

12th Annual Meeting of the Ethological Society

# From Sensory Perception to Behaviour

February 22-24, 2017



Poppelsdorfer Schloss, Institute of Zoology, University of Bonn

### Plenary speakers

Johan Bolhuis, Utrecht / Theresa Burt de Perera, Oxford  
Molly Cummings, Austin, USA / Volker Dürr, Bielefeld  
Alexander Kotrschal, Stockholm / Markus Knaden, Jena



Please visit: <http://Etho2017.de/>





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## **Welcome to Bonn for the 12th Annual Meeting of the Ethological Society!**

The topic of this year's meeting "**From Sensory Perception to Behaviour**" covers the key processes that connect the environment to the individual and through its behaviour the individual back to the environment. Along this scheme, the participants of this meeting submitted 92 abstracts for talks and posters, which beautifully reflect these complex interactions between the individual and the animate and inanimate environment mediated through sense organs and brain circuits. Accordingly, we divided the contributions into five subtopics:

- Signals and Signal Processing
- Sensory Perception
- Cognition
- Behavioural Ecology
- Cooperation

In 43 Short Talks and 49 Posters flanked by five Plenary Talks and one public Evening Talk this meeting constitutes a multifaceted assembly of contributions along the scheme of this meeting. Our hope is that this will give the participants the opportunity to develop new ideas, meet new friends and inspire them to have a look beyond their particular field of work.

The Organizing Committee:

- Gerhard von der Emde
- Theo Bakker
- Horst Bleckmann
- Ulrike Hanslik
- Michael Hofmann
- Joachim Mogdans
- Ingolf Rick
- Vera Schluessel
- Anke Schmitz
- Helmut Schmitz



### Talks:

Please upload your talks on the laptop located in the "Kartenraum" near the lecture hall. You have to copy your presentation file and any accompanying files (e.g. videos) to the folder designated for your talk. Folders are labeled with "day\_hour\_minute\_surname". All files must be uploaded not later than during the *session before* your talk.

There will be a Windows laptop with recent versions of Microsoft Powerpoint, Adobe Acrobat Reader and VLC media player in the lecture room. In case you compiled your presentation on a Mac it is possible to plug your own MacBook into the system but you have to make sure that you have your *own adapter* with you (VGA and HDMI cables are available).

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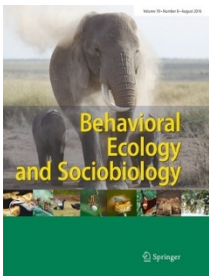
### Posters:

Posters will be shown during the entire conference. On Thursday, February 23rd there will be a special poster session in the evening. Posters should have a maximum of Din A0 upright format. The attachment material will be provided.

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### Publication:

We offer the possibility of publication of presentations with a clear behaviour component in the journal Behavioral Ecology and Sociobiology (BES). When you are interested to contribute, please contact as soon as possible Theo Bakker at [tbakker@evolution.uni-bonn.de](mailto:tbakker@evolution.uni-bonn.de). Manuscripts will be subjected to the normal reviewing process of the journal. After



acceptance, they will be published in the journal (from 2017 onwards BES will practice continuous article publishing) and be included in the online available topical collection "From sensory perception to behaviour". Editors: Theo Bakker, Horst Bleckmann, Joachim Mogdans, Vera Schluessel.

Deadline for manuscript submission: 31 Mai 2017. Please submit online via Editorial Manager to

Behavioral Ecology and Sociobiology and mention that it is part of the topical collection "From sensory perception to behaviour". We hope that at the beginning of 2018 the topical collection will be completely published.

Instructions for Authors: <http://www.springer.com/life+sciences/behavioural/journal/265>



### **Award:**

As at every topical meeting, the Ethological Society will award two **Eberhard-Gwinner-prizes**: one for the best poster and one for the best short talk of a junior scientist given at this meeting. Both come with a prize money of 200 €, each! During registration, you will receive two ballot cards to vote for best poster and best talk, respectively. After hearing the last talk and after visiting the posters, please fill out these cards and put them into the ballot boxes near the poster room (*Stucksaal*) and the lecture hall. At the closing session on Friday, the prizes will be awarded to this year's winners.

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### **Important address and telephone number**

Institute of Zoology  
Meckenheimer Allee 169  
53115 Bonn  
Fon: +49 228 73 5454  
Fax: +49 228 73 5458  
E-Mail: [zoologie@uni-bonn.de](mailto:zoologie@uni-bonn.de)

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### **Transportation:**

In case that you are traveling by bus, there are two bus stations close to the *Poppelsdorf castle* (see map).  
Service call for ordering a cab: **+49 228 55 55 55**.

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### **Conference Dinner and Lunch:**

The conference dinner takes place in the *President Hotel* (see map). Only registered members may take part in this dinner.  
During the meeting catering will be provided at the "*Gartensaal*" in the *Poppelsdorf castle*.

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### **Medical trouble:**

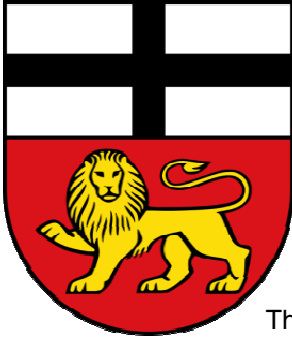
In case of emergencies please call:  
Emergency: **112**  
Police: **110**

Do not hesitate to contact the Etho2017 organization team if you need help!

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### **WiFi:**

WiFi access is available for the duration of the conference. The necessary login details can be found in the flyer you will get when you register.

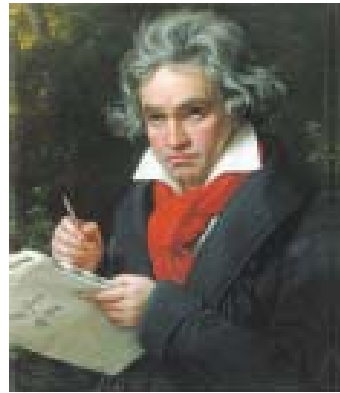


Bonn can be considered as one of Germany's oldest cities. Its history dates back to the year 12 BC when the Roman army appears to have stationed a small unit at the river Rhine. Between the 11th and 13th centuries, the Romanesque style "Bonner Münster" was built. In 1597, Bonn became the seat of the Archdiocese of Cologne and the influence and the dimensions of the town grew considerably.

The elector Clemens August (ruled 1723–1761) ordered the construction of a series of baroque buildings. Today his main palace in the city center houses the university main halls. His summer residence, the *Poppelsdorf castle*, nowadays houses the Department of Zoology.

In 1170, Bonn's most famous child, Ludwig van Beethoven, was born in the "Bonngasse 20". Until he moved to Vienna in 1792, he lived and composed in Bonn.

The "Rheinische Friedrich-Wilhelms-Universität Bonn" was founded in 1818. The University of Bonn today is a traditional research university with almost 36,000 students (as of 2016) and about 8,900 employees (as of 2010).





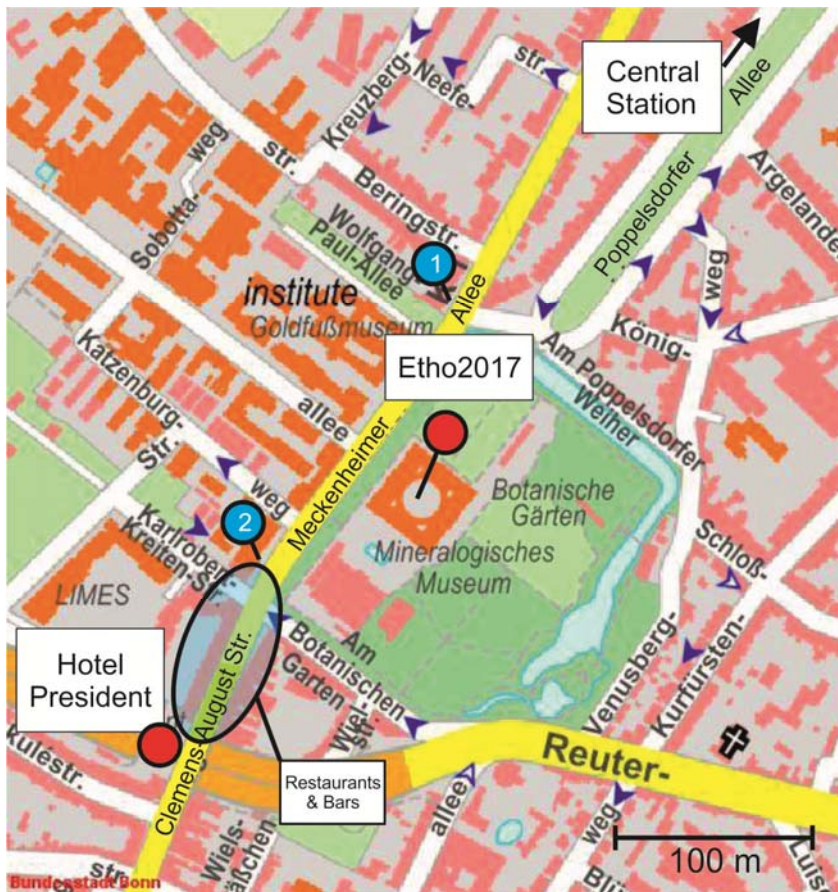
In September 1945, the ceremonial act of the parliamentary council took place in the main hall of the “Alexander Koenig Research Museum” in Bonn. Between 1949 and 1990, Bonn was the capital and seat of the government. After the reunification of Germany, Berlin was made the new capital of Germany. In recognition, Bonn was given the new title “Bundesstadt”.

Bonn provides a high living quality, since it has become a melting pot of all, culture, history, science and business situated at the river Rhine at the foot of the “Siebengebirge”.



During the ethological meeting one of the most famous traditions of the Rhineland takes place: the *carnival*. The so called “fifth season” begins each year on 11 November at 11:11 a.m. and finishes on “Aschermittwoch” (29.02.2017). The street carnival starts at “Weiberfastnacht” (23.02.2017) with its highlight “Rosenmontag” (27.02.2017).

“Weiberfastnacht” celebrates the beginning of the “female presence in carnival”, which began in 1824, when washer-women celebrated a “workless day”. In each city, women conquer the city hall. Also, as a tradition, women are allowed to kiss every man who passes their way, and “wild” women cut men's ties wherever they get hold of them. During these days hundreds of people celebrate in the streets and bars dressed up in colored costumes. So, if you want to get a good impression of the Bonn carnival, the “Bonner Altstadt” is a good way to start gathering your own experiences.



### Legend

**Etho2017**  
**President Hotel**

*Poppelsdorf castle*  
Conference Dinner

- 1. **Bus stop:**
- 2. **Bus stop:**

*“Beringstraße”*  
*“Botanischer Garten”*





## Restaurants & Bars in Bonn Poppelsdorf

There are a few Restaurants and Bars along the „*Clemens-August Straße*“.

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### Left side of the “*Clemens-August Straße*”

<i>Gelateria Haliana</i>	Ice Cream Café
<i>Havanna</i>	Café, Bar and Restaurant
<i>Monte Christo</i>	Bar, Restaurant
<i>Dirk Diggler</i>	Bar
<i>Hans im Glück</i>	Burger Restaurant
<i>Bonnanza</i>	Burger Restaurant
<i>Sarter</i>	Butcher Shop and Snack Bar
<i>The Indian Teahouse</i>	Indian Snack Bar
<i>Tibet Imbiss</i>	Tibet Snack Bar
<i>Meyer´s</i>	Restaurant
<i>Bäckermeister Blesgens</i>	Bakery
<i>Gesindehaus</i>	Restaurant

### Right side of the “*Clemens-August Straße*”

<i>Botan Grill</i>	Turkish Snack Bar
<i>CanCun Story</i>	Mexican Restaurant
<i>Kamps</i>	Bakery
<i>Kugelfisch</i>	Sushi Bar
<i>La Loca</i>	Tapas Restaurant
<i>Extra Dry</i>	Burger Restaurant



<b>Wednesday, February 22nd</b>	
11:00 - 14:00	<b>Registration</b>
14:00 - 14:15	<b>Gerhard von der Emde (Bonn): Welcome</b>
14:15 - 15:15	<b>1. Plenary Talk: Alexander Kotrschal (Stockholm)</b> <b>The costs and benefits of large brain size</b> Chair: Gerhard von der Emde
15:15 - 16:00	<b>Short talks, Session 1: Cognition A Chair: Joachim Frommen</b> <b>15:15: ST1.1: Long-distance relationships in mollies: the use of public information in mate choice is not affected by distance</b> <i>Gierszewski, Stefanie; Keil, Melissa; Witte, Klaudia</i> <b>15:30: ST1.2: Cognition in bamboo sharks and freshwater stingrays</b> <i>Schlüssel, Vera</i> <b>15:45: ST1.3: Sharks can “see the magic” as well: 4 different optical illusions in the grey bamboo shark (<i>Chiloscyllium griseum</i>).</b> <i>Fuss, Theodora; Schlüssel, Vera</i>
16:00 - 16:30	<b>Coffee break</b>
16:30 - 18:30	<b>Short talks, Session 2: Cognition B Chair: Peter Kappeler</b> <b>16:30: ST2.1: Visual discrimination of natural and artificial stimuli in pigeons (<i>Columba livia</i>)</b> <i>Matzinger, Theresa M. E.; Aust, Ulrike</i> <b>16:45: ST2.2: Personality and learning via odour cues in bank voles</b> <i>Mazza, Valeria; Dammhahn, Melanie; Jacob, J.; Zaccaroni, M.; Eccard, Jana A.</i> <b>17:00: ST2.3: Mate-copying of a natural trait in <i>Drosophila melanogaster</i></b> <i>Nöbel, Sabine; Isabel, Guillaume; Danchin, Etienne</i> <b>17:15: ST2.4: Cross-modal object recognition and sensory processing in a fish</b> <i>Schumacher, Sarah; Burt de Perera, Theresa; Thenert, Johanna; von der Emde, Gerhard</i> <b>17:30: ST2.5: Mirror image stimulation- investigating self-recognition in crows</b> <i>Vanhooland, Lisa-Claire; Bugnyar, T.; Massen, J. J. M.</i> <b>17:45: ST2.6: Do wild Zebra Finches (<i>Taeniopygia guttata</i>) learn to use artificial symbols as cues to optimise foraging?</b> <i>Hardenbicker, Marie-Christin; Brandl, Hanja B.; Griffith, Simon C.; Schuett, Wiebke</i> <b>18:00: ST2.7: What do parrots talk about with their owners? Lexicon of African grey parrots kept as pets.</b> <i>Lindová, Jitka</i> <b>18:15: ST2.8: The impact of elevated cortisol on personality traits in adolescent and adult caviés</b> <i>Guenther, Anja</i>
19:00 - 22:00	<b>Conference Dinner</b>



<b>Thursday, February 23rd</b>	
9:00 - 10:00	<b>2. Plenary Talk: Molly Cummings (Austin)</b> <b>Identifying cognitive-behavioral syndromes that vary by mating system in Poeciliid fishes</b> Chair: Vera Schlüssel
10:00 - 11:00	<b>Short talks, Session 3: Behavioral Ecology A Chair: Fritz Trillmich</b> <b>10:00: ST3.1: Prospecting in wild zebra finches – the effect of brood size manipulation on breeding decisions</b> <i>Brandl, Hanja B.; Griffith, Simon C.; Schuett, Wiebke</i> <b>10:15: ST3.2: Female reproductive behaviour under infanticide risk</b> <i>Breedveld, Merel C.; Folkertsma, Remco; Eccard, Jana A.</i> <b>10:30: ST3.3: Effects of female density on mating decisions in a sexually cannibalistic spider <i>Argiope bruennichi</i></b> <i>Cory, Anna-Lena; Becker, Julia; Schneider, Jutta M.</i> <b>10:45: ST3.4: Social foraging and exploitative behaviour: the maintenance of cooperation in spiders</b> <i>Dumke, Marlis; Herberstein, Marie E.; Schneider, Jutta M.</i>
11:00 - 11:30	<b>Coffee break</b>
11:30 - 13:00	<b>Short talks, Session 4: Behavioral Ecology B Chair: Elke Zimmermann</b> <b>11:30: ST4.1: Cooperatively breeding fish benefit from anti-predator vigilance</b> <i>Frommen, Joachim G.; Dällenbach, Laura; Taborsky, Michael</i> <b>11:45: ST4.2: Context-dependent reproductive decisions along an ecological gradient</b> <i>Heubel, Katja U.; Mück, Isabel; Vallon, Martin</i> <b>12:00: ST4.3: Shoal sex composition and predation risk influence sub-adult three-spined stickleback shoaling decisions</b> <i>Rystrom, Taylor L.; Clement, Vic F.; Rick, Ingolf P.; Bakker, Theo C. M.; Mehlis, Marion</i> <b>12:15: ST4.4: Dis-assortative female mate choice for boldness in a monogamous cichlid</b> <i>Scherer, Ulrike; Kuhnhardt, Mira; Schuett, Wiebke</i> <b>12:30: ST4.5: Influence of inter-individual differences on individual movement and space use behaviour in different species</b> <i>Schirmer, Annika; Eccard, Jana A.; Dammhahn, Melanie</i> <b>12:45: ST4.6: Data on the ecology of Nigerian-Cameroonian Chimpanzees (<i>Pan troglodytes ellioti</i>) and Cross-River Gorillas (<i>Gorilla gorilla diehli</i>).</b> <i>Linnarz, Sebastian; Bleckmann, Horst</i>
13:00 - 14:00	<b>Lunch</b>



14:00 - 15:00	<p><b>3. Plenary Talk: Theresa Burt de Perera (Oxford)</b>  <b>Navigating in a three-dimensional world</b>          Chair: Helmut Schmitz</p>
15:00 - 17:00	<p><b>Short talks, Session 5: Sensory Perception Chair: Klaudia Witte</b>  <b>15:00: ST5.1: Biosonar encoding of surface waves: bats' perceptual sensitivity to spatial and temporal frequency</b>  <i>Baier, Leonie; Goerlitz, Holger R.; Wiegrebe, Lutz</i>  <b>15:15: ST5.2: Mole-rats like it hot</b>  <i>Burda, Hyněk; Dohmen, Josefine; Mladěnková, Nella; Vole, Christiane; Begall, Sabine; Šumbera, Radim</i>  <b>15:30: ST5.3: Female brain size affects the assessment of male attractiveness during mate choice</b>  <i>Corral-López, Alberto; Bloch, Natasha I.; Kotrschal, Alexander; van der Bijl, Wouter; Buechel, Severine D.; Mank, Judith E.; Kolm, Nicolas</i>  <b>15:45: ST5.4: Relative value perception in an insect: expectations and effort influence the perceived quality of food sources in the ant <i>Lasius niger</i></b>  <i>Czaczkas, Tomer J.; Oberhauser, Felix B.; Wendt, Stephanie</i>  <b>16:00: ST5.5: Phonotactic orientation during flight of the parasitoid fly <i>Emblemasoma auditrix</i> (Diptera: Sarcophagidae)</b>  <i>Tron, Nanina; Lakes-Harlan, Reinhard</i>  <b>16:15: ST5.6: Traffic noise drowns out great tit alarm calls</b>  <i>Zollinger, Sue Anne; Templeton, Christopher N.; Brumm, Henrik</i>  <b>16:30: ST5.7: The importance of underwater sound: Noise can affect mating behavior and reproduction in vocal fish.</b>  <i>de Jong, Karen; Amorim, M. Clara P.; Fonseca, Paulo J.; Klein, Adrian; Fox, Clive; Heubel, Katja U.</i></p>
17:00 - 17:30	<p><b>Coffee break</b></p>
17:30 - 18:30	<p><b>Public Lecture: Markus Knaden (Jena)</b>  <b>Navigation unter extremen Bedingungen: wie Wüstenameisen möglichst schnell nach Hause finden</b>          Chair: Horst Bleckmann</p>
19:00 - 22:00	<p><b>Posters (with Beer and Snacks)</b></p>



