Researchers find neurons responsible for tying together fearful events with environment

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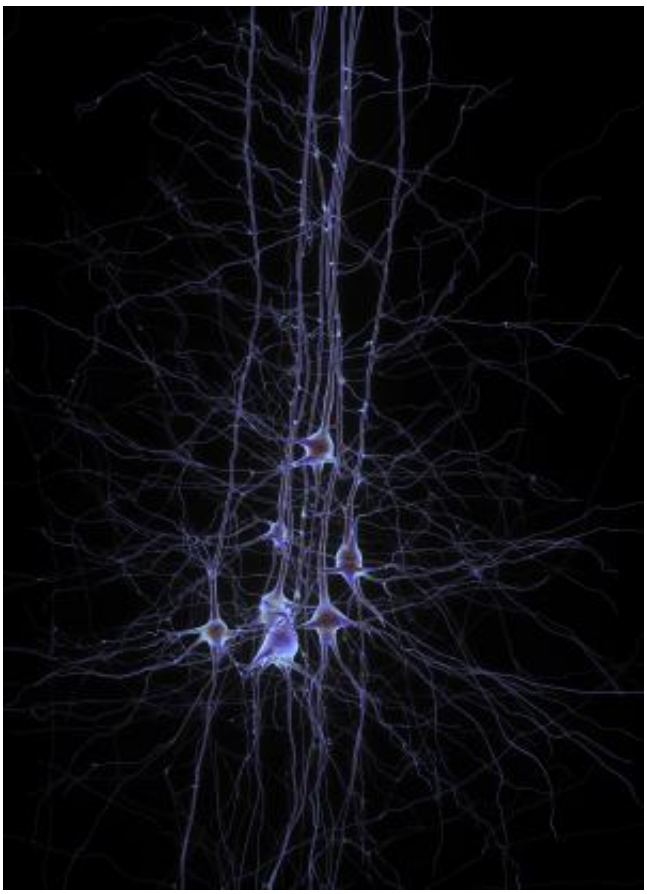

This is a group of neurons. Credit: EPFL/Human Brain Project

(Medical Xpress)—Researchers working at Columbia University have identified a neuron that serves to tie fearful events with the environment

in which they occurred. In their paper published in the journal *Science*, the team explains how they isolated the special neuron and how its identification furthers the understanding of how memories are formed in the brain.

When an animal (or person) experiences something that truly frightens them, say by being shocked when touching a badly grounded appliance, they learn to fear not only the thing that shocked them (the appliance) but the environment in which the shock occurred (such as the kitchen). Such learning experiences are clearly an evolutionary development that aids in a species surviving—by avoiding such environments and appliances in the future, they will be more likely to survive. But there's a little more to the story, prior research has shown that the brain also builds memories that tie the two parts of the experience together—memories specifically geared to causing a reaction when encountering both the environment and the actual thing that shocked them. Scientists have known for some time that an intermediate step must be involved in such memory creation, but until, haven't been able to isolate it. In this new effort, the researchers have found the specific neurons in the brain that appear to be responsible for tying such information together to form associated memories.

Suspecting that neurons in the hippocampus might be involved, the researchers focused on inhibitor cells known as intermeurons. To find out if they do indeed play a role, the researchers trained mice to fear a specific environment (a special box) by shocking them when they were put into it. Subsequent tests showed that the mice grew fearful of the environment—but when the intermeurons in the mouse brains were physically deactivated, the mice no longer feared the box. This shows, the researchers suggest, that intermeurons are essential for the formation of memories that are associated with an environment.

Isolating the particular neurons that play a key role in the creation of

memories that are tied to both an event that occurred and its environment might perhaps be useful for helping treat people with disorders such as anxiety or even PTSD. If the neurons responsible for the creation of disturbing memories can be disabled or muted, then the person might find some relief from the emotional reactions that occur when exposed to triggers.

More information: Dendritic Inhibition in the Hippocampus Supports Fear Learning, *Science* 21 February 2014: Vol. 343 no. 6173 pp. 857-863. DOI: 10.1126/science.1247485

Abstract

Fear memories guide adaptive behavior in contexts associated with aversive events. The hippocampus forms a neural representation of the context that predicts aversive events. Representations of context incorporate multisensory features of the environment, but must somehow exclude sensory features of the aversive event itself. We investigated this selectivity using cell type–specific imaging and inactivation in hippocampal area CA1 of behaving mice. Aversive stimuli activated CA1 dendrite-targeting interneurons via cholinergic input, leading to inhibition of pyramidal cell distal dendrites receiving aversive sensory excitation from the entorhinal cortex. Inactivating dendrite-targeting interneurons during aversive stimuli increased CA1 pyramidal cell population responses and prevented fear learning. We propose subcortical activation of dendritic inhibition as a mechanism for exclusion of aversive stimuli from hippocampal contextual representations during fear learning.