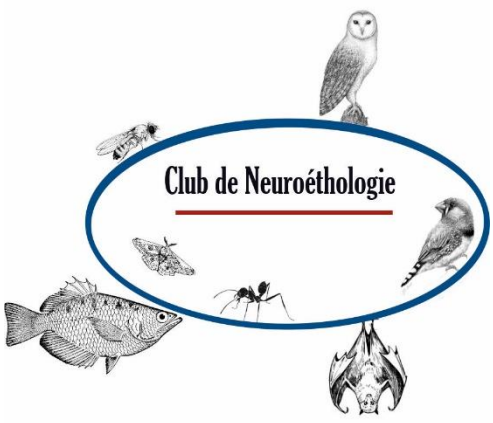

Club Neuroéthologie
Réunion Annuelle 2024
Albi, May 21st 2024

Institut National Universitaire Champollion https://www.univ-jfc.fr/
Place de Verdun - 81012 Albi cedex 09

Convenors: Aurore Avarguès-Weber, Martin Giurfa,
German Sumbre & Eléonore Rolland

I. Program

9:00: Welcome
9:15 – 10:05: **INVITED TALK – Stefan SCHUSTER (University of Bayreuth, Germany)**: ***"High-speed decision making in archerfish". (p.4)***
10:05 – 10:25: Cécile Bellanger (Ethos – Caen): *Control of body colour change in a cephalopod (p.5)*
10:25 – 10:45: Lola Fauré (CRCA – Toulouse): *Capacity to discriminate two siblings is lost early in Alzheimer's disease mouse model (p.5)*
BREAK 20 min
11:05 - 11:55: INVITED TALK – **Severine TRANNOY (CNRS - University of Toulouse)** (35 +10): ***"Molecular mechanisms regulating the intensity of aggressive behaviors in Drosophila melanogaster". (p.4)***
11:55 – 12:15: Elena Kerjean (CRCA - Toulouse): *Numbers matters: honeybees preferentially use numerical cues in an ecologically relevant task of quantity discrimination (p.6)*
12: 15 – 14:00: Lunch + Poster Session
14:00 – 14:50: INVITED TALK – **Emily BAIRD (University of Stockholm, Sweden)**: ***"Some don't like it hot: Assessing the effect of temperature on insect foraging behavior". (p.4)***
14:50 – 15:10: Alid Al-Asmar (CRCA - Toulouse): *An experimental test of optimal foraging theory in the worm Caenorhabditis elegans (p.6)*
15:10 – 15:30: Martin Dessart (IRBI - Tours): *Cognitive abilities in mosquito larvae as indicators of environmental quality (p.7)*
BREAK 20 min
15:50 – 16:40: INVITED TALK – **Arthur LEBLOIS (CNRS - University of Bordeaux)**: ***"Exploration, motor variability and the basal ganglia-cortical network: Lessons from songbirds". (p.5)***
16:40 – 17:00: Laure Tosatto (CRPN - Marseille): *The role of chunk stability in sequence searning in Guinea baboons (Papio papio) (p.7)*
17:00 – 19:00: Poster Session + Best oral and poster communication prizes

Posters

Alexandre Chambard (IGF – Montpellier) : *Heterogeneous defensive behaviors reflect social competition in male and female mice (p.8)*
Roman Coupeau (Ethos – Caen) : *Comparison of the effect of different types of looming visual stimuli on crayfish Procambarus alleni: Creation of a new behavioural test (p.8)*
Rafael Carvalho Da Silva (IBPS – Paris): *Unraveling the effects of the short neuropeptide F (sNPF) in Winter bees (p.8)*
Blandine Mahot-Castaing (CRCA – Toulouse): *Bumblebees under the radar: Do bees feel electromagnetic waves and can they use it as a cue to forage? (p.9)*
Catherine Macri (IBPS – Paris) : *Uncovering the neuro-ethological components of emotions in honeybees (p.9)*
Claire Marcout (IBPS - Paris): *Statistical learning in honey bee (p.10)*
Francesca Pinna (ICM – Paris): *How social experience affects numerical discrimination abilities? (p.10)*
Eléonore Rolland (ISC - Lyon) : *Evidence of organized but not disorganized attachment in wild Western chimpanzee offspring (Pan troglodytes verus) (p.11)*
Germán Sumbre (ENS – Paris): *Whistle variability and social acoustic interactions in bottlenose dolphins (p.11)*
Frank Weber (IBPS – Paris): *The impact of odor cues from invasive floral species on appetitive responses of honey bees: attractiveness as a factor of success (p.11)*

How to get there?

