Flies remember where to chill out

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(PhysOrg.com) -- By recalling landmarks in the environment, a leopard can return to the tree where it stashed its kill and a shopper can find her car in the mall's parking lot. Fruit flies also commit details of their surroundings to memory, a new study reveals. Understanding how the insects store this information might help researchers find out how humans and other animals create so-called spatial memories.

Vertebrates build a mental map of the landscape in the hippocampus, a brain structure crucial for memory. Currently, it is very hard for scientists to address the question of how that spatial information becomes encoded in the activity of neurons in the hippocampus, says neurobiologist Michael Reiser, at the Howard Hughes Medical Institute's Janelia Farm Research Campus. But researchers might be able to start dissecting the mapping of spatial memory by analyzing the process in fruit flies, which have simpler brains whose cells researchers can precisely target for manipulation. "The fly presents a real sweet spot to try to answer this question," says Reiser.

He teamed up with HHMI investigator Charles Zuker of the Columbia College of Physicians and Surgeons in New York City, who is also a senior fellow at Janelia Farm. Together they mentored Tyler Ofstad, an M.D./Ph.D. student at the University of California, San Diego, who has been working at Janelia Farm as a visiting scientist. The research team came together through the Janelia Farm Visitor Program, through which scientists from all over the world, ranging in career stage from graduate students to senior investigators, conduct research of their own design on the research campus for periods ranging from a few weeks to several

years.

The first issue to resolve was whether flies can actually remember a location based on what they see around them. The researchers tested flies' ability to memorize their surroundings by shepherding the insects into a small, circular arena. A clear glass top just above the flies' heads prevents them from escaping. Most of the arena's floor was at a temperature of 36 degrees Celsius, uncomfortable for the flies but a temperature they can easily withstand. However, one tile in the floor was only 25 degrees Celsius, pleasantly cool for fruit flies. Each time the flies enter the arena, they typically wander around the floor, but "once they find the cool spot, they stop there and stay there," says Ofstad. The flies go through 10 five-minute trials to learn the location of the tile.

The cool tile doesn't look different from the rest of the floor, so the only landmarks in the arena are vertical, horizontal, and angled bars projected on the wall. To determine whether the flies use that background to guide them to the cool tile, the researchers rotated the floor and the walls of the arena simultaneously after each trial. Although the location of the cool tile on the floor changed, its position relative to the wall patterns remained the same. The flies quickly learned to pinpoint the cool spot. After 10 attempts, the insects could find the tile in under 60 seconds, less than half the time it took on their first try, the group reports in the June 9, 2011, issue of the journal *Nature*. After training, when the researchers challenged the flies with an arena lacking a cool tile, the insects congregated where the tile would be expected to be, based on the visual background.

But then the team tricked the flies, rotating the thermal pattern on the arena floor after each trial but leaving the wall stationary, so that the background pattern no longer corresponded to the location of the cool tile. The flies were baffled. They also couldn't learn the way to the cool tile in the dark. "Flies can form memories about spatial locations," says

Ofstad. Or to put it another way, “the message is that flies are smarter than people think they are,” says Reiser.

Next, the team wanted to nail down the location of those smarts in the brain. To do so, they turned to genetic tools developed in the lab of Janelia Farm director Gerald Rubin that allow researchers to switch off small groups of neurons in a fly’s brain. They first silenced neurons in the mushroom bodies, structures that help flies recall smells and are important for visual learning in other kinds of insects. Researchers had suspected that the mushroom bodies were responsible for spatial learning, but turning off these neurons didn’t hinder flies’ ability to find the cool tile. The insects did forget their way around the arena if the researchers disabled neurons in another brain structure, the ellipsoid body, suggesting that it is crucial for storing or retrieving spatial information.

“The next big step is to understand how the cells [in the ellipsoid body] are encoding space,” says Ofstad. He and Reiser note that researchers have the tools to do the job, including the genetic methods to shut off neurons and techniques for recording the electrical activity of individual cells while flies are behaving. “It’s exciting,” says Ofstad.

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