Virtual driving leads psychologists to the cells that sense direction in the brain: Path cells

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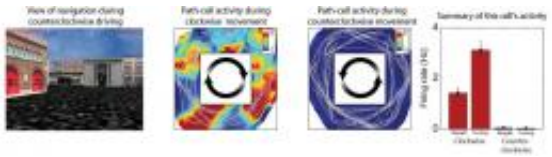

This series of images indicates showing the virtual navigation game, path cell movement and activities. Credit: University of Pennsylvania

Psychologists led by the University of Pennsylvania have used implantable electrodes and a first-person driving game to identify the cells of the brain that indicate travel in a clockwise or counterclockwise motion, called "path cells." The study will be published this week in the *Proceedings of the National Academy of Sciences*.

The study demonstrated that during navigation, these path cell neurons encode the direction in which a person is traveling. An individual path cell activates when the person is driving clockwise around a circular road and is silent when the person is moving counterclockwise. By representing direction, these path cells complement other "place cells" that encode location. Working together, these cells help people navigate to their desired destinations.

The results support the hypothesis that the entorhinal cortex, or EC, where path cells are found, encodes general properties of current

navigation that are used by the hippocampus to build unique, cognitive representations of each spatial environment. Because these brain regions are also important for memory, the study indicates that path cells help people to remember in which direction they were driving when they saw a particular landmark. Path cells also may help us remember two different landmarks that are near each other because they are often viewed while driving along a path in a particular direction.

"Finding our way in spatial environments is an essential part of daily life," said Michael Kahana, professor in the Department of Psychology and director of the Computational Memory Lab at Penn. "Our goal in this research was to determine how the brain comes to possess this sense."

Researchers asked patients undergoing an unrelated neurosurgical procedure to play a virtual-navigation video game called "Yellow Cab." Patients used a handheld joystick to drive a taxi through a circular virtual town, either clockwise or counterclockwise, to a randomly selected destination.

During game play, researchers recorded the patterns of activity in the brain, examining the relationship between each neuron's firing rate and the patient's simultaneous behavior. Using intracranial depth electrodes implanted into the brains of the patients, researchers recorded the firing of more than 1,400 neurons from across the brain.

Researchers already knew that navigation was supported by place cells, which are neurons in the hippocampus that activate when a person is at a particular location. This research showed that navigation is also supported by path cells that encode the current direction. Together, place and path cells work together to tell people where they are and which direction they are going.