, this notion needs better evidence, as it lies in the core of the still unsolved mechanisms generating search strategies in animals. That these searches are typically described as a Lévy walk process is consensual, though.

Here we explore such a balance in the context of social interactions among termites. We checked whether changes in the density of nestmates and the density of castes would trigger search-modulation in termite workers of *Cornitermes cumulans* when searching for social interactions. Our results seem to point to a two-fold process. Termite workers confined in petri dishes do displace them- selves in a Lévy-like walking, no matter the density or the type of targets therein present (targets being other workers or soldiers, which do differ in interactivity). Such movements, however, seem fine-tuned by group composition: as the density of workers increases so does the μ exponent of the power law describing the frequency of their step lengths.

In contrast, the mean speed of focal termites decreased exponentially with the increments of both the density of nestmates and the density of termite workers. Whereas indicative of interindividual movement obstruction, these results also point out that such an obstruction is affected by the type of interaction (worker-worker or worker-soldier). It is hence plausible to suspect that their general Lévy displacement pattern would indeed be affected by social interactions more than simply by the obstruction effect of inert targets.

It seems, therefore, that (i) while termites do have an innate propensity to perform Lévy walks, (ii) external constraints, at least in the form of opportunities for social interactions, would add an important modifier to these displacements.

Structural adaptation of group sensitivity

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One advantage of animals living in groups is the ability of the collective to gather (and combine) multiple observations of the environment and share this information within the group. A single individual in a group can thus rely on socially transmitted information (e.g. on the presence of a predator) and adapt its behavior accordingly leading to a group response.

This process of transmission, amplification and filtering of signals has most likely evolved to the requirements of the environment and determines how and which information is shared or ignored.

Theoretical physics suggests that biological systems should have evolved to operate close to a critical point in order to be able to distinguish a large variety of input signals in their behavioral response.

We test his hypothesis in a study of startling cascades in groups of golden shiners for two different contexts (before and after exposure to Schreckstoff, an alarm signal). We model the school's information transfer as a complex contagion process on a vision and distance based network of social interactions and use this model to determine the school's distance from criticality.

Dominance in habitat preference and diurnal explorative behavior of the weakly electric fish *Apteronotus leptorhynchus*

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[1]Institute for Neurobiology, Eberhard Karls Universität, Germany

Electrocommunication and -localization behaviors of weakly electric fish have been studied extensively in the lab, mostly by means of short-term observations on constrained fish. Far less is known about their behaviors in more natural-like settings, where fish are less constrained in space and time. We tracked individual fish in a population of fourteen brown ghost knifefish (*Apteronotus leptorhynchus*) housed in a large 2 m3 indoor tank based on their electric organ discharges (EOD). The tank contained four different natural-like microhabitats (gravel, plants, isolated stones, stacked stones). In particular during the day individual fish showed preferences for specific habitats which provided appropriate shelter. Male fish with higher EOD frequencies spent more time in their preferred habitat during the day, moved more often between habitats during the night, and less often during the day in comparison to low-frequency males. Our data thus revealed a link between dominance indicated by higher EOD frequency, territoriality, and a more explorative personality in male *A. leptorhynchus*. In females, movement activity during both day and night correlated positively with EOD frequency. In the night, fish of either sex moved to another habitat after about 6 seconds on average. During the day, the average transition time was also very short at about 20 seconds. However, these activity phases were interrupted by phases of inactivity that lasted on average about 20 minutes during the day, but only 3 minutes in the night. The individual preference for daytime retreat sites did not reflect the frequent explorative movements at night.