<b>Friday, February 24th</b>	
9:00 - 10:00	<b>4. Plenary Talk: Volker Dürr (Bielefeld)</b> <b>Locomotor Flexibility: Adaptive coordination and exploration in insect locomotion</b> Chair: Joachim Mogdans
10:00 - 11:00	<b>Short talks, Session 6: Signals and Signal Processing A</b> <b>Chair: Jan Benda</b> <b>10:00: ST6.1: Functional correlates of fluorescent color patterns across the fish phylogeny</b> <i>Anthes, Nils; Theobald, Jennifer; Gerlach, Tobias; Meadows, Melissa G.; Michiels, Nico K.</i> <b>10:15: ST6.2: Court and spark in the wild: communication at the limits of sensation</b> <i>Henninger, Jörg; Kirschbaum, Frank; Grewe, Jan; Krahe, Rüdiger; Benda, Jan</i> <b>10:30: ST6.3: Linking brain activity to odour-guided behaviour in the hawkmoth <i>Manduca sexta</i></b> <i>Bisch-Knaden, Sonja; Dahake, Ajinkya; Knaden, Markus; Sachse, Silke; Hansson, Bill S.</i> <b>10:45: ST6.4: Hawkmoths evaluate scenting flowers with the tips of their tongues</b> <i>Haverkamp, Alexander; Yon, Felipe; Bing, Julia; Keeseey, Ian W.; Mißbach, Christine; Koenig, Christopher; Baldwin, Ian T.; Kessler, Danny; Hansson, Bill S.; Knaden, Markus</i>
11:00 - 11:30	<b>Coffee break</b>



11:30 - 12:30	<p><b>Short talks, Session 7: Signals and Signal Processing B</b> <b>Chair: Henrik Brumm</b></p> <p><b>11:30: ST7.1: Active photolocation using modified ambient light in diurnal marine fishes</b> <i>Michiels, Nico K.; Bitton, Pierre-Paul; Anthes, Nils; Harant, Ulrike K.; Fritsch, Roland; Drohm, Sanja; Kalb, Nadine; Seeburger, Victoria; Santon, Matteo</i></p> <p><b>11:45: ST7.2: Sensory-drive speciation: visual development affects colour-based mate preference</b> <i>Wright, D. Shane; Seehausen, Ole; Groothuis, Ton G. G.; Maan, Martine E.</i></p> <p><b>12:00: ST7.3: Ultrasonic communication in rodents</b> <i>Wöhr, Markus</i></p> <p><b>12:15: ST7.5: Volatile sampling to study olfactory communication in mammals</b> <i>Kücklich, Marlen; Birkemeyer, Claudia; Weiß, Brigitte M.; Einspanier, Almuth; Manser, Marta; Holland, Ruben; Widdig, Anja</i></p>
12:30 - 13:00	<p><b>Short talks, Session 8: Cooperation A Chair: Jutta Schneider</b></p> <p><b>12:30: ST8.1: Limited evidence for 'proper' third party punishment in <i>Labroides dimidiatus</i></b> <i>Aellen, Mélisande; Bshary, Redouan</i></p> <p><b>12:45: ST8.2: Causes and consequences of alternative dispersal decisions in the cooperatively breeding Seychelles warbler</b> <i>Groenewoud, Frank; Kingma, S. A.; Komdeur, J.</i></p>
13:00 - 14:00	<p><b>Lunch</b></p>
14:00 - 15:00	<p><b>5. Plenary Talk: Johan J. Bolhuis (Utrecht)</b> <b>Twitter evolution: Birdsong, speech, and language</b> Chair: Theo Bakker</p>



15:00 - 16:00	<p><b>Short talks, Session 9: Cooperation B Chair: Jutta Schneider</b></p> <p><b>15:00: ST9.1: Strategic adjustment of helping behaviour in the cooperatively breeding cichlid <i>Neolamprologus savoryi</i></b> <i>Josi, Dario; Taborsky, Michael; Tanaka, Hirokazu; Frommen, Joachim G.</i></p> <p><b>15:15: ST9.2: Reciprocity and kin selection - two alternative mechanisms underlying cooperation in Norway rats</b> <i>Schweinfurth, Manon; Taborsky, Michael</i></p> <p><b>15:30: ST9.3: Climate change negatively affects the ontogeny of cognitive performance in cleaner fish</b> <i>Triki, Zegni; Wismer, Sharon; Levorato, Elena; Bshary, Redouan</i></p> <p><b>15:45: ST9.4: Social feedback and within-group diversity in the collective temperature homeostasis of bumblebees</b> <i>Weidenmüller, Anja; Garrison, Linda; Kleineidam, Christoph</i></p>
16:00	<b>Closing</b>



**Dr. Markus Knaden**  
Department of Evolutionary Neuroethology,  
MPI for Chemical Ecology, Jena

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Markus Knaden started his work on insect behavior already during his diploma thesis in Bonn, when he investigated decision making in subsocial beetles. From then on, and especially when he started to work on the desert ant *Cataglyphis*, Markus was fascinated how insects with their small brains often become much better navigators than humans.

Since 2006 Markus is a group leader at the Max Planck Institute for Chemical Ecology in Jena focusing on odor-guided behavior in flies, moths, and ants. Flies, i.e. *Drosophila*, offer great molecular tools to e.g. shut down whatever pathway to investigate its involvement in a specific task. Regarding flies and moths, Markus' group is trying to understand the valence of olfactory cues. Why are some odors innately attractive or repellent, what is their ecological relevance, and which neuronal circuits are involved from detection to decision making? While the desert ant *Cataglyphis fortis* does not offer elaborate molecular tools yet, it still has become a famous model just because of its fantastic navigational performance. Current research in Markus' group is focusing on how olfaction helps individual ants to localize food and find their way back to the nest after up to 1500m-long foraging journeys.





**Dr. Alexander Kotrschal**  
Department of Zoology, Stockholm  
University, Sweden

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Alexander Kotrschal is a Biologist with a strong interest in both Animal Behaviour and Evolution. His topics range from phenotypic plasticity of behaviour and physiology to the evolution of brain size and cognitive ability. he predominantly works with fish - be it cichlids from Lake Tanganyika, Salmon from Canada and Sweden, or Guppies from Trinidad - but has also worked with wild house mice and nightingales.

As a previous Erwin Schrödinger fellow (Austrian Science Fund) he was involved in a large-scale experiment in which he experimentally investigated brain size evolution of vertebrates. After determining the costs and benefits of a large brain using artificial brain size selection in Guppies at Uppsala University, Sweden, he moved to the Konrad Lorenz Institute of the Veterinary School in Vienna to investigate how animals with large and small brains perform in a naturalistic setting and whether they differ in immunity. At Stockholm University (since autumn 2014) he continues to pursue a number of questions with those large- and small-brained fish. Currently he is a forskare in a Wallenberg project investigating the basis of sociality, which includes another artificial selection approach with guppies.



**Prof. Dr. Theresa Burt de Perera**  
Department of Zoology, University of Oxford

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Theresa Burt de Perera is an Associate Professor in the Department of Zoology, University of Oxford and a Tutorial Fellow at St John's College. Prior to this she was awarded a Royal Society Dorothy Hodgkin Research Fellowship, a L'Oreal UK Women in Science Fellowship and the EPA Junior Research Fellowship at Keble College in Oxford. Before that she worked as a postdoc in the Universidad Nacional Autonoma de Mexico for one year after completing her D.Phil. in the Department of Zoology, Oxford in 1998.

Feats of animal navigation fascinate lay people and scientists alike, and are often key to animals' survival and success. Theresa's group investigates how individuals sense, learn and remember information from their local environments and how they use this information to orient efficiently.

She is particularly interested in how fish navigate in three dimensions (a difficult task for AI systems and humans). She studies this problem in two broad, but overlapping streams of research that aim to discover: 1) how spatial information is sensed, and 2) how a representation of volumetric space is acquired and encoded. These questions sit at the interface of ethology, psychology and neuroethology, and she uses techniques borrowed from all three disciplines to answer them.



### **Prof. Dr. Molly Cummings**

Department of Integrative Austin

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Molly Cummings is a Professor of Integrative Biology at the University of Texas at Austin, USA. Her research blends sensory ecology, neuroethology and behavioral genomics to identify mechanisms of divergence in communication, behavior and cognitive traits. She has conducted field and laboratory experiments with frogs and fishes, with a particular emphasis on freshwater poeciliid fishes since 2001.

For the past decade, Dr. Cummings has been using behavioral genomics to uncover the neurogenomic pathway of mate choice decisions in poeciliid fishes. Initial research with the northern swordtail, *Xiphophorus nigrensis* (a female mate choice taxa), implicated learning and memory pathways involved in female mate choice decisions. Interestingly, these same gene pathways are differentially engaged (suppressed during interactions with males) in a closely related poeciliid with a male coercion mating system (*Gambusia affinis*). Current research in her laboratory examines the cognitive and behavioral trade-offs associated with differences in mating systems by characterizing activity, anxiety, sociability, boldness and general cognitive abilities across poeciliid fish species.



**Prof. Dr. Volker Dürr**  
Bielefeld University, Germany

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Volker Dürr is professor for Biological Cybernetics at Bielefeld University, Germany, where he is also principal investigator Centre of Excellence on Cognitive Interaction Technology (CITEC). The main objective of his research is how animals achieve autonomous, context-dependent control of behaviour through active interaction with their environment. For this, he combines methods from behavioural physiology, neurophysiology, computational modelling and biomimetics. In the past years, his lab focused on active tactile exploration, spatial coordination and distributed proprioception in insect locomotion.



### **Prof. Dr. Johan J. Bolhuis**

Department of Psychology, University of Utrecht

Johan J. Bolhuis is full professor of Cognitive Neurobiology at the Departments of Psychology and Biology, Utrecht University, The Netherlands. He obtained his PhD in Zoology (cum laude) at the University of Groningen, The Netherlands, and was a Postdoctoral Research Fellow at the Universities of Edinburgh and Cambridge, UK. He was Associate Professor at Leiden University, The Netherlands. He has served as an editor of *Animal Behaviour*, and as president of the Royal Dutch Zoological Society and is currently Editor-in-Chief of *Behavioural Processes* and Academic Editor of *PloS One* and *Scientific Reports*. He was awarded the Zoology Prize of the Royal Dutch Zoological Society in 2001. His main research interests are in the behavioural, neural and cognitive mechanisms of learning, memory and development. His current research is focused on the neural mechanisms of song learning in songbirds, and the parallels with human speech and language, on which he published two reviews in *Nature Reviews Neuroscience*. In addition, he has a theoretical interest in the relationship between evolution, cognition, and the brain, on which he published essays in *Nature* and *PLoS Biology*. He is editor or co-editor of seven books on animal behaviour and cognitive neuroscience, including *Brain, Perception, Memory* (OUP, 2000), in honour of Sir Gabriel Horn, and the forthcoming *Birdsong, Speech, and Language* (MIT Press, 2013). Together with Luc-Alain Giraldeau he is editor of the university textbook *The Behavior of Animals* (Blackwell, 2005).



**PT01: Navigation unter extremen Bedingungen: wie Wüstenameisen möglichst schnell nach Hause finden**

Kaden, Markus

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Die tunesische Wüstenameise *Cataglyphis fortis* bewohnt die Salzpflanzen Nordafrikas. Dieser Lebensraum ist aufgrund der hohen Temperaturen und der alles überziehenden Salzkruste extrem unwirtlich. Die Ameisen graben tiefe Nester in den Sandboden, in denen die ganze Kolonie vor Sonne und Hitze geschützt ist. Einzelne Arbeiterinnen müssen jedoch das Nest verlassen, um auf Nahrungssuche zu gehen. Als Hauptnahrung dienen dabei Insekten, die meist durch Zufall in die Salzpflanze gelangt sind, um dort nach kurzer Zeit zu verenden. Die futtersuchenden Ameisen müssen die toten Insekten möglichst schnell zum Nest transportieren, um nicht selber den harschen Bedingungen der Salzpflanze zum Opfer zu fallen. Die Tiere legen bei der Futtersuche jedoch oft mehrere hundert Meter zurück. Gleichzeitig ist das Nest, in das sie hinterher zurückkehren, oft nur durch ein daumennagel-großes Eingangsloch in der Salzkruste zu erkennen. Daher ist es für *Cataglyphis* extrem wichtig, sich gut orientieren zu können. Die Ameisen betreiben einerseits Wegintegration, d.h. sie berechnen basierend auf der Kombination von Kompassinformation und Schrittzähler während der Futtersuche kontinuierlich ihre Position zum Nesteingang. Zu diesem Eingang kehren sie dann nach erfolgreichem Auffinden eines Futterstückes auf geradliniger Strecke zurück. Zusätzlich zur Wegintegration sind die Ameisen jedoch in der Lage, sowohl sichtbare als auch duftende Landmarken zu lernen und beim Heimfinden zu nutzen. In letzter Zeit sind verblüffende Strategien entdeckt worden, die allesamt dazu dienen, einerseits möglichst effizient Futter zu finden, um dann andererseits so schnell wie möglich ins schützende Nest zurück zu kehren. Auf der Futtersuche laufen die Tiere z.B. über lange Distanzen rechtwinklig zum Wind, um dann nach Kontakt mit geringsten Mengen von Futterdüften das tote Insekt gegen den Wind anzusteuern. Da sie so mehrere Hundert Meter quer zum Wind laufen können und dabei selbst die Duftfahnen von kleinen Insekten (in der Größe einer Fruchtfliege) über mehr als 5 Meter Distanz detektieren, suchen einzelne Ameisen während einer einzigen Futtersuche oft Flächen von mehreren hundert Quadratmetern ab. Diese Effizienz in der Futtersuche (zusammen mit der Fähigkeit, auch nach komplizierten Ausläufen das Nest schnell wieder zu finden) ist es



wahrscheinlich, die es Cataglyphis erlaubt, selbst in dieser für fast alle anderen Tiere tödlichen Umgebung zu überleben.



### **IT01: The costs and benefits of large brain size**

Kotrschal, Alexander

Stockholm University, Department of Zoology, Stockholm, Sweden

Variation in brain size is believed to have evolved through the balance between selection for cognitive advantages of larger brains and prohibiting energetic costs associated with a larger brain. While comparative studies highlighted several important selection pressures, experiments have so far been lacking. We used artificial selection to create large- and small-brained lines of guppies (*Poecilia reticulata*), which we now use to experimentally test the costs and benefits of having smaller or larger brains. Our results demonstrate that a 13 % difference in relative brain size between up- and down-selected replicate lines can evolve surprisingly fast - but at some cost. Large-brained animals show a decreased fecundity, develop smaller guts, grow slower, and exhibit an impaired immune response. These costs are likely offset by a selective advantage of large-brained offspring in cognitively challenging environments, since relatively larger brains should confer a cognitive benefit. Indeed large-brained individuals outperform small-brained individuals in several aspects of cognitive ability such as spatial, numerical and reversal learning. We confirmed the ecological relevance of increased cognition by discovering a survival advantage of large- compared to small-brained females under semi-natural conditions. These results provide the first experimental evidence of costs and benefits of brain size evolution and have important implications for our understanding of the evolutionary reasons for the remarkable variation in brain size evident among vertebrates





**IT02: Identifying cognitive-behavioral syndromes that vary by mating system in Poeciliid fishes**

Cummings, Molly

University of Texas, Department of Integrative Biology, Austin, U.S.A.

There is a growing movement to explore how social complexity and intensity of sexual selection shapes the brain. Early research with primates identified a correlational relationship between neocortex size and social group size (a proxy for social complexity), and more recent research has begun comparative neuroanatomical examinations across mating systems [e.g. monogamy vs promiscuity; parental care vs non-parental]. One dimension of the social complexity and cognition interplay that has been largely unexplored is the precopulatory mating landscape. Research in my lab has focused on the complexity of the male mating environment in poeciliid fishes, the social landscape that females must navigate prior to copulation, as a selective force shaping female behavior and cognition. Poeciliid fishes offer a wide diversity in the number of male phenotypes or mating tactics a female may encounter; and a great deal of variation in female responses towards these males. Our neurogenomic research with *Xiphophorus nigrensis*, a poeciliid with a complex mating landscape, demonstrates that female preference response covaries with synaptic plasticity gene expression (genes linked to learning) in the brain; and that pharmacological modification of that pathway alters preference behavior. Interestingly, we found an opposite pattern of synaptic plasticity gene expression and preference behavior in female poeciliids with a simple mating landscape (*Gambusia affinis*), suggesting that learning modules are differentially engaged during pre-mating interactions across poeciliid taxa. This opposing pattern between poeciliid species stimulated two hypotheses we are currently testing: (1) that sexual selection has pleiotropic effects influencing cognitive processes that are predicted by mating system complexity, and (2) that cognitive-behavioral profiles will vary across mating systems due to costs associated with cognition. To test the relationship between cognition, behavioral tendencies and mating system, we are conducting a series of behavior (activity, sociability, anxiety, exploration, mate choice) and cognition (numerosity discrimination) assays across poeciliids. I will share with you recent results with *G. affinis* demonstrating sex-specific differences in cognitive-behavioral profiles; as well as our a priori predictions for how cognitive-behavioral profiles are likely to vary across poeciliid taxa.



### **IT03: Navigating in a three-dimensional world**

Burt de Perera, Theresa

University of Oxford, Department of Zoology, Oxford, England

To navigate around their local environment, animals must recognise their own position with respect to their goal. This task can be completed successfully if animals have a representation of space in their brain, built upon learning and remembering environmental features. We have a good understanding of how animals navigate horizontally from place to place, however the real world is three-dimensional and most individuals must also move vertically. This is taken to an extreme in flying or swimming animals, which move with six degrees of freedom (unlike those that are surface constrained that move with three). This adds a huge amount of complexity, and both humans and AI systems find it extremely hard to navigate through such environments. Given this, how do relative small-brained vertebrates, such as fish, cope? By using experimental and theoretical approaches, my group considers how pelagic and benthic fish deal with the problem of 3D navigation. We show that vertical and horizontal components of space are stored separately in the fishes' representation of space and that the vertical axis contains particularly salient spatial cues, including hydrostatic pressure, that fish can use to pinpoint their vertical position. We also demonstrate that freely swimming fish are able to accurately encode metric information (both distance and direction) in a volume. By comparing our work to the classical model system that is used in neuroethology, the surface-bound rat, we argue that fish have a supramodal representation of space that is seated in the lateral pallium and that is homologous to place cells found in the hippocampus of mammals. Further, we suggest that space is represented isotropically – in other words, the postulated neurones that encode space fire with a spherical distribution. More generally, we hypothesise that the representation of space in vertebrates' brains might be shaped by the degrees of freedom of movement that binds the animal. References: Burt de Perera, T. Holbrook, R and Davis, V. 2016. The representation of three-dimensional space in fish. *Frontiers in Behavioral Neuroscience*. Holbrook, R and Burt de Perera T. 2013. Three-dimensional spatial cognition: freely swimming fish accurately learn and remember metric information in a volume. *Animal Behaviour*, 86, 1077-1083. Taylor, G.K., Holbrook, R.I. and Burt de Perera, T. 2010. Fractional rate of change of swim-bladder volume is reliably related to absolute depth during vertical displacements in teleost fish. *Journal of the Royal Society Interface* 7, 1379-1382.



### **IT04: Locomotor Flexibility: Adaptive coordination and exploration in insect locomotion**

Dürr, Volker

University of Bielefeld, Department of Biological Cybernetics, Bielefeld, Germany

In many traditional studies on animal locomotion, experimental paradigms serve to focus on steady state behaviour and/or restrain the behaviour in favour of better control of experimental variables. While both of this is necessary for systematic probing of the effects of particular factors or parameters, it comes at the cost of potentially unnatural motor behaviour. This is because the essence of locomotion is the physical interaction of the body with its environment through transient contact events. Interfering with this interaction will affect the behaviour. Moreover, natural locomotion behaviour can be very variable. In my talk, I will argue that this variability should be considered a source of flexibility in the face of an unpredictable environment. Based on analyses of unrestrained walking and climbing in insects, I will discuss how the existence of distinct step types, spatial coordination among legs and rapid adjustments of reaching movements extend or challenge traditional views on terrestrial locomotion in insects. In particular, I will explain the concept underlying an established model of adaptive locomotion that was originally derived from behavioural experiments on walking insects and crayfish. I will show how recent results tell us how some of the core properties of this model may be implemented physiologically, and how the physical interaction of the body and its environment may be exploited in favour of adaptive coordination of multiple legs. Finally, I will expand the view on the intimate relationship between locomotion and active exploration, using active tactile sensing as an example. More specifically, I will illustrate how species with different limb proportions explore their ambient environment with distinctly different usage of their limbs, and show how contact events experienced by legs and antennae mutually affect the other limb type. I will discuss the role of distributed proprioception in active exploration, and highlight the relationship between active exploration and attention.



### **IT05: Twitter evolution: Birdsong, speech, and language**

Bolhuis, Johan J.

