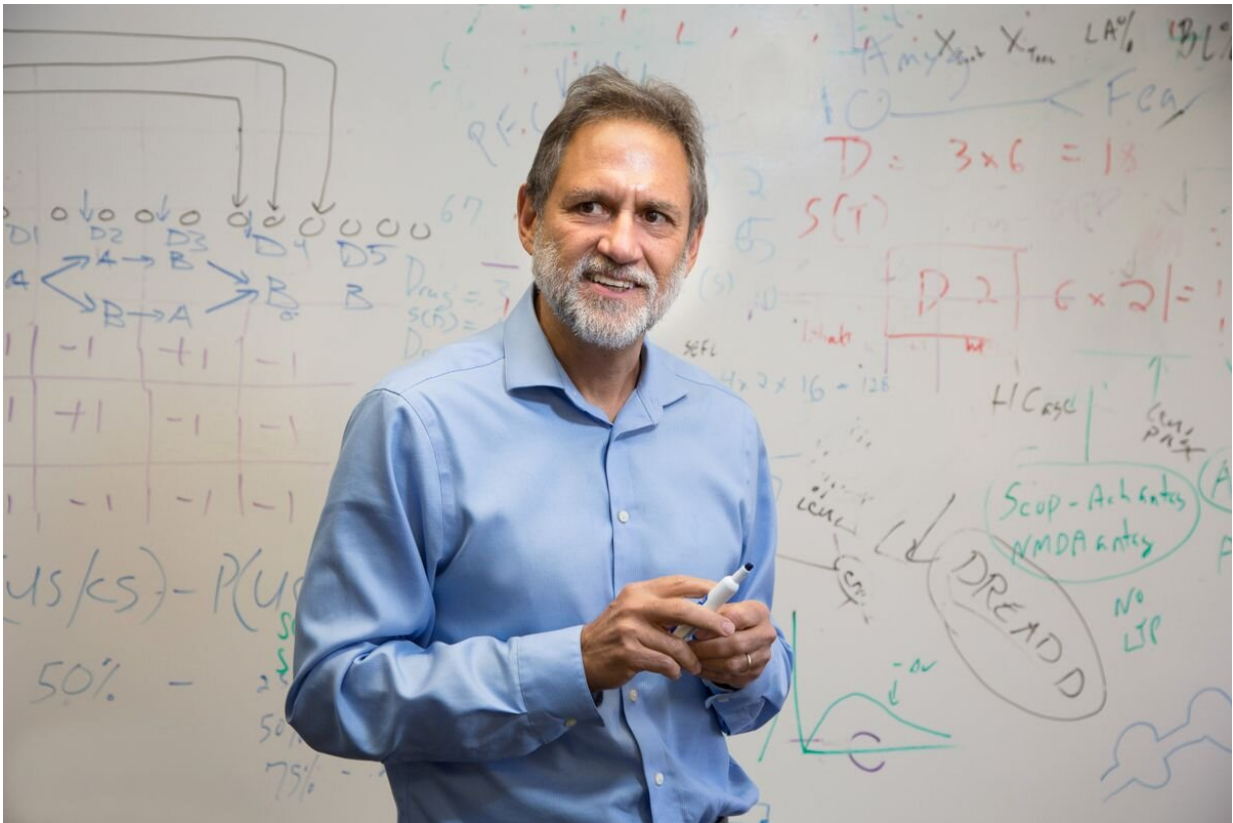


Study reveals how brain injury can lead to post-traumatic stress disorder

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Senior author Michael Fanselow and a team of psychologists and neurologists discovered that a traumatic brain injury causes changes in a brain region called the amygdala. Credit: Reed Hutchinson/UCLA

Post-traumatic stress disorder in U.S. military members frequently

follows a concussion-like brain injury. Until now, it has been unclear why. A UCLA team of psychologists and neurologists reports that a traumatic brain injury causes changes in a brain region called the amygdala; and the brain processes fear differently after such an injury.

"Is one causing the other, and how does that occur?" asked senior author Michael Fanselow, who holds the Staglin Family Chair in Psychology at UCLA and is the director of UCLA's Staglin Music Festival Center for Brain and Behavioral Health. "We're learning."

Two groups of [rats](#) were studied. Through surgery, a concussion-like brain [injury](#) was produced in 19 of the rats. Sixteen other rats—a control group—also had the surgery, but did not sustain a brain injury. All of the rats were then exposed to a low level of noise, followed by a series of moderate, brief foot shocks. The foot shocks were frightening to the rats, but not very painful, Fanselow said. Because the rats learned to associate the noise with the shock, they became afraid of the noise.

Rats tend to stand still when they experience fear. When they recall a frightening memory, they freeze. Their [heart rate](#) and blood pressure go up—and the stronger the memory, the more they freeze, Fanselow said. On the experiment's third day, the researchers again exposed the rats to the same place where they had been shocked, but did not give them any additional shocks, and studied their reactions.

The rats in the control group did freeze, but the rats that received the brain injury froze for a much longer time. The researchers discovered that even without receiving a foot shock, the rats that had a brain injury showed a fear response to the noise.

"Sensitivity to noise is a common symptom after concussion, which suggested to us that this might partly explain why fear reactions to certain stimuli are increased after brain injury," said Ann Hoffman, a

UCLA researcher in psychology and lead author of the research, which is published in the journal *Scientific Reports*.

"It's almost as if the white noise acted like the shock," Fanselow said. "The noise itself became scary to them, even though it wasn't much noise. They treated it almost like a shock."

The researchers studied the amygdala, which is known to be crucial in learning fear. People with anxiety disorders have increased activity in the amygdala, and PTSD has been linked to increased activity in the amygdala.

The amygdala is made up of neurons, and a rat's amygdala has about 60,000. The researchers discovered that five times as many neurons in the amygdala were active during the white [noise](#) in the rats with the brain injury than in the control group, Hoffman said.

The amygdala listens to other brain areas that provide it with information. "The amygdala makes a decision whether a situation is frightening, and when it decides a situation is frightening, it generates a fear response," Fanselow said.

Another new discovery the researchers report is that after the traumatic brain injury, the brain processes sounds from a more primitive part of the brain—the thalamus—than from a more sophisticated, highly evolved area of the brain—the auditory cortex. The thalamus provides a more simplistic, crude representation of sound than the auditory cortex. About four times as many neurons were active in a network from the thalamus to the amygdala in the rats with the injury than in the [control group](#) rats, Hoffman said.

The study raises the question of whether it is possible to get the brain's [amygdala](#) back to normal following a concussion-like injury, perhaps

through behavioral therapy or a pharmaceutical. If so, that could benefit members of the military, as well as civilians who have had serious [brain injuries](#), Fanselow said. He and his team will continue their research in an effort to answer this question.

More information: Ann N. Hoffman et al, Sensory sensitivity as a link between concussive traumatic brain injury and PTSD, *Scientific Reports* (2019). [DOI: 10.1038/s41598-019-50312-y](https://doi.org/10.1038/s41598-019-50312-y)

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