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Brain activity may mark the beginning of memories

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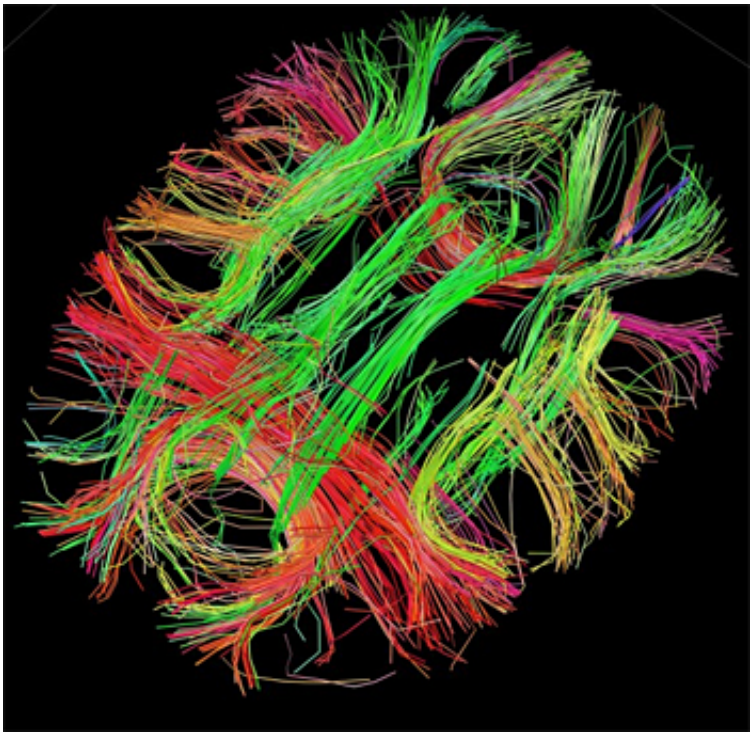

White matter fiber architecture of the brain. Credit: Human Connectome Project.

By tracking brain activity when an animal stops to look around its environment, neuroscientists at the Johns Hopkins University believe they can mark the birth of a memory.

Using lab rats on a circular track, James Knierim, professor of

neuroscience in the Zanvyl Krieger Mind/Brain Institute at Johns Hopkins, and a team of brain scientists noticed that the rats frequently paused to inspect their environment with head movements as they ran. The scientists found that this behavior activated a place cell in their brain, which helps the animal construct a cognitive map, a pattern of activity in the brain that reflects the animal's internal representation of its environment.

In a paper recently published in the journal *Nature Neuroscience*, the researchers state that when the rodents passed that same area of the track seconds later, place cells fired again, a neural acknowledgement that the moment has imprinted itself in the brain's cognitive map in the hippocampus.

The hippocampus is the brain's warehouse for long- and short-term processing of episodic memories, such as memories of a specific experience like a trip to Maine or a recent dinner. What no one knew was what happens in the hippocampus the moment an experience imprints itself as a memory.

"This is like seeing the brain form memory traces in real time," said Knierim, senior author of the research. "Seeing for the first time the brain creating a spatial firing field tied to a specific behavioral experience suggests that the map can be updated rapidly and robustly to lay down a memory of that experience."

A place cell is a type of neuron within the hippocampus that becomes active when an animal or human enters a particular place in its environment. The activation of the cells

helps create a spatial framework much like a map, that allows humans and animals to know where they are in any given location. Place cells can also act like neural flags that "mark" an experience on the map, like a

pin that you drop on Google maps to mark the location of a restaurant.

"We believe that the spatial coordinates of the map are delivered to the hippocampus by one brain pathway, and the information about the things that populate the map, like the restaurant, are delivered by a separate pathway," Knierim said. "When you experience a new item in the environment, the hippocampus combines these inputs to create a new spatial marker of that experience."

In the experiments, researchers placed tiny wires in the brains of the rats to monitor when and where brain activity increased as they moved along the track in search of chocolate rewards. About every seven seconds, the rats stopped moving forward and turned their heads to the perimeter of the room as they investigated the different landmarks, behavior called "head-scanning."

"We found that many cells that were previously silent would suddenly start firing during a specific head-scanning event," Knierim said. "On the very next lap around the track, many of these cells had a brand new place field at that exact same location and this place field remained usually for the rest of the laps. We believe that this new place field marks the site of the head scan and allows the brain to form a memory of what it was that the rat experienced during the head scan."

Knierim said the formation and stability of place fields and the newly activated place cells requires further study. The research is primarily intended to understand how memories are formed and retrieved under normal circumstances, but it could be applicable to learning more about people with brain trauma or hippocampal damage due to aging or Alzheimer's.

"There are strong indications that humans and rats share the same spatial mapping functions of the hippocampus, and that these maps are

intimately related to how we organize and store our memories of prior life events," Knierim said. "Since the hippocampus and surrounding brain areas are the first parts of the brain affected in Alzheimer's, we think that these studies may lend some insight into the severe memory loss that characterizes the early stages of this disease."

Provided by Johns Hopkins University