University of Utrecht, Department of Psychology, Utrecht, Netherland

A major stumbling block for the comparative analysis of language evolution is that, so far, there is no evidence for human-like language syntax in any non-human species. There is no a priori reason why a version of such a combinatorial computational system could not have evolved in non-human animals, either through common descent (e.g., apes) or convergent evolution (e.g., songbirds). Although the auditory-vocal domain is just one possible external interface for language (with signing being another), it could be argued that the strongest animal candidates for human-like syntax are songbirds and parrots. This is because they exhibit vocal imitation learning, a trait that is shared with certain marine mammals and hummingbirds, but that is absent in our closest relatives, the great apes. There are striking behavioural similarities between auditory-vocal learning in human infants and in songbirds. In both cases, auditory learning takes place during a sensitive period early in development, and there is a transitional period of early vocalisation which is called 'babbling' in humans and 'subsung' in birds. At the neural level, songbirds have 'Broca-like' brain regions involved in the production of song as well as in sensorimotor learning, and 'Wernicke-like' regions involved in auditory perception and memory. Furthermore, these regions exhibit patterns of hemispheric lateralisation that are very similar to those in human speech- and language related regions. Finally, there are interesting parallels regarding certain genes that are involved in vocalisation. Although birdsong can be quite complex, contrary to recent suggestions, to date there is no evidence to suggest that birdsong patterns exhibit the hierarchical syntactic structure that characterizes human language. Considering the evidence, an evolutionary scenario emerges where three factors are important. First, there is neural homology, where similar brain regions are involved in auditory learning and vocal production, not only in songbirds and humans, but also in other mammals. Second, there is evolutionary convergence with regard to the mechanisms of auditory-vocal learning, which proceeds in essentially the same way in songbirds and human infants, but not in non-human primates. Third, as yet there is no evidence to suggest that non-human animals possess the combinatorial complexity of human language syntax. It may be that the neural mechanisms that evolved from a common ancestor, combined with the auditory-vocal learning ability that evolved in



## Invited Talks

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both humans and songbirds, contributed to the emergence of language uniquely in the human lineage.



### **ST1.1: Long-distance relationships in mollies: the use of public information in mate choice is not affected by distance**

Gierszewski, Stefanie; Keil, Melissa; Witte, Klaudia

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Animals can gain additional information about potential mates by observing conspecifics during sexual interactions. They copy the mate choice of others when they prefer or reject the same individual, or another individual of the same phenotype, as the observed conspecific (the model) did. In standard mate-choice copying experiments in females, stimulus males and the model female are positioned directly next to each other without physical contact but providing visual information through glass at a typical distance of about 1 cm, a distance which can also be observed during courtship. In the wild, it may occur that a male and a female are still interacting although both are apart from each other. Therefore, we tested in sailfin molly females (*Poecilia latipinna*) whether females still copy the mate choice of another female when this model is 40 cm apart from the interacting male. We performed three mate-choice copying experiments with: (1) a distance of 1 cm between male and model; (2) a distance of 40 cm between male and model; and (3) no visible model as a control. We found that test females copied the mate choice of a model female when it was positioned at close proximity (1 cm) but also at larger distance (40 cm) to a prior non-preferred stimulus male. The strength of copying did not differ between both experiments and test females were consistent in their mate choice when no public information was provided. Our results show that even distant interactions between a male and a female model provide enough information to affect the mate choice of the observing female. We conclude that we have to keep in mind that the public information network in sailfin mollies functions in a much larger range than previously thought.



### **ST1.2: Cognition in bamboo sharks and freshwater stingrays**

Schlüssel, Vera

University of Bonn, Institute of Zoology, Bonn, Germany

Learning and memory functions were assessed in bamboo sharks (*Crespective hiloscyllium griseum*) and freshwater stingrays (*Potamotrygon motoro*) on a behavioural and neuronal level. Most behavioural studies were performed as two-alternative forced choice experiments, in which the positive stimulus was reinforced by a food reward. Selected spatial and visual discrimination experiments in sharks were complemented by lesion experiments or immediate-early gene expression studies using *egr-1* and *c-fos* to determine involvement of selected brain structures. Sharks and rays successfully mastered a variety of object recognition and categorization tasks and showed visual perception of illusionary contours, symmetry and movement, as well as spatial orientation and memory retention capabilities. Both lesion and gene expression studies in sharks indicate that even in the absence of a neocortex, selected cognitive functions are processed in the telencephalon, with some pallial regions matching potentially homologous areas in other vertebrates where similar functions are being processed. Results of these studies indicate that the here assessed cognitive abilities in bamboo sharks and freshwater stingrays are as well developed as in many other vertebrates, aiding them in activities such as food retrieval, predator avoidance, mate choice and habitat selection.



**ST1.3: Sharks can “see the magic” as well: 4 different optical illusions in the grey bamboo shark (*Chiloscyllium griseum*).**

Fuss, Theodora; Schlüssel, Vera

University of Bonn, Institute of Zoology, Department of Comparative Neurophysiology, Bonn, Germany

Juvenile bamboo sharks (*Chiloscyllium griseum*) were tested for their ability to perceive subjective, illusionary contours and 2 different size illusions. Individuals were able to discriminate between Kanizsa figures and alternative stimuli, and between subjective contours in >75% of all tests. However, sharks were not deceived by Müller-Lyer illusions and succumbed either to side preferences or chose according to chance. Similarly, sharks were neither deceived by Ebbinghaus-Titchener circles nor variations of the Delboeuf illusion. Instead, they seemed to choose according to assimilation effects. Effects of perceptual information processing mechanisms such as ‘filling-in’, ‘(a)modal completion’, ‘perceptual grouping’, and ‘local’ or ‘global’ visual perception were taken into account and are considered to be present in neural visual processing and associative interpretation of optical illusions in *Chiloscyllium griseum*.





**ST2.1: Visual discrimination of natural and artificial stimuli in pigeons (*Columba livia*)**

Matzinger, Theresa M. E. <sup>1</sup> ; Aust, Ulrike <sup>2</sup>

<sup>1</sup> Department of Cognitive Biology, University of Vienna, Austria <sup>2</sup> Messerli Research Institute, University of Veterinary Medicine Vienna, Medical University of Vienna, University of Vienna, Austria

For more than 50 years pigeons have been an important model species for testing avian discrimination and categorization abilities. In numerous studies, pigeons have been found able to discriminate between a wide variety of stimuli as diverse as geometrical figures, line drawings, paintings, point-light figures, photographs and many more. However, differences have repeatedly been reported regarding the ease and accuracy with which different tasks were solved and it has been suggested that the use of inappropriate stimulus material rather than general deficits in the birds' perceptual and/or cognitive skills may have been responsible for the pigeons' difficulties in dealing with certain discrimination tasks. The aim of the present study was to investigate the influence of naturalness and, respectively, artificiality of stimuli on pigeons' performance in visual discrimination tasks. To this end, three groups of pigeons were trained and tested on natural (colour photographs), semi-artificial (colour illustrations) and artificial (black and white line drawings) versions of otherwise identical stimuli in a two-alternative-forced-choice touchscreen procedure. Pigeons trained with natural and with semi-artificial stimuli acquired the task much more easily than pigeons trained with artificial stimuli. Furthermore, analysis of both response accuracies and latencies showed that transfer was possible (though poor) from natural to semi-artificial stimuli and vice versa, but not from natural and semi-artificial stimuli to artificial ones. Also, birds trained with natural and semi-artificial stimuli failed to generalize to greyscale versions of their training stimuli. By contrast, inversion or scrambling of the training stimuli did not impair performance. Taken together, the results suggest that mainly colour and texture features controlled the pigeons' discrimination and recognition of the presented stimuli, whereas orientation and configuration played only a subordinate role, if any. This finding confirms those of previous studies that have reported evidence of the importance of colour and texture information in pigeons' perception and categorization of visual stimuli.



### **ST2.2: Personality and learning via odour cues in bank voles**

Mazza, Valeria; Dammhahn, Melanie; Jacob, J.; Zaccaroni, M.; Eccard, Jana A.

University of Potsdam, Biochemistry and Biology, Potsdam, Germany

The ability to respond appropriately to environmental stimuli is essential to survival and mating success. How quickly the association between cue and response is formed, might depend on by among-individual differences in behaviour. To deepen our knowledge of this potential relation, we conducted an associative learning experiment in bank voles (*Myodes glareolus*) using olfactory cues. For 86 subjects we measured the learning speed of the association between a “neutral” odour (orange or pineapple juice) and reward, in a simple Y-maze. We also assessed the reversal learning speed, switching the positive and the negative cues. Lastly, we quantified among-individual differences repeatedly for activity levels, neophobia and risk-taking behaviour. We found that bolder, more active individuals were faster learners than less active, shy individuals. However, shyer, less active individuals were more flexible learners and learned the reversed task faster than bolder, active individuals. Furthermore, making the correct choice in the Y-maze required more time for both behavioural types, indicating the presence of a speed-accuracy trade-off. We could detect no differences in personality or in learning scores between the sexes. Our results are consistent with the hypothesis that among-individual differences are reflected in different “cognitive styles”, differentially trading off speed for flexibility in cognitive tasks. Among-individual differences thus seem to affect not only behaviour and physiology, but also cognitive performance, making their study more and more important in both ecological and evolutionary perspectives.



**ST2.3: Mate-copying of a natural trait in *Drosophila melanogaster***

Nöbel, Sabine; Isabel, Guillaume; Danchin, Etienne

Université Toulouse III Paul Sabatier, EDB Laboratoire Évolution & Diversité Biologique, Toulouse, France

Using social information constitutes a potential strategy to assess potential mates' quality by observing sexually interacting conspecifics. Mate-copying constitutes an example of such social learning in mate-choice. During mate-copying an observer individual sees sexual interactions between heterosexual conspecifics, which influence its future mate choice. Mate-copying has been demonstrated in a suite of vertebrate species, but concerning invertebrates only in *Drosophila melanogaster* with the use of artificial male phenotypes. Here, we show for the first time in an invertebrate that female fruit flies can also copy the choice for males with contrasting fitness affecting genotypes (wild types (WT) versus curly wings (Cy) mutants). When facing the choice between WT and Cy males, naïve females of both genotypes showed strong, but not equivalent, preferences for WT males. Our mate-copying experiment contained two phases: a demonstration followed by a copulation test. For the demonstration we either showed a female copulating with a Cy or a WT male plus a male of the opposite genotype standing by alone, while a naïve observer female (either Cy or WT) was watching. Afterwards, the observer female was given the choice between two new males, one of each genotype. Both, Cy and WT observer females, showed similar results in that they increased their preference for Cy after seeing another Cy male being selected during the demonstration. Interestingly, a demonstration for WT did not change the probability that the observer female would copulate with the WT males during the subsequent test. This shows for the first time in an invertebrate that mate-copying can also exist with natural fitness-related trait. This suggests that this social learning capacity may occur in nature.



### **ST2.4: Cross-modal object recognition and sensory processing in a fish**

Schumacher, Sarah; Burt de Perera, Theresa; Thenert, Johanna; von der Emde, Gerhard

Universität Bonn, Institut für Zoologie, Bonn, Germany

Within a multisensory system cross-modal object recognition increases flexibility, allowing an animal to react quickly to environmental changes. Dynamic weighting of sensory inputs enables the system to integrate multisensory information efficiently and to obtain a reliable overall percept. So far both abilities have only been shown in mammals, raising the question as to whether such high-level functions may be absent in animals lacking complex mammalian brain structures. We tested whether a non-mammalian vertebrate, the weakly electric fish *Gnathonemus petersii*, is capable of cross-modal object recognition and dynamic weighting of sensory inputs. The fish were trained to discriminate between two objects at a distance of 1 cm using either only vision, only the active electric sense or both senses. Subsequently, object discrimination at varying distances was tested in uni-modal trials (visually, electrically). When trained with both senses available, electrolocation dominated vision, leading to an inability/decreased ability to fulfil the visual tests at 1 cm distance. Fish trained with only vision or only the electric sense were subsequently able to solve the task using only the untrained sense, demonstrating cross-modal object recognition. In the electrically trained fish the electrosensory input dominated vision at short distances but with decreasing reliability of the electric input at longer distances, the performance increased, showing that the sensory inputs are weighted dynamically. Our results show for the first time that a fish is capable of cross-modal object recognition and dynamic weighting of sensory inputs and suggest that these cognitive abilities may be phylogenetically ancient mechanisms of vertebrates.



### **ST2.5: Mirror image stimulation- investigating self-recognition in crows**

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Inquiries of visual self-recognition involving mirrors date back to 1970 when Gordon G. Gallup designed the Mark Test and showed that chimpanzees are able to recognize themselves in mirrors. The Mark Test has since then become the approved method to test for self-recognition in animals and its passing has been connected to ToM and some form of self-awareness. Implementing this test, it has been shown that apart from humans several other species e.g. great apes, dolphins, Asian elephants and more recently magpies possess the ability of mirror self-recognition (MSR) and share a similar pattern as to the evolution of their behaviours in front of the mirror: 1. Social behaviour, 2. Mirror Inspection, 3. Contingency Checking, and 4. Mirror Guided Self-directed behaviours. The latter being a type of behaviour only performed by individuals considered able of MSR. Nevertheless, attempts to find MSR in other corvid species have so far failed, and with only few studies conducted it is difficult to explain these inter-species differences. The present study aimed to expand the number of corvid species tested in this assay and examines the response to mirror image stimulation in hooded and carrion crow hybrids (n=8). We found that the crows, as many bird species, exhibited a preference for viewing the mirror vs. the control and showed a common pattern as to the evolution of their behaviours in front of the mirror over time. When presented with a mirror the crows did not display the expected social behaviours, but did successively exhibited investigative and contingency checking behaviours. They however failed to show spontaneous self-exploration in front of the mirror and further failed to perform self- or mark-directed behaviours in the subsequent Mark Test, preventing claims about the ability of MSR to be made in the case of the carrion crow at this stage.



**ST2.6: Do wild Zebra Finches (*Taeniopygia guttata*) learn to use artificial symbols as cues to optimise foraging?**

Hardenbicker, Marie-Christin; Brandl, Hanja B.; Griffith, Simon C.; Schuett, Wiebke

Hamburg University, Department of Biology, Hamburg, Germany

Cognitive skills, such as remembering spatial or object-specific characteristics of food patches, can increase an individual's fitness and consequently its chance of survival. Especially in less predictable environments it should be beneficial to quickly learn how to find new valuable resources. Yet, cognitive abilities of individuals living in less predictable environments have rarely been studied in the natural habitat. In this study we examined whether wild, free-living zebra finches (*Taeniopygia guttata*) are able to associate object-specific cues with different food-types in the arid zone of Australia. Zebra finches were tested for their ability to distinguish between two artificial symbols and associate these with food of two different qualities. Prior to the experiment we verified that zebra finches preferred the high quality food. The results of the experiment suggest that zebra finches are capable of associating artificial symbols with different types of food. We discuss the findings in light of potential effects of food location and inter-individual differences in behaviour.



### **ST2.7: What do parrots talk about with their owners? Lexicon of African grey parrots kept as pets.**

Lindová, Jitka

Charles University, Faculty of Humanities, Prague, Czech Republic

Label acquisition projects with the grey parrot (*Psittacus erithacus*) demonstrated cognitive and communicative skills of this species comparable to great apes, including use of abstract concepts and combinations of “words” into simple “sentences”. In contrast, grey parrots kept in households as pets are considered to merely mimic human words. A study exploring the common nature of communication between the parrot and the owner is missing. We questioned 27 owners of pet grey parrots (age 0.5-11 yrs). Parrots produced 0-256 “words”. According to the owners, a vast majority of them was used context specifically. Vocal production and complexity increased gradually with age. We identified 8 functional categories of “words”: greetings, names, food, love expressions, instructions, conversational phrases, emotional words, and neutral. Greetings, names (of household members including the parrot itself), and food labels (e.g. food, water, nut) were among the first used “words”. According to Caselli et al. (1995), 4 out of 5 words acquired first by both English and Italian infants were greetings, names and food words. Next, the parrots acquire conversational words and phrases (e.g. love, honey, give me a kiss) and expressive words (e.g. ouch, yuck). This indicates that parrots do not only simply repeat words that are most frequent in the household, but are especially prone to remember and produce words that are used by the owner to contact the bird, and words that have a high emotional connotation. In consequence, apart from a limited capability to label objects and individuals, they are especially skilful at leading (“fake”) conversations with their owners.



### **ST2.8: The impact of elevated cortisol on personality traits in adolescent and adult caviies**

Guenther, Anja

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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. The mechanisms by which personality is shaped are poorly known, although the connection between personality traits and HPA-axis related hormones, mainly cortisol and corticosterone, has now been demonstrated in a number of species. In addition, it is known from the area of stress-research that elevated cortisol levels during development can have profound long-term effects upon physiology and behaviour. I investigate the effect of elevated cortisol levels during sexual maturation and during adulthood on personality traits in the south American wild cavy (*Cavia aperea*). The animals were tested several times for stress-coping, boldness, exploration and aggressiveness following a cortisol treatment for three weeks. First results indicate more passive stress coping and enhanced aggressiveness in animals that received cortisol compared to a control group. Furthermore, the effects are only present in animals that received the treatment during adolescents while adult personality is not influenced by the treatment.





### **ST3.1: Prospecting in wild zebra finches – the effect of brood size manipulation on breeding decisions**

Brandl, Hanja B.; Griffith, Simon C.; Schuett, Wiebke

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In harsh and unpredictable environments information about the surrounding can be crucial for survival and successful reproduction. Nevertheless, very little is known about the mechanisms and significance of information use in unpredictable habitats, such as arid zones. We tested the hypothesis that perceived breeding success of conspecifics serve as cue for habitat quality and hence influence breeding decisions, both breeding habitat choice and investment in a brood. We conducted a brood size manipulation experiment in an opportunistic breeder, the zebra finch (*Taeniopygia guttata*) in Australia. Zebra finches often visit, i.e. prospect on, the nests of conspecifics, likely to obtain social information. In 6 areas, clutch sizes of more than 300 nests of breeding zebra finches were either all enlarged or reduced throughout the breeding season and breeding decisions of subsequent breeders were monitored. Our findings show that the number of naturally laid eggs was not considerably affected by the brood size manipulation. Hatching success increased over the season, while pairs that were recorded during two consecutive broods significantly decreased the clutch size of the second broods. The results suggest that zebra finches employ high opportunism as a key strategy for reproduction in an unpredictable environment. Laying as many eggs as possible in their own inherent condition might pose a lower risk than to strongly rely on social information, which can be unreliable. Also, personal information obtained by experience appears to be important.



**ST3.2: Female reproductive behaviour under infanticide risk**

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The potential threat to parents of losing offspring to infanticidal conspecifics is widespread in the animal kingdom. If infanticide occurs, this poses an enormous fitness cost to parents, in terms of losing out on reproductive investment made. Therefore, the level of infanticide risk that a parent perceives should importantly affect its behavioural strategy, for instance, in terms of offspring protection. Using the bank vole, *Myodes glareolus*, as a model species we experimentally investigated how infanticide risk affects behaviour. Bank voles have rapid reproductive cycles, producing a new litter every few weeks, and infanticide has been shown to occur, especially by conspecific males that are unrelated to the offspring. Females show post-partum estrus, i.e. they are receptive again immediately after giving birth, and therefore must search for a mate to fertilize their subsequent litter while at the same time providing parental care and protection to their existing litter. This trait makes rodent females especially prone to the trade-off between current and future reproduction, and thus ideal to study the existence of behavioural reproductive strategies in response to the level of infanticide risk. Females were mated in the laboratory with known males and, shortly after parturition, were released with their litter in a nest box in outdoor enclosures. By spreading either the familiar scent of her litter's sire or the scent of an unfamiliar male in the area surrounding the female's point of release, we simulated low and high infanticide risk respectively. Using automated radio telemetry and RFID reading stations, we studied the effects of scent treatment on female spatial behaviour, including her presence/absence at the nest, activity level and movement pattern. We discuss findings of how infanticide risk posed by a potential mate partner affects female behaviour indicative of her investment in future reproduction (e.g. time away from the nest to find the mate) versus current reproduction (e.g. time at the nest to guard her litter).



### **ST3.3: Effects of female density on mating decisions in a sexually cannibalistic spider *Argiope bruennichi***

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Sexual selection theory predicts that investment in a current mate should be a function of mate availability and competition. In sexually cannibalistic spiders, such as *Argiope bruennichi*, male mating investment is very high, but males can choose between investing maximally into a single female (monogyny) or splitting investment between two females (bigyny). Previous experiments have shown that males respond to chemical cues from females and we assume that differences in density could also be perceived through volatile cues. We tested the hypothesis that males would be more likely to use the bigynous mating tactic under high female densities. We used test arenas, in which males perceived pheromone signals from either one or four females before they start their mate searching and make their mating decision. The frequency of the bigynous male mating tactic did not differ between high or low female densities. From a female's perspective, an increased female density might increase competition for males and affect signalling effort. Therefore, our second hypothesis was that females under competition produce more pheromones to attract males with a higher probability. To test this idea we let males choose between two females of which only one had been exposed to other females. Against our prediction, females under competition did not attract males with a higher probability. We conclude that the fitness of males and females is far less influenced by female density than by female quality which is known to affect male choosiness but also the ability to attract males.



