

The architects of the brain: Scientists decipher the role of calcium signals

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German neurobiologists have found that certain receptors for the neurotransmitter glutamate determine the architecture of nerve cells in the developing brain. Individual receptor variants lead to especially long and branched processes called dendrites, which the cells communicate with. The researchers also showed that the growth-promoting property of the receptors is linked to how much calcium they allow to flow into the cells.

"These results allow insights into the mechanisms with which [nerve cells](#) connect during development", says Prof. Dr. Petra Wahle from the RUB Working Group on [Developmental Neurobiology](#). The scientists report in *Development*.

It all depends on a few amino acids

"Nerve cells communicate with chemical and [electrical signals](#)", explains Wahle. "The electrical activity controls many developmental processes in the brain, and the neurotransmitter glutamate plays a decisive role in this." In two different cell classes in the [cerebral cortex](#) of rats, the researchers studied the nine most common variants of a glutamate receptor, the so-called AMPA receptor. When glutamate docks on to this receptor, [calcium ions](#) flow into the nerve cells either directly through a pore in the AMPA receptor or through adjacent calcium channels. Depending on the variant, AMPA receptors consist of 800-900 amino acid building blocks, and already the exchange of one amino acid has important consequences for the calcium permeability. Among other things, calcium promotes the growth of new dendrites.

Different cell types, different mechanisms

One at a time, the Bochum team introduced the nine AMPA receptor variants into the nerve cells and observed the impact on the cell architecture. In several cases, this resulted in longer dendrites with more branches. This pattern was

demonstrated both for several receptor variants that allow calcium ions to flow directly into the cell through a pore and for those that activate adjacent [calcium channels](#). "It was surprising that in the two cell classes studied, different receptor variants triggered the growth of the dendrites", says Dr. Mohammad Hamad from the Working Group on Developmental Neurobiology. "In the inhibitory interneurons, only one of the nine variants was effective. Calcium signals are like a toolbox. However, different cell classes in the cerebral cortex make use of the toolbox in different ways."

More information: Hamad, M. I., Ma-Hogemeier, Z. L., Riedel, C., Conrads, C., Veitinger, T., Habijan, T., Schulz, J. N., Krause, M., Wirth, M. J., Hollmann, M., Wahle, P. (2011) Cell class-specific regulation of neocortical dendrite and spine growth by AMPA receptor splice and editing variants. *Development* 138, 4301-4313, [doi: 10.1242/dev.07107](#)

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