Dopamine-producing neurons fulfil important function in the brain

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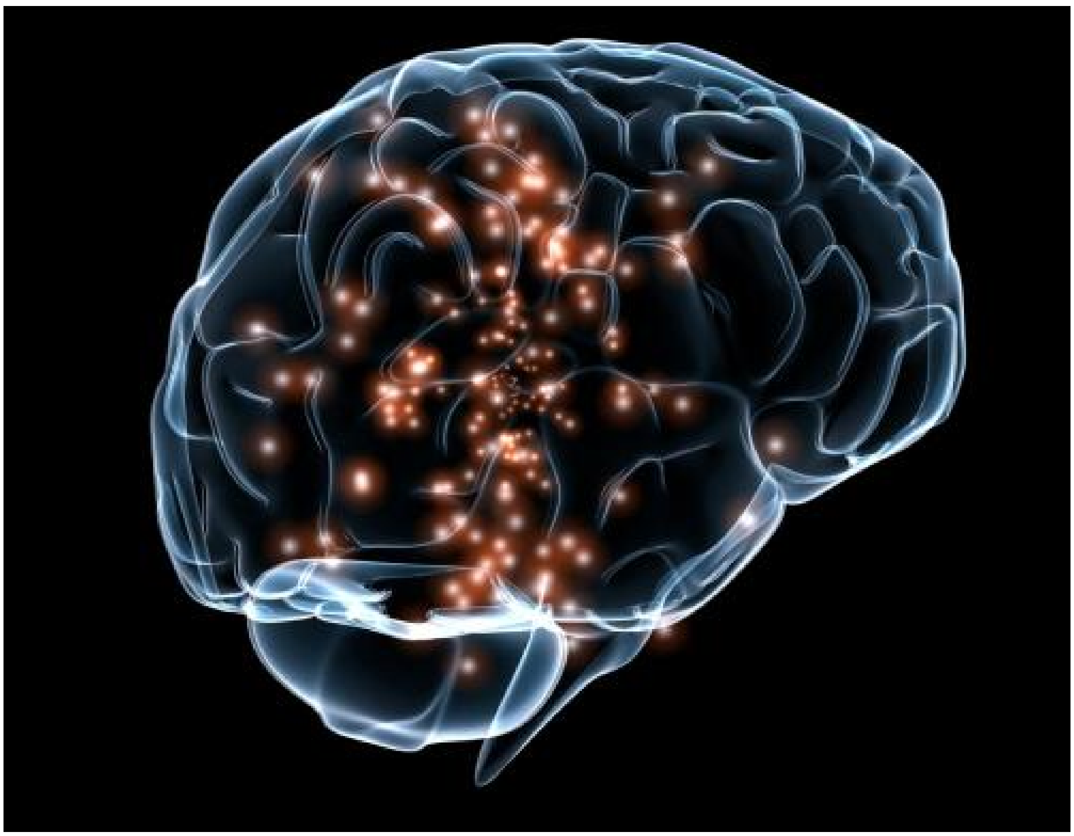

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Nerve cells that produce dopamine for the purpose of transmitting signals to other cells affect numerous crucial brain functions. This becomes evident in diseases such as Parkinson's and schizophrenia, where dopamine transmission in the brain is impaired. In collaboration with researchers from Bonn, RUB scientists at the Mercator Research Group "Structure of Memory" have now identified in what way a specific form of this important cell is generated and which networks it forms in the course of brain development. In the process, the researchers discovered a data highway of sorts: the nerve cells use not only dopamine for signal transmission, but also the much-faster glutamate.

The results have now been published in the trade magazine *Nature Neuroscience*.

Crucial role in signal transmission

Dopamine-producing neurons fulfil a crucial role in signal transmission: as the brain develops, they mature into several specialised subtypes, which, acting as a kind of networkers, generate synapses to other important brain regions. Their name derives from the fact that they utilise dopamine as a messenger. This neurotransmitter is very important: it affects, for example, motor control, reward behaviour, motivation and impulse control. Symptoms of diseases such as Parkinson's and schizophrenia include dying of dopamine neurons resp. disruption of dopamine signal transmission.

Glutamate facilitates rapid signal transmission

In collaboration with colleagues from the German Center for Neurodegenerative Diseases (DZNE), the Life & Brain Center Bonn and the Mercator Research Group "Structure of Memory", scientists at Bonn University discovered a data highway of sorts in the animal model. While dopamine-aided signal transmission between neurons is relatively slow, the analysed dopamine-producing neurons have additionally used glutamate as a messenger.

Researchers excited single nerve cells with light stimuli

Using genetic-engineering methods, the researchers coupled the dopamine-producing neurons of mice with light-sensitive proteins. Thus, they were able to excite individual dopamine-neurons with light stimuli and track the signalling pathways. With the aid of glutamate, locally inhibiting neurons were activated in the prefrontal cortex, a control centre in the brain. These, in turn, are responsible for the regulation of signal transmission in the prefrontal cortex: they are involved, for example, in deciding if a signal should be forwarded. In order to identify in what way different subtypes of dopamine-producing neurons are generated, the researchers muted one gene in mice. Thus, the formation of dopamine-neurons in the prefrontal cortex was suppressed.

Mice had to nudge a blinking light

What were the consequences of the lack of dopamine-producing cells? Together with the team headed by Prof Dr Magdalena Sauvage from Ruhr-Universität Bochum, the researchers from Bonn tested this in attention experiments. Mice were rewarded with food if they nudged a rapidly blinking light as quickly as possible. "The results have shown that animals in which the dopamine-producing cells had been genetically switched off didn't demonstrate any apparent changes to their attention and impulse control, but they pursued acquired behaviour patterns much more persistently," says Prof Sauvage. A pathological clinging to certain notions or repeating words and movements in an unsuitable context does also occur in mental disorders such as obsessive-compulsive disorder or schizophrenia, where the function of the prefrontal cortex is disturbed. Accordingly, the results of the research cooperation contribute to an improved understanding of the development and function of dopamine-producing neurons and possibly the diseases related thereto.

More information: A. Kabanova et al. (2015): Function and developmental origin of a mesocortical inhibitory circuit, *Nature Neuroscience*, [DOI: 10.1038/nn.4020](https://dx.doi.org/10.1038/nn.4020)

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