UC SANTA BARBARA

THE Current

March 21, 2019
Harrison Tasoff

Shining a Light on Memory

Brains don't store memories the way computers do, in well-defined chunks of data on a storage medium. In brains, memories are diffuse, distributed over trillions of connections between neurons. Understanding how the brain encodes memories over long periods of time is perhaps one of the paramount pursuits of neuroscience.

With a grant from the Whitehall Foundation, UC Santa Barbara neuroscientist Michael Goard hopes to advance this goal by studying spatial memory formation. Founded in 1937, the non-profit organization is dedicated to scholarly research in the life sciences and, more specifically, neurobiology.

"I'm honored that the Whitehall Foundation is supporting this research," said Goard, an assistant professor jointly appointed to the departments of Molecular, Cellular, and Developmental Biology and Psychological & Brain Sciences. "It is especially helpful at this point since this is a new research direction for me, which means it is hard to acquire funding from traditional government sources that require a lot of preliminary data. This grant will be instrumental in getting this new research program off the ground."

Early in his career Goard investigated visual processing and short-term memory in mice. Recently he's shifted his focus to take better advantage of mice as a model organism. Training mice is hard, and they have a much lower visual resolution than humans, he explained. They seem to use their vision primarily to avoid predators and navigate through their environment. To take advantage of this, Goard decided to focus on studying their memory for spatial associations.

“We know that we use our previous knowledge of our environment in order to guide our movements through it,” he said. “For example, if you wanted to go get a cup of coffee right now, you would combine your knowledge of where you currently are and your knowledge of the coffee shop’s location in order to head toward your goal.”

Goard uses a simpler task for his mice. He presents a mouse with a simple virtual maze. The wall pattern tells the mouse which direction to go when it reaches the end of the virtual corridor. When it gets there, it uses its paws to turn a miniature joystick in order to earn a reward. Fluorescent proteins enable Goard to see the activity of individual neurons as the mouse performs different tasks.

Remarkably, although this task is very simple, investigating spatial memory provides a window into the broader workings of the brain. “It seems to use the same circuitry as other, more general types of memory,” Goard said, “and yet it’s something that is experimentally very accessible.”

In addition to its importance on a fundamental level, Goard’s research also lends itself to work on memory deficits like dementia and Alzheimer’s disease. “Getting lost is often one of the first symptoms of neurological disease,” he explained. “There are common brain regions and pathways used for many types of memories, so if the memory circuitry becomes disrupted, disorientation is one of the first symptoms we notice.”

He also is investigating the neurotransmitter acetylcholine, which is associated with attention and encountering unexpected errors. “We think it might stimulate the restructuring of neural circuits when they need to learn new information,” said Goard, who wants to know whether releasing this compound into the brain can speed up learning and increase mental plasticity. If the compound does prove important in spatial learning, it could be a therapeutic target for people who are starting to suffer memory deficits.

Neuroscience has exploded with new technologies in the past decade, and looking back on his career so far, Goard believes he’s found the path that best serves his curiosity. “I think I have the same overall interests now that I did as a psychology undergraduate years ago, but I’ve found I can see much farther by borrowing techniques from biology, physics and engineering. At some point, I realized I really wanted to understand the nuts and bolts of how neurons encode memories.”

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.