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PROJECT

Insect Intentionality and Sentience: Understanding Complex Behaviors in Social Insects

I posit that much of what makes animals "intelligent" is caused by an interplay of many learning circuits on varying levels. A classical reductionist approach to the study of learning aims at controlling as many variables as possible, in order to isolate (ideally) a single learning mechanism and study it in detail. While this approach has proven extremely powerful, we need to add new approaches that allow us to study experimental settings in which many parameters remain open, to allow for multiple memory traces that thus create complex memories and behaviors. This is sometimes done in behavioral analyses (in particular in open field observation studies), but not yet on an analytical level that would allow us to record neural activity in dedicated physiological experiments.

The long-term goal is to understand intentionality and sentience. I define intentionality as a process used by animals for action selection. When an animal is in a situation in which several behaviors can be selected from, and the animal has to choose (in a simple case, for example, fly West or East), action selection is necessary. This can be based on past experience, inherited algorithms, randomness - or any combination. Alternatively, the animal could "visualize" the future outcome of its actions for each alternative. ("Visualize" is a poor word here, because it refers to the visual system only; "experience" is better, but easily misunderstood.) If an animal gauges alternative future outcomes internally, it uses intentionality. Intentionality entails an internal representation of the outside world and the capacity to evaluate a "virtual reality" therein. Intentionality – or the capacity for it - may relate to properties that are more complex: the internal representation of self, self-awareness, sentience (the capacity to feel subjectively), and consciousness. I believe it is important to include these in our thinking, but at the same time to keep them clearly and explicitly distinct.

My hypothesis is that these capacities (including action selection, intentionality, self-awareness, sentience, consciousness) do not come automatically with increased complexity. I will focus on the honeybee as a social, experimentally amenable insect. Experimental designs can then be extended to other species at a later stage.

Recommended Reading

Galizia, C. Giovanni (2014). "Olfactory coding in the insect brain: data and conjectures." Eur J Neurosci 39, 11: 1784-95.

Galizia, C. Giovanni and Pierre-Marie Lledo, eds. (2013). Neurosciences - from molecule to behavior: a university textbook. Heidelberg: Springer.

Galizia, C. Giovanni and Wolfgang Rössler (2010). "Parallel olfactory systems in insects: anatomy and function." Annu Rev Entomol 55: 399-420.

COLLOQUIUM, 19.05.2020

Do Honeybees Dream?

When I told you about my project over lunch or dinner, in pre-Corona times, many of you were puzzled or fascinated by the topic: could a bee dream? And if so, how would we know? Even more, isn't this a topic that digs into questions about consciousness and the like - but would we really want to attribute such typically human mental capacities to these furry, flying critters?

In an essay with the captivating title "What is it like to be a bat?", Thomas Nagel writes: "I assume we all believe that bats have experience. After all, they are mammals, and there is no more doubt that they have experience than that mice or pigeons or whales have experience. I have chosen bats instead of wasps or flounders because if one travels too far down the phylogenetic tree, people gradually shed their faith that there is experience there at all."

Contrary to Nagel, my hope is that, by moving away from animals that we feel related to, we may also move away from arguments such as "I assume" and into evidence-based "the data shows". This is one of the motivations for working with insects: they have complex behavior, but are sufficiently alien to us as to preclude (to a large extent) the temptation of projecting our own mind onto them.

I will cover three topics:

1. Do bees dream?

Several aspects need to be covered here: do bees sleep? Does sleep show different phases? What does brain activity look like in the awake bee and in the sleeping bee, and - if the brain is active during sleep - what does that activity mean?

2. Do bees use maps to navigate?

Assume a foraging bee collects nectar. If, in a dream, she would recapitulate her visit to the flower, would that happen in an inner representation of the outer world? And, if so, would we call this a map?

3. Do bees have intentionality or consciousness?

Intentionality, like many concepts in this semantic cloud (consciousness, agency, experiences...), is ambiguous, because different scholars use the word with different associations, connotations, and usually with fuzzy definitions. Going back to the original definition by Franz Brentano in 1874, we would attribute intentionality to the bee when a bee dreams (assuming the answer to question 1 is positive) or when she uses a mental map (assuming the answer to question 2 is positive), since she creates an inner (mental) representation of an outside world (to what extent that world needs to correspond to the real world is irrelevant here). The bee would have consciousness, if she herself were part of that world, i.e., if she would dream not "just" a flower meadow, but also dream of herself flying in that meadow.

I am convinced that these questions are objective and scientifically tractable questions that, in the end, will have answers such as "Yes, because the data shows that..." (or no, if the data refutes the assumptions), with the open ending that even those findings may be falsifiable by later experiments. The aim of my project is to develop appropriate experimental approaches to address these issues.

As a spoiler: the answers to the three questions, in my talk, are (1) I don't know (but there is tentative data towards yes), (2) I don't know (but there is controversial data toward yes), (3) I don't know (for consciousness, there is no convincing data).

PUBLICATIONS FROM THE FELLOW LIBRARY

Galizia, Giovanni (Oxford [u.a.],2025)

Olfactory receptor responses to pure odorants in Drosophila melanogaster

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1925491277

Galizia, Giovanni (Jerusalem,2015)

Forgetting : an interdisciplinary conversation

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1621796140

Martin Buber Society of Fellows notebook series

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1621796140

Galizia, Giovanni (Oxford,2014)

Olfactory coding in the insect brain : data and conjectures

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Galizia, Giovanni (Berlin, Heidelberg,2013)

Neurosciences - from molecule to behavior : a university textbook

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Galizia, Giovanni (Dordrecht,2012)

Honeybee neurobiology and behavior : a tribute to Randolf Menzel

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=663491436

Galizia, Giovanni (Palo Alto, Calif.,2010)

Parallel olfactory systems in insects : anatomy and function

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Galizia, Giovanni (Konstanz,2010)

Wie kommen die Düfte ins Gehirn? : Bericht aus der Werkstatt der Neurobiologie ; [... erweiterte Fassung des Vortrags, der am 7. November 2008 im Rahmen des 25. Wissenschaftsforums der Stiftung "Wissenschaft und Gesellschaft" und der Universität Konstanz ... gehalten wurde]

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