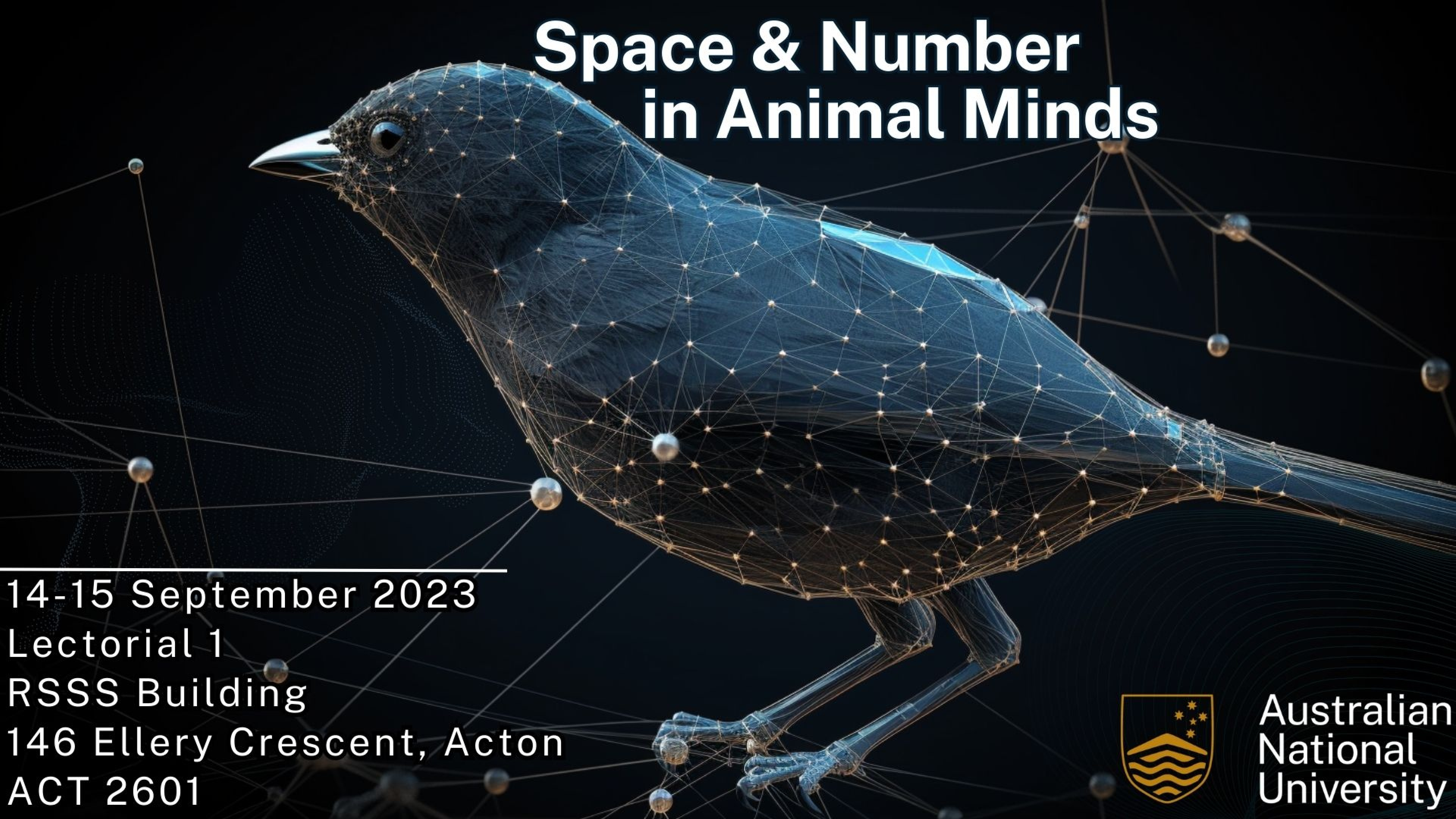
Space & Number
in Animal Minds
14-15 September 2023
Lectorial 1
RSSS Building
146 Ellery Crescent, Acton
ACT 2601
Australian
National
University