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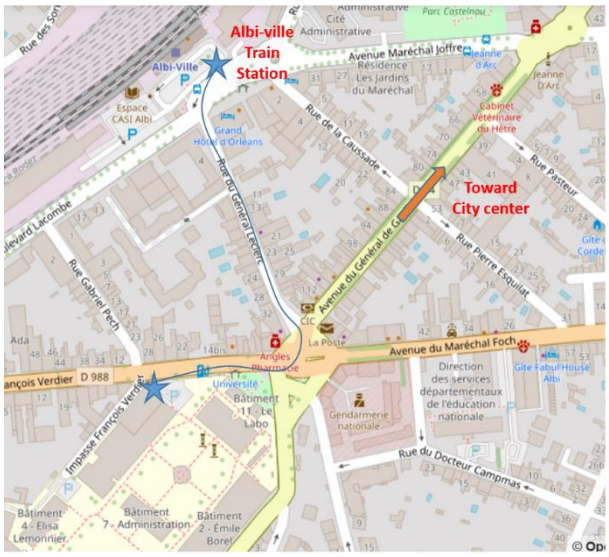

Building 2 – Jean Jaurès
Amphitheatre JJ035

Building 7
Restaurant for lunch

II. Guests

Stefan Schuster

Bayreuth University, Germany

High-speed decision making in archerfish

In recent years it has become clear that many decisions do not obey the rule that more time yields better decisions. These 'blink' decisions can be made remarkably fast and yet accurately, sometimes based on very limited information. It is presently unclear whether such 'blink' or high-speed decisions lack cognitive aspects that only much slower 'deliberative' decision-making can support. Here we demonstrate an unexpected degree of flexibility and cognition in a decision made by a hunting animal at reflex-like speed. Based on observing initial speed, direction, and height of falling prey archerfish decide in just 40 milliseconds on a turn toward the later ballistic landing point. This enables the fish to dash off so as to arrive simultaneously with prey and to secure it against numerous competitors. We established an approach that allowed us to replace ballistics, the rule that governs the turn decisions, with a novel rule of how to connect the input variables with the rewarded turns. This approach revealed that the fish are not using a hardwired circuit but were able to reprogram their decision in efficient ways that allowed them to immediately generalize to untrained settings. Training even allowed the decision to simultaneously use two distinct sets of rules, one for each of two distinct objects. The flexibility of the decision and the occurrence of high-level cognitive features are counterintuitive for a reflex-like decision made faster than an Olympic sprinter can respond to the start gun. However, they imply that combining speed and accuracy in rapid decisions does not generally make them less smart than decisions made over far longer timescales.

Séverine Trannoy

Centre de Recherches sur la Cognition Animale (CRCA, CNRS/Université Toulouse 3)

Molecular mechanisms regulating the intensity of aggressive behaviors in *Drosophila melanogaster*

In competition for valuable resources such as food, mates and territory, most animal species, including *Drosophila melanogaster*, will respond with the use of aggressive behaviors. As aggression is an energetically costly behavior, it needs to be finely regulated. Previous studies identified the VPM4 octopaminergic neurons as crucial for regulating male-male aggression (Sherer et al, 2020). Moreover, it has been demonstrated that VPM4 neurons are dual-transmitting neurons, releasing both octopamine (OA) and glutamate to regulate aggression. In our study, we demonstrated that only the release of glutamate is crucial to regulate aggression. Using the connectome, we have identified one VPM4 postsynaptic neuron crucial for controlling high-intensity aggression, the MBON-11 neuron. Conditionally activating this MBON-11 results in hyperaggressive males. Furthermore, we have identified one glutamatergic receptor, GluCla, as modulator of MBON-11 synaptic activity to regulate male-male agonistic interactions. Our findings contribute to the existing understanding of the underlying mechanisms that support the regulation of appropriate aggressive behaviors.