**ST3.4: Social foraging and exploitative behaviour: the maintenance of cooperation in spiders**

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Although social foraging provides benefits, such as faster discovery and communal protection of food sources, it also entails costs that challenge the maintenance of cooperation. When only a few individuals are needed to secure a collective food source, group members may exploit the efforts of others. Theory and experimental evidence indicate that members of social foraging groups specialize in either ‘producing’, where they acquire and share food, or in ‘scrounging’, where they feed on the food others acquired. It is yet unclear whether producing is a cooperative behaviour, meaning that producers readily share, or whether producing is merely the consequence of the scroungers’ competitive efforts to obtain parts of the food source. Furthermore, it remains to be studied how the producer-type is retained despite the higher costs of this behaviour. As a possible explanation, the spread of the scrounger-type might be limited if groups of scroungers had reduced individual food intake because they don’t share and consequently compete over food. To test this hypothesis, the present study investigated the effect of biased feeding-type compositions on social foraging performance in the subsocial crab spider *Australomisidia ergandros*. We created *A. ergandros* groups of two extreme compositions (all producers or all scroungers) and documented the groups’ predatory success and communal feeding behaviour over three weeks. Scrounger-groups performed significantly worse in nearly all recorded parameters, including individual weight gain and survival. When only comparing successful attacks between group compositions, we moreover found extensive scrounging in producer-groups and reduced communal feeding in scrounger-groups, suggesting that producing is indeed a cooperative behaviour. Overall, our findings explain the maintenance of the cooperative producer-type, and thus the advantages of feeding type variation in social foraging groups.



### **ST4.1: Cooperatively breeding fish benefit from anti-predator vigilance**

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Group living can increase protection from predators through enhanced vigilance, often referred to as the “many eyes effect”. Predation risk has been shown to select for sociality and cooperation, partly due to the benefits of task sharing in anti-predator defense. Here we tested whether group members of the cooperatively breeding fish *Neolamprologus pulcher* may benefit from increased predator protection also through enhanced vigilance. We repeatedly exposed single individuals and differently sized groups to computer animated photos of sympatric cichlid fish depicting either a dangerous predator or a harmless herbivore. Individuals in groups generally responded faster to the presentations than single individuals, and this effect increased with group size. Furthermore, groups responded less often inappropriately to the presentation of harmless herbivores. These results reveal potential benefits of increased vigilance behavior in a cooperative breeder, which adds to the accumulating evidence for the importance of predation risk in the evolution of complex social organization.



### **ST4.2: Context-dependent reproductive decisions along an ecological gradient**

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Many studies on mating and parenting decisions thus far have been carried out while ignoring the population ecological context. Here I address the question how sexual selection and its natural context interact in a small annual marine fish with exclusive paternal care, the common goby (*Pomatoschistus microps*) occurring in the Baltic sea along a steep salinity gradient. Specifically, field and behavioural experiments were carried out to study interactions between reproductive decisions and the perception of the environmental context. The results elucidate the seasonal and spatial plasticity of reproductive traits and decisions in populations with changing environmental contexts and highlight the importance of direct and indirect density effects. Insights in temporal dynamics of the mating system interacting with the natural context and its potential population level evolutionary consequences shall be discussed.



### **ST4.3: Shoal sex composition and predation risk influence sub-adult three-spined stickleback shoaling decisions**

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Group formation as an anti-predator behaviour is a common phenomenon throughout the animal kingdom and is most effective when all individuals are behaviourally and phenotypically similar. Shoal preferences are influenced by the individual, the members of the shoal, and the environmental conditions. While shoaling behaviour has been studied extensively in the three-spined stickleback (*Gasterosteus aculeatus*), it is unclear whether sex of shoal mates has an influence on the shoal preference of non-reproductive males and females and how this changes under increasing predation risk. Although non-reproductively active sub-adult sticklebacks are sexually monomorphic in appearance, behavioural differences may result in sexual segregation when shoaling. Here we show that male and female sub-adult three-spined sticklebacks had contrasting preferences for shoal mate sex, and that this preference was dependent on the level of predation risk during standardised experimental choice tests. When an individual was presented with an all-male shoal and an all-female shoal (each consisting of four individuals), both the sex of the test individual and predation risk (either tested in tap or perch (*Perca fluviatilis*) water) significantly influenced the shoal preference. Furthermore, sub-adult males showed a prominent shoaling preference for same-sex shoals under high predation risk. Our results demonstrate that behavioural differences between sexes in species with a sexually monomorphic non-reproductive stage are sufficient to result in an association preference for a certain sex. Most studies examining sexual segregation focus on sexually dimorphic species, but these results highlight the potentially widespread occurrence of sexual segregation beyond the sexually dimorphic reproductive stage.



### **ST4.4: Dis-assortative female mate choice for boldness in a monogamous cichlid**

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Although the existence of personality differences, i.e. consistent between-individual differences in behaviour, has been well described over the last decade the adaptive value of stable personality variation remains unclear. Here, we tested whether sexual selection may play a major role in generating and maintaining personality variation in a monogamous, biparental cichlid, *Pelvicachromis pulcher*. We measured male and female boldness (activity under simulated predation risk) repeatedly to assess the behavioural level and behavioural consistency as well as short- and long-term personality variation for all individuals. Females were allowed to choose between two males differing in their natural boldness using a standard mate choice test. Prior to mate choice, females could observe these two males expressing their natural boldness. We found significant short- and long-term personality variation in both sexes. Further, females showed a dis-assortative preference pattern for the behavioural level: shy females preferred bold males and bold females preferred shy males. The behavioural consistency did not affect female mate choice. Such dis-assortative preference patterns might increase mate compatibility. Our results provide suggestive evidence that personality differences are sexually selected.





### **ST4.5: Influence of inter-individual differences on individual movement and space use behaviour in different species**

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In the growing research area of inter-individual differences, i.e. animal personality traits, the consequences of that consistent intra-specific variation for ecological interactions within- and between species are often disregarded. Research of the last decades has provided many examples for inter-individual differences in behaviour, in a variety of taxa, but these studies, often performed in the laboratory, have mainly focused on the characterizations of patterns of variation and the understanding of proximate and ultimate causation. The aim of the present study was to test to what extent inter-individual differences in exploration, boldness and activity influence the intra-specific space use and movement patterns of two rodent species, the bank vole (*Myodes glareolus*, n=22) and the striped field mouse (*Apodemus agrarius*, n=15), under natural conditions. Individuals of each species, originating from three subpopulations from northeast Germany, were captured in their natural habitat and inter-individual differences in exploration, boldness and activity were quantified directly in the field. Subsequently, space use and movement patterns were monitored via automated VHF telemetry for both study species. We found that within each species bolder, more explorative individuals occupied larger home ranges, estimated via kernel density analysis, and obtained longer movement paths. Furthermore, home ranges of individuals of similar behavioural types intra-specifically overlapped to a higher extent with each other than those of individuals that differed more in their behavioural type. This intra-specifically, non-random spatial distribution of behavioural types within a habitat might reduce intra-specific resource competition and thereby affect ecological interactions within- and between species.



**ST4.6: Data on the ecology of Nigerian-Cameroonian Chimpanzees (*Pan troglodytes ellioti*) and Cross-River Gorillas (*Gorilla gorilla diehli*).**

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The Lebiale Highlands of West Cameroon still house small populations of Nigeria-Cameroon Chimpanzees (*Pan troglodytes ellioti*) and Cross-River Gorillas (*Gorilla gorilla diehli*). We studied these primates in the Tofala Reserve. The Tofala primate population marks the most southeastern range of Cross-River Gorillas, the only area for which no scientific data are available. The anthropogenic pressure exerted upon the chimpanzees and the gorillas living in the examined area is very high because there are ten villages adjacent to the area. We wanted to find out if there are special adaptations due to the high human pressure and how the two populations distinguish compared to other chimpanzee and gorilla groups of these subspecies. Our findings show that both species living in the examined area prefer to build the nests on steep hillsides instead of building them, as they usually do otherwise, close to food resources. Cross River Gorillas generally looked for herbivorous food on farms that had been illegally built in the forest. By contrast, chimpanzees mainly had a frugivorous diet.



### **ST5.1: Biosonar encoding of surface waves: bats' perceptual sensitivity to spatial and temporal frequency**

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Bats use echolocation as the main remote sense to image their environment. They emit ultrasonic signals and extract object information from the returning echoes e.g. distance, size, surface properties or position. Many bats from diverse taxa have specialised in trawling prey from water surfaces. Trawling bats foraging on agitated water surfaces must process both the structure and the movement of the waves, i.e. the waves' spatial and temporal frequency. Echolocation seems to be ill-suited for either of the tasks. Firstly, echo features like frequency, duration or loudness hold no direct cues on the spatial layout of the environment because the bat cochlea represents echoes along an audio-frequency axis, not along spatial axes like the retina. Therefore bats must compute a spatial representation from the spectro-temporal echo representations in their ears. Secondly, echolocation is stroboscopic. A bat emits a very short call (<5ms), then must be silent in order to hear the returning echoes. Variations in echo delay must be sampled across a sequence of call-echo pairs and for e.g. fast periodic changes in echo delay the bat may run into perceptual errors such as aliasing. In order to find out how bats meet these challenges we have systematically evaluated their perceptual sensitivity 1) to spatial frequency (meaning periodic change as a function of space) and 2) to temporal frequency (meaning periodic change in echo delay as a function of time). In two formal psychophysical experiments, echolocating bats of the species *Phyllostomus discolor* were trained and tested in the discrimination of two targets. In experiment 1), the reference target had a spatial frequency of 0 /m, corresponding to a flat surface, while the test target was covered with concentric waves of varying spatial frequencies. In experiment 2), the reference target had a temporal frequency of 0 Hz, corresponding to an immobile target, while the test target's distance (and thus its echo delay) was modulated at varying temporal frequencies (1-1000 Hz). Our results clearly show that echolocation in bats is more sensitive to higher spatial frequencies than to lower spatial frequencies. While the bats needed a wave height of about  $\pm 9$  mm at a spatial frequency of 8.9 /m for discrimination, the just noticeable wave height decreased with



increasing spatial frequency to  $\pm 1$  mm at a spatial frequency of 71.1 /m. Preliminary data on the temporal frequency sensitivity suggests that the sensitivity is highest to periodic changes of 1000 Hz and decreases towards temporal frequencies of around 50 Hz. For modulation frequencies below 20 Hz, sensitivity improves again. These results are discussed with respect to different perceptual cues available to the bats, especially the interplay of modulation frequency and inter-call-interval. Overall, these findings have the following implications for the biosonar encoding of surface waves: While a still water surface exposes a floating prey item, an agitated water surface reflects echoes that mask prey-generated echoes. By applying a perceptual high-pass filter for spatial frequency, bats can circumvent this masking effect and segregate prey from background according to spatial frequency. Bats' excellent skills regarding the analysis of minute temporal differences possibly grants them the ability to track target modulations across a sequence of echoes. While a high sensitivity to high modulation frequencies may serve the detection of small insects' fast wing beats, a high sensitivity to low modulation frequencies may allow trawling bats to track the movement of floating prey and even use prey-generated water ripples as foraging cues.



**ST5.2: Mole-rats like it hot**

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The naked mole-rat, a subterranean rodent (Bathyerigidae) gained popularity within the last 35 years thanks to its hairlessness, eusociality, heterothermia, longevity, resistance against cancer, and tolerance of pain mediated by skin receptors. While before 1980 almost unknown, today it is kept in many zoos and institutions all over the world and it has become a prospective model animal in biomedical research. Its alleged uniqueness is, however, a complex of traits which frequently characterize also other bathyerigids or even other subterranean mammals. Here we studied the reduced perception of pain (nociception) due to skin irritation. Chemoreceptors at free nerve endings which participate in nociception react on protons and in mammals (not in birds and amphibians) on capsaicin. The naked mole-rat does not react on subcutaneously injected capsaicin because neuropeptides SP and CGRP which are needed for nociception are missing in the skin and mucosa. The changes in the nociceptive system of the naked mole-rat are considered an adaptation to high concentration of carbon dioxide in burrows which can result in acidosis of tissues and thus in pain. If this is a real ecophysiological adaptation we have to expect convergent adaptations also in other subterranean mammals. We have tested this hypothesis, yet have chosen a non-invasive "voluntary" method - instead of injecting capsaicin under the skin we have offered food soaked in solution of capsaicin of different concentrations. We found that all the tested species of subterranean rodents (*Heterocephalus glaber*, *Heliophobius argenteocinereus*, *Fukomys anselli*, *F. darlingi*, *F. kafuensis*, *F. mechowii*, *F. micklei*, *Spalacopus cyanus*) accepted readily capsaicin-treated food (even in very strong concentrations) and most tested individuals did not react after consumption. Only a very few individuals exhibited behavioural changes indicating discomfort. The epigeic species (*Microtus arvalis* and *Acomys dimidatus*) under study avoided capsaicin and in the case of contact showed distinct reactions.



### **ST5.3: Female brain size affects the assessment of male attractiveness during mate choice**

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Mate choice decisions are central in sexual selection theory aimed to understand how sexual traits evolve and their role in evolutionary diversification. Here we test the hypothesis that brain size and cognitive ability are important for accurate assessment of partner quality and that variation in brain size and cognitive ability underlies variation in mate choice. We compared sexual preference in guppy female lines selected for divergence in relative brain size, which we have previously shown to have substantial differences in cognitive ability. In a dichotomous choice test, large-brained and wild-type females showed strong preference for males with color traits that predict attractiveness in this species. In contrast, small-brained females showed no preference for males with such traits. In depth analysis of optomotor response to color cues and gene expression of key opsins in the eye revealed that the observed differences were not due to differences in visual perception of color, indicating that differences in the ability to process indicators of attractiveness are responsible. We thus provide the first experimental support that individual variation in brain size impacts mate choice decisions and conclude that differences in cognitive ability may be an important underlying mechanism behind variation in female mate choice.



### **ST5.4: Relative value perception in an insect: expectations and effort influence the perceived quality of food sources in the ant *Lasius niger***

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Animals are often considered economically rational, in that they assign fixed values to resources of fixed absolute qualities. However, humans show relative value perception the value assigned to a resource is affected by many things, included their prior expectations and the effort invested in obtaining a reward. The explanation for such relative value perception often involves complex cognition, such as self-justification or fear of loss. Some non-human vertebrates also show relative value perception. In a series of experiments, we test whether the value perception of individual ant foragers is also distorted by expectations or effort. We find that ants which expect high quality food but receive medium quality food undervalue the medium quality food, and vice versa for an expectation of low quality. This demonstrates that ants value qualities relative to a reference point, much as humans do a prediction of Prospect Theory. We further show that ants suffer from expectation disconfirmation, and devalue food which is different, but not worse, than they expect: Ants expecting rosemary scented food devalue lemon scented food of the same quality, and vice versa. Lastly, we show that ants overvalue food gained after a greater investment of either physical or cognitive effort: Ants overvalue food gained after climbing a high-effort vertical path as opposed to a low effort horizontal path, and preferentially choose cues associated with high effort. Ants also overvalue food which requires the memorisation of a turn, when compared to food reached by an identical path in which no learning is required. These many parallels between humans, non-human vertebrates, and insects suggest that relative value perception is a strongly adaptive behaviour. We suggest that such relative value perception allows animals to better respond to a changing environment.



### **ST5.5: Phonotactic orientation during flight of the parasitoid fly *Emblemasoma auditrix* (Diptera: Sarcophagidae)**

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The parasitoid fly *Emblemasoma auditrix* locates its hosts by using acoustic cues from sound producing males of the cicada *Okanagana rimosa*. Phonotaxis has to be performed in three-dimensional space. Here, we experimentally analysed the flight path of the phonotaxis from a landmark to a sound source especially in respect to the vertical orientation. Vertical flight direction angles were initially negative (directed downwards relative to starting position), grew positive (directed upwards) in the second half of the flight and eventually flattened (directed horizontally or slightly upwards), typically resulting in a landing above the loudspeaker. This phonotactic flight pattern was largely independent from sound pressure level or target distance, but depended on the elevation of the sound source. The flight velocity was partially influenced by sound pressure level and distance, but also by elevation. The more elevated the target, the lower was the speed. The accuracy of flight increased with elevation of the target as well as the landing precision. The minimal vertical angle difference eliciting differences in behaviour was  $10^\circ$ . By changing the elevation of the acoustic target after take-off, we showed that the fly is able to orientate acoustically while flying. The precision of acoustic orientation depends on the auditory behaviour as well as on the directionality of the hearing system. Therefore, we experimentally analysed the fly's phonotactic behaviour in the field also for dependence of the frequency composition of the attractive acoustic signal. Flight parameters depended on the frequency composition of the signal. In conclusion the flies may use the frequency components as an additional mechanism to improve the sound source localisation.





### **ST5.6: Traffic noise drowns out great tit alarm calls**

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Anthropogenic noise is one of the fastest growing and ubiquitous types of environmental pollution, and it can impair acoustic communication in a variety of animals. Recent research has shown that birds can reduce signal masking by adjusting acoustic parameters of songs in noisy environments, but we know little about other types of vocalizations. Anti-predator signals contain subtle information that is critical for avoiding predation, and failure to detect these calls due to anthropogenic noise could have large fitness consequences by negatively impacting survival. We investigated whether traffic noise impacts the production and perception of avian alarm calls using a combination of lab and field experiments with great tits (*Parus major*), a songbird that frequently inhabits noise-polluted environments. In response to experimental noise manipulation in controlled laboratory conditions, great tits increased the amplitude, but not frequency parameters, of their alarm calls. Playback experiments conducted in the wild indicate that current levels of road traffic noise mask alarm calls, impeding the ability of great tits to perceive these critical signals. These results show that despite the vocal adjustments used to compensate for anthropogenic noise, great tits are not able to restore the active space of their calls in even moderately noisy environments. Consequently, birds are likely to suffer from increased predation risk under noise, with likely effects on their behaviour, populations, and community dynamics in noise-polluted areas.



### **ST5.7: The importance of underwater sound: Noise can affect mating behavior and reproduction in vocal fish.**

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Increasing levels of underwater noise from for example boats and wind farms are a major cause of concern, and are likely to hamper acoustic communication under water. Fish are a highly vocal taxa. Even though this is still not widely known, over 800 species of fish have been documented to produce sounds, often during reproduction. When such reproductive signals are affected by human made noise, this could lead to a decrease in reproductive success or a change in sexual selection. The two-spotted goby (*Gobiusculus flavescens*) and the painted goby (*Pomatoschistus pictus*) are closely related, but live in different habitats. In both species males defend a nest, attract females to spawn and take care of the eggs until they hatch. We compared visual and acoustic male courtship and female spawning in a noisy versus a quiet environment. Males of both species reacted similarly to increased noise levels: In the noisy treatment males used less of the call type that was most masked by the experimental noise. Visual courtship decreased partially in noisy conditions as well. In the painted goby, we found that females were significantly less likely to spawn in the noisy treatment and they spawned with different males. Thus, reproductive behaviour, reproductive success and sexual selection can be affected by noise in these species.



### **ST6.1: Functional correlates of fluorescent color patterns across the fish phylogeny**

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Marine environments are largely devoid of ambient red light because water rapidly attenuates long wavelength photons. This rare “red” spectral component opens scope for exploitation by those who can perceive and/or locally generate red light, for example through fluorescent pigments. The recent discovery of phylogenetically widespread biofluorescence among marine fish has triggered extensive research on its putative behavioral functions. While current experimental investigation is restricted to a small set of model species, we lack insights into the broader evolutionary significance of this phenomenon. We therefore apply a comparative approach to investigate correlates of red fluorescence across the phylogeny of more than 600 marine fish species covering 90 families and 21 orders. Based on a priori hypothesis regarding function, we compare the prevalence of red fluorescence among pre-defined sets of species based on their ecological or biological characteristics, and after controlling for shared ancestry. Specifically, we assess whether the phylogenetic distribution of red fluorescence coincides with functions in contrast enhancement, sexual signaling, within-group communication, prey detection based on retroreflection, or camouflage. Moreover, we quantify and categorize the diversity of fluorescent color patterns based on spectral measurements in more than 100 species of fish. Our dataset reveals how the diversity and putative functions of biofluorescence map on the evolutionary history of fishes, and thus provides novel insights into the general significance of this covert mechanism in signaling and foraging.



