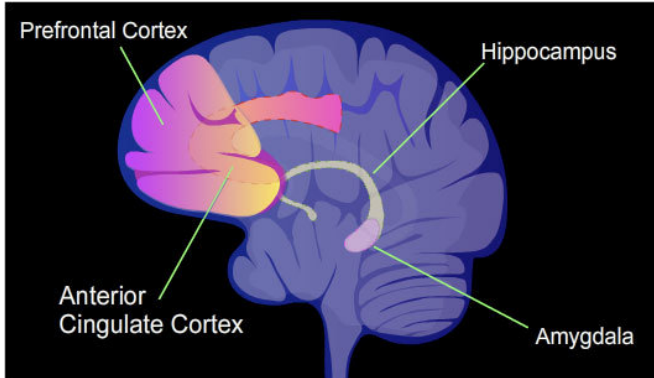


How we know where we are

8 December 2017, by Sarah Haurin



The hippocampus is a key structure in formation of memories and includes cells that represent a person's environment. Credit: Duke University

The brain is a personalized GPS. It can keep track of where you are in time and space without your knowledge.

Daniel Dombeck PhD, and his team of researchers at Northwestern University have been using a technique designed by Dombeck himself to figure out how exactly the brain knows where and when we are. He shared his methods and findings to a group of researchers in neurobiology at Duke on Tuesday.

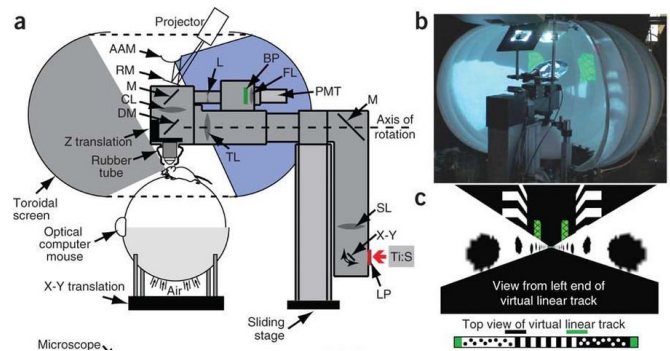
The apparatus used for these experiments was adapted from a [virtual reality](#) system. They position a [mouse](#) on a ball-like treadmill that it manipulates to navigate through a virtual reality field or maze projected for the mouse to see. Using water as a reward, Dombeck's team was able to train [mice](#) to traverse their virtual fields in a little over a week.

In order to record data about brain activity in their mice as they navigated virtual hallways, Dombeck and his team designed a specialized microscope that could record activity of single cells in the hippocampus, a deep brain structure previously found to be involved in spatial navigation.

Previous research has identified hippocampal place cells, specialized cells in the hippocampus that encode information about an individual's current environment. The representations of the environment that these place cells encode are called place fields.

Dombeck and his colleague Mark Sheffield of the University of Chicago were interested in how we encode new environments in the hippocampus.

After training the mice to navigate in one virtual environment, Sheffield switched the virtual hallway, thus simulating a new environment for the mouse to navigate.



The device allows researchers to observe single cells as a mouse navigates through a simulated hallway. Credit: Duke University

They found that the formation of these new [place cells](#) uses existing neural networks initially, and then requires learning to adapt and strengthen these representations.

After identifying the complex system representing this spatial information, Dombeck and colleagues wondered how the system of representing time compared.

Jim Heys, a colleague of Dombeck, designed a new virtual reality task for the lab mice.

In order to train the mice to rely on an internal representation of passing time, Heys engineered a door-stop task, where a mouse traversing the virtual hallway would encounter an invisible door. If the mouse waited 6 seconds at the door before trying to continue on the track, it would be rewarded with water. After about three months of training the mice, Heys was finally able to collect information about how they encoded the passing of time.

Heys identified cells in the hippocampus that would become active only after a certain amount of time had passed – one cell would be active after 1 second, then another would become active after 2 seconds, etc. until the 6-second wait time was reached. Then, the mouse knew it was safe to continue down the hallway.

When comparing the cells active in each different task, Dombeck and Heys found that the cells that encode time information are different from the cells that encode [spatial information](#). In other words, the cells that hold [information](#) about where we are in time are separate from the ones that tell us where we are in space.

Still these [cells](#) work together to create the built-in GPS we share with animals like mice.

Provided by Duke University

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