Baird Emily

University of Stockholm, Sweden

Some don't like it hot: Assessing the effect of temperature on insect foraging behavior

In the temperate regions of northern Europe, Asia and America, bumblebees and butterflies are two of the most essential taxa for pollination. The great success of these insect groups is largely due to their ability to develop and forage in colder temperatures than those typically required for ectotherm species. However, studies have shown that pollinator populations in temperate climates are decreasing at an alarming rate. One of the factors that is responsible for these declines is the rapidly increasing environmental temperature associated with climate change. Exactly how increasing temperatures could contribute to the vulnerability of insect pollinators and how this affects the development and function of the sensory and neural structures and behaviour necessary for foraging remains unclear. In this talk, I will present work that my lab has been doing to address this knowledge gap.

Arthur Leblois

Institut des Maladies Neurodégénératives (CNRS/Université de Bordeaux)

Exploration, motor variability and the basal ganglia-cortical network: Lessons from songbirds

Like speech in humans, birdsong relies on the tight coordination of numerous muscles in the vocal cords and breathing system. This complex sensorimotor skill is acquired by juvenile birds through a long trial-and-error process akin to speech learning in human infants. In songbirds, a specialized brain circuit in the cortex and basal ganglia is responsible for song learning and plasticity. This circuit generates song variability that underlies vocal experimentation in young birds and modulates song variability depending on the social context in adult birds. Combining behavioral, pharmacological, electrophysiological and modelling studies, our research group has dissected the mechanisms underlying the production and modulation of song variability by the cortico-basal ganglia-thalamo-cortical circuit. After revealing remarkable similarities in the babbling statistics of human infants and juvenile songbirds, I will show how neuronal irregularity translates into behavioral variability, and how it is modulated by the dopaminergic input to the basal ganglia.

III. Presentations

Cécile Bellanger

Ethos – Caen

Control of body colour change in a cephalopod

Cécile Bellanger, Anaïd Gouveneaux, Salomé Brousseau, Nicolas Elie, Thomas Knigge

Colour change is a widespread ability among animals associated with a series of functions: thermoregulation, UV protection, camouflage or communication. Cephalopods provide well studied models for their colour change abilities to express skin patterns used in camouflage and communication. Their skin colour changes are particularly rapid and finely controlled by nervous pathways. Dynamic colour changes mainly involve the mechanical action of neuromuscular structures associated to the chromatophores (pigmented skin organelles), resulting in their expansion or contraction. Control of colour change in cephalopods can be modulated by neuroactive drugs on whole animals as part of behaviours, but also at the tissue and cellular levels. Our recent studies focused on the quantification of chromatophore activity from skin explants of the common cuttlefish (Sepia officinalis) in response to topical application of neuroactive drugs.

Lola Fauré

CRCA – Toulouse

Capacity to discriminate two siblings is lost early in Alzheimer's disease mouse model

Lola Fauré, Sébastien Gauzin, Camille Lejards, Laure Verret, Claire Rampon

Discrimination between individuals is essential for rodent social behaviors because it enables the identification of familiar individuals from strangers. This ability relates to social recognition memory, which is capacity to recall and identify of known conspecifics (Wang and Zang, 2022). Within the framework of social recognition, individual recognition is a more complex process. It occurs when one takes into account distinctive traits such as group membership, kinship, age, sex, hierarchical standing... (Gheusi et al. 1997). Here, we investigated if mice could achieve a subtle individual recognition. We postulated that two mice of same age and same sex, sharing same parents, same cage would be more difficult to discriminate than two mice coming from different parents and raised in different cages. We found that C57BL6/J mice can discriminate siblings regardless of their sex and regardless of the demonstrator sex. Many brain illnesses such as autism, schizophrenia, and Alzheimer's disease (AD), are intimately linked to social memory impairments (Henry et al. 2016). An alteration of social memory was reported in a mouse model of Alzeimer's disease (Tg2576 line) at 9 months of age (Rey et al. 2022). Therefore, we evaluated subtle social memory abilities in this AD mouse model at an early age considered as asymptomatic. Our results show that 3-month-old AD mice display subtle social memory impairments while

their general social memory remains unaffected. Hence, we identify incapacity for subtle social discrimination as an early cognitive impairment that arises prior to other well-documented memory abnormalities in this AD mouse model.