**ST6.2: Court and spark in the wild: communication at the limits of sensation**

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The active electrosensory system of Neotropical weakly electric fish is used for electrolocation of objects and for communication. Electrocommunication signals like chirps are brief frequency modulations of the periodic electric organ discharges (EOD) of *Apteronotus* species. These signals have been studied in detail in the lab, but their meaning is still debated. We developed a submerged multi-electrode array and tracked communication behavior of *A. rostratus* in their Neotropical habitats in Panama with high spatio-temporal resolution. This big-data approach allowed us to clearly link signals to behavior. Highly stereotyped patterns of small chirps leading up to a long chirp emitted exclusively by the female synchronized spawning in courting dyads. The sub-second precision of male echo responses in these interactions and their importance for reproduction is contrasted by a surprisingly weak activation of the electrosensory system because of frequency mismatch arising from sexual dimorphism in EOD frequency. On the other hand, electrocommunication in same-sex aggressive encounters matches frequency tuning of receptor neurons well but occurs at distances of up to 1.7 m where electric signals decayed down to the microvolt range. Our field data identify a number of behaviorally relevant electrosensory stimuli that are poorly encoded by electroreceptor neurons and thus point to computational challenges faced and solved by sensory systems at the limits of sensation. Our results on natural stimulus statistics demonstrate that a much larger stimulus space has to be probed in further physiological studies on the processing of communication signals by the electrosensory system.



**ST6.3: Linking brain activity to odour-guided behaviour in the hawkmoth *Manduca sexta***

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Female hawkmoths, *Manduca sexta*, use olfactory cues to locate nectar sources and oviposition sites. These environmental odours are coded as spatial activation patterns across the antennal lobe, the first olfactory neuropil of the insect's brain. We investigated if the valence of an odour is represented already at this early processing level. Using in vivo calcium imaging, we first established a functional atlas of the antennal lobe by stimulating the moths with a panel of 100 monomolecular compounds belonging to different chemical classes (terpenes, aromatics, aldehydes, alcohols, esters, ketones, and acids). A subset of the compounds was used as diagnostic odours that enabled us to identify 23 activity spots, so-called olfactory glomeruli. These functional units of the antennal lobe had distinct response spectra but were mainly broadly tuned, indicating a combinatorial olfactory coding strategy. In order to study the innate significance of the tested odours, i.e. which odours might act as feeding stimuli, and which odours are repellent, we tested the compounds in two-choice experiments (odour versus solvent) in a wind tunnel. We found that moths were highly attracted by some of the odours, especially by aromatics and esters, while other odours like acids and aldehydes were avoided. Linking our behavioural results with the obtained functional activity patterns in the brain revealed that innate olfactory valence is encoded in the moth's antennal lobe by two groups of glomeruli that are preferentially activated by attractive or aversive odours, respectively.



**ST6.4: Hawkmoths evaluate scenting flowers with the tips of their tongues**

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In order to forage efficiently nectar feeding animals need to make informed choices about individual flowers. This is particularly important for pollinators such as hummingbirds or hawkmoths, which feed during hovering flight - making their decisions particularly costly. In a natural environment however, floral odors are quickly intermixed with other volatile compounds from the environment such as green leaves or neighboring flowers. Due to this a hawkmoth might need to evaluate individual flowers at a close range before investing energetically costly hovering time. When we tested the hawkmoth *Manduca sexta* in a semi-natural free flight tent assay we found that the moth approached wild-type *Nicotiana attenuata* flowers just as often as neighboring flowers in which the emissions of the main flower compound had been genetically silenced. In spite of this, nectar uptake was drastically reduced in scentless flowers, indicating a low degree of foraging success by the moth. Further tests in a wind tunnel revealed that also pollen take-up and pollen delivery on scentless flowers was strongly reduced due to a lower time investment of the hawkmoth into odor-free flowers. However, as these tests indicated that the hawkmoth considered volatiles of individual flowers mainly in the close vicinity, we hypothesized a mechanism for close-range odor detection, in addition to the odor detection by the moth antenna. Using morphological, molecular and electrophysiological approaches we demonstrated the presence of olfactory neurons on the moth proboscis, which respond strongly to floral volatiles. To further explore the behavioral significance of these neurons, two-choice assay was developed, in which only the moth proboscis was exposed to the flower odors. Through this we could demonstrate that the proboscis neurons were indeed sufficient to mediate the increased time investment into scented flowers and could thus also help to explain the higher foraging and pollination success of the moth on these flowers. Taken together, our results highlight the importance of volatile signals for plant- pollinator interactions and therefore also for the co-evolution of these two mutualistic partners.



**ST7.1: Active photolocation using modified ambient light in diurnal marine fishes**

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Marine fishes possess a diversity of ways to modify and reflect or re-emit incoming light from their eyes. We study the possibility that this can generate perceptible reflections in the eyes of cryptic prey and predators, revealing their location. I shall present experimental and visual modelling data that support the idea of "active photolocation" in our model species, a small triplefin from the Mediterranean. Further examples from other species suggest a widespread, diverse phenomenon with far-ranging consequences for the evolution of eyes in both detecting and detected organisms.



**ST7.2: Sensory-drive speciation: visual development affects colour-based mate preference**

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Sensory drive predicts a co-evolutionary relationship between sensory systems and signals. Aquatic environments provide a natural spectral gradient that is useful for exploring such coevolution. *Pundamilia pundamila* and *Pundamilia nyererei* are two sympatric species found at rocky islands across southern portions of Lake Victoria, differing in male coloration and the depth they reside. Previous work has shown species differentiation in colour discrimination, corresponding to divergent female preferences for conspecific male coloration. A mechanistic link between colour vision and preference would provide a rapid route to reproductive isolation between divergently adapting populations. This link is tested by experimental manipulation of colour vision - raising both species and their hybrids under light conditions mimicking shallow and deep habitats. Using two-way mate choice, we test female preference under both light conditions and then quantify the expression of retinal opsins. We find behavioural support for sensory drive - rearing light significantly affects female preference and 'natural' rearing light increases species assortativeness - suggesting that differences in visual perception underlie variation in mate preference.





### **ST7.3: Ultrasonic communication in rodents**

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Rats are highly social animals, with a rich social behavior repertoire. They emit distinct types of ultrasonic vocalizations (USV), which serve as situation-dependent socio-affective signals with important communicative functions. Low-frequency 22-kHz USV typically occur in aversive situations, such as social defeat or predator exposure, whereas high-frequency 50-kHz USV can be observed in appetitive situations, like social play in juveniles or mating in adults (Lukas & Wöhr, *Psychoneuroendocrinology*, 2015). Importantly, the two main USV types serve distinct communicative functions and induce call-specific behavioral responses in the receiver. While 22-kHz USV serve as alarm calls and induce freezing behavior in the receiver, 50-kHz USV lead to social approach behavior, indicating a pro-social, affiliative communicative function (Seffer et al., *Frontiers in Behavioral Neuroscience*, 2015). The opposite behavioral responses are paralleled by distinct patterns of brain activation. Freezing elicited by 22-kHz USV is accompanied by increased neuronal activity in brain areas regulating fear and anxiety, such as the amygdala. In contrast, social approach behavior evoked by 50-kHz USV is paralleled by reduced activity levels in the amygdala, but enhanced activity and dopamine release in the nucleus accumbens, a brain area implicated in reward processing (Willuhn et al., *The Journal of Neuroscience*, 2014). Together, this indicates that affective USV might be an important tool for studying the neurobiology underlying socio-affective communication in rats.



**ST7.5: Volatile sampling to study olfactory communication in mammals**

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Mammals can derive a variety of information from the body odour of conspecifics. Scent can be used for species, group or individual identification, as well as to determine sex or dominance rank. Sampling of body odour in non-human mammals is mostly done by rubbing cotton swabs over the fur of the animal and extracting the substances on the swabs with solvents. Alternatively, thermodesorption tubes can be used, which is a common method in the research field of plant ecology. This sampling method includes less contamination, enables storage at ambient temperature and captures more volatile substances compared to cotton swab sampling. In both methods, samples are subsequently measured with gas chromatography – mass spectrometry (GC-MS) in the lab. A third possibility is the use of a mobile GC-MS with thermodesorption tubes that can measure body odour samples immediately in the field without storage. A comparison of the available methods was done with samples of common marmosets (*Callithrix jacchus*) collected in parallel with cotton swabs, thermodesorption tubes and a mobile GC-MS device. Furthermore, we tested the applicability of thermodesorption tubes for potential sampling of



mammals which move freely. Samples of varying distance from the animal, different sample volumes and different inter-individual distance were taken from two populations of meerkats (*Suricata suricatta*). We successfully applied this method to demonstrate differences between the chemical profiles of the two populations. Based on the results of these two pilot studies, we provide an optimized protocol for sampling body odour of non-human mammals to study the information chemically encoded therein. This protocol would be applicable for field-studies on questions such as population differences, group membership, kin discrimination or fertility differences over the menstrual cycle.



**ST8.1: Limited evidence for ‘proper’ third party punishment in *Labroides dimidiatus***

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In humans, a failure to help/cooperate may lead to punishment by an otherwise uninvolved observer. Individuals may benefit from providing such third-party punishment in the future, for example through a gain in reputation. Previous studies showed that a simple form of third party punishment occurs in the bluestreak cleaner wrasse (*Labroides dimidiatus*): larger males may chase her female partner for cheating a jointly inspected client reef fish due to the female behaving more cooperatively during future joint inspections. This in turn allows the male to eat more off those future clients. Importantly, however, males are not truly bystanders when females cheat a jointly inspected client but suffer immediate loss of foraging opportunities due to the client leaving. Therefore, we tested whether males would also punish a female for cheating a client that she inspected alone but in his presence. We used an experimental paradigm in which we offered food on Plexiglas plates. In the first experiment, the female received food while the male was kept behind a barrier. The barrier was lifted only once the female’s interaction ended. We varied what the males saw, namely whether the interaction ended due to the plate ‘fleeing’ (removed fast with the attached lever) or not. As a control we used an opaque barrier. We then quantified the number of chases by the male during the 30s following the removal of the barrier. In a second experiment, the couple could move freely but we provided two plates simultaneously. In trials in which male and female chose different plates, we either let the female forage on the plate or let it flee from her inside the aquarium and asked whether males were more likely to chase the females in the second condition. Only in the second experiment we found marginally non-significant tendencies that males increase aggression towards females when the latter appear to cheat their clients. There is thus limited evidence that male cleaner fish perform third party punishment as uninvolved bystanders.



**ST8.2: Causes and consequences of alternative dispersal decisions in the cooperatively breeding Seychelles warbler**

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In cooperative breeders, ecological constraints and low breeder turnover often result in high competition for independent breeding positions. As a result, subordinates delay dispersal after reaching sexual maturity. Dispersal decisions are of key importance here because fitness is dependent on an individual's ability to obtain a high quality breeding territory. While dispersal to a breeding position is the most commonly observed, some individuals either float in the population, or join a non-natal territory as a subordinate. While this behaviour has been described for many species, the causes and consequences of these alternative dispersal decisions are poorly understood. In the current study, we investigated the proximate factors that cause alternative dispersal decisions as well as the costs and benefits of these decisions in the cooperatively breeding Seychelles warbler. Our analyses show that both floating and between group dispersal are likely suboptimal solutions that result from constraints on dispersal. However, females that prospected more when they were younger, were more likely to find a subordinate position in another territory than to become floaters. Out of these females that dispersed between groups, 65% (13/20) become helpers in the territories to which they disperse and the likelihood of helping is strongly dependent on the risk of nest predation in the new territory. Over half of these individuals also gain reproduction in the territories where they help. Moreover, despite being of similar age at the time of dispersal, individuals that join other territories as subordinates have a higher life expectancy than individuals that become floaters. Our study suggests that dispersal strategies are flexible under adverse conditions and that the benefits of group living are not limited to extended parental care.



**ST9.1: Strategic adjustment of helping behaviour in the cooperatively breeding cichlid *Neolamprologus savoryi***

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Helping behaviour in cooperative breeding systems has been intensively studied in many species of birds and mammals, and in a few species of fish. Here, helpers engage in brood care, territory defence and shelter maintenance. These tasks can be unequally shared among group members, depending on their body size, sex, and status. Shelter maintenance involves digging out sand, which is a costly behaviour in terms of energy expenditure, but shelters provide essential protection from predators. The cooperatively breeding cichlid *Neolamprologus savoryi* is a hitherto little studied model system for the adaptive value of seemingly altruistic helping behaviour. We asked how breeders and helpers in this species share the costly effort of shelter maintenance, and how their investment is influenced by the presence of dependent young. For this purpose, we conducted a field experiment aiming to increase the workload of group members by adding sand to the breeding shelter. Groups were selected according to the presence or absence of helpers and dependent young. We find clear evidence that the presence of dependent young increases the workload of digging, which is highly skewed toward breeding females and large helpers. The latter's effort reduces the workload of females, and helping is strategically adjusted to need. Our results highlight the specialisation of brood care helpers in a costly cooperative task in highly social cichlid fish.



**ST9.2: Reciprocity and kin selection - two alternative mechanisms underlying cooperation in Norway rats**

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Social groups often contain individuals with varying degrees of relatedness. Group members may help each other at some cost without receiving immediate benefits from their collaboration. Evolutionary mechanisms responsible for such cooperation include kin selection and reciprocity. The interplay between these alternative mechanisms has been little studied. Here we tested to which extent cooperation among wild-type Norway rats (*Rattus norvegicus*) is affected either by relatedness or by previously experienced help. Under natural conditions, rats live in colonies of various sizes consisting of related and unrelated individuals. In our study, right after weaning brothers were separated for 15 months and then tested for sibling recognition, which they indeed accomplished. In the experiment, test rats experienced either unfamiliar kin or unfamiliar non-kin, which either provided food to them or not. Subsequently, the test rats could provide food to the same social partners. Focal rats provided more food to previous food donors than to uncooperative partners, irrespective of relatedness. This shows that rats apply the reciprocal decision rule “help someone who has helped you” similarly to kin and non-kin. Interestingly, test rats overall provided more food to non-kin than to related social partners, suggesting an increased investment into social relationships with unrelated conspecifics. Direct reciprocity apparently can explain cooperation both among related and unrelated individuals, therefore both mechanisms are not mutually exclusive.



### **ST9.3: Climate change negatively affects the ontogeny of cognitive performance in cleaner fish**

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Climate change poses a major threat to coral reef ecosystems worldwide. While much research focuses on the impacts of projected future climate change on coral reefs, current extreme weather events may be altering communities now. Here, we present the immediate negative effects of extreme weather disturbances on the cognitive sophistication of cleaner wrasse *Labroides dimidiatus* (hereafter ‘cleaners’). Cleaners are key organisms on coral reefs contributing to the maintenance of healthy fish communities through their removal of ectoparasites. Their ability to effectively interact with a range of client species requires sophisticated cognitive strategies, and thus, cleaners have become a textbook example of both the application of evolutionary game theory to cooperation and the ecological approach to cognition. We report a significant decline in the ability of cleaners to manage their own reputation and strategically prioritise clients, key components of their cognitive performance and the stability of this mutualism, following habitat destruction in 2014-2016. Individuals caught from a site heavily impacted by cyclones in 2014 and 2015 suffered this cognitive impairment when tested in 2016, compared to individuals tested three to four years prior to these disturbances. Furthermore, cleaners from a site unaffected by cyclones, but heavily impacted by the 2016 el Niño event, showed similar performance impairments when tested only three months following the onset of coral bleaching compared to individuals from the same site tested two years prior coral bleaching. This implies that the reduced cognitive performance has ontogenetic causes. Lower cleaner densities, and thus reduced competition for clients, emerged as key explanations for the observed loss in sophistication. Given that extreme weather events, including cyclones and heat waves, are increasing in frequency, contemporary climate change may cause diverse and unexpected effects on species interactions, including the loss of more complex cognition.





### **ST9.4: Social feedback and within-group diversity in the collective temperature homeostasis of bumblebees**

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Bumblebee colonies maintain a stable brood temperature of 32°C. This collective feature allows colonies to raise brood even under unfavorable ambient conditions; it is based on the thermoregulative actions of individual workers. These can either decrease brood temperature by fanning their wings or increase brood temperature by directly incubating it. In both cases, the effect on brood temperature is local. Workers perform fanning or incubating for varying times and at varying locations within the nest; and we find consistent inter-individual variability in thermal behavior. In order to understand how individual thermoregulative behavior is integrated into a functioning, decentralized homeostatic unit, we analyze both the properties of individual behavior and the feedback loops that modulate it. We test single workers in experimental arenas with heat-controlled brood dummies, within groups and within their colonies. Comparing the response behavior of workers tested individually with their response within groups, we unravel the feedback mechanisms between workers. Manipulating group composition we analyze the effect of group diversity (inter-individual variability in thermal behavior) on individual responses and on the collective homeostatic ability. Finally, using automated tracking methods in combination with thermovision images, we begin to document and analyze networks of thermoregulating bees. Collective control of temperature in bumblebees is a uniquely accessible model system. Understanding individual behavior and its function within and modulation by the group will contribute to our knowledge of the mechanisms giving rise to emergent phenomena in social insects.



**PO01: More action with interaction? Investigating the effect of interactive virtual 3D-fish on association time in the sailfin molly, *Poecilia latipinna***

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Stimuli such as computer animations have been widely used to elicit a reaction from different species to discover more about visual animal communication and interaction. Although computer animations have allowed a range of factors to be altered, they have, so far, lacked a sense of interactivity. In contrast to behavioural experiments using live fish as the stimuli, virtual stimuli do not respond to the behaviour of the test animal. Using an advanced 3D tracking system, we created virtual animated fish that respond in real-time and, hence, “interact” with live fish according to positional tracking information. Here we present first data on the use of interactive computer animations of sailfin mollies (*Poecilia latipinna*). We tested whether live male and female test fish respond differently when presented with interactive or non-interactive virtual fish of the opposite sex that are presented on two monitors at opposite ends of a fish tank. The virtual fish were controlled for their size but their appearances were altered between individuals. Our experiment entailed two treatments: (1) interactive male/female vs an empty tank and (2) non-interactive male/female vs an empty tank. The fish could observe both monitors before making a choice and it was hypothesised that the time spent near the interactive stimulus would be significantly greater than the non-interactive stimulus. Using interactive computer-animated stimuli we hope to improve the realism experienced by live test fish and to increase acceptance towards the virtual stimuli. We expect that our new approach will enable more controlled and standardized testing procedures to investigate mate choice in this species.



**PO02: Can a dummy replace a fish? Group dynamics, electric behaviour and motor-interactions in mixed and natural groups of the weakly electric fish *Mormyrus rume* (Mormyridae, Teleostei)**

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*Mormyrus rume* is a weakly electric fish that produces brief, pulse-type electric organ discharges (EODs). The fish use these electric signals for active electrolocation and electro-communication. The temporal variations of inter-discharge intervals (IDI) play a pivotal role in electro-communication and can be related to behavioural contexts and social reactions. Altogether, the electrosensory system is crucially involved in intra-specific communication, formation of groups and their coherence. Here, we aim to reveal patterns of electrical communication and motor behaviours of *M. rume* in small groups of three fish. In mixed groups consisting of two real fish and an EOD-emitting dummy fish, we tested whether and how the dummy was integrated into the group. To achieve an adequate quantification of group and social behaviour, we set up an experimental tank divided into a sheltered and an open field area. The swimming trajectories and electric discharge synchronisations between group members were measured while fish were swimming from the shelters into the open field. Subsequently, mixed groups were created by replacing one member of each group with a moving dummy fish. The dummy emitted electric signals that were previously recorded in corresponding group situations in pure natural groups. The behavioural responses of the fish towards the dummy were investigated by recording electric communication signals and swimming trajectories of the fish. When leaving the sheltered area, fish swimming in natural groups often synchronised their EOD-activity. In mixed groups, the dummy initiated following behaviour and, moreover, the fish synchronised their EOD-activity with the playback patterns of the dummy. In conclusion, the members of small natural groups of *M. rume* show specific electric and motor social behaviours. An electro-communicating dummy, which is integrated into mixed groups, can initiate corresponding behavioural patterns of the remaining fish.



