Experience puts the personal stamp on a place in memory

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Seeing and exploring both are necessary for stability in a person's episodic memory when taking in a new experience, say University of Oregon researchers.

The human brain continuously records experiences into memory. In experiments in the UO lab of Clifford G. Kentros, researchers have been studying the components of memory by recording how neurons fire in the hippocampus of rats as they are introduced to new activities. As in humans, brain activation in rats is seen in particular locations called "place cells." It has been believed that these cells together form a mental map of the environment.

There are subtle but important differences, though, in how mapping is done, the researchers say in a paper online in advance of regular publication in the Proceedings of the National Academy of Sciences. Rats need to directly experience a place to create a stable representation of it in their brains, researchers say. Seeing provides the big picture, but exploration burns it into memory.

"The hippocampus is a small structure deep in the medial temporal lobe of humans," said lead author David C. Rowland, a postdoctoral researcher with Kentros in the Institute of Neuroscience. "It is critical for the formation of new episodic memories, and it is therefore unsurprising that the hippocampus is also one of the main targets of memory disorders such as Alzheimer's disease."

To differentiate between simply observing a new environment and exploring it more deeply, researchers injected rats with a drug that destabilized newly formed place fields in the hippocampus. They measured the firing of place cells as the animals either observed or directly experienced an environment. The rats were then placed in two concentric boxes. Initially in an inner box, they could only observe the outer box. The rats then either were injected with saline or a chemical that blocked the NMDA receptor, which binds with glutamate and is needed for memory formation, and allowed the rats to explore the outer box.

The place fields representing the outer box were significantly different in the NMDA receptor-blocked animals, and resembled those of a new environment. Blocking that receptor destabilized the place fields of areas extensively observed but not experienced.

"We found that the place cells active in the outer box area behaved as if the area was completely novel," Rowland said. "That is, their spatial preference developed only as the animal directly experienced the environment, echoing the autobiographical nature of episodic memory."

How does this translate to human experience?

"Stop to think about what you did yesterday, and you will immediately begin to relive those experiences -- what you had for dinner, the conversations you had and so on," Rowland said. "Psychologists refer to this sort of memory as 'episodic memory,' or a memory of events that occurred in your life. A key feature of this type of memory is its autobiographical nature: it is a memory of your experiences, what you had for dinner, the conversations you had."

To illustrate the difference between simple observation and exploration, think of going to a concert in an unfamiliar auditorium, Rowland said.

"You take your seat before the lights go down. With a few glances, you create an internal representation of the entire auditorium, including your rough location within it relative to the stage, balconies and exits -- the important landmarks. You could easily generate a number of distinct novel routes to these other locations, with your eyes closed if need be, and you could draw or otherwise describe a conception of that space. In other words, you've created a map of your environment without visiting more than a small portion of it."

This preliminary map is like a third-person description, but it is not committed to memory, the researchers concluded. "The first-person experience is essentially the basis of what we define as episodic memory," Rowland said. "We found that the construction of this hippocampal representation of space -- the map's construction -- is also self-centered. The place cells therefore appear to help create an autobiographical record of experience. Our results help to align the hippocampal 'place cell' phenomenon with the hippocampus's well-described role in episodic memory, a connection that has been elusive."

Provided by University of Oregon

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