Elena Kerjean
CRCA - Toulouse

Numbers matters: honeybees preferentially use numerical cues in an ecologically relevant task of quantity discrimination

Elena Kerjean, Scarlett Howard, Aurore Avargues-Weber

Despite a growing body of evidence that a wide variety of animals can count objects, the ecological relevance of possessing concepts of number remains questioned. Would individuals still rely on numbers if other - less computatively demanding - cues were available to evaluate quantities? In primates, a numerical bias is present, i.e. individuals tend to preferentially use the number of items to categorize quantities rather than correlating non-numerical cues, such as density or total surface area. In this study, we investigated which cues would be favoured by honeybees during an ecologically relevant task of quantity discrimination. Individual free-flying honeybees were trained to discriminate between two sets of images displaying either two or four dots, to get a sucrose solution. Here, importantly, individuals could either use continuous cues of quantity (ex.: total surface) and/or numerical cues to resolve the task as would be normally the case in real-life scenario. Transfer tests' performances revealed that honeybees preferentially used numerosity rather than surface ratio to choose between quantities. We also looked at the individual strategies of each bee, revealing that 25% of honeybees did use the difference in surface to guide their discrimination suggesting that, despite an overall numerical bias, different strategies still exist at the individual level drawing a more complex picture of quantity evaluation and use of numbers in honeybees. Ultimately, these results contribute to strengthen the relevance of numerical cognition as an essential part of honeybees' cognition and highlight the evolutional convergence of the number sense between Vertebrates and Invertebrates.

Alid Al-Asmar
CRCA - Toulouse

An experimental test of optimal foraging theory in the worm *Caenorhabditis elegans*

Alid Al-Asmar, Roger Lloret-Cabot, Alfonso Pérez-Escudero

Foraging behavior is one of the key components of the fitness of animals. As such, foraging has long been studied through the prism of mathematical optimality. In that framework, the Marginal Value Theorem (MVT) determines how to forage optimally in a patchy environment. However, the MVT is hard to test extensively in most animals, and offers limited insight into the actual behavioral processes taking place. For these two reasons, we study the MVT in an organism suitable for high-throughput experiments, and with strong behavioral constraints, the 1mm-long nematode *Caenorhabditis elegans*. In order to study the foraging behavior of C. elegans with enough throughput and detail, we built an automated experimental pipeline that records the trajectories of individual worms while exploiting different environments. We used this pipeline to record individual worms in ~1500 experimental arenas covering different food qualities and inter-patch distances. We found that C. elegans meets qualitative predictions of the MVT by spending more time in patches when inter-patch distance is higher, successfully learning the statistics of the environment in spite of its limited sensory inputs. However, the MVT cannot describe plausible behavioral strategies in species with strong sensory constraints, in which only part of the observed effects are driven by actual behavioral adaptations. We are currently working on disentangling the behavioral and non-behavioral components of *C. elegans*' foraging, and on adapting the abstract modeling framework of the MVT to the actual constraints of the worm, in order to compare worm performance with quantitative predictions.