**PO03: Behavioral lateralization and asymmetry in sexual traits in male sticklebacks**

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The preferential use of one side of the body over the other during behavioral activities (i.e. behavioral lateralization) is a consequence of functional cerebral asymmetries and can be found throughout the animal kingdom. Evidence suggests that individuals with strongly lateralized brains possess cognitive advantages compared to less-lateralized individuals. However, little is known about the importance of individual variation in lateralization for social behaviors such as courtship. We studied lateral biases in male threespine sticklebacks (*Gasterosteus aculeatus*). Individual lateralization in sub-adult males was determined by using a standard mirror test. After becoming reproductively active the same males were provided with a stimulus female to determine lateral biases in courtship behavior. In addition, the expression of the characteristic red nuptial coloration was spectrophotometrically measured on both sides of the body to quantify visual-model dependent measures of chroma and hue. The relationship between individual lateralization, lateral posture during courtship and asymmetry in the expression of nuptial coloration will be discussed in the context of sexual signaling.



**PO04: Predator exposure affects development of male ornamentation and female mate choice in three-spined stickleback**

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Predator-induced phenotypic plasticity is a wide-spread phenomenon in prey animals. Here, we examined whether and how predator exposure during development and acute predator presence affect male secondary sexual traits and female mate choice in the three-spined stickleback, *Gasterosteus aculeatus*, a fish with conspicuous male ornamentation. Males that were reared in the presence of predators developed a less intense red colouration, but showed higher activity during mate choice than non-predator-exposed males. Blue eye colouration and body size of males were not affected by long-term predator exposure. Acute predator presence during mate choice did not influence any male behavioural or ornamental trait. Predatory developmental environment did not affect female choice behaviour, but acute predator presence did. In the presence of a predator, females preferred less active males, whereas the opposite was true without predator presence suggesting an adaptive switch in preferences. Generally, male ornaments that were not affected by long-term predator presence (male body size, eye colouration) influenced female choice. Males having more intense coloured blue eyes and larger body size were preferred. In contrast, traits that were responsive to predator exposure (redness) had no impact on female mate choice. Our results demonstrate that the interplay between predator-induced plasticity in male ornamental traits and flexible female mate choice leads to highly dynamic processes which can alter the strength and even the direction of sexual selection.



**PO05: The influence of ambient water temperature on reproductive behaviour of three-spined sticklebacks (*Gasterosteus aculeatus*)**

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Climate change defined as any change in global temperature considered over a long time period can either be caused by natural and/or human activities. During the past decades, climate change caused a net increase in temperature for large parts of the world ocean, resulting in negative consequences for aquatic organisms especially in fluctuating environments. The three-spined stickleback (*Gasterosteus aculeatus*) is a fish that is distributed throughout coastal regions of the Northern Hemisphere. Reproduction takes place between April and August in shallow waters so that a rise in temperature may affect reproductive behaviour in this species. Moreover, stickleback males often try to steal fertilisations in nests of neighbouring males (sneaking), which consequently results in sperm competition. A recent study revealed that larger sperm numbers resulted in a higher proportion of fertilized eggs at low temperatures (15 °C). Contrary, smaller sperm numbers fertilized more eggs at high temperatures (25 °C), but fertilization rate never reached its maximum. As stickleback males are sperm limited careful sperm allocation is a critical component of reproductive success. Therefore, using a paired study design, fourteen males were allowed to build a nest in random order both in 15 °C cold water and in 25°C warm water. After nest completion male aggression, courtship intensity and colouration as well as the number of released sperm were quantified. In addition, female behaviour (e.g. willingness to mate) was determined. The perception of ecologically relevant ambient water temperatures and potentially associated behavioral adaptations will be discussed.



**PO06: Helpers improve the condition of breeders in the cooperatively breeding cichlid *Neolamprologus obscurus***

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Helpers in cooperative breeders are expected to reduce workload and increase condition of breeders. However, beneficial effects of helpers are often difficult to assess. We examined the effect of helpers in a cooperatively breeding cichlid *Neolamprologus obscurus*, which feeds on benthic invertebrates. Helpers increase the excavated stone area inside the breeder's territory by sand digging, which may be important to acquire food resources. However, helpers consume the same food as breeders, which make their effect unclear. Behavioural observation in a wild population revealed that the workload of breeders decreased and feeding behaviour of breeders increased according to the helper numbers. Using body mass data, breeder's condition increased according to the excavated stone area, but decreased with the helper number. Detailed analysis revealed that only larger helpers are most likely to improve the condition of breeders. This study shows novel aspect of helper's function in cooperatively breeding vertebrates.



**PO07: The role of spatial extra- versus intramaze cues on cannabinergic impairment of spatial memory retrieval in the zebrafish**

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**Introduction:** The vertebrate endocannabinoid system is crucially involved in acquisition of and retrieval from spatial memory. There are two different spatial learning strategies: A) egocentric and B) allocentric. The first depends on the location of objects in space relative to the body axis. The latter one relies on the location of one object with respect to other objects and it is more sensitive to cannabinoid interference than the first one, suggesting the involvement of different neuronal substrates. The teleost lateral pallium of the telencephalon is heavily involved in spatial learning and memory and it shows rich expression of the cannabinoid receptor CB1.

**Objective:** This study aimed at investigating the role of extra- versus intramaze cues (flags) on cannabinergic impairment of retrieval from zebrafish spatial memory.

**Methods:** For acquisition of spatial memory, two groups of zebrafish were trained in a hole-board task. The setup was equipped for A) with extramaze cues only, for B) intramaze cues were additionally introduced. After reaching a constant behavioral level, we exposed the animals to the CB1 agonist THC ( $\Delta^9$ -tetrahydrocannabinol) before testing for memory retrieval.

**Results:** Depending on the extramaze cues, animals decreased the time to find the baited food hole, while intramaze cues improved acquisition learning. THC treatment impaired memory retrieval in group A), while this effect was less pronounced in B).

**Conclusions:** Associating a direct indicator (flag) of a food spot involves a spatial learning strategy differing from a pure allocentric orienting performance, being independent of the endocannabinoid system, supporting the participation of another neuronal basis.





**PO08: How a contagious and a non-contagious parasite influence shoaling behaviour in three-spined sticklebacks**

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Parasites play an important role in animal (grouping) behaviour. How they affect group dynamics depends to a large degree on whether they are directly transmitted (risk of infection) and their impact on their host's competitiveness and appearance (predator attraction due to oddity). Here, we used three-spined sticklebacks, *Gasterosteus aculeatus*, and two common macroparasites – the flatworms *Gyrodactylus* spp. and *Diplostomum pseudospathaceum* – to test whether laboratory infections with these pathogens affect their hosts' shoal choice decisions and/or general body condition. The ectoparasite *Gyrodactylus* spp. is spread via body contact and able to reproduce clonally with short generation times. *D. pseudospathaceum* has a complex (multihost) life cycle. The larval stage inside the eye lenses of freshwater fish needs to be trophically transmitted to a piscivorous bird. Our experiments showed that sticklebacks infected with *Gyrodactylus* spp. had a lower body condition and that uninfected fish were able to distinguish and avoid conspecifics infected with this contagious parasite. The results did not point to an effect of *D. pseudospathaceum* on the behaviour or body condition of the fish. Rather, they suggested that any potential impact of *D. pseudospathaceum* on vision and swimming performance, if present, was compensated for by the fish. As *Gyrodactylus* spp. requires the frequent introduction of uninfected hosts and *D. pseudospathaceum* would benefit from an increased predation risk, e.g. due to isolation from the group or conspicuous swimming behaviour, in both cases, the results are in favour of the host and show once more the complex interplay of parasites and host behaviour.



**PO09: Enhanced levels of ambient UVB-radiation affects physical condition and predator inspection behavior of three-spined sticklebacks (*Gasterosteus aculeatus*)**

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Ultraviolet (UV) radiation can act as an important ecological stressor on aquatic organisms. The ozone-related increase in solar UV radiation, especially in the UVB range (280-320 nm), is known to have effects on molecular, cellular, morphological and behavioral levels. In fish, UVB influenced physiological and immunological functions at least when individuals were exposed to artificially high amounts of radiation for short terms. Evidence for the impact of long-term exposure to ecologically relevant levels of UVB light, especially on a behavioral level, is comparably scarce. The present work focused on long-term effects of low-dose UVB on the physical condition and predator inspection behavior of three-spined sticklebacks (*Gasterosteus aculeatus*). Groups of sticklebacks were raised under semi-natural conditions in outdoor mesocosms. Fish were exposed to two different spectral irradiation conditions so that they received either only natural solar radiation or natural solar radiation temporally enhanced with UVB. Individuals from both groups were compared regarding their physical condition and predator inspection. Predator inspection behavior was tested by placing sticklebacks in a special tank and visually exposing them to a live rainbow trout (*Oncorhynchus mykiss*) as a potential predator. The time spent in various distances to the predator was measured to quantify the level of inspection behavior. Sticklebacks raised under enhanced levels of ambient UVB-radiation showed a significantly reduced physical condition and an increased predator inspection behavior independent of sex and predator activity. Gaining information about a potential predator seems to be more important for physically weaker three-spined sticklebacks. These findings highlight the adverse consequences of ecologically relevant UVB-radiation on the physical condition of a teleost fish species and additionally reveal behavioral modifications when being at risk.



**PO10: Danionella: A new vertebrate model system for optical transgenic neuroscience in a vocalizing and fully translucent zebrafish-like species.**

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Great tractability and a large potential for genetic analysis and cellular observation made the zebrafish a highly successful model system for neuroscience. However, because zebrafish become intransparent as they age, many studies employing optical imaging focused on its larval stages that, unfortunately, provide only a limited behavioral repertoire. Here, we present our progress in establishing a novel vertebrate model system for optical neuroscience that expands the advantages of the zebrafish: *Danionella translucida*. *D. translucida* shares many of the zebrafish's beneficial traits, i.e., small size, transparency and a relatively short reproduction cycle. Additionally, Danionella remain translucent throughout their adult life and display rich social behavior, including acoustic communication. This species is closely related to zebrafish, potentially making them accessible to established state-of-the-art genetic tools. Together, these traits shape a powerful research tool that allows for probing the mechanisms of neural circuits in behaving animals on a single cell level using readily reproducible natural sounds. In this presentation we will present data on various behaviors of Danionella, including acoustic communication. We expect our work on Danionella to be an important contribution that will facilitate the study of acoustic processing, the neural mechanisms underlying the generation of vocalizations, and cortical function.



**PO11: Fear learning induced c-Fos expression in the dorsal telencephalon of zebrafish**

Zeymer, Malou; von der Emde, Gerhard; Ruhl, Tim

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Ostariophysan fish respond with innate fear responses when the skin of a conspecific is wounded. After injury, a skin extract, called Schreckstoff induces alarm behaviors as natural reactions to predator occurrence and protection against attacks. Thus, fish are able to associate the presence of Schreckstoff with occurring menace or danger. In zebrafish, typical fear reactions are increased bottom dwelling, erratic movements and freezing. In the present study, we tested whether zebrafish are able to associate the exposure to Schreckstoff (unconditioned stimulus UCS) with a neutral visual stimulus (conditioned stimulus CS) under laboratory conditions. Schreckstoff and a red light stimulus were presented simultaneously to groups of five fish during a single acquisition session. On the following day, the group was tested for memory retrieval by the presentation of the CS without re-exposure to the USC. Another group served as control and received distilled water during acquisition before being tested for memory retrieval. Only Schreckstoff presentation induced significantly increased bottom dwelling and erratic movements during acquisition, whereas the control group did not show any fear responses. During memory retrieval test, zebrafish responded to the CS with significantly increased bottom dwelling, indicating successful acquisition learning. Furthermore, when analyzing the neuronal background of fear learning by c-Fos expression, antibody staining revealed that both the Schreckstoff (UCS) exposure during acquisition learning as well as memory retrieval during CS presentation significantly increased c-Fos expression in the medial and lateral pallium of the dorsal telencephalon, but not in the striatum and habenula. In the thalamus, only memory retrieval increased number of labeled cells. In the present study we could show that zebrafish are able of successful associative fear learning between Schreckstoff and a red light stimulus, probably under the involvement of pallial structures of the dorsal telencephalon.



**PO12: The brain of gobies**

Gebhardt, Isabelle; Hofmann, Michael

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Gobies are with more than 2000 species the largest marine fish family. They are bottom dwelling fish inhabiting diverse habitats from coral reefs to flat bottom or coastal areas. The aim of this study was to study the brains of gobies to see whether there are group specific differences in sensory, cognitive, or motor functions compared to other fish groups. Although we have sampled only 32 species of gobiform fishes, we found a number of features that are consistently different in the species investigated. In all gobies, we found a new area in the telencephalon that has never been described in any other fish. It is remarkably similar in histology to the hippocampus of mammals but is certainly not homologous to it. It suggests a specific cognitive function that is present in gobies, but not or not to this extent in other fish. The torus longitudinalis, a structure in close association with the visual tectum opticum is histologically distinct in gobies compared to other fishes. The vagal lobe is processing intraoral taste information and is very large in some, but not all, gobies. This points to an elaborated food processing mechanism in some species. It is surprising to see that there are some features in the goby brain that are unique to the group. Cognitive functions associated with these areas may have implications for the success of the group in different habitats and ecological conditions.



**PO13: Cortisol modulation of cleaning interactions in the facultative cleaning goby *Elacatinus prochilos***

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Neuroendocrine and neuromodulatory mechanisms are important pathways underlying the regulation of social behaviour. They can act in a causal way to modulate social behaviour and are also shaped by environmental and social interactions. Steroid hormones, for example, have been shown to modulate as well as to be shaped by cleaning interactions in both cleaner wrasse and cleaning gobies. In the facultative cleaning goby species *Elacatinus prochilos*, variation in habitat use is correlated to changes in social behaviour, diet and frequency of cleaning interactions. Individuals living in corals or other substrates depend mostly on cooperative cleaning interactions with client reef fish for feeding, while individuals living in basket sponges feed mostly on micro-organisms living inside the sponges' tissue and only rarely engage in cleaning interactions. Here we aimed to know if steroid hormones have a modulating role on the cleaning behaviour variation within this species. We found that sponge dwellers had significantly lower whole-body cortisol levels than cleaners. However, laboratory experiments revealed that cleaners of both sexes and female sponge-dwellers did not differ in the latency to engage in cleaning interactions nor the proportion of time spent in cleaning interactions with predatory and non-predatory clients. In contrast, male sponge dwellers hardly interacted with either type of client. We then exposed gobies inside glass jars to the same predatory and non-predatory clients and processed the holding water for cortisol concentrations. These data are currently analysed and results will be presented at the conference. Nevertheless, the current conclusion is that cortisol levels have limited explanatory power for the presence/absence of cleaning interactions in our system, while sex of individuals apparently matters.



**PO14: The brain of blennies**

Tsobanidis, Kostas; Hofmann, Michael

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Blennies are with about 1000 species the second largest marine fish group. They are similar in body shape and habitat to gobies, but display a number of morphological differences. We investigated the brains of some blennies and compared them with gobies and other fishes. As a group, blennies have the smallest lateral line center of all fishes. The taste systems are also not well developed. This is also true for the olfactory system. This leaves the visual system as the most important sensory system. There are a number of other visually related areas in the midbrain that are also relatively well developed. One important pathway relays visual information from the tectum opticum via the nucleus glomerulosus to the inferior lobes of the hypothalamus. This pathway is involved in visual cognitive processing, but the exact function is not known. Not only the size, but also the differentiation into distinct glomeruli of the nucleus glomerulosus is well developed in blennies. Further studies are needed to uncover what aspects of visual information processing may be so important for the blennies.



**PO15: Effects of chronic THC exposure on brain aging in the zebrafish**

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Introduction: Considering the increasing number of elderly in the world's population today, investigation of the aging process represents one of the biggest challenges in biomedical research. To attenuate or decelerate the consequences of senescence, animal models may help identifying key factors of cellular aging contributing to the cognitive decline at elevated ages. The zebrafish (*D. rerio*) represents a promising model organism in this research. During natural aging, zebrafish undergo a gradual decline in cognitive abilities between the age of 1-2 years. Concurrently, the oxidation of cellular macromolecules in the animals' brains increases, suggesting that enhanced oxidative stress may contribute to cognitive impairments. Phytocannabinoids like THC ( $\Delta^9$ -tetrahydrocannabinol) are known to possess direct and indirect anti-oxidative properties. Objective: Our study aimed to investigate the anti-oxidative properties of THC on age dependent learning deficits and cellular aging in zebrafish. Methods: We performed chronic THC-treatment of 1 and 2 years old zebrafish and tested the animals in color discrimination and active-avoidance conditioning. Afterwards, we determined the levels of oxidized macromolecules in the animals' brains. Results: We found that chronic THC treatment in zebrafish accelerated learning without increasing behavioral performances compared with untreated controls. This effect was considerably stronger in the one year old animals. Furthermore, level of oxidation was reduced in THC treated animals. Conclusion: Experimental evidences show cannabinoid's neuroprotective activity. Elevation of cannabinoid level could be a promising strategy for slowing down the progression of brain aging.





**PO17: Food presentation and swimming behavior of trout**

Klein, Adrian

University of Bonn, Institute of Zoology, Bonn, Germany

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**PO18: Visual perception and discrimination of numerical information in bamboo sharks (*Chiloscyllium sp.*)**

Kwak, Eun-Joo; Schlüssel, Vera; Fuss, Theodora

University of Bonn, Institute of Zoology, Department of Comparative Neurophysiology, Bonn, Germany

The capability for counting and numerosity estimation presents an interesting research topic that has recently claimed a lot of attention not only in human infants, children or adults but also in a wide variety of vertebrate species. In the present study, 13 juvenile bamboo sharks (*Chiloscyllium sp.*) were tested for their ability to perceive and discriminate numerical information. In a visual discrimination task using two-dimensional (2D) geometric symbols, sharks were trained to distinguish between larger quantities being the positive (rewarded) stimulus, and several smaller quantities in a series of two alternative forced-choice experiments (i.e., 4 vs. 1, 5 vs. 2, 6 vs. 3, 7 vs. 4, 7 vs. 5, 7 vs. 6). All stimuli have been controlled for continuous variables, such as shape, size and colour (3 different grey levels) to prevent any kind of unintentional cueing or bias in the sharks' choice. All tasks were successfully mastered within 5 – 50 training sessions, with sharks discriminating between various different ratios in >70% of all training trials. Having completed these tasks successfully, sharks were presented with (a) various different new 2D symbols that have not been used previously and (b) various different but randomly chosen quantities within in a training session. However, a series of transfer tests revealed that – in contrast to juvenile freshwater stingrays (*Potamotrygon motoro*) – sharks most likely did not make their choices based on numerical information but seemed to prefer other cues such as the surface area occluded by the higher or lower number of 2D symbols.



**PO19: Discrimination of biological motion patterns in juvenile bamboo sharks (*Chiloscyllium griseum*)**

Stehr, Karsten A.; Russnak, Vanessa; Fuss, Theodora; Schlüssel, Vera  
University of Bonn, Institute of Zoology, Department of Comparative Neurophysiology, Bonn, Germany

The aim of the present study was to observe the ability to perceive and discriminate simple and complex biological motion patterns in juvenile grey bamboo sharks (*Chiloscyllium griseum*). Experiments were carried out as two-alternative forced choice experiments; choosing the designated positive stimulus was rewarded with food. Individuals were first expected to differentiate two dots moving at different velocities, amplitudes and in different directions (i.e., vertical, horizontal, diagonal) surrounded by a squared reference frame to stress a relative movement of the presented stimuli. All tasks were successfully mastered within 3-40 training sessions, with sharks choosing correctly >70% of all training trials and 74% of all transfer test trials, respectively. However, following simple movement discrimination, individuals were presented with complex biological movement patterns (videos) of different organisms such as an eel, a trout, an eagle, a bat, a dolphin or a shark. A series of transfer tests elucidated whether sharks would recognize these movement patterns using (a) a different perspective (front or sideways) and (b) point displays (PDs) of these organisms. Results of the present study were rather surprising as sharks appeared to be well able to discriminate relative simple and complex movements using videos and PDs but absolute movements (i.e., without a reference frame) proved a major challenge.



**PO20: Colour discrimination in juvenile freshwater stingrays**

Seifert, Friederike; Schlüssel, Vera

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Since the ability to perceive different colors has been demonstrated in marine stingrays recently (Theiss et al., 2007, van Eyk et al., 2011, Bedore et al., 2013), the present study examined color vision in 5 juvenile freshwater stingrays (*Potamotrygon motoro*) using two-alternative forced-choice visual discrimination tasks. During training, individuals were presented with two differently colored stimuli of different brightness with red being the positive, rewarded stimulus and green being the negative, unrewarded one. All individuals mastered this task successfully within 3 – 12 training sessions. In a series of transfer tests, stingrays were presented with stimuli of (a) same brightness, but different wavelength (different levels of grey) and (b) same wavelength (different levels of red), with different brightness. All individuals significantly preferred the positive training stimulus ( $0,001 \leq p \leq 0,043$ ) in 77,75% of all transfer test trials. Additionally, they were presented with (c) the learned negative stimulus (green) against newly introduced transfer stimuli (different grey levels). All individuals clearly identified the green (negative) stimulus as (learned) wrong by significantly choosing the new transfer stimuli. Present results suggest that *P. motoro* is capable of discriminating colored reward stimuli from other colored distracter stimuli of variable brightness. Moreover, stingrays did not simply remember the positive stimulus during transfers but – to a certain degree – also seemed to learn the negative stimulus as well.