PROGRAMME

THURSDAY | 14 SEPTEMBER		FRIDAY | 15 SEPTEMBER
Coffee & Tea | Welcome & Intro @ 9:15am	**9:00 AM**	Coffee & Tea
Jochen Zeil (ANU)	**9:30 AM**	**Ken Cheng (Macquarie)**
Morning Tea	**10:30 AM**	Morning Tea
Alexandre Duval (ANU)	**11:00 AM**	**Scarlett Howard (Monash)**
Lunch	**12:00 PM**	Lunch
Jeanne Godard (Macquarie)	**1:00 PM**	**Marie-Geneviève Guiraud (Sydney)**
Ehsan Arabzadeh (ANU)	**2:00PM**	**Jon Opie (Adelaide)**
Afternoon Tea	**3:00 PM**	Afternoon Tea & Close
Shaam Al Abed (ANU)	**3:30PM**	-
Close	**4:30 PM**	Drinks @ Badger & Co.

Contact:
robert.farquharson@anu.edu.au
alexandre.duval@anu.edu.au

ABSTRACTS

Jochen Zeil

Helpful and Unhelpful Concepts in the Study of Insect Navigation:

I am interested in the ‘knowledge-base’ of insect navigation, in particular on the local scale of their daily activity schedule. I will review the navigation-relevant information that is in principle available to animals and will discuss in detail some key observations and experimental results that shed light on the insects’ use of that information. Most importantly, I will emphasize that the ability of insects to find their way back to places that are relevant to them, are (and need to be!) acquired through exquisitely choreographed learning routines, which shed light on the structure of the ‘homing problem’ and the information processing that is needed to solve it. I will argue that concepts such as ‘cognitive map’ and ‘geometry’ do not help (at least me) with understanding the navigational abilities of insects. The concepts are not needed to explain what we know about these abilities, they are not supported by evidence and are basically an unproductive distraction. Instead, I will try to make the case for a principled bottom-up approach that starts with quantifying navigational information in natural habitats, proceeds with detailed records of what animals actually do and where they’ve been throughout their foraging careers, followed by neuro-ethological robotics as a closed-loop testbed for navigational routines and by neurophysiological studies in reconstructed visual reality arenas.

Alexandre Duval

Mammals Can Represent Geometry (to navigate the world):

Many species rely on the three-dimensional surface layout of an environment to find a desired goal following disorientation. They generally do so to the exclusion of other important spatial cues. Two influential frameworks for explaining that phenomenon are provided by geometric-module theories and view-matching theories of reorientation respectively. The former posit a module that operates only on representations of the global geometry of three-dimensional surfaces to guide behavior. The latter place snapshots, stored representations of the subject’s two-dimensional retinal stimulation at specific locations, at the heart of their accounts. In this presentation, I take a fresh look at the debate between them. First, I present a new explanatory problem — the representation selection problem — that offers the prospect of breaking the impasse between these two frameworks by introducing a new type of explanatory consideration that both must address. The representation selection problem requires explaining how subjects can reliably select the relevant representation with which they initiate the reorientation process. Second, I argue that the view-matching framework does not have the resources to address this problem — at least when it pertains to mammalian species — while a certain type of theory within the geometric-module framework can provide a natural response to it.

ABSTRACTS

Jeanne Godard

The Birds and the Bees: Comparing the Cognitive Abilities of Two Nectar-Foragers

The goal of my PhD project is to find ways to compare the cognitive abilities of two distant species: honeybees (Apis mellifera) and hummingbirds (Rufous hummingbirds). Both animals are nectar-foragers with great visual and navigational skills. However, the structural differences between the vertebrate and the invertebrate brain should lead to differences in their cognitive abilities. My research focuses on finding experiments adapted to both animals that reflect these neural differences.

Ehsan Arabzadeh

Temporal Resolution of Sensory Processing: from Neural Representations to Behaviour

A key challenge in neuroscience is to understand how the external world is represented in the world inside our brain. How does neuronal activity lead to perception and behaviour? How is the neural processing modulated by expectation and attention? And finally, what is the temporal precision of neuronal representations? In this talk, I will describe electrophysiology, imaging, and psychophysics experiments from rodents and humans to approach the question of neuronal representation and their temporal dynamics.