Martin Dessart
IRBI - Tours

Cognitive abilities in mosquito larvae as indicators of environmental quality

Martin Dessart, Claudio Lazzari, Fernando Guerrieri

Learning and memory abilities may constitute proxies for assessing environmental quality, in particular, the presence of pollutants. Non-associative learning (habituation) has been employed in aquatic animals to this aim. In our work, we focussed on assessing learning and memory in mosquito larvae, and on the evaluation of the effect of chemical pollutants on habituation. Mosquito larvae spend most of their time at the water surface, diving when a potential danger is perceived. If the stimulus reveals innocuous upon repeated passages, larvae habituate to its occurrence, reducing their response to further stimulation. We adopted habituation as bioassay and adapted an automated tracking system for quantifying the response of larvae to the passage of a shadow. We validated our methodology by examining the habituation of laboratory-reared Aedes aegypti larvae and we analysed the persistence of the mnesic trace and the effect of the intertrial time during training on larval memory. In addition, we assessed the impact of pollutants, alone or in mixtures, on Ae. aegypti habituation. We observed adverse effects on the cognitive abilities and on the activity of larvae reared in the presence of herbicides, as well as of a popular medical drug. Finally, we compared learning abilities of laboratory- and field-reared mosquito larvae collected from 5 natural habitats in the department of Indre et Loire, France. We propose a reliable and reproducible way to characterise the behaviour of mosquito larvae, which may serve as a tool for evaluating the quality of aquatic environments.

Laure Tosatto
CRPN - Marseille

The role of chunk stability in sequence learning in Guinea baboons (*Papio papio*)

Laure Tosatto, Joel Fagot, Arnaud Rey

As individuals in constant interaction with the environment, primates evolve in a continuous stream of stimulations that trigger behavioral responses. Most behaviors are produced sequentially and learning rapidly and efficiently long sequences of actions represents an evolutionary challenge. Chunking mechanisms - the processes by which several items are grouped together into a single processing unit - are central to the acquisition of long sequences, as they allow for the compression of information and the bypassing of memory limits. In the case of visuo-motor sequences, studying the precise mechanisms by which chunks are formed and maintained during sequence learning showed that they can be reorganized throughout learning. This can mainly occur by two mechanisms: the recombination of preexisting chunks and the concatenation of two distinct chunks into a single one. Using data from a previous study in which eighteen Guinea baboons (*Papio papio*) repeatedly produced the same fixed sequence of nine movements during 1,000 trials by pointing to a moving target on a touch screen, we analyzed how two key parameters - the stability of a chunk and the stability of chunk boundaries - are related to these reorganizations. Our analyses showed that less stable chunks and less stable boundaries are more likely to produce reorganizations. These results provide new evidence about the fine-grained dynamics of chunking mechanisms during sequence learning.

IV. Posters

Alexandre Chambard
IGF – Montpellier

Heterogeneous defensive behaviors reflect social competition in male and female mice

Alexandre Chambard

Active avoidance has been poorly studied as compared to other defensive behaviors. Current studies rely on conditioned stimuli predicting a punishment (sounds, lights). Here we use the active place avoidance task (APA) that allows users to study defensive behaviors with a more naturalistic approach. This paradigm consists in a rotative arena where the animal can learn how to avoid a danger zone using stationary visual cues placed around the arena. Our first results show that a subpopulation of mice display a different avoidance strategy (non-avoiders), with a slight sex difference. In an attempt to understand what behavioral trait may best predict non-avoidance, we identified the unforeseen relationship between social competition and active avoidance. We established social competition using the tube test. This assay consists in nose-to-nose duels among cage-mates in a transparent tube. It appears that non avoiders in the APA tend to win more often in the tube test. These results indicate that social competition may exert a profound influence on mice behavior beyond the social domain. Interestingly, these effects were only observed in male but not female mice. Altogether, these results shed light on discrete traits that can influence defensive behaviors. Future work will aim at deciphering and modulating the neural circuits implicated.

Roman Coupeau
Ethos – Caen

Comparison of the effect of different types of looming visual stimuli on crayfish *Procambarus alleni*: Creation of a new behavioural test

Roman Coupeau, Cassandre Aimon, Marion Gentil, Ines Bennehard, Ludovic Dickel, Julien Bacque-Cazenave

