Researchers record sight neurons in jumping spider brain

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For the first time, a team of interdisciplinary researchers have made recordings of neurons associated with visual perception inside the poppy seed-sized brain of a jumping spider (*Phidippus audax*).

Though neurobiologists have tried for half a century to better understand the brains of jumping spiders, no one has succeeded. The liquid in spiders' bodies is pressurized, as they move with hydraulic pressure and muscles, so they don't tolerate previous research techniques.

As a result, the research team tried a different strategy: make a very tiny hole that self-seals around a hair-sized tungsten recording electrode.

"The team, together for almost two years now, had to pull together as a collective on every aspect of the work, from designing experiments, writing programs, performing statistical analysis, doing brain surgery, to writing the papers," said Ron Hoy, professor of neurobiology and behavior at Cornell University and the senior author of the study published this month in an early online edition of *Current Biology*. "No one or two of them, without the others, could have pulled off this formidable challenge," he added.

Gil Menda, a postdoctoral researcher in Hoy's lab and the paper's first author, recognized that if a hole was small enough, the spider's self-sealing properties could close a cut. He used steady hands to insert microelectrodes into the spider's brain and record electrical spikes from neurons in its visual processing networks.

Jumping spiders have unique visual systems that have a nearly 360 degree panoramic view. They also have a pair of large, specialized front-facing eyes that are almost as acute as human eyes. This visual system supports the spider's cat-like hunting behavior; it stealthily stalks and pounces on its prey. Unlike most other spiders, jumping spiders don't build webs, but hunt nomadically like cats instead.

Menda and colleagues used a 3-D printer to construct a tiny harness for the spider, to hold it in place, and they made even smaller blinders to cover certain eyes while leaving others exposed. With the inserted microelectrode, Menda recorded bursts of activity from individual neurons when an image of a fly, the spider's natural prey, was projected moving across a screen.

A jumping spider's unique visual system permits them to use different sets of eyes to process acuity and motion, requiring the spider to integrate inputs from different sets of eyes in the brain in a nonlinear manner. The researchers learned that when one set of eyes was open and another set was covered, there was little response in the visual processing parts of the brain when a stimulus was projected on a LCD screen. When different sets of eyes were open together, the same image elicited neural activity. "It needs all the eyes open for the brain to process information," said co-author Paul Shamble, a graduate student in Hoy's lab who specializes in spiders.

"Usually, you know what you are getting into, but a spider's brain is so small, we couldn't," said co-author Eyal Nitzany, a graduate student in the field of biological statistics and computational biology. "We put the electrode in, and then we had to verify what we were getting into."

The study provides clues for the first time into how a jumping spider's brain processes information and opens up a new field of basic neuroscience, Hoy said. The work could also be applied to optical sensor technology: "Researchers are always interested in miniaturizing biosensors – and jumping spiders have really tiny eyes," Shamble said.

"In the modern age, animals like this are smarter than robots," said co-author James Golden, who has a master's in electrical engineering from Cornell and is a doctoral student in the field of psychology interested in robotics and optical systems. "Jumping spiders have been this little black box of behaviors. We can now investigate how these things happen."

More information: *Current Biology*: www.sciencedirect.com/science/ … ii/S0960982214011506

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