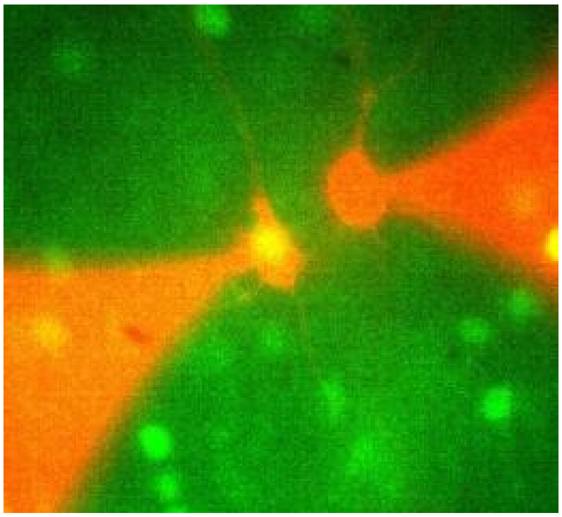
Researchers identify 'Facebook neurons'

January 10 2011



Paired cell recording from the cerebral cortex of the fosGFP transgenic mouse. Credit: Carnegie Mellon University

Carnegie Mellon University researchers have found that within the brain's neocortex lies a subnetwork of highly active neurons that behave much like people in social networks. Like Facebook, these neuronal networks have a small population of highly active members who give and receive more information than the majority of other members, says Alison Barth, associate professor of biological sciences at Carnegie Mellon and a member of the Center for the Neural Basis of Cognition (CNBC). By identifying these neurons, scientists will now be able to study them further and increase their understanding of the neocortex, which is thought to be the brain's center of higher learning.

Up to trillions of neurons make up the neocortex, the part of the cerebral cortex that is responsible for a number of important functions, including sensory perception, motor function, spatial reasoning, conscious thought and language. Although neuroscientists have been studying the neocortex for 40 years, technologies had only allowed them to look broadly at general areas of the brain, but not at the high-resolution of individual neurons. While they believed only a small proportion of neurons were doing most of the work in the neocortex, they couldn't see if this was indeed the case.

In the current study, published in the journal *Neuron*, the researchers used a specialized transgenic mouse model developed by Barth to overcome these challenges and clearly see which neocortical neurons were the most active. The model links green fluorescent protein (GFP) with the activity-dependent gene fos, causing the neuron to light up when it is activated. The researchers, including former Carnegie Mellon and CNBC postdoctoral student Lina Yassin, who is now at the Ludwig-Maximillians-Universtat Munich, took recordings from both fos-labeled and unlabeled neurons and found that the most active neurons were expressing the fos gene. The researchers were then able to isolate the active neurons using imaging techniques and take electrophysiological recordings from the neurons, allowing the researchers to begin to understand the mechanisms underlying the increased activity.

Barth and colleagues were able to see that the fos-expressing neurons weren't more active because they were intrinsically more excitable; in fact, the neurons seemed to be calmer or more suppressed than their neighboring, inactive neurons. What made them more active was their input.

According to Barth, it seems that this active network of neurons in the neocortex acts like a social network. There is a small, but significant, population of neurons that are more connected than other neurons. These neurons do most of the heavy lifting, giving and receiving more information than the rest of the neurons in their network.

"It's like Facebook. Most of your friends don't post much — if at all. But, there is a small percentage of your friends on Facebook who update their status and page often. Those people are more likely to be connected to more friends, so while they're sharing more information, they're also receiving more information from their expanded network, which includes other more active participants," Barth said.

The findings stand to have a dramatic impact on neuroscience. Now that researchers are able to identify and visualize these active cells they can begin to determine why they are more active and how stable the activity is. The Carnegie Mellon researchers plan to study these neurons to see what, if any, role these neurons play in learning.

The results also will help to further computational neuroscience, specifically in the area of sparse coding. In sparse coding, scientists hope to study how the brain recruits a small population of neurons to encode information. This research will for the first time allow for the study of the electrophysiological properties of strongly responsive but sparsely populated cells.

More information: Paper online: doi:10.1016/j.neuron.2010.11.029

Provided by Carnegie Mellon University