In the wild, predator detection is crucial for survival and triggers antipredator behaviours such as freezing, fleeing or fighting, which require an operant locomotor system under the control of the sensorimotor functions. Emotional states are known to affect antipredator behavioural response and its intensity. We hypothesize that sensorimotor functions may be affected as a result. On various taxa, virtual looming visual stimuli, consisting of a rapidly growing shape that simulates the approach of a predator, elicit defensive behaviour responses. The looming test thus appears to be a promising tool for investigating the relationship between the emotional state and physical impairment. Thanks to its decentralized nervous system allowing us to focus more on sensorimotor functions, crayfish *Procambarus alleni* seems like a propitious model to study the effect of the depression on it. However, it requires understanding which visual stimuli are best suited to elicit the most intense responses in crayfish. In this regard, we investigated the effects of modulating the shape, size and speed of stimuli appearance on the intensity of crayfish defensive behavioural responses. In our preliminary results we observed that regular and simple shapes induced more intense responses with a wide variety of behaviours expressed. Then, we tested their behavioural responses after chronic stress exposure to induce emotional-like state.

Rafael Carvalho Da Silva
IBPS – Paris

Unravelling the effects of the short neuropeptide F (sNPF) in Winter bees

Rafael Carvalho Da Silva, Martin Giurfa, Maria Gabriela De Brito Sanchez

The neuropeptide F (NPF) and the short neuropeptide F (sNPF) of invertebrates have similar functions as the neuropeptide Y (NPY) of vertebrates and modulate several biological processes such as circadian rhythms, learning, memory, and feeding. In the honeybee, the sNPF represents a key molecule driving

foraging-related behaviors during periods of food-search activity. These behaviors include food intake, sucrose sensitivity, olfactory perception, and visual memory formation. Yet, it is unclear whether sNPF exerts the same effects in winter bees, which do not engage in foraging activities and remain in their hive performing thermoregulatory duties. Here we studied the effects of sNPF in winter bees, via topical exposure to the neuropeptide. We asked if increasing sNPF levels would rescue summer-like states and hence enhance different appetitive behaviors in environmental conditions inconsistent with this enhancement. Increasing levels of sNPF in winter bees increased sucrose responsiveness yet failed to achieve a similar effect for appetitive olfactory spontaneous responsiveness, olfactory learning, memory, and food consumption. Our results demonstrate that sNPF may seasonally affect honeybees. During summer, the sNPF system modulates outdoor behaviors that will ensure colony preparation and survival for the winter (e.g. searching for food). During winter, the system may regulate only traits that guarantee individual survival within the hives (e.g. gustatory responsiveness). Increased gustatory sensitivity may ensure that bees will perceive and hence feed on any available resource within their hives ensuring their survivorship. Our results suggest that the sNPF signaling system is dynamic and is impacted by external factors such as seasonality.

Blandine Mahot-Castaing
CRCA – Toulouse

Bumblebees under the radar: Do bees feel electromagnetic waves and can they use it as a cue to forage?

Blandine Mahot-Castaing, Mathilde Lacombrade, Leïna Rawat, Alexandre Dore, Laurene Le-Breton, Hugo Cormier, Dominique Henry, Hervé Aubert, Mathieu Lihoreau

Pollinating insects, such as bumblebees, provide an essential ecosystem service by pollinating our plants. Studying their movements can help identify navigation strategies, and thus provide a better understanding of how plants are pollinated. Over recent years, radar systems have been developed to track the trajectories of individual bees when foraging in the field. However, whether the electromagnetic waves generated by the radars influence the behavior of insects remains unexplored. Here we tested the ability of bumblebees to perceive radar waves and, if they do, whether they could use them as spatial cues to forage. We ran controlled lab experiments in a T-shape maze in which we could precisely vary the presence/absence of electromagnetic waves (60 GHz) and color cues in each arm. Our analysis of bee trajectories shows their movements are modified when entering the electromagnetic fields, thereby suggesting bees sense the electromagnetic waves. However, this does not affect their ability to learn the association between a color and a sucrose reward and does not allow them to learn the waves' position in the maze. Future experiments should precise the impact of radar waves on flying bees in the field and test whether bees can associate other types of electromagnetic waves to the presence or absence of rewards.

