Knowing where the center of a space is helps inform spatial awareness

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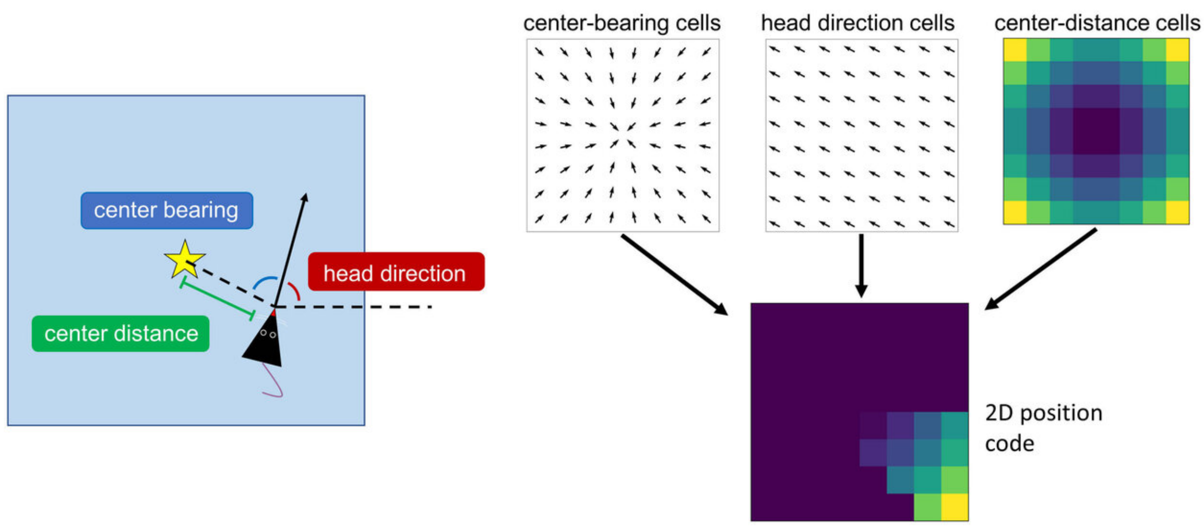

Spatial coding in rat's postrhinal cortex. Neurons in the rat postrhinal cortex encode the egocentric bearing and distance of the geometric center of the local environment during free foraging, as well as the animal's head direction in allocentric coordinates. Credit: Diagram is included in the study, and was provided by Patrick A. LaChance.

As you enter a new environment such as visiting a classroom for the first time, your brain takes in information about your surroundings to help inform where you are and what direction you are facing. Knowing where the center of the room is located helps provide a reference point for processing space. A Dartmouth study published in *Science* provides new insight into navigation and spatial learning by examining how the rat brain processes spatial information from the outside world in an egocentric framework and converts it to information in relation to the animal's spatial position in an allocentric framework (referenced to the world at-large).

As the study explains, the postrhinal cortex of the rat brain is considered "the rodent homolog of the human parahippocampal cortex," which is thought to be responsible for spatial navigation. The study examined how the rat brain processes incoming sensory information to inform where it is. For each trial, the rat was placed in an open box ("room") and trained to forage for sugar pellets that fell from overhead. The rat was filmed and its brain activity was recorded using electrodes. Following the trials, the researchers analyzed what the spatial cells were doing in relation to where the rat was in the environment. The results demonstrated that the postrhinal cortex contains three types of spatial cells, which act together to provide a sense of where the rat is located and its directional orientation within the local environment.

- Some neurons are "center-bearing" cells, which are egocentric in nature, and identify where the geometric center of the space is located in relation to the animal. The center-bearing cells inform the animal of its directional orientation relative to where the center of room is, such as whether the room center is in front or behind the animal.
- Other neurons are "center-distance" cells, whose firing rates encode the distance the rat is from the center of the environment. Some center-distance cells may fire more rapidly in the center while others may fire more slowly there, but both types of these cells are encoding the same type of information.
- Finally, other neurons are "head-direction" cells, which respond to and are specific to a cardinal direction. Regardless of where the animal is located in the room, the cell will fire whenever the

animal is looking in a specific direction. Different head direction cells encode different directions and the population of this cell type appears to encode all 360 degrees.

Together, the center-bearing cells, center-distance cells and head-direction cells tell the animal where it is and what direction it is facing.

"Our results demonstrate that it appears that the rat uses the center of the environment to ground where its located, providing new insight into how these animals locate and orient themselves in an area that has boundaries," explains lead author Patrick A. LaChance, a graduate student in the department of psychological and brain sciences at Dartmouth.

"In the area of spatial learning, the study's findings are exciting, as they illustrate how the postrhinal cortex could provide a template for how humans convert egocentric information (the reference frame in which all information enters the brain) into allocentric information (the reference frame relative to the external world) in the parahippocampal cortex, says co-author Jeffrey S. Taube, a professor of psychological and brain sciences at Dartmouth, whose lab focuses on spatial cognition and the neural correlates of navigation.

Other studies have shown that when humans experience brain damage to the parahippocampal cortex region, they may have topographical disorientation and may not be able to form new spatial representations and often are disoriented and get lost. In sum, the study sheds light on how and where in the brain spatial information gets processed in order to enable us to do things such as find our car in the parking lot at the end of the day and direct our route home.

More information: A sense of space in postrhinal cortex, *Science* 12 Jul 2019: Vol. 365, Issue 6449, eaax4192 , DOI:

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