How Odors Are Turned into Long Term Memories

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Summary: A new study reveals the piriform cortex is able to archive long term memory, but requires instruction from the orbiotfrontal cortex to indicate the event is to be stored as a long-term memory.

Source: RUB.

The neuroscientists Dr Christina Strauch and Prof Dr Denise Manahan-Vaughan from the Ruhr-Universität Bochum have investigated which brain area is responsible for storing odors as long-term memories. Some odors can trigger memories of experiences from years back. The current study shows that the piriform cortex, a part of the olfactory brain, is involved in the process of saving those memories; the mechanism, however, only works in interaction with other brain areas. The findings have been published in the journal *Cerebral Cortex*.

"It is known that the piriform cortex is able to temporarily store olfactory memories. We wanted to know, if that applies to long-term memories as well," says Christina Strauch.

Artificial sensation through stimulation

Synaptic plasticity is responsible for the storing of memories in the memory structures of the brain: During that process the communication between neurons is altered by means of a process called synaptic plasticity, so that a memory is created. Strauch and Manahan-Vaughan examined if the piriform cortex of rats is capable of expressing synaptic plasticity and if this change lasts for more than four hours; indicating that long-term memory may have been established.

Neuroscientists from Bochum have investigated why the brain stores some odors in a special way NeuroscienceNews.com image is adapted from the RUB news release.

The scientists used electrical impulses in the brain to emulate processes that trigger the encoding of an olfactory sensation as a memory. They used different stimulation protocols which varied in the frequency and intensity of the pulses. It is known that these protocols can induce long-term effects in another brain area that is responsible for long term memories: the hippocampus. Strikingly, the same protocols did not induce long-term information storage in the form of synaptic plasticity in the piriform cortex.

Signal from a higher brain area needed

The scientists wondered whether the piriform cortex needs to be instructed to create a long-term memory. They then stimulated a higher brain area called the orbitofrontal cortex, which is responsible for the discrimination of sensory experiences. This time the stimulation of the brain area generated the desired change in the piriform cortex. "Our study shows that the piriform cortex is indeed able to serve as an archive for long-term memories. But it needs instruction from the orbitofrontal cortex – a higher brain area – indicating that an event is to be stored as a long-term memory," says Strauch.

About this neuroscience research article

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Abstract

In the Piriform Cortex, the Primary Impetus for Information Encoding through Synaptic Plasticity Is Provided by Descending Rather than Ascending Olfactory Inputs

Information encoding by means of persistent changes in synaptic strength supports long-term information storage and memory in structures such as the hippocampus. In the piriform cortex (PC), that engages in the processing of associative memory, only short-term synaptic plasticity has been described to date, both in vitro and in anesthetized rodents in vivo.

Whether the PC maintains changes in synaptic strength for longer periods of time is unknown: Such a property would indicate that it can serve as a repository for long-term memories. Here, we report that in freely behaving animals, frequency-dependent synaptic plasticity does not occur in the anterior PC (aPC) following patterned stimulation of the olfactory bulb (OB). Naris closure changed action potential properties of aPC neurons and enabled expression of long-term potentiation (LTP) by OB stimulation, indicating that an intrinsic ability to express synaptic plasticity is present. Odor discrimination and categorization in the aPC is supported by descending inputs from the orbitofrontal cortex (OFC). Here, OFC stimulation resulted in LTP (>4 h), suggesting that this structure plays an important role in promoting information encoding through synaptic plasticity in the aPC. These persistent changes in synaptic strength are likely to comprise a means through which long-term memories are encoded and/or retained in the PC.

"In the Piriform Cortex, the Primary Impetus for Information Encoding through Synaptic Plasticity Is Provided by Descending Rather than Ascending Olfactory Inputs " by Christina Strauch and Denise Manahan-Vaughan in *Cerebral Cortex*. Published online November 24 2017 doi:10.1093/cercor/bhx315

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