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

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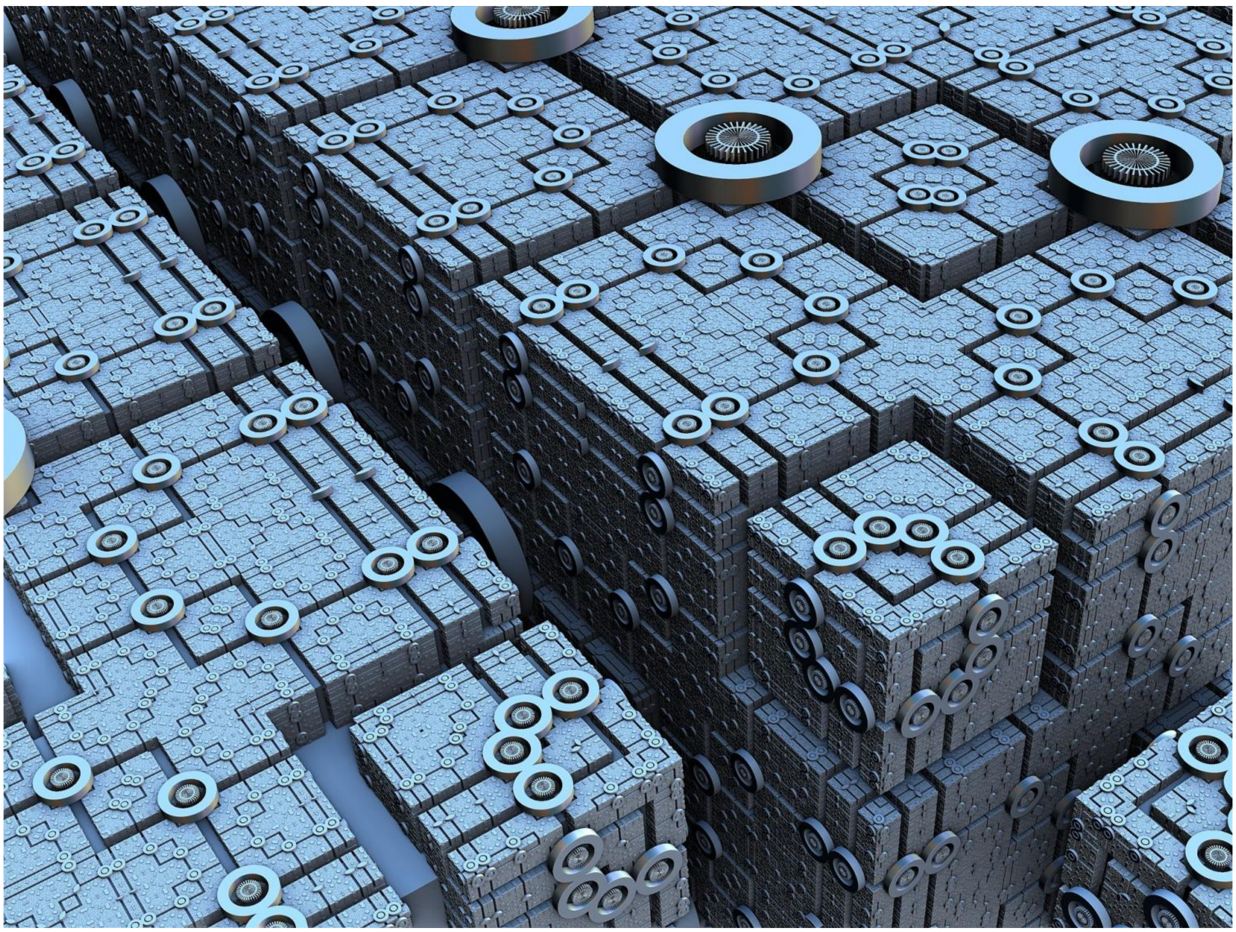

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Navigation in mammals including humans and rodents depends on specialized neural networks that encode the animal's location and trajectory in the environment, serving essentially as a GPS, findings that led to the 2014 Nobel Prize in Medicine. Failure of these networks to function properly, as seen in Alzheimer's disease and other neurological conditions, results in severe disorientation and memory deficits. Researchers at NERF (VIB-imec-KU Leuven) have now uncovered striking neural activity patterns in a brain area called the retrosplenial cortex that may assist with spatial memory and navigation.

The prime example of spatial information coding is the firing of so called place cells in the hippocampus, a brain area known for its role in navigation and memory formation. Place cells fire when an animal enters a specific place in its environment. At any given location, only a small fraction of place cells is active, leaving the remaining neurons largely silent. This sparse firing pattern maximizes information storage in memory networks, but at the same time minimizes energy demands.

The hippocampus, however, is not the only brain area involved in spatial orientation and learning. The retrosplenial cortex is also highly active during navigation and memory retrieval and connects the hippocampus to the visual cortex and other areas of the brain. Damage to the retrosplenial cortex results in memory deficits and disorientation, and patients with Alzheimer's disease have reduced activity in their retrosplenial cortex.

To better understand the role of the retrosplenial cortex, Drs. Dun Mao and Steffen Kandler, researchers in the laboratories of Profs. Vincent Bonin and Bruce McNaughton at NERF, measured its activity in mice that moved on a treadmill fitted with tactile stimuli. In this setting they could precisely track the animal's behavior and location. By combining genetic labeling of cortical neurons and highly sensitive live microscopic techniques, the researchers were able to compare the activity of the neurons in the retrosplenial cortex with those in the hippocampus.

"Previous studies could only record from a few retrosplenial neurons simultaneously. With our cellular imaging technique, we could monitor the activity of hundreds to thousands of neurons simultaneously, which gave us a rich view into the neurons' activity patterns," explains prof. Vincent Bonin.

The researchers discovered a new group of cells that fire in smooth sequences as the animals run in the environment. Their activity resembled that of hippocampal place cells in terms of their sparse firing properties; however, the retrosplenial neurons responded differently to sensory inputs.

These results indicate that the retrosplenial cortex carries rich spatial activity, the mechanisms of which may be partially different from that of the hippocampus. They pave the way for a better understanding of how our brain processes spatial information. Prof. Vincent Bonin: "The next step is to investigate directly the relationship between retrosplenial activity and hippocampus as well as its link to visual inputs. It will also be interesting to know how activity in the retrosplenial cortex relates to the development of different neuronal diseases in mouse models."

More information: Dun Mao et al. Sparse orthogonal population representation of spatial context in the retrosplenial cortex, *Nature Communications* (2017). DOI: 10.1038/s41467-017-00180-9

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