**PO21: Visual perception and discrimination of numerical information in juvenile freshwater stingrays (*Potamotrygon motoro*)**

Christofzik, Nele; Fuss, Theodora; Schlüssel, Vera

University of Bonn, Institute of Zoology, Department of Comparative Neurophysiology, Bonn, Germany

In a visual quantity discrimination task using different amounts of two-dimensional (2D) geometric stimuli (circles, squares, triangles), juvenile freshwater stingrays (*Potamotrygon motoro*) were trained to distinguish between larger quantities being the positive (rewarded) stimulus, and several smaller quantities in a series of two alternative forced-choice experiments (i.e., 4 vs. 1, 5 vs. 2, 6 vs. 3, 7 vs. 4, 7 vs. 5, 7 vs. 6). Stimuli have been controlled for continuous variables, such as shape, size and colour (black + 3 different grey levels) to prevent any kind of unintentional cueing or bias in the stingrays' choice. Several transfer tests then elucidated whether individuals chose (a) by using the numerical information provided by the stimuli or (b) other information such as the different surface areas occluded by the smaller amount of symbols (i.e., the surface area occluded by the smaller quantity has been adjusted to the overall surface area of the surface area occluded by the higher quantity). All tasks, except 7 vs. 6, were successfully mastered within 3 – 29 training sessions, with stingrays discriminating between various different ratios, as well as higher quantities over adjusted surface areas in 75% of all tests. However, having completed these tasks successfully, stingrays were presented with (a) various different new 2D symbols that have not been used previously and (b) various different but randomly chosen quantities within in a training session. 3 of 5 individuals were able to solve this task successfully within 7 – 13 sessions. Present results suggest that *P. motoro* is not only capable of selecting the larger amount of 2D symbols relying mainly on numerical information, but also of retaining (at least some) information about a previously learned task when progressing to a new one.



**PO22: Source separation with the lateral line system by the surface-feeding fish *Pantodon buchholzi***

Lindenmeier, Miriam; Bleckmann, Horst; Mogdans, Joachim  
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With their cephalic lateral line surface-feeding fish can determine the direction and distance to a single wave source. It is not known, however, whether surface-feeding fish can separate simultaneously active waves sources. We studied whether the African butterfly fish, *Pantodon buchholzi*, can detect and localize a 30 Hz surface wave source in the presence of one or even two 20 Hz wave sources. Single-frequency surface-waves were generated with air puffs delivered from up to three loudspeakers through plastic pipettes. *P. buchholzi* (N=5) were conditioned to orient and swim towards the source of a 30 Hz wave stimulus (1s or 0,5s duration, up to 300  $\mu\text{m}$  pp-displacement) while ignoring one or two simultaneously presented constantly active 20 Hz surface waves. The origin of the rewarded stimulus was randomly changed between sessions. The orientation behaviour of the fish was videotaped and turning angles and swimming distances were analysed offline. *P. buchholzi* localized the source of a 30 Hz wave stimulus precisely. If the 30 Hz surface wave was simultaneously presented with one or two 20 Hz wave stimuli, the precision of wave source localization was not impaired. Our data show that *P. buchholzi* can separate up to three active wave sources and thus can perform a true hydrodynamic scene analysis.



**PO23: Fish world in motion: Perception and discrimination of biological motion patterns in *Pseudotropheus zebra***

Hiller, Jennifer; Schlüssel, Vera

University of Bonn, Institute of Zoology, Department of Comparative Neurophysiology, Bonn, Germany

Different aspects of visual perception such as color, brightness or object size are of primary importance for many fish species, as is the recognition of movement since prey, predators and the fish itself constantly move. Malawi cichlids (*Pseudotropheus zebra*) were tested for their ability to perceive and discriminate different simple movements with respect to a vertical or horizontal orientation and complex biological movements of different organisms such as an eel, a trout, an eagle, a bat, a dolphin or a shark using 2-alternative forced choice experiments. Choosing the designated positive stimulus was rewarded with food. All stimuli were presented in either black or two different grey levels. Following successful training, fish were presented with (a) one different perspective (sideways) and (b) different complex movement patterns of dots and objects, including biological motion patterns using point displays (PDs) of these organisms in a series of transfer tests. All tasks were successfully mastered within 3–26 training sessions, with cichlids discriminating between various sets of simple vertical, horizontal or diagonal movements and complex biological movements using PDs in >79,46 % of all tests. Moreover, stimuli were successfully distinguished by most fish irrespective of its size and from different perspectives.



**PO24: Social interactions in a pulse-type weakly electric fish only rely on passive reception of electric communication signals**

Worm, Martin; von der Emde, Gerhard

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Mormyrid weakly electric fish discharge sequences of electric signals to actively sense their environment and to communicate with conspecifics. These functions are mediated by different types of dermal electroreceptor organs, which are mormyromasts for active electrolocation and knollenorgans for electrocommunication. Our behavioral experiments reliably demonstrated attraction of the weakly electric fish *Mormyrus rume* towards a mobile dummy fish equipped with electrodes emitting playback of electrical discharge patterns. Both, signaling patterns and motor behaviors displayed in response to playback signals, reflect social interactions between individuals. This study aimed to show that social interactions among weakly electric fish can be mediated solely by passive reception of electrical communication signals. By moving a playback emitting dummy along a predefined trajectory within an electrically transparent tube under infrared light, we excluded vision and hydrodynamic cues as factors that could initiate interactive behaviors between *M. rume* and the dummy. Additionally, some fish were electric silenced to control for active electrolocation. Upon detection of playback signals, a prolonged period of electrical silence, followed by a characteristic discharge pattern, was induced in the receiving animals. Fish followed the dummy on stereotypical swimming trajectories. These behaviors were absent in control trials without playback. Trajectories of silenced fish were similar to those observed in intact fish. In conclusion, electric signaling alone suffices as a key stimulus to induce social behaviors and interactions among weakly electric fish.





**PO25: Multisensory discrimination of gravel grain sizes by the weakly electric fish, *Gnathonemus petersii***

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The weakly-electric fish *Gnathonemus petersii* uses active electrolocation for analyzing object in its environment at night. Fish emit electric probing signals (electric organ discharges, EOD) and simultaneously perceive them with electroreceptor organs in their skin. *G. petersii* have a moveable chin appendage, the so-called Schnauzenorgan, which contains hundreds of electroreceptor organs and maybe also tactile receptors (trigeminal free nerve endings). During food search and object inspection, the fish move their Schnauzenorgan over the surface, presumably gaining information about the surface structure. Previous experiments have shown that *G. petersii* inspects objects using multiple senses, in particular active electrolocation and vision. Here, we investigated whether these fish can discriminate between different grain sizes of the gravel covering the aquarium floor, and - if they can - which sensory modality (electrolocation, touch, vision) they use to do so. Fish were offered four beakers filled with gravel, one of which contained a food item (chironomid larvae) buried in the gravel at a depth of 5 mm. The bated beaker contained gravel of a grain diameter of 1 – 1.5 mm (S+), while the gravel grain sizes of the other three beakers were either larger (2 – 3.15 mm, 3.6 – 6 mm) or smaller (0.2 – 1 mm) than S+. After the fish had learned to search for food only in S+, test trials were conducted, during which all beakers were non-bated and the time of food search over each beaker was measured. Results showed that the fish searched significant longer over S+ than over the other beakers, no matter which of the three grain sizes were used as alternatives for S+. Fish could do so even in complete darkness, which indicates that vision is not necessary for grain size discrimination. As a control, two fish were electrically silenced preventing active electrolocation. The silenced fish could still discriminate grain sizes, but failed to do so in darkness. This indicates that intact fish might use active electrolocation to gain information about surface roughness, while silenced fish probably use vision. Haptic information acquired by touching the gravel was probably not used for this task in our experiment. Apparently, fish are flexible in using different senses and adapt their search strategy according to the sensory conditions.



**PO26: Electric signalling behaviour during agonistic encounters in the weakly electric fish, *Mormyrus rume***

Kersten, Anna; Worm, Martin; von der Emde, Gerhard

Universität Bonn, Institut f. Zoologie, Neurothologie/Sensorische Ökologie, Bonn, Germany

Like all African weakly electric fish (Mormyridae), *Mormyrus rume* emit pulse-type electric signals of constant amplitude and waveform with an electric organ located in their tail. These electric organ discharges (EOD) are perceived by the fish via epidermal electroreceptor organs. This system enables active electrolocation of objects in the environment and also allows for electrocommunication with conspecifics. Information about a sender's current behavioural state can be transferred by producing EOD at different rates and different temporal patterns. Highly variable inter-discharge intervals (IDI) are the result, and there are several discharge patterns known to correlate with specific social interactions. So far no studies used pairings of two individuals of *M. rume* to analyse their behaviour and electric communication patterns during agonistic encounters. Results of previous studies let us to hypothesize that so-called double-pulse patterns, characterized by alternating short and long IDIs, might be typical for agonistic interactions in *M. rume*. Thus, this study aims at investigating electric signalling behaviour during agonistic encounters and, in particular, to find out whether double pulses function as an antagonistic signal. We performed contests between pairs of similar sized fish to establish a "winner" or "loser" state for each individual and to minimize the impact of size-dominance correlations. Three segments (beginning, middle and end) of each contest situation were analysed and tested for the occurrence of characteristic electric discharge patterns, such as double pulses. We found that the amount of double pulses differed significantly between "winner" and "loser" fish, with winners producing significantly more double pulses. For "winner" fish double pulse emission also varied significantly between the three segments of the contest, with most double pulses being produced in the first segment of the encounter. In addition, we found that "winners" showed significantly more discharge pauses (IDI of 500 ms or longer) than "losers". Our results support the assumption that later "winner" and "loser" fish show characteristic electric discharge behaviours while establishing a dominance relationship. Double pulses and discharge pauses seem to play a vital role during agonistic social interactions in *M. rume*.



**PO27: Raider of the lost coin: Object detection within substrate in the weakly electric fish *Gnathonemus petersii***

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The mormyrid weakly electric fish *Gnathonemus petersii* is able to find food items (insect larvae) that are buried in the substrate using multiple senses, including olfaction, and both passive and active electrical sensing. During active electrolocation the fish detect objects by perceiving object-evoked changes in a self-generated electric field. While many experiments have investigated this sense, the majority have focused on object detection in open water. We investigated the limits of object detection within substrate by determining firstly, the minimal detectable size of aluminium coins buried in gravel and secondly, the depth threshold, at which the fish were able to detect living and dead insect larvae within the ground. In experiment one, three *G. petersii* were trained to associate an aluminium coin (Ø 22 mm, 2 mm) with a food reward and were subsequently tested to determine whether they were able to detect a coin of a particular diameter (between 22 – 4 mm) when buried 0.5 cm deep in one of four alternative gravel-filled cups. In experiment two, three other individuals were tasked with finding a single Chironomidae larva (living or dead) buried at varying depths in one of two gravel filled cups. Controls were conducted to test which senses were involved in the detection. The results show that all fish were able to detect the 6 mm coin within the substrate and one individual was even able to find the 4 mm coin. Furthermore preliminary results reveal that the fish dug for the larva up to a depth of at least 2.5 cm. Although the substrate consisted of isolating material, which was only interspersed with conductive water *Gnathonemus petersii* was able to detect objects very efficiently, even finding items not much bigger than the surrounding gravel stones.



**PO28: Surface wave perception in crocodiles**

Grap, Nadja; Bleckmann, Horst

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Crocodiles can sense capillary water surface waves with their integumentary sensory organs (ISOs). The ISOs – located mainly on the jaws – are sensitive to water surface waves elicited by prey, predators or conspecifics. The aim of our study was to determine the frequency and amplitude content of natural surface wave stimuli and whether and to what precision crocodiles can discriminate and locate different types of wave stimuli. Furthermore we investigated whether crocodiles can remember a certain task over a period of seven weeks. Using operant conditioning, crocodiles were trained to show an oriented response to a certain surface wave stimulus, produced by blowing air onto the water surface. To investigate their surface wave discrimination abilities a second unrewarded wave stimulus was presented. If single-frequency wave stimuli were presented, frequency discrimination limens were 0.04 at 40 Hz and 0.1 at 15 Hz. Frequency changes (e.g. from 40 to 38.5 Hz) within a wave train were also recognized. Crocodiles were able to remember the rewarded stimulus for seven weeks. Nile crocodiles determined the direction and – roughly – the distance to a surface wave source even in the presence of an interfering surface wave stimulus.



**PO29: Lombard effect onset times reveal the speed of vocal plasticity in a songbird**

Hardman, Sam; Zollinger, Sue Anne; Koselj, Klemen; Leitner, Stefan; Brumm, Henrik

Max Planck Institut for Ornithology, Communication and Social Behaviour Group, Seewiesen, Germany

Animals that use acoustic signals to communicate often compensate for interference and masking from background noise by raising the amplitude of their vocalisations. This response has been termed the Lombard effect. However, despite more than a century of research little is known how quickly animals can adjust the amplitude of their vocalisations after the onset of noise. The ability to respond quickly to increases in noise levels would allow animals to avoid signal masking and ensure their calls continue to be heard, even if they are interrupted by sudden bursts of high amplitude noise. We tested how quickly singing male canaries (*Serinus canaria*) exhibit the Lombard effect by exposing them to short playbacks of white noise and measuring the speed of their responses. We show that canaries exhibit the Lombard effect approximately 300 ms after the onset of noise and are also able to increase the amplitude of their songs mid-song and mid-phrase without pausing. Our results demonstrate high vocal plasticity in this species and suggest that birds are able to adjust the amplitude of their vocalisations very rapidly to ensure they can still be heard even during sudden changes in background noise levels.



**PO30: Neuron numbers in the brains of waterfowl (Anseriformes)**

Osadnik, Christin; Kersten, Ylva; Olkowicz, Seweryn; Kocourek, Martin;  
Begall, Sabine; Němec, Pavel; Malkemper, E. Pascal  
University Duisburg-Essen, Zoology, Essen, Germany

Neurons are considered to be the major factor determining brain function and its computational capacities. Recently, a method called isotropic fractionator has been developed that allows the determination of the cellular and especially neuronal composition of brains. The basic idea of this method is to turn anisotropic brain structures into isotropic suspensions containing free-floating cell nuclei that can be counted easily. The neuronal nuclei in this suspension are detected by immunocytochemical staining and are expressed as a fraction of the total cell number. This method was used to determine the differences between brains of different mammals. Since brains vary in size across species it was tested whether size and contained cell amounts change in similar ways across mammalian orders. It was found that the relationship between brain size and neuron numbers differs between orders, as described by the so called scaling rules. This underlines that bigger brains do not necessarily contain higher amounts of neurons. Data on neuron numbers in avian orders are only rarely available so far. Avian brains show a different architecture compared to those of mammals, one example is the lack of a layered neocortex in birds. However, it is known that some bird species, especially corvids and parrots, have superior cognitive abilities and show more complex behaviour than most mammals. For songbirds and parrots it has been revealed that their brains contain equal or higher amounts of neurons than primates with greater brain size, especially in the forebrain. Here we determined neuron numbers of 13 waterfowl species for whole brains as well as single brain parts. The results for this rather basal avian lineage revealed scaling rules different from those found in mammals and songbirds as well as parrots. They also provide information about the possible evolution of the avian brain.



**PO31: Vocal ontogenesis in African Grey Parrots in comparison to humans**

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Human speech is considered to be unique means of communication. Preverbal and early verbal human vocalization shows, however, some common patterns to what can also be found in animal communication. There are similarities between humans and animals in terms of social organization, neural control, cognition and function of vocal signals. Moreover, it seems that humans have closer parallels with birds, especially parrots, in these respects than with other primates. Vocal ontogeny was, however, at least in parrots, investigated only marginally. African Grey Parrots (*Psittacus erithacus*) show a wide range of cognitive abilities and are thus suitable species for comparison with humans. We studied repertoire of four fledglings of wild captured African Grey Parrot parents, using video and audio recordings from nesting boxes. We identified 5 types of calls in the repertoire of parrots. First call types to occur in the first weeks are begging calls and “beep calls”. During the development, the repertoire is gradually enhanced by “squeak calls”, “trill calls” and “hybrid calls”. During vocal development, the complexity of calls is increasing within all types (except for beggings which recede). We also found one interesting vocalization context which we call “monolog” and which can be compared to children’s vocal play. Subsequently, we used 3 published stage models of vocal development in children to point to some similar trends in early vocal ontogeny of African Grey Parrots and children.



**PO32: Affairs happen – to whom? A study of extra-pair paternity in common nightingales (*Luscinia megarhynchos*).**

Landgraf, Conny; Wilhelm, Kerstin; Wirth, Jutta; Weiss, Michael; Kipper, Silke

TU MÜNchen, Chair for Zoology, Freising, Bavaria/Germany

Extra-pair mating (EPM) in birds seems common, but its function as a mating strategy is not yet fully understood. In socially monogamous species, females do not gain any direct benefits (such as contribution to paternal care or access to resources) by EPM, but may gain through an increase in their offspring's genetic fitness. Since male quality is mostly not directly measurable, females base mating decisions (and also EPM choices) on male secondary traits that are indicating their phenotypic and/or genetic quality. In birds, male song is such a sexual ornament and song repertoire size has been suggested to be related to EPM rates in few species. We investigated the proportion of extra-pair paternity (EPP) in a population of common nightingales in Potsdam-Golm (Brandenburg) and found that 21.5 % of all chicks tested were not sired by their social father. Also, we found that the occurrence of EPP was related to the spatial distribution with nests in densely occupied areas containing more extra-pair young. Furthermore, we found that a measure of song complexity, namely song repertoire size, was negatively related to the probability of being cuckolded. In a direct comparison, extra-pair mates mostly had larger repertoires than social mates. We conclude that song as well as other factors need to be considered to understand EPM decisions and underlying behavioural strategies.





**PO33: Vocalizations separate species in a cryptic nocturnal primate radiation, the Mouse Lemurs (*Microcebus spp.*)**

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Acoustic signaling systems do often mediate discrimination between species and play a major role in speciation and evolution. Empirical research on this topic for primates is rare. Our aim is exploring to what extent ecological/sexual selection and genetic drift contribute to explain micro- and macrogeographical divergence in vocalization and drive speciation and evolution in primates by using the world's smallest primates, the species-rich and cryptic mouse lemurs, as a model. We apply an integrative bioacoustic, behavioral, and genetical approach. Findings for the first four study sites ("Bombetoka", "Ampijoroa", "Mahatazana" and "Marosely") with dry deciduous forest along a transect in northwestern Madagascar will be presented. The variation in vocalization and its use in signaling as well as social bonding patterns were determined by standardized methods using a social encounter paradigm (N=12 dyads/study site). First comparative data on agonistic calls between five genetically closely related cryptic species revealed a uniform acoustic contour, but species-specific statistical distinctiveness in acoustic structure. Acoustic divergence between species can be predicted by genetic distance. The studied calls do not play a major role in mate choice, neither do they display habitat-specific differences. Thus, findings support an acoustic diversification caused by genetic drift. The project provides a fundamental framework for illuminating the role of vocalization in primate species diversity and evolution with implications for taxonomy and conservation biology. Supported by the German Academic Exchange Council (DAAD) and the Small Rufford Fund.



**PO34: Duel of mouse lemurs: Comparing innovative abilities in two sympatric mouse lemurs (*Microcebus murinus* and *M. berthae*)**

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Innovative abilities provide individuals with the potential to learn new behaviors or behavioral variants which might be effective to increase their fitness when dealing with novel ecological or social challenges. On the species level the innovation propensity has been linked to its degree in foraging specialization, with generalists being more innovative than specialists. On the individual level the innovation propensity has been linked to individual characteristics such as persistence or neophilia. In order to examine species and individual factors influencing innovation, we presented two sympatric mouse lemur species (*Microcebus murinus* and *M. berthae*), exhibiting different levels of generalism, an artificial feeding box that could be opened by three different techniques, with only one technique being available at a time. 54 wild mouse lemurs in Kirindy forest, western Madagascar, were tested. Open field and novel object tests were conducted to examine variation in personality. Preliminary results indicate that in both species fewer individuals were able to solve the tasks with increasing complexity. The specialist, *M. berthae*, had shorter success latencies, especially in the more complex variants as the generalist, *M. murinus*, which might rather be explained by their higher activity in exploration and manipulation than by their habitat and diet specialization.



