Medical Xpress

Understanding the smallest brain circuits

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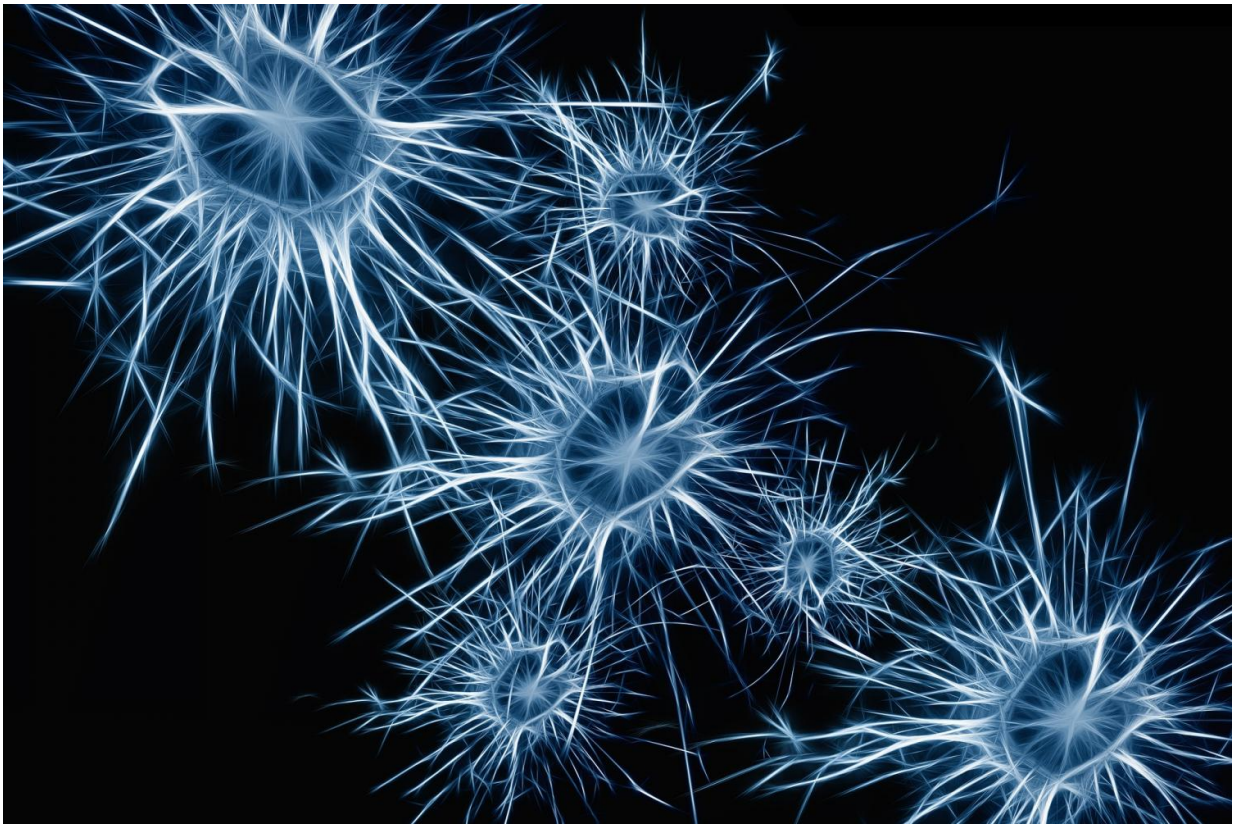

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Roberto Fernández Galán, an assistant professor of electrical engineering and computer science at the university's School of Engineering, and a team of undergraduate researchers at Case Western Reserve have been recording the electrical activity of hundreds of neurons as they fire inside the brain of a mouse model-for up to half an hour at a time.

"Neurons are highly active spontaneously, so 30 minutes is actually a very long time," Galán said.

For decades, neuroscientists examined the activity at shorter time-scales-tens of milliseconds, he said-and their aim was limited to observing some neurons firing together at times and others not.

However, Galán and his lab focused on the interactions between neurons at multiple time-scales from milliseconds to minutes.

"This is our main contribution," he said. "We have found very significant interactions between neurons on longer timescales, on the order of seconds."

Mapping more activity

It turns out that a previously hidden connection among the neurons is revealed when neurological activity is recorded and graphed across timescales.

"We observe that when some neurons speed up, others slow down-and they do this in a coordinated fashion over several seconds," Galán said.

"What we are discovering here, revealing for the first time, is a mode of operation of the brain circuits that shows you cannot have all of your networks operating at once," he said.

Galán and his team explain those two anatomically distinct and competing networks in the smallest of the brain's microcircuits, calling them "anti-correlated cortical networks," in a recent issue of *Scientific Reports*.

Co-authors include biology Professor Hillel Chiel and undergraduate

students Nathan Kodama (first author), Tianyi Feng, James Ullett and Siddharth Sivakumar.Galán said the discovery was especially gratifying because it culminates the testing of a mathematical model he developed a decade ago.

"That was a theoretical prediction-the idea that the wiring of brain circuits could be inferred from their spontaneous activity," he said. "When we were finally able to test this idea experimentally, we discovered the competing neural networks; it all came together in this study."

More information: Nathan X. Kodama et al, Anti-correlated cortical networks arise from spontaneous neuronal dynamics at slow timescales, *Scientific Reports* (2018). DOI: 10.1038/s41598-017-18097-0

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