ABSTRACTS

Shaam Al-Abed

Space and Time in Memory: a Window Upon Novel Therapeutics?

Our ability to store and recall conjunctive information about what happened when and where, i.e., the episodic component of declarative memory, undergoes preferential degradation during aging, bringing with it some psychiatric disorders. Memorizing both temporal and spatial associations that underlie declarative memory is known to critically rely on the hippocampus in mammals, but the underlying mechanisms remain largely hypothetical. By designing specific paradigms relevant to human aspects of memory, we have identified temporal binding and contextualisation as cardinal features of adaptive declarative memory formation, which are degraded in aging and traumatic memory, respectively. In this presentation, I will describe the paradigms and psychological processes critical to memorisation in human and non-human mammals, and cover the extent to which space and time can be harnessed to rescue memory deficits throughout life span.

Ken Cheng

A Basis for Orientation and Navigation Across Species

I present the thesis that servomechanisms working with oscillators form a common basis for orientation and navigation in all life. A servomechanism is a goal-directed device that specifies a target to aim for, in orientation and navigation, a direction to travel in or a place to reach. A servomechanism uses sensory feedback to track errors from the set goal, on the basis of which it generates actions to reduce errors. The encoding and comparing of sensory input means that this view complements a representational view of cognition. While an emphasis is put on the action generated, I do not see this framework as a radical departure from a representational view of cognition. In navigation and orientation, the action generation commonly calls on oscillators, which are endogenous mechanisms that generate oscillations, which are regular, periodic actions. I illustrate with examples across all scales of mobile life, from bacteria travelling micrometres to sea turtles travelling thousands of kilometres.

ABSTRACTS

Scarlett Howard

Insights into Mathematics as the Language of the Universe: Studying Numerical Cognition in Miniature Brains

Many animals must process numerical and quantity information to survive. Such tasks can be useful for assessing food resources, aggressive interactions, predator avoidance, and prey choice. Honeybees have become an ideal model species for examining cognition in miniature insect brains. Furthermore, honeybees have demonstrated a range of numerical abilities extending from spontaneous quantity discrimination to more conceptual tasks such as ordering empty sets (“zero”). I will discuss the capacity of miniature bee brains to perform tasks such as rudimentary counting, quantity matching, quantity discrimination, numerical ordering, arithmetic, symbolic representation of numbers, and categorisation of odd or even quantities. I will also discuss important criticisms and debates in animal numerical cognition, explore upcoming experiments, present evidence of numerical tasks in other insects, and discuss currently unpublished work in the field. I will also delve into the idea that understanding how an insect can perform complex numerical tasks gives us an insight into the extent of mathematical abilities across species. Given that honeybees and humans are separated by over 600 million years of evolution, our findings suggest that advanced numerical cognition may be more accessible to nonhuman animals than previously suspected.

Marie-Geneviève Guiraud

Active Vision: Bees Tell us Where to Look - Elegant & Simple Solutions to Complex Problem-Solving

More and more studies are emerging about the amazing learning capabilities of our furry flying pollinators. These studies have led many animal researchers to believe that bees can acquire abstract concepts and numerical abilities. However, some scientists are more sceptical about these findings. They believe that there are other ways of accounting for the results of the relevant studies. In my presentation, I will weigh in on this debate as it pertains to numerosity and the abstract concepts above and below. I will emphasize the importance of paying attention to the specific kind of visual and navigational strategies that bees use to succeed at these tasks. For instance, with training, bees can learn to attend only a fraction of visual stimuli instead of whole stimuli. They will follow edges and look for anything that allows them to ‘cheat’. Could bees use these strategies in the experiments designed to test their numerical abilities and their abilities to deploy the abstract concepts above and below? We shall see.

ABSTRACTS

Jon Opie

Lessons from the Blowfly

During flight, a blowfly is susceptible to windborne forces that cause unpredictable whole-body motion. Such motion threatens the fly's visual acuity. But blowflies are able to correct for this using the dynamic global structure of the visual signal itself to continuously adjust their head orientation. The mechanism responsible for this feat offers some important lessons about the nature of representation in neurozoans. In particular, I argue, it calls for a triadic account of representation, and a structural account of representational content.