Social interactions and environmental conditions lead to opposite preferences between individuals and groups

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Numerous studies on the influence of the physical environment and social interactions on the collective decision-making of groups have showed that interaction between individuals usually amplifies individual preferences. Thus, social interactions can improve discrimination abilities among several options through social amplification of the individual preference when choosing shelter, nest or food resources. Nevertheless, in some cases, individuals and groups show opposite preferences, seemingly in disagreement with the expectations of social amplification. Most social arthropods like cockroaches are able to perform collective decisions when choosing resting places. In this presentation I will explain two cases where isolated individuals and groups display clearly opposite preferences regarding the odor and relative humidity of the shelter or resting place. I discuss how a combination of experimental and modelling work helped disentangle the interplay between individual preference, social interactions, and environmental conditions, and speculate upon the possible proximal mechanisms underlying such an inversion of preferences.

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Using sudden shifts in resource abundance to infer the underlying drivers of sociality

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There is a wide variety of purported benefits to sociality, including an increased ability to find food, avoid predators, and successfully disperse to a new environment. For any particular species, it is usually difficult to determine which of these many potential benefits is the dominant selective force maintaining sociality. For any combination of benefits and costs of sociality, there will be some group size that maximizes fitness (i.e., probability of survival) -- how this optimal group size changes as the abundance of resource in the environment changes, however, is not clear. We modeled a large number of the potential benefits of sociality and examined how, for each benefit, the optimal group size changes when resources change from abundant to scarce (for example, during a sudden drought). We reveal that some benefits result in a decrease in group size, some result in an increase in group size, while still other benefits do not lead to a change in group size. Searching through the empirical literature, we find instances of each of these patterns in nature. Our results suggest that observing how group size changes when resource abundance changes is a simple but potent method to quickly narrow down which of the many benefits of sociality is the dominant one for a particular species.

Spiders, Webs and Soft Robotics

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The spider's web is both a record of the animal's inherited behaviour algorithm and a highly functional extension of the spider's body phenotype. Each thread joint in the structure is carefully placed by the animal to create the correct structural geometry. Because the web is primarily a well-adapted fly-trap, web construction is foraging behavior. The solidified foraging path consists of a long sequence of integrated movement and manipulation patterns that have been terminated long before any prey is caught. Thus web-building is a long-term phylogenetic response rather than a short-term immediate reaction to prey - albeit with scope for some day-to-day fine-tuning adaptations.

In essence, web morphology is the phenotypic embodiment of the spider's way-finding and thread-placement decision rules, which in turn allow for corrections such as detours in the spider's transient path in order to appropriately position the lasting thread junctions.

Rather than depend solely on core hardware (i.e. body) the functional unit of spider-plus-web outsources certain phenotype features to software (i.e. behaviour). Such extended anatomy features are economically cheap and provide responsive flexibility as well as increasing the reach of the animal's basic anatomy/morphology. The concept of behaviour contributing to the overall body plan of an animal can provide inspiration for bio-inspired robotics. For example, consider a robot able to use integrated additive manufacturing ad hoc to extend and expand the physical boundaries of its hard shell.

Intra-specific behavioural change in resource-manipulated environments of *Neolamprologus multifasciatus*

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When resources become limited in animal groups, costs may be disproportionately felt by individuals in different social positions. As such, conflict between or within particular social classes may increase under conditions of resource limitation but be unaffected in other classes. Here we explore how inter- and intrasexual conflict is mediated by reduction in the availability of breeding sites in a communally breeding Cichlid fish. Small groups of *Neolamprologus multifasciatus* were presented with a foreign male or female conspecific in Lake Tanganyika while the amount of shells (which act as breeding shelters) in the nest was manipulated. Using machine learning assisted tracking and behavioral analysis, we then measured all interactions among group members and towards introduced conspecifics. Aggression among females was predicted to be higher when resources were limited due to higher relative costs than for males, for whom aggression was expected to be unaffected by resource reduction. Inter-sexual interactions were more complex, with males expected to respond more aggressively to foreign males and resident females, but show more courtship to foreign females, when resources were increased. In contrast, female responses to males were predicted to be unaffected in all conditions. Understanding how social group interactions are mediated by fluctuations in resource availability offers insight into the mechanisms of selection on social behaviour generally.

