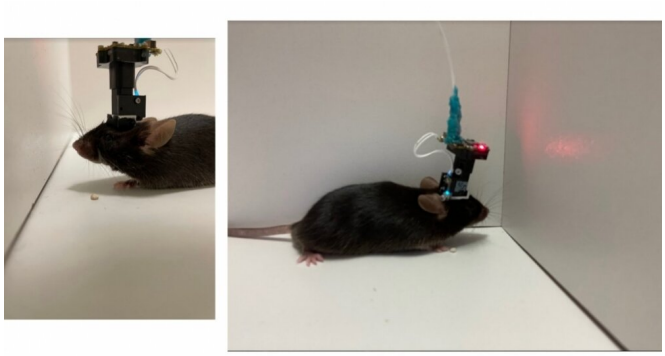
Researchers identify neurons that specialize in remembering speed and location

14 September 2022, by Mônica Tarantino



The study involved the use of biosensors, algorithms and open-source software to build a miniature microscope. The findings contribute to a better understanding of how our brains track and retain information about routes and learn new locations (miniature microscope recording electrical activity of neurons in mice. Credit: Archive of Peter J. Schuette et al

Over a decade after the role of pyramidal neurons in mental representations of space and location was discovered, a group of Brazilian and American researchers has made an important contribution to scientists' understanding of the brain's navigation system by identifying a subtype of these neurons that can gauge speed with great precision.

"In experiments involving animals, we demonstrated an association between the electrical activity of inhibitory interneurons and speed representations in the brain," Alexandre Kihara, a neuroscientist at the Federal University of the ABC in São Paulo state, Brazil, told Agência FAPESP. Kihara is a co-author of an article on the study published in *Scientific Reports*.

Excitatory neurons and inhibitory interneurons are located in the hippocampus, a bilateral brain structure in the temporal lobe (behind the ears) that is associated with the formation of new memories, learning, emotions, and as has recently been discovered, spatial representation. Excitatory neurons activate other neurons, while inhibitory interneurons hinder or block them. Together they can modulate signaling in brain regions to avoid the excess activity associated with seizures, for example.

"Although they all play a role in encoding space, we found that inhibitory neurons have some additional functions," said Juliane Midori Ikebara, who holds a bachelor's degree in science and technology and a Ph.D. in neuroscience and cognition from UFABC.

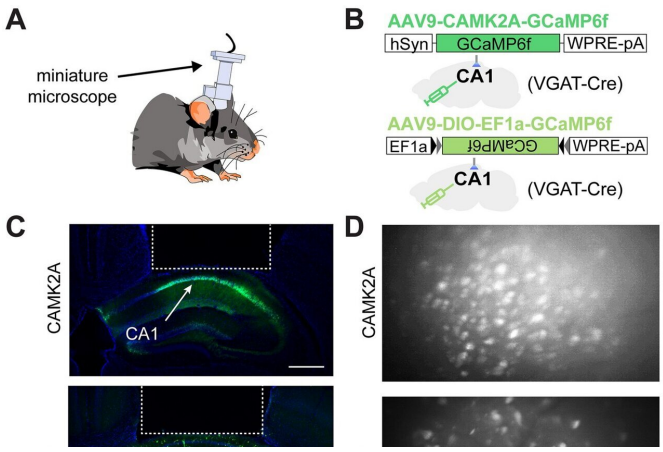
Ikebara is the lead author of the article, alongside Peter Schuette, a researcher in the Psychology Department at the University of California, Los Angeles (UCLA) in the United States.

Analyzing video images of neural activity in mice, the group also observed that inhibitory neurons reacted differently to changes in the environment such as rotation or size. "They were more stable than excitatory neurons, which sometimes alter position encoding in response to environmental changes," Kihara said.

This behavior was unknown and may be associated with spatial memory. "These more stable neurons may be linked to the ability to remember routes or the location of the living room or bathroom when we wake up in the same house, for example," said Kihara, who supervised Ikebara's Ph.D. research.

In practice, Ikebara noted, this is the first study to evidence the functions of inhibitory cells, which account for less than 10% of pyramidal neurons. The idea of studying these cells arose while she was doing a sandwich doctorate in the US in 2020-21. Having been awarded a scholarship by FAPESP, she went to work for a period at the UCLA laboratory led by Professor Avishek Adhikari, the corresponding author of the *Scientific Reports*

article, to learn to build the miniature microscope used to record neuronal electrical activity.



Recording calcium transients in CAMK2A- and VGAT-expressing cells in dorsal hippocampal area CA1. (**A**) Scheme showing mouse with miniaturized microscope to record calcium transients from either CAMK2A- or VGAT-expressing cells in dorsal hippocampal area CA1. (**B)** Scheme showing viral constructs used to target expression of the calcium indicator GCaMP6f to either CAMK2A- or VGAT-expressing cells in CA1. VGAT-cre driver mice were used in both cases. (**C**) Representative histology showing expression of GCaMP6f in CAMK2A- and VGAT-expressing cells. The location occupied by the miniaturized microscope lens is outlined by a dashed white line (scale bar = 500 ?m). (**D**) Representative maximum projection showing views of CAMK2A- (top) and VGAT- (bottom) expressing cells through the implanted lens. (**E**) The miniscope post-processing procedure. (**F**) Representative traces of CAMK2A (top) and VGAT (bottom) cells from area CA1 of the dorsal hippocampus. (**G**) Shown are example CAMK2A and VGAT traces before and after z-scoring. (**H**) Bars represent the rate of calcium peaks (left; CAMK2A rate = 0.11 ± 0.001 peaks/s; VGAT rate = 0.17 ± 0.004 peaks/s) and peak width (right; CAMK2A peak width = 0.77 ± 0.007 s; VGAT peak width = 1.34 ± 0.09 s) for CAMK2A and VGAT cells. (two-sample t-test; CAMK2A n = 2303 (from 8 mice); VGAT n = 937 (from 12 mice); (left) t-statistic = ? 17.7, (right) t-statistic = ? 10.1). ***p