Catherine Macri
IBPS – Paris

Uncovering the neuro-ethological components of emotions in honeybees

Catherine Macri, Luigi Baciadonna, Martin Giurfa, Marco Paoli

The idea that invertebrates may have subjective, internal states assimilable to 'emotions' is growing, although their characterization is still at its infancy. We used a multicomponent approach, including behavioral, neurophysiological, and cognitive analyses to determine whether honey bees (*Apis mellifera*) may experience an 'emotional state' of fear upon the perception of an immediate or future nociceptive stimulus. To answer this question, we used a behavioral paradigm similar to fear conditioning in rodents. Bees were trained to associate a contextual blue light with the occurrence of electric shock in an enclosed chamber, which allowed us to characterize the behavioral and physiological building blocks of â€˜fear'. Not only did the bees learn and remember that blue light anticipated the electric shock one hour after the training, but their behavior was modulated by the intensity of the shock. Moreover, bees that learned the association had a different respiratory dynamic than control bees.

Furthermore, using HPLC mass spectrometry, we found higher levels of 5-HT in the brains of bees having learned the aversive association compared to control bees. Here, we show that changes were restricted to learners and not found in controls that had also experienced the shock. This result shows that 5-HT variation was not a mere response to the shocks but reflected a state triggered by the anticipation of shock, akin to anticipatory fear. This investigation is particularly relevant in the ongoing debate about the presence of sentience in invertebrates, opening valuable ethical discussion.

Claire Marcout

IBPS - Paris

Statistical learning in honey bee

Claire Marcout, Chiara Santolini, Martin Giurfa, Marco Paoli

The extraction of the statistical properties of complex scenes is a cognitive challenge encountered by different species. Notably, in the visual and auditory domains, the ability to extract probabilistic information from sensory inputs has been shown - among others - in humans and non-human primates, birds, and bees. Such a comparative approach underscores the universality of statistical learning across species and sensory modalities. Here, we adopted the honey bee as an animal model because of its perceptual richness and complex cognitive abilities and investigated its aptitude to detect the probabilistic structure of a sequence of olfactory stimuli. Employing the olfactory conditioning paradigm of the proboscis extension reflex, we showed that bees can discriminate and learn the order of two adjacent, consecutive olfactory stimuli (e.g., AB vs BA). One-hour memory retention tests against the elemental components of the learned sequences showed that bees respond preferentially to the odorant that was temporally associated with the sucrose reward. However, when tested against the rewarded and unrewarded sequences, bees display a selective response towards the conditioned stimulus configuration, indicating their ability to incorporate probabilistic information of a complex olfactory input. This study shows that the ability to extract, learn, and use statistical information from sensory inputs is a fundamental cognitive toolkit that can also be found in insect brains.

Francesca Pinna

ICM – Paris

How social experience affects numerical discrimination abilities?

Francesca Pinna, Bassem Hassan, Mercedes Bengochea

Numerical discrimination is crucial for fitness across all animal kingdom. Many species use the numerical information to display a spontaneous preference or a learnt behavior response. Recent attention has turned to flies, as models for investigating numerical cognition and the underlying neural mechanisms. There is evidence linking numerical magnitude perception and social experience: adult fruit flies decrease the duration of freezing behavior in response to an inescapable threat with the increasing of the group size and the amount of motion perceived. Here we argue that social experience could be a modulator in the development of the number sense. We used the Buridan's paradigm to test the spontaneous preference of the same fly across 4 numerical contrasts in isolation or non-isolation. This design allowed us to investigate the role of social experience in the development of number sense, and the stability of flies preference across the contrasts. Our results reveal no significant difference in performance among the tested conditions. These findings may show that socialization is not a key factor in the development of number sense, suggesting that this ability may have innate origins.

