Unraveling a debate on insect cognition

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Do insects such as honeybees create mental maps or do they rely on environmental cues to navigate? The debate has divided insect-cognition researchers for decades. Credit: József Szabó/Unsplash

There's a debate among insect-cognition researchers, but the two camps have been arguing for so many decades that many onlookers are no longer sure what they are arguing about. SFI Postdoctoral Fellow Kelle Dhein, a philosopher and historian, has published a paper in *Studies in History and Philosophy of Science* clarifying the debate, with lessons for

philosophers, historians, and scientists alike.

One camp, led by Randolf Menzel, argues that insects form cognitive maps, assembling their memories into sophisticated mental representations that tell them where they are. The other camp, led by Rüdiger Wehner, argues that insects have toolkits that tell them where to go, depending on environmental clues and whether they are venturing out to forage or returning to the nest.

Oddly, Dhein points out, Menzel and Wehner were trained at the same time by the same mentor in Germany, and initially, they both rejected the idea that honeybees use cognitive maps. But Menzel became influenced by American experimental learning psychology and began advocating learning-driven cognitive maps, while Wehner remained in the European ethological model that emphasized instinct.

This led to very different cultures in the two groups. While both performed behavioral experiments in the field, the cognitive map group also investigated the neural processes underlying honeybee learning through laboratory conditioning experiments. Meanwhile, the toolkit group developed computational models of insect navigation based on behavioral experiments with ants. These experiments have led to a sort of stalemate, however, because each side can explain the experimental results using their own model.

Mammalian navigation researchers largely accept the cognitive map hypothesis thanks to research by John O'Keefe, May-Britt Moser, and Edvard Moser that won a Nobel Prize in 2014. These scientists discovered that patterns of neuronal firing in rats systematically correspond to a rat's location in space. One of the ways to settle the dispute in insects will be to understand insect neurology with a similar depth.

For philosophers, Dhein argues, the debate shows that cognitive science is a rich source of ideas for making sense of hard-to-define concepts like "representation." For historians, it shows that the debate between instinct and learning is still very much alive, though less obvious than it once was. And for scientists, it clarifies the issues underlying the dispute.

"I've become a big fan of both sides of the debate," Dhein says. "The whole tradition they come out of represents an extraordinarily productive way of knowing animals that is evolving before our eyes."

More information: Kelle Dhein, The cognitive map debate in insects: A historical perspective on what is at stake, *Studies in History and Philosophy of Science* (2023). DOI: 10.1016/j.shpsa.2022.12.008

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