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Broad receptive field responsible for differentiated neuronal activity

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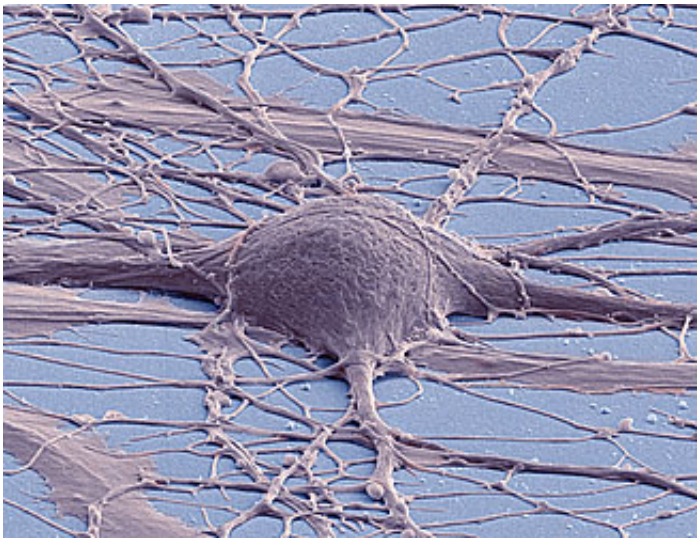

This is a scanning electron micrograph (false color) of a human induced pluripotent stem cell-derived neuron. Credit: Thomas Deerinck, UC San Diego

Some neurons are more active than others, even when they are positioned right next to each other and are one and the same neuron type. Dr. Jean-Sébastien Jouhanneau and Dr. James Poulet of the Max Delbrück Center for Molecular Medicine (MDC) Berlin Buch have discovered the cause for this phenomenon. They found that the more active neurons in the somatosensory area of the brain respond to a broader receptive field and probably play a particularly important role in our sensory perception. The findings of the researchers, who also work at the NeuroCure Cluster of Excellence at Charité in Berlin, have now

been published in the journal *Neuron*.

Billions of neurons process signals in our brain. In the sensory part of our cerebral cortex, which is responsible for perceptions of the outside world, not all neurons are equally active: even neurons positioned directly next to each other can be differentially active. If there is input of a stimulus, some neurons respond more than their neighbors. Until now, the reason for this remained elusive. Are the more active neurons perhaps more strongly connected within the cortex? Or do they get more information from upstream areas of the brain?

To clarify this, the researchers stimulated the whiskers of mice and investigated how different neurons in the brain react. For this purpose, they measured the activity of two neurons simultaneously. The active cells are characterized by a high concentration of the protein cFos. Since this was coupled to the green fluorescent protein (GFP), the researchers were able to distinguish more active cells from less active ones.

First they stimulated only one central whisker. Surprisingly, no differences showed up between the two neurons. However, if the researchers stimulated many whiskers at the same time with a short airpuff, the response of the GFP-labeled neuron was significantly earlier and larger. Apparently, the more active neurons are distinguished by the fact that they respond to a wider receptive field. But where does this information come from?

Before we perceive a stimulus from our environment, it must pass through the thalamus in the brain. This area is therefore also called "the gateway to consciousness". In mice, the signals from the whiskers are processed in two areas of the thalamus, the so-called ventral posteromedial nucleus (VPM) and the area of the posteromedial nucleus (POm). Using optogenetic stimulation, the team led by James Poulet determined which of these two nuclei is responsible for the enhanced

response of specific neurons. By means of light impulses in the brain, they could specifically activate the thalamic nuclei and thus selectively simulate a flow of information through one of the two nuclei.

If the scientists activated the VPM, both types of neurons showed an equally strong response. They behaved exactly as if only a single whisker was touched. This specific reaction is thus apparently mediated by the VPM. The POm, by contrast, elicited - just like the stimulation of several whiskers - a stronger and faster response of the GFP-labeled neurons.

The POm is known for covering a broad receptive field and for transmitting the signals to widely distributed areas in the cerebrum. According to current research, the most active neurons in the somatosensory (touch-sensitive) cortex are characterized by the fact that they not only get specific information from the VPM, but can also draw on the wide receptive field of the POm. This parallel processing of specific and large-scale stimulus information by separate groups of neurons could be a fundamental mechanism of sensory perception. The more active neurons may have a particularly important role in sensory perception.

More information: Cortical fosGFP Expression Reveals Broad Receptive Field Excitatory Neurons Targeted by POmб www.sciencedirect.com/science/ … ii/S089662731400912X

Provided by Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

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