Maternal care: the mother of cooperation between animals

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Cooperation is widespread and we now have a solid theoretical understanding of how it can evolve. However, cooperation in animals is not a single trait behaviour, but includes offspring care, coalitionary support, hunting, or food sharing. While the evolution of these diverse forms of cooperation is associated with different ecological, life-history, and social factors, their proximate regulation appears to uniformly rely on hormones from the oxytocin-mesotocin family, and prolactin. These neuro-hormones regulate maternal and paternal care, which includes diverse behaviours (incubating eggs, social tolerance, offspring protection, food provisioning, prolonged offspring care). Remarkably, the same set of hormones facilitates reproductive cooperation by helpers and allo-mothers, as well as cooperative behaviours outside the reproductive context. Thus, maternal care has a fundamental but so far underappreciated role in the evolution of cooperation. Based on these shared mechanisms, we propose the "Mother of Cooperation" hypothesis, stating that maternal care enables the evolution of reproductive cooperation and many other forms of cooperation in animals, with repercussions for behaviour and psychology. Our hypothesis fills gaps in our knowledge concerning the ecological, social and life-history drivers of cooperative behaviours, and provides a unifying evolutionary framework to understand the evolution of cooperation in animals.

Being flexible in a rigid trait: modulation of L´evy walks in termite workers under distinct social encounter context

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Movement is a crucial element of behaviour: animals displace themselves in space in search of suitable conditions for survival and reproduction. It is hence expected that movement patterns in animals will be determined by the way they efficiently balance (i) their intrinsic individual displacing abilities with (ii) the spatial distribution of food, enemies, mates, etc. However intuitive, this notion needs better evidence, as it lies in the core of the still unsolved mechanisms generating search strategies in animals. That these searches are typically described as a L´evy walk process is consensual, though.

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Testing the effects of enforced monogamy and polyandry on reproductive success in a field cricket

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Our understanding of sexual selection as an evolutionary force cannot advance without integrating the effects of pre- and post-mating sexual selection. However, the question of how interactions between pre- and post-mating selection shape the evolutionary diversification of reproductive traits remains unsolved. Since pre-mating selection is favoured in monogamous mating scenarios when access to females is reduced and female re-mating rates are low, and post-mating selection is favoured in polygamous mating scenarios with high female re-mating rates, pre- or post-mating traits could be favoured depending on the number of available mating partners. This could lead to different fitness benefits for females, as it is expected for polyandrous females to show higher reproductive output than monogamous females, due to genetic variation. In this study I will address the question of whether monogamous or polyandrous behaviour in the field cricket *Gryllus bimaculatus* affects reproductive fitness in females, by inducing three different types of treatments. To impose pre-mating or post-mating sexual selection female crickets were either mated polyandrously with three consecutive males (post-mating selection); or monogamously three times with the same male, but allowed to choose their partner out of three competing males (pre-mating selection), or they were mated monogamously with no choice (no sexual selection).

I will present results on the effects of the different mating treatments on female reproductive fitness (fecundity, fertility, survival) and offspring quality (size and growth rates).

Intentionality in chimpanzee vocal communication

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Comparing the cognitive abilities involved in communication between humans and primates can help to understand the evolution of language. One of the most debated topic in those comparative studies is the degree of intentionality displayed by primates, especially great apes, when they produce specific signals. Studies have shown that primates were able to produce certain gestures and vocalisations in a goal directed way (first-order intentionality) but the evidence that they possess the ability to communicate according to others' mental state (second-order intentionality) is still very thin and criticized. The aim of my Ph.D. project is to identify the cognitive processes involved in chimpanzee communication in different contexts. I collect observational data during traveling, resting and feeding events to try and determine if the vocal signals used in these contexts (rest hoo, travel hoo, food grunt and pant hoot) present criteria for first order intentionality. I also conduct an experimental study using presentation of model snakes and playbacks to investigate if chimpanzees are able to attribute a state of knowledge to other individuals and to communicate accordingly. My preliminary results show that the time spent with a social partner seem to influence the production of rest hoos hence playing a role in group cohesion. The production of food calls appear to depend on the context (joining or being joined in a feeding tree) and the rank of the signaler and would be used to advertise rank and assert dominance.

