University of Lethbridge
News Release

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Navigation and spatial memory — brain region newly identified to be involved

Research conducted in a collaboration between Drs. Dun Mao, a researcher in Dr. Bruce McNaughton's lab at the Canadian Centre for Behavioural Neuroscience at the University of Lethbridge, and Steffen Kandler, a researcher in Professor Vincent Bonin's lab at Neuro-Electronics Research Flanders (NERF) in Belgium, has found neural activity patterns that may assist with spatial memory and navigation.

Their study, Sparse orthogonal population representation of spatial context in the retrosplenial cortex, has been published in Nature Communications.

"Previously, we knew little about how spatial information is encoded in large neuronal populations outside of the hippocampal formation," says Mao (PhD '17), who's now a postdoctoral fellow at Baylor College of Medicine in Houston, Texas. "Now we have revealed that the retrosplenial cortex, which is highly connected with the hippocampus, encodes spatial signals in a way similar to the hippocampus. These results will help us understand how the hippocampus and neocortex interact to support spatial navigation and memory."

Navigation in mammals, including humans and rodents, depends on specialized neural networks that encode the animal's location and trajectory in the environment, serving essentially as a GPS (global positioning system). Failure of these networks, as seen in Alzheimer's disease and other neurological conditions, results in severe disorientation and memory deficits.

When an animal enters a specific place in its environment, 'place cells' in the hippocampus, a brain area known for its role in navigation and memory formation, begin firing. At any given location, only a few place cells are active, with the remaining neurons being largely silent. This sparse firing pattern maximizes information storage in memory networks while minimizing energy demands.

In addition to the hippocampus, the retrosplenial cortex is involved in spatial orientation and learning and has dense connections with the hippocampus. To better understand its role, Mao and Kandler measured activity in the retrosplenial cortex in mice as they moved on a treadmill fitted with tactile stimuli. As they precisely tracked the animal's behaviour and location, they used highly sensitive live microscopic techniques to compare the activity of neurons in the retrosplenial cortex and the hippocampus.

The researchers discovered a new group of cells that fire in smooth sequences as the animals run in the environment. While the activity resembled that of place cells in the hippocampus, the retrosplenial neurons responded differently to sensory inputs.

"We found these two functional cell types in the retrosplenial cortex, one devoted to spatial mapping and the other devoted to visual processing. We are now studying how these two information streams interact in the retrosplenial cortex," Mao says.

The results show that the retrosplenial cortex carries rich spatial activity, the mechanisms of which may be partially different from that of the hippocampus. While more research is needed to investigate the relationship between retrosplenial activity and the hippocampus, the results pave the way for a better understanding of how the brain processes spatial information.

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