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Communication without detours: Previously unknown nerve cell shape presented

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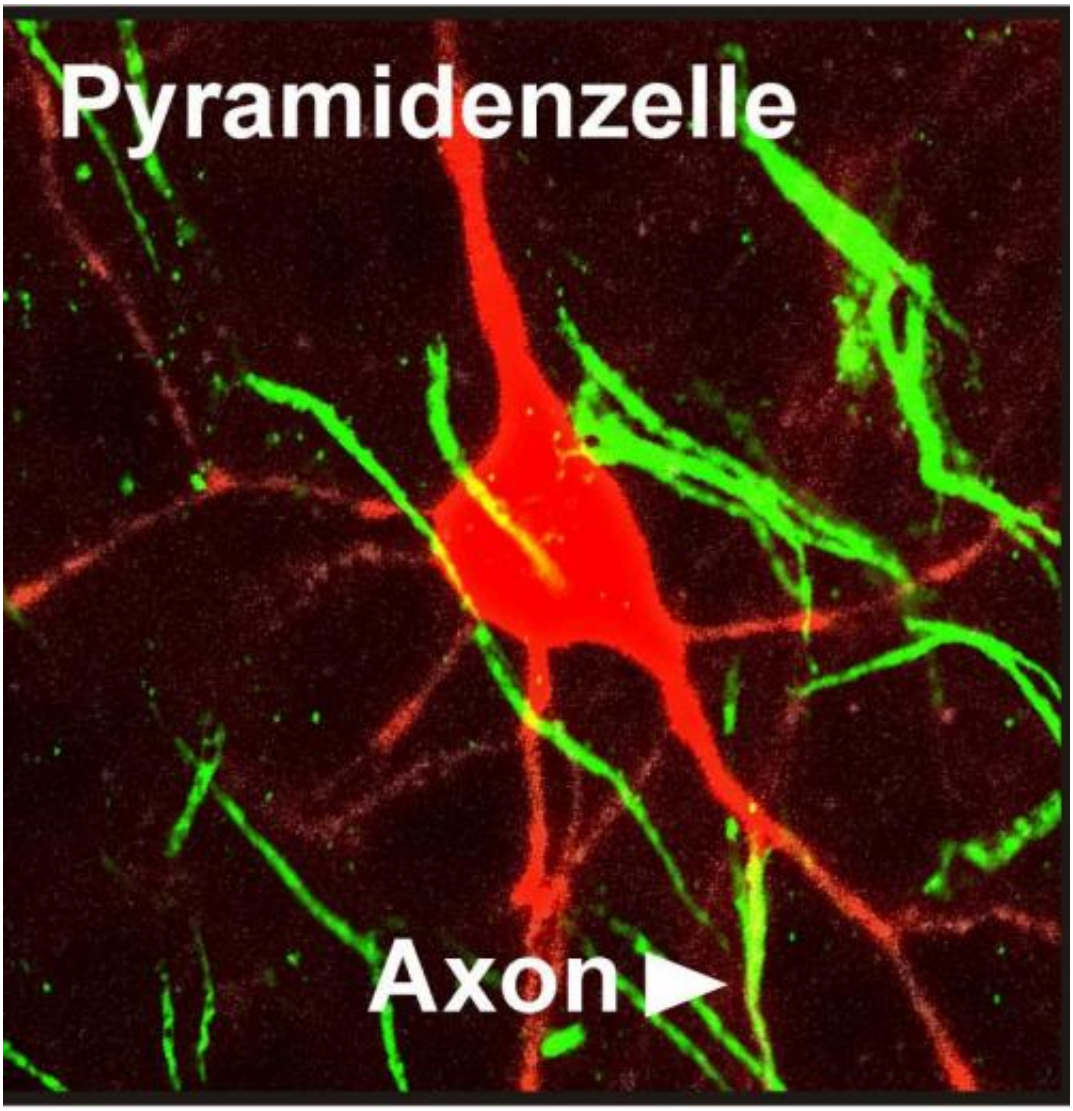

This image shows a neuron in which the axon originates at a dendrite. Signals arriving at this dendrites become more efficiently forwarded than signals input elsewhere. Credit: Alexei V. Egorov, 2014

Certain nerve cells take a shortcut for the transmission of information: signals are not conducted via the cell`s center, but around it like on a bypass road. The previously unknown nerve cell shape is now presented in the journal *Neuron* by a research team from Heidelberg, Mannheim and Bonn.

Nerve cells communicate by using electrical signals. Via widely ramified cell structures—the dendrites—, they receive signals from other neurons and then transmit them over a thin cell extension—the axon—to other nerve cells. Axon and dendrites are usually interconnected by the neuron's cell body. A team of scientists at the Bernstein Center Heidelberg-Mannheim, Heidelberg University, and the University of Bonn has now discovered neurons in which the axon arises directly from one of the dendrites. Similar to taking a bypass road, the signal transmission is thus facilitated within the cell.

"Input signals at this dendrite do not need not be propagated across the cell body," explains Christian Thome of the Bernstein Center Heidelberg-Mannheim and Heidelberg University, one of the two first authors of the study. For their analyses, the scientists specifically colored the places of origin of axons of so-called pyramidal cells in the hippocampus. This brain region is involved in memory processes. The surprising result: "We found that in more than half of the cells, the axon does not emerge from the cell body, but arises from a lower dendrite," Thome says.

The researchers then studied the effect of signals received at this special dendrite. For this purpose, they injected a certain form of the neural transmitter substance glutamate into the brain tissue of mice that can be activated by light pulses. A high-resolution microscope allowed the neuroscientists to direct the light beam directly to a specific dendrite. By the subsequent activation of the messenger substance, they simulated an

exciting input signal.

"Our measurements indicate that dendrites that are directly connected to the axon, actively propagate even small input stimuli and activate the neuron," says second first author Tony Kelly, a member of the Sonderforschungsbereich (SFB) 1089 at the University of Bonn. A computer simulation of the scientists predicts that this effect is particularly pronounced when the information flow from other dendrites to the axon is suppressed by inhibitory input signals at the cell body.

"That way, information transmitted by this special dendrite influences the behavior of the nerve cell more than input from any other dendrite," Kelly says. In a future step, the researchers attempt to figure out which biological function is actually strengthened through the specific dendrite—and what therefore might be the reason for the unusual shape of these neurons.

More information: C. Thome, T. Kelly, A. Yanez, C. Schultz, M. Engelhardt, S. B. Camebridge, M. Both, A. Draguhn, H. Beck and A. V. Egorov (2014): Axon-Carrying Dendrites Convey Privileged Synaptic Input in Hippocampal Neurons. *Neuron*, 83, 1418-1430. DOI: 10.1016/j.neuron.2014.08.013

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