**PO35: Effects of group size variation on ranging and stress in Verreaux's sifakas (*Propithecus verreauxi*)**

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Fitness consequences of group size variation are thought to be mediated by individual health and condition. In order to optimize these consequences, there should be stabilizing selection for intermediate-sized groups. Yet, variation in group size persists and its effects on individual health and fitness remain poorly studied. To evaluate the costs and benefits of different group sizes, we examine correlations between group size and ecological and physiological variables in a wild population of Verreaux's sifakas. During a pilot study in 2016, we collected 639 faecal samples of 29 individuals of six differently sized groups (range 2–8) in order to measure individual stress levels non-invasively. Simultaneously, we equipped each group with a GPS collar to assess home range sizes and daily travel distances. We will present preliminary results on possible correlations of group size variation with individual stress levels and ranging behaviour. Ultimately, we expect to make a significant contribution to the general understanding of the costs and benefits of sociality. This study is part of the Research Group “Sociality and Health in Primates” and is funded by the “Deutsche Forschungsgemeinschaft (DFG)”.



**PO36: Study of behaviour of Barbary Macaque in the Middle Atlas**

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Faculty of Sciences Dhar El Mahraz- Sidi Mohamed Ben Abdellah University , Department of Biologie, Fez, Morocco

The Barbary Macaque (*Macaca sylvanus*) is an emblematic species and characteristic of the cedar forest, But because of several threats (Tourism, inappropriate management, climate change), this species is in danger of disappearing. Among these threats, it was tourism, which is irregular and uncontrolled. It changes social behavior (affiliative, agnostic, and neutral) of wild populations in semi wild populations. The study was conducted in the central part of the Middle Atlas, in forests located in the east of the city of Azrou (33 ° 15'N, 5 ° 15'W), with a density of 30 individuals / km<sup>2</sup>. The group chose to study and close observation we have named 'blue' group is composed of 32 individuals and is in an intermediate state between the wild and semi-wild. We realized the study of the impact of tourism on the behaviour of the Barbary macaque in the group. In our study, we were able to determine the degree of anthropogenic influence caused by tourism; and the precise impact on the behavior of the Barbary macaque. We also noted that tourism is essentially on very specific behaviours (such as affiliative behaviours) while the facial expressions gestures are infected less.



**PO37: The place to my left is free, lie next to me! Lying behaviour and nearest neighbour analysis in pregnant sows (*Sus scrofa*)**

Franke, Clara; Rippstein, Lena; Geiger, Sarah; Schalk, Christiane; Stefanski, Volker; Pfaffinger, Birgit

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In intensive pig husbandry, the housing of pregnant sows in social groups from four weeks after mating is mandatory in the European Union for welfare reasons. As a consequence, regrouping or mixing of unfamiliar sows is often difficult to avoid. This might lead to aggressive conflicts and interactions with negative impacts on animal health and productivity. The present study was therefore designed to assess the effects of repeated social mixing of the same individuals on activity, lying behaviour and nearest neighbour choice of gestating sows. A total of 20 pregnant sows (German Landrace) were housed in groups of 5 animals each. Two groups were assigned to a social mixing treatment (MT), the other two groups remained undisturbed in their original composition without mixing (NON-MT). In the mixing treatment, two randomly selected sows from each of the two mixed groups were exchanged twice a week from week 11 to 4 pre partum over a period of 8 weeks. Before, during and after the mixing period the posture, location and lying partners of sows were analysed at 8 time points by video recording (scan sampling, instantaneous sampling). Statistical analysis of activity and lying behaviour was conducted with Mann-Whitney-U tests. MT sows showed decreased lying behaviour at the beginning of the mixing period and less lateral lying during the entire mixing period ( $p < 0.05$ ) compared to NON-MT sows. No influence of social mixing could be found for walking and sitting ( $p > 0.05$ ). Sows of both treatment groups showed a similar preference for lying in peripheral areas of the pen ( $p > 0.05$ ). Contrary to our expectations, NON-MT sows had no specific lying partners, whereas individual differences among MT sows to specific lying partners were recognisable. In conclusion, our results indicate that repeated mixing of the same individuals alters activity and lying behaviour of pregnant sows and leads to more agitation within groups which may negatively affect sow welfare and productivity. In further investigations, we currently examine the influence of repeated social mixing on aggressive behaviour, reproduction parameters and the physiological outcome.



**PO38: What do pigs want? – Initial findings on behavior in preference tests**

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Public opinion on the question of how animals should be treated under human care has changed remarkably over the last decades. Enhanced housing to improve animal welfare of livestock is one important demand by many consumers in the EU. The question is, however, how welfare can be determined. In the past, indicators for poor welfare, such as injuries or bad physical condition, were used to assess the welfare status of animals. The evaluation of welfare and positive affective state of animals is still a challenge. One approach to assess “what animals want” is the use of preference tests. Mainly developed for laboratory animals, preference testing is a suitable method to draw conclusions regarding the importance of key housing elements. The aim of the present study was to implement a preference test for growing pigs and to evaluate the preferences of individual animals for different enrichment materials. The data are the first of a series of experiments in a larger animal welfare project. In successive tests, animals were offered access to soil, straw, metal chains or sisal ropes (the last two being common enrichment “toys” for pigs). Pigs (40 kg) were housed in groups of two. Each enrichment material was presented for 4 days. The pigs' behavior was observed on one control day prior to enrichment (empty pen), as well as on the first and third day after enrichment. The behavior was videotaped and analyzed by continuous recording at several intervals for 1.5 h daily. Apart from analyzing the preference for specific materials, special attention was given to social interaction and play behavior before and after enrichment. Preliminary analysis indicates that the duration and frequency of interaction with enrichment materials varied substantially: growing pigs were much more attracted by soil and straw than by the other enrichment objects (metal chain, rope). Analysis of social data is in progress and first results will be presented at the meeting. So far, we can conclude that our preference test is a useful tool to examine pigs' priorities for enrichment material. Further analysis will show whether enrichment also has an impact on the social behavior of the pen mates. Subsequent experiments will also include the



measuring of physiological parameters (urinary cortisol) to validate the importance of certain enrichments, especially if access is subsequently denied. We are confident that this approach will allow us to decide which enrichments are of particular importance for pigs, and can thus further contribute to the improvement of housing conditions.



**PO39: Does the early social environment prepare for the future? A match-mismatch experiment in female wild cavies**

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Parents can pass on information about the current social environment in order to prepare their offspring to fit future challenges. Such adaptations can be detected by match-mismatch experiments where the offspring either faces a matching or a mismatching environment to their parental environment. In the present study, we performed a match-mismatch experiment with 22 wild cavy daughters whose mothers had either lived in a stable ("stable daughters"=SD) or an unstable ("unstable daughters"=UD) social environment during pregnancy and lactation. For this purpose, we housed one SD together with one UD in a stable social environment. Our hypothesis was that if SD experience a matching environment they will perform better than UD which are confronted with a mismatching condition. We measured fitness proxies such as dominance, stress hormone levels and body weight gain. Surprisingly, the number of daughters which became dominant did not differ between the two groups. However, higher stress hormone levels and less body weight gain indicated that UD were significantly more stressed in a stable social environment than SD. Thus we conclude that SD, whose mothers lived in a stable social environment during pregnancy and lactation, are better adapted to conditions of social stability than UD in later life.





**PO40: Scanning of echo-acoustic flow in the bat *Phyllostomus discolor***

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LMU Munich, Division of Neurobiology, Department Biology II, Martinsried, Germany

Movement directly influences our perception of space. This direct link between movement and sensory perception has received much attention in the visual system. Here, movement like we experience it for example in a roller coaster or when looking out of a moving train, induces optic flow that in turn elicits saccadic eye movements. These fast, dart-like movements of the eyes allow rapid reorientation of the foveal focus and thus an expansion of the area that is scanned. Flow fields contain essential information on the spatial arrangement of objects, as well as on the distance between the observer and the objects. However, this information is encoded not only in optic flow fields. Echolocating bats navigate elegantly through complex environments in pitch darkness, and flight guidance is affected by echo-acoustic flow. Previous work on the echolocation system has focused mainly on the extraction of temporal and spatial parameters for 3D reconstruction of the immediate environment in static situations. However, to date the empirical investigation of the perception and neural representation of dynamic changes in these parameters is insufficient. In this study we investigate in a tightly controlled behavioral experiment how bats employ their echolocation system when scanning echo-acoustic flow. To this end, we monitor and reconstruct in 3D both a close-up of the facial structures, including the motile nose leaf and outer ears, as well as the sonar-beam axis of the bat while it is moved along structured surfaces. The results demonstrate a temporal correlation between the emission of echolocation calls and movements of the nose leaf as well as movements of the outer ears while calls are emitted at altering sonar beam axes. The call-correlated movements of the facial structures may lead to a higher directionality of the echolocation system and may enable the bat to adjust their echo acoustic gaze to dynamic environments



**PO41: Insights into the neurobiological basis of mammalian magnetoreception**

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The ability to sense the Earth's magnetic field is widespread across the animal kingdom including mammals, a fact that is well documented on the behavioural level. The receptors mediating the response, however, still remain one of the biggest mysteries in modern biology. Due to the transparency of biological tissue for magnetic fields these receptors could reside anywhere within the body. Behavioural experiments and theoretical considerations have narrowed down the region of interest to the head region and provided clues about the physical characteristics of the underlying mechanisms. Nonetheless, progress in the field is extremely slow and often hampered by contradicting results. We attempt to tackle the problem by employing a novel top-down neurobiological approach. Using subterranean mole-rats and laboratory mice as complementary model systems we employ a modern tissue clearing technique for whole brain quantification of neuronal activity in response to magnetic stimulation. Immediate early genes serve as a surrogate measure of neuronal activity and the distribution of their expression is automatically mapped onto a digital brain atlas. Differentially activated areas are then identified by a designated software called ClearMap. This allows us to identify (new) brain areas involved in magnetoreception in a completely unbiased way. Brain-wide identification of these magnetoreception circuits will deepen our understanding of the magnetic sense in mammals and ultimately allow us to locate the primary receptor areas by means of anterograde and retrograde tracing. We will present the first steps taken and insights gained within this long term project.



**PO42: First insight into the vocal ontogeny of a large-bodied semi-social mammal, the white rhinoceros**

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Infant acoustic communication plays an important role in the coordination of social interactions between infant and care-givers. Thus, current research provides evidence that infant mammals signal specific needs to their care-givers. Infant white rhinoceros are very vocal, but to date there is very little known about their call repertoire as well as about the function of these calls. Thus, this study aimed to (1) characterize the infant vocal repertoire of the Southern white rhinoceros, (2) to quantitatively specify behavioral contexts in which calls are uttered and (3) to relate this findings to the adult vocal repertoire. The behavior of eight white rhinoceros calves (3 males, 5 females) was simultaneously audio and video taped at three zoos: Serengeti-Park Hodenhagen, Zoo Dortmund and Zoo Augsburg. Thereby one calf was hand-raised by the keepers. Age of calves ranged from 1 month to 3.5 years. Four call types were discriminated based on a multi-parametric sound analysis. The most common call type was the Whine followed by Snort, Threat and Pant. All call types were also uttered by the hand-raised calf, suggesting that social interactions with the mother are not required to acquire the species-specific vocal repertoire. The noisy call types Snort, Threat and Pant were also present in the adult vocal repertoire and were recorded in comparable contexts. In contrast the tonal call type Whine seemed to be specific for the infant vocal repertoire. Thus, it occurred in infant specific contexts such as suckling or suckling attempts and call rate decreased with age. All in all, findings provide first evidence that infant rhinoceros utter specific call types in distinct contexts, even if there is no social interaction with conspecifics. The decrease of the Whine call rate with age may be explained by a decreasing dependence of the infant from a nursing mother. Thus, infant vocal behavior may be used as an indicator of infant's developmental stage.



**PO43: Is there a Lombard effect in acoustically communicating insects?**

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Abiotic and biotic noise has the potential to affect the efficiency of acoustic communication, and the calling behavior of many animal species revealed various adaptations on the sender and receiver side that improve signal detection as well as signal recognition in a noisy habitat. So far, however, the so-called Lombard effect, with an increase in broadcast sound amplitude, has been demonstrated only in vertebrates. Males of a trilling *Mecopoda* species generate ear-deafening amplitude-modulated calling songs consisting of loud and soft song segments. We hypothesized that males increase the amplitude of their calling songs and/or the proportion of loud song segments during background noise playbacks (81 dB SPL). Playbacks were interrupted by 5 minutes of silence to test for a dynamic adjustment of calling behavior. Contrary to our expectations, males did not increase their signal amplitude in the presence of masking noise, which excludes the existence of a Lombard effect in this species. However, in sessions with noise playbacks males significantly extended the duration of loud song segments relative to soft segments compared to songs produced in silent control sessions. This plasticity of calling behavior may improve signal detection in their natural habitat where many acoustically communicating insect species are simultaneously active.



**PO44: Why do some eyes emit a beam of redirected ambient light? - The optic-nerve-transmitted eyeshine phenomenon.**

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High performance in vision requires eyes to shield their photoreceptors from excessive light and light that arrives from directions deviating from the optic path. Therefore, eyes are usually one-way receptacles for light. The phenomenon of eyeshine, where the eyes of certain animals seem to emit light, challenges this dogma. Here, we present a new form of eyeshine, found in small teleosts, that results from light entering the eye through the head and optic nerve, eventually emanating through the pupil as a narrow beam: the Optic-Nerve-Transmitted (ONT) Eyeshine. We characterize ONT eyeshine in the triplefin blenny *Tripterygion delaisi* (Tripterygiidae) in comparison to three other teleost species, using behavioural and anatomical observations, spectrophotometry, histology, and magnetic resonance imaging. ONT eyeshine intensity benefits from locally reduced head pigmentation, a thin skull, the gap between eyes and forebrain, the potential light-guiding properties of the optic nerve, and, most importantly, a short distance between the head surface and the optic nerves. The generality of these factors implies that ONT eyeshine is widespread among small fish species. We discuss how ONT eyeshine links environment, anatomy, and behaviour of *T. delaisi* by how it is generated and how it might affect, or even serve, visual perception and signalling.



**PO45: Variation in individual-level learning improves collective intelligence**

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Human and non-human animals can combine their decisions to increase decision accuracy, an effect known as collective intelligence or swarm intelligence. Whereas numerous studies have demonstrated this effect, the underlying mechanisms promoting swarm intelligence are still poorly understood. Here we present evidence for a novel mechanism promoting swarm intelligence: individual-level differences in learning rules. We performed an experiment with human groups, which were faced with the following binary classification task: participants observed a fictitious cartoon character and needed to decide whether this character was a cooperater or defector. The character contained both informative and uninformative cues. After observing a character, individuals first made a personal decision, upon which they received social information consisting of the decision of their group members. Then all individuals made a second decision. Additionally, individuals reported their beliefs in the different cues. Our results show that individuals made better decisions after observing the decisions of others. Interestingly, individuals receiving exactly the same information developed very different beliefs about the cues, including many false beliefs. This diversity in beliefs was, in turn, a crucial predictor of collective performance. Combining decisions of individuals with different beliefs promoted collective intelligence. This benefit of diversity was present in informative cues (as it allowed the collective to integrate different relevant information) and uninformative cues (as different wrong beliefs canceled out at the collective level). Our results illustrate how variation in individual-level learning drives swarm intelligence and how diverse collectives can protect against false individual beliefs, such as superstition.



**PO46: Sex differences and inter-individual differences in foraging and explorative behaviour**

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Foraging efficiency is pivotal for individual fitness. Meanwhile, animals use foraging trips for other behaviour and combine territory patrolling and mate search with foraging. Thus, if there are inter-individual differences in risk-taking and activity, we may also find repeatable, inter-individual differences in foraging behaviour, i.e. a “foraging personality”. Foraging theory often treats individuals alike, neglecting potential inter-individual differences in foraging behaviour. Here, we question this assumption and aim to test whether foraging behaviour is sex-dependent and whether it consistently differs among individuals. We investigated foraging behaviour (activity, mobility, food intake, changes between food sources, behaviour after disturbance) of 24 common voles (*Microtus arvalis*) of both sexes experimentally in outdoor arenas with two food sources. Animal behaviour was measured repeatedly under different risk scenarios. We manipulated risk of travelling among sources and the risk of feeding at a source separately. We quantified among-individual differences across risk scenarios using adjusted repeatability estimates. We found differences between males and females mainly in resuming of activity after disturbance and the propensity to travel among food sources. Further, among-individual differences in foraging behaviour were repeatable across risk scenarios. How individuals balance foraging and risk might have important consequences for individual fitness and thus for selection among different foraging personality types.



**PO47: A time to wean? Impact of weaning age on anxiety-like behaviour and stability of behavioural traits in full adulthood**

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In mammals, weaning constitutes an important phase in the progression to adulthood. It comprises the termination of suckling and is characterized by several changes in the behaviour of both mother and offspring. Furthermore, numerous studies in rodents have shown that the time point of weaning shapes the behavioural profile of the young. Most of these studies, however, have focused on 'early weaning', while relatively little work has been done to study 'late weaning' effects. The aim of the present study was therefore to explore behavioural effects of 'late weaning', and furthermore to gain insights into modulating effects of weaning age on the consistency of behavioural expressions over time. In total, 25 male and 20 female C57BL/6J mice, weaned after three (W3) or four (W4) weeks of age, were subjected to a series of behavioural paradigms widely used to assess anxiety-like behaviour, exploratory locomotion, and nest building performance. Behavioural testing took place with the mice reaching an age of 20 weeks and was repeated eight weeks later to investigate the stability of behavioural expressions over time. At the group level, W4 mice behaved less anxious and more explorative than W3 animals in the Open Field and Novel Cage, while anxiety-like behaviour on the Elevated Plus Maze was modulated by a weaning-age-by-sex interaction. Furthermore, weaning age shaped the degree of behavioural stability over time in a sex-specific way. While W3 females and W4 males displayed a remarkable degree of behavioural stability over time, no such patterns were observed in W3 males and W4 females. Adding to the existing literature, we could thus confirm that effects of weaning age do indeed exist when prolonging this phase, and were furthermore able to provide first evidence for the impact of weaning age and sex on the consistency of behavioural expressions over time.





**PO48: Movement patterns in different structures: A comparison of linear and planar habitat structures**

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With increasing agricultural land use, landscape fragmentation is threatening environments and species. Fragmentation leads to decrease or loss of habitats. Habitat corridors are gaining value for biodiversity conservation and for connecting habitat patches. Animal movement in corridors is therefore an important trait to stabilise and equalise biodiversity. Hedge rows in an agricultural landscape may serve as habitat themselves, but not as corridors for rodents. Still, movement processes in a hedge as a habitat with a linear shape may differ from movement behaviour in planar habitats. Here, we test the hypothesis that small mammals adjust their space use and movement to linear shapes, resulting in differences in home range shape and movement patterns between linear and planar habitats. Moreover, population dynamics and turnover may be affected by movement characteristics. Within the BioMove Research Training Group (DFG-GRK 2118/1) we examined five linear and six planar sites in the northwest Uckermark in summer 2016, by capture-mark-recapturing rodents and radio-tracking voles via an automated and manual VHF-telemetry. Home ranges, moved distances, direction of movement will be discussed pertaining to potential restrictions of the linear habitat. Capture-mark-recapture data will be used to assess population dynamics and individual fitness in the different habitat types. Results may indicate mechanisms of how linear habitat structures affect individual movement processes and potentially stabilise biodiversity in a habitat corridor.



**PO49: On the evolution of morality**

Medicus, Gerhard

University Innsbruck, Psychology, Innsbruck, Austria

The emotional roots of morality and humanity are reflected in early mammals by brood provisioning, later within our primate ancestors by social behaviour and familiarity, reciprocal altruism, attractive behaviour, internalisation and the (unconscious) sense of pledge after having received an altruistic act. The cognitive roots within early hominoid ancestors lie in the ability for self-exploration and empathy. In humans, this is anchored in the theory of mind, verbal language, reflection, responsible morality, the pursuit of recognition and the desire for self-esteem. Thanks to the capacity to reflect, humans are able to recognise areas of concern as they relate to their natural dispositions and can counteract these with personal decisions as well as cultural, pedagogical and political measures.



## Posters

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We would like to thank the ***Deutsche Forschungsgemeinschaft*** and the ***Deutsche Akademie der Naturforscher Leopoldina*** for their financial support.



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