Investigating how baboon behaviour and ecology contributes to Guinea worm transmission in Ethiopia

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While the use of animal models to examine human disease and the study of animal behaviour in response to disease are widespread, the concept of understanding animal behaviour to inform control of human disease remains largely unexplored. An increasing number of 'human' neglected tropical diseases are being detected in non-human primates, indicating that insights into how wild animals contract and transmit such diseases may be crucial to disease management and eradication. We investigate the behaviour and ecology of a social species, the olive baboon (*Papio anubis*), in Gambella, Ethiopia to test the hypothesis that Guinea worm disease (dracunculiasis) may persist in the region due to human-animal transmission. We combine observations of social behaviour from six focal troops with ranging data over 12 months from manual tracking and GPS collars, and dietary data from stable isotope analyses of whiskers to elucidate how baboon behaviour puts them at risk of Guinea worm infection. By linking these behavioural, dietary and ranging information to data on infection history obtained from serology tests of blood samples from individuals, we assess whether certain individuals are more likely to contract and transmit dracunculiasis due to their social position/rank and associated foraging behaviours and/or access to resources. Information on baboon interactions (drinking, eating fish/frogs) with water bodies also used by humans will be particularly informative for control efforts. Our work provides important evidence to inform the new frontier of Guinea worm eradication, plus broader insights into the role non-human social species may play in transmission of human disease.

Information flow during group decision making in fish

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Quantifying how information spreads within mobile groups and how this subsequently affects group performance are important steps towards understanding the benefits of behaving collectively. Yet previous works have lacked a standardized measure of information flow. The recent development of a method aiming to quantify the gains (or loses) of predictability about a fish trajectory given another fish trajectory data - termed as transfer entropy - has enabled us to identify and quantify predictive information flows from the trajectory data of an entire group. By quantifying how information flows in space and time, the use of transfer entropy allows to consider information dynamics during group decision making. In a Y shaped maze, we tested different group sizes of mosquitofish (*Gambusia holbrooki*) to determine their ability to make an adaptive decision by avoiding the maze arm containing a predator model. Using trajectory data, we quantified the information flow inside the group and found an important effect of group size, with larger groups having greater values of transfer entropy. Investigation of the relationships between transfer entropy, speed and distance to the decision zone will be used to explain the ability of the group to accurately avoid the predator.

An agent-based model to simulate the formation of self-assembled structures in army ants

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Army ants of the genus *Eciton* join their bodies together to create self-assembled structures that are responsive to traffic and environmental conditions, and function as a kind of living infrastructure for the colony. Here I present an individual-based model that simulates the formation and growth of two kinds of structures, bridges and flanges. These two structure types form under different conditions in nature, and the model reproduces both cases, as the same underlying set of individual-level rules results in different structures depending on the geometry of the environment. In the model, ants interact with the environment by detecting the surface ahead (either a void, solid surface, or an ant structure), and the concentration of pheromone deposited by other ants. Mobile ants interact with others encountered within a sensory zone representing the antennae and legs, and ants within a structure can sense contacts from other ants passing over the structure. The model takes three inputs corresponding to variables measured from experimental data: the overall rate of traffic flow; the proportion of ants carrying prey; and the proportion of bidirectional traffic. With these inputs, I test the model under different environmental conditions corresponding to two different experimental setups, for bridges and flanges. Within certain ranges of behavioral parameter values, structures of similar size, geometry, and growth dynamics emerge for both bridges and flanges when compared to experimental data given the same traffic conditions, and I show which parameters appear to be important for the formation of stable and responsive structures.