Eléonore Rolland
ISC - Lyon

Evidence of organized but not disorganized attachment in wild Western chimpanzee offspring *(Pan troglodytes verus*)

Eléonore Rolland, Oscar Nodé-Langlois, Cédric Girard-Buttoz, Holly Rayson, Catherine Crockford, Roman Wittig

Mother-offspring attachment, vital for offspring fitness, manifests in humans in three organized types - secure, insecure-avoidant, insecure-resistant - and one disorganized type, suggested to be a maladaptive survival strategy for the offspring. Shared traits with humans led us to hypothesize distinct mother-offspring attachment types in wild chimpanzees (Pan troglodytes). Focusing on responses to natural threats, akin to the 'strange situation' in humans, we observed 309 reactions from 18 chimpanzees (ages 1.5-6) in three chimpanzee communities (*P.t. verus*), in Taï National Park, Cote d'Ivoire, and recorded 1232 hours of observations over 16 months on offspring behavior and mother-offspring proximity. Using dimension reduction, cluster analysis and Bayesian models, we found that wild chimpanzees exhibited organized attachment patterns, paralleling humans. Some sought maternal closeness during threats, echoing secure attachment, while others showed independence, akin to insecure-avoidant attachment. Unlike humans and captive chimpanzees, disorganized attachment was absent in wild chimpanzees, suggesting its non-adaptability in natural settings and enhancing our understanding of attachment's adaptive role in social evolution.

Germán Sumbre
ENS – Paris

Whistle variability and social acoustic interactions in bottlenose dolphins

Faadil Mustun, Chiara Semenzin, Dean Rance, Emiliano Marachlian, Zohria-Lys Guillerm, Agathe Mancini, Inès Bouaziz, Elisabeth Fleck, Nadav Shashar, Gonzalo G. de Polavieja, Germán Sumbre

Bottlenose dolphins exhibit a sophisticated social structure, known as a fission-fusion society. To sustain this complex system, dolphins rely on acoustic communication. Their vocal repertoire comprises clicks exclusively used for echolocation, burst-pulse sounds associated with emotions during social interactions, and whistles, including signature whistles that serve as individual-specific identifiers (‘names’). How dolphins maintain their complex social structure based only on a limited repertoire of sounds remains elusive. Here, we studied the acoustic interactions between dolphins in a natural environment. Using a uniquely large dataset, we observed that signature whistles exhibit variations in their frequency contours. Unsupervised clustering revealed that signature whistles could be classified into several sub-categories (signature whistle variants), suggesting that these whistle variations are not the consequence of a random process. Moreover, these whistle sub-categories did not depend on the emitter. These findings suggest that dolphins modulate the signature whistles to transmit additional information beyond their identities. Analysis of pairwise interactions between sub-categories revealed a clustered structure. Network analysis showed that whistle sub-categories had different functional roles. Some behave like hubs, others as bridges and certain are used for turn taking between the main whistle categories. These results suggest that dolphins engage in “dialogue-like” acoustic interactions.

Frank Weber
IBPS – Paris

The impact of odor cues from invasive floral species on appetitive responses of honey bees: attractiveness as a factor of success

Frank Weber

In the French Pyrenees, invasive alien plant species (IAS) such as the Himalayan balsam *(Impatiens glandulifera Royle*) and the Japanese knotweed (*Reynoutria japonica Houtt.*) show widespread dispersion patterns. Pollinator choice - in particular of honey bees - may contribute to IAS invasive success via attractive signalling and rich nectar and pollen rewards. Here, we evaluated the bees' response to

the principal volatiles compounds (VOCs) emitted by *I. glandulifera* and *R. japonica* in order to determine if they exert an innate attractiveness a for honey bees, thus enhancing their reproductive success. Firstly, we used gas chromatography (GM-GC) to identify the main volatile compounds (VOCs) emitted by these flowers. While *I. glandulifera* weakly emits a compound close to a rare molecule termed ambrettolide*, R. japonica* strongly emits linalool and its derivatives. We then tested the olfactory attractivity of these odorants by presenting them to harnessed bees and assessing their appetitive spontaneous proboscis extension response (PER) upon stimulation with increasing concentrations of the odorants. Linalool elicited spontaneous PER upon its first presentation thus showing its attractiveness. Interestingly, ambrettolide presentation resulted in an increase of responsiveness along increasing concentrations of the odorant in a phenomenon akin to sensitization. These results indicate that IAS benefit from olfactory cues to enhance their attractiveness and thus enhance their competitive success in the rich floral pollination market of the French Pyrenees.