Researchers find that neurons in the primary visual cortex listen to just a small subset of synaptic inputs

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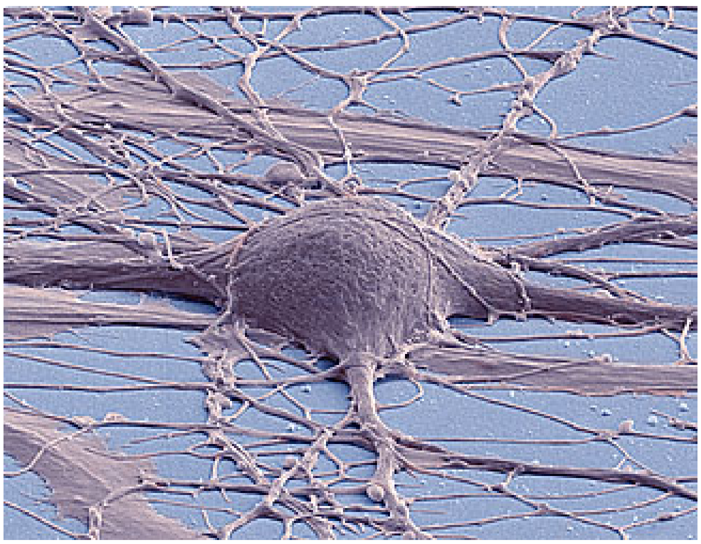

This is a scanning electron micrograph (false color) of a human induced pluripotent stem cell-derived neuron. Credit: Thomas Deerinck, UC San Diego

(Medical Xpress)—A team of bio-researchers with members affiliated with institutions in the U.K., Switzerland and Hong Kong, has found that neurons in the primary visual cortex of mice listen to just a small subset of the huge number of synaptic inputs vying for attention. In their paper published in the journal *Nature*, the team describes how they combined two research methods to create a way to demonstrate how much impact different inputs have on neurons, at least in the visual cortex of mice.

Benjamin Scholl and Nicholas Priebe, with the University of Texas, offer a News & Views perspective on the work in the same journal edition.

Scientists have known for some time that neurons in the visual cortex (of mice, humans and other animals) receive information from many (one to ten thousand) other neurons via synaptic inputs. What has not been clear is the relative importance each neuron places on the information received from each of the inputs. The difficulty in solving this mystery has been in the limited number of ways there are to study such nerve cells, i.e., when the cells are still in the living subject, or when they are grown in a lab and studied. Each has its limitations, for obvious reasons. In this new effort, the researchers were able to get a better look at what happens when neurons in the visual cortex send messages to one another by combing the two techniques. That allowed them to create receptive field maps for the neurons, which showed how much attention was paid to each input (as demonstrated by measurements of cell excitation).

In studying the receptive fields, the researchers found that rather than giving each input its full attention, neurons tended to react minimally to most inputs, while giving their full attention to just a few. Similar, Scholl and Priebe note, to the way that people with many Facebook "friends" give most of their attention to just a few family members or friends. The researchers also found that those inputs that were listened to the most were from those that were most like them. That of course begs the question of why have so many connections if most of them are going to be mostly ignored. The researchers do not know yet, but Scholl and Priebe suggest it might be to save time or preserve resources—rather than have to wait for a new contact to grow if something new arises in the environment, the neuron can just start listening closer to one of those that is already there.

More information: Functional organization of excitatory synaptic

strength in primary visual cortex, *Nature* (2015) [DOI: 10.1038/nature14182](https://doi.org/10.1038/nature14182)

Abstract
The strength of synaptic connections fundamentally determines how neurons influence each other's firing. Excitatory connection amplitudes between pairs of cortical neurons vary over two orders of magnitude, comprising only very few strong connections among many weaker ones. Although this highly skewed distribution of connection strengths is observed in diverse cortical areas, its functional significance remains unknown: it is not clear how connection strength relates to neuronal response properties, nor how strong and weak inputs contribute to information processing in local microcircuits. Here we reveal that the strength of connections between layer 2/3 (L2/3) pyramidal neurons in mouse primary visual cortex (V1) obeys a simple rule—the few strong connections occur between neurons with most correlated responses, while only weak connections link neurons with uncorrelated responses. Moreover, we show that strong and reciprocal connections occur between cells with similar spatial receptive field structure. Although weak connections far outnumber strong connections, each neuron receives the majority of its local excitation from a small number of strong inputs provided by the few neurons with similar responses to visual features. By dominating recurrent excitation, these infrequent yet powerful inputs disproportionately contribute to feature preference and selectivity. Therefore, our results show that the apparently complex organization of excitatory connection strength reflects the similarity of neuronal responses, and suggest that rare, strong connections mediate stimulus-specific response amplification in cortical microcircuits.