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Two studies show that animals' brain activity 'syncs' during social interactions

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Two papers publishing June 20 in the journal *Cell* show that Egyptian fruit bats and mice, respectively, can "sync" brainwaves in social situations. The synchronization of neural activity in the brains of human conversation partners has been shown previously, as a result of one person picking up social cues from the other and modulating their own behavior based on those cues. These studies now suggest that something similar occurs when animals engage in natural social interactions and find that some aspects of the animals' social behavior can be predicted based on neural observations.

"Animal models are really important for being able to study brain phenomena at levels that we can't normally access in humans," says Michael Yartsev of the Department of Bioengineering at the University of California, Berkeley, and senior author of one of the papers. "Because bats are extremely social and naturally live in highly complex social environments, they are a great model for tackling important scientific questions about social behavior and the neural mechanisms underlying it."

"If you think of the brain like a black box that receives input and gives some kind of output in response, studying social interactions is like trying to understand how the output of one box provides input to another, and how those two boxes work together and create a loop," says Weizhe Hong of the Departments of Biological Chemistry and Neurobiology at the University of California, Los Angeles, and senior author of the other paper. "Our research in mice allows us to peer inside these black boxes and get a better look at the internal machinery."

Previous studies showing how neural activity in humans becomes synchronized during social interactions have used technologies like fMRI and EEG, which look at brain activity with relatively coarse spatial and temporal resolutions. These studies found that when two people interact, structures in their brain simultaneously decode and respond to signals from the other person.

Because the new studies looked at neural activity at a level of detail that is difficult to obtain in humans, they could explore the detailed neural mechanism underlying this phenomenon.

The Berkeley team monitored the bats for sessions of about 100 minutes each as they engaged in a wide range of natural social interactions, such as grooming, mating, and fighting. The bats were filmed with high-speed cameras, and their specific behaviors and interactions were carefully characterized.

As this was happening, the scientists were using a technology called wireless electrophysiology to simultaneously record the brain activity in the bats' frontal cortices across a wide range of neural signals, ranging from brain oscillations to individual neurons and local neural populations. They saw that the brains of different bats became highly correlated and that this correlation was most pronounced in the high-frequency range of brain oscillations. Furthermore, the correlation between the brains of individual bats extended across multiple timescales of social interactions, ranging from seconds to hours. Remarkably, by looking at the level of correlation, they could predict whether the bats would initiate social interactions or not.

The UCLA team took a different tack. They used a device called a miniaturized microendoscope to monitor the brain activities of mice during social situations. These tiny devices, which weigh only two grams, are fitted on the mice and allow the researchers to monitor the activity of hundreds of neurons at the same time in both animals. They saw that mice also exhibit interbrain correlations in natural social interactions where animals freely interact with each other. Moreover, the access to thousands of individual neurons gave them an unprecedented view of both animals' decision-making processes and revealed that interbrain correlation emerges from different sets of neurons that encode one's own behavior and behavior of the social partner.

Social interactions are often nested within the context of a dominance hierarchy. By imaging two mice in a competitive social interaction, they discovered that behavior of the dominant animal drives synchrony more strongly than behavior of the subordinate animal. Remarkably, they also found that the level of correlation between two brains predicts how mice will respond to each other's behavior as well as the dominance relationships that develop between them.

"Natural social interactions are complex," says Wujie Zhang, a postdoctoral researcher in Yartsev's lab and first author of the fruit bat paper. "It is important to embrace this complexity in order to understand real-life social interactions at the neural level."

"We know that social interactions are altered in many mental diseases in human, including autism spectrum disorders and schizophrenia," says Lyle Kingsbury, a graduate student in Hong's lab and first author of the mouse paper. "Developing a genetically tractable model system opens up the possibility of exploring how interbrain synchrony is disrupted in people with these conditions and may provide novel information about possible interventions."

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Cell, Zhang and Yartsev: "Correlated Neural Activity Across the Brains of Socially Interacting Bats." https://www.cell.com/cell/fulltext/S0092-8674(19)30551-3 DOI: 10.1016/j.cell.2019.05.023

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Cell, Kingsbury et al: "Correlated Neural Activity and Encoding of Behavior Across Brains of Socially Interacting Animals." https://www.cell.com/cell/fulltext/S0092-8674(19)30550-1 DOI: 10.1016/j.cell.2019.05.022

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Media Contact

Carly Britton
press@cell.com
617-417-7053

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