Researchers discover method to change emotionally charged memory patterns

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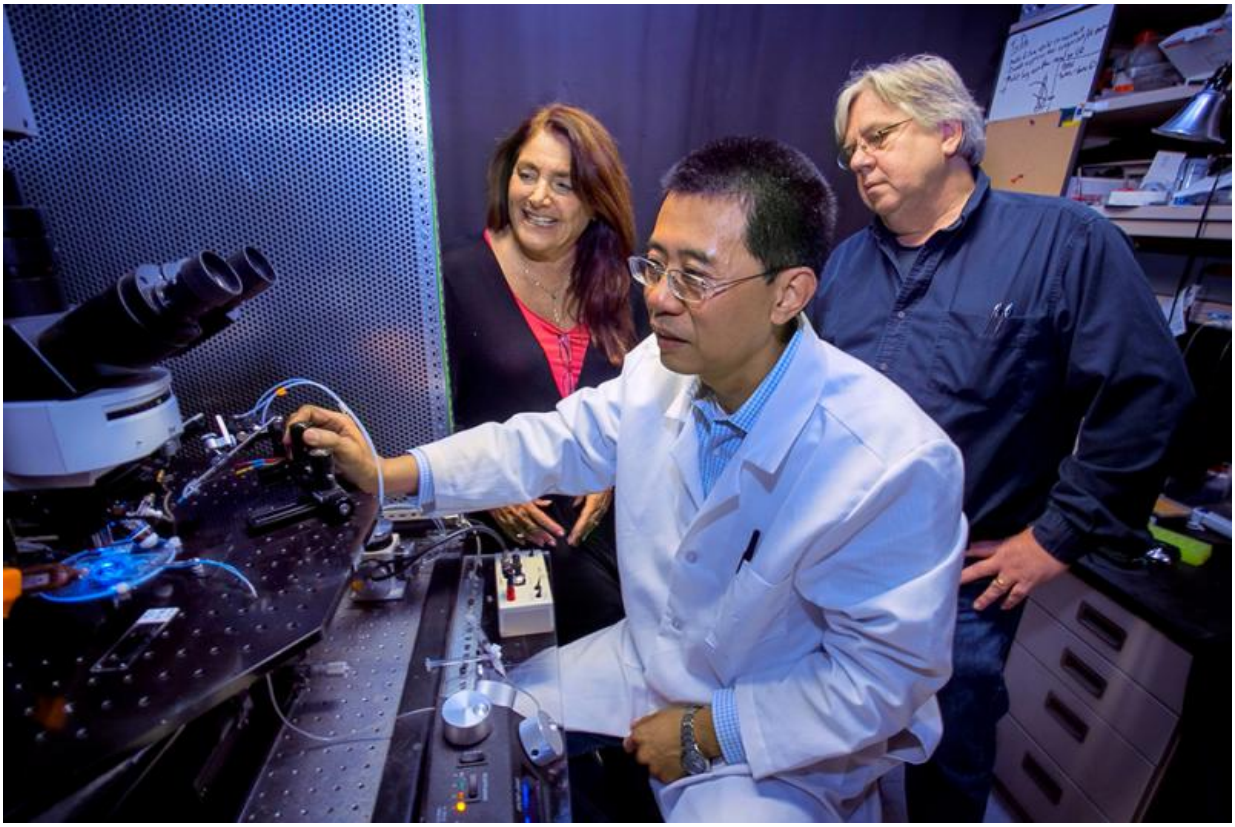

A Stony Brook University research team has developed a method to manipulate the neurotransmitter acetylcholine to control memory in mice. Members of the team include: Li Jiang (at microscope), Lorna Role, and David Talmage.

Imagine if memory could be tuned in such a way where good memories

are enhanced for those suffering from dementia or bad memories are wiped away for individuals with post-traumatic stress disorder. A Stony Brook University research team has taken a step toward the possibility of tuning the strength of memory by manipulating one of the brain's natural mechanisms for signaling involved in memory, a neurotransmitter called acetylcholine. Their findings are published in the journal *Neuron*.

Brain mechanisms underlying memory are not well understood, but most scientists believe that the region of the brain most involved in emotional memory is the amygdala. Acetylcholine is delivered to the amygdala by cholinergic neurons that reside in the base of the brain. These same neurons appear to be affected early in cognitive decline. Previous research has suggested that cholinergic input to the amygdala appears to strengthen emotional memories.

"Memories of emotionally charged experiences are particularly strong, whether positive or negative experiences, and the goal of our research is to determine the mechanisms underlying the strengthening of memory," said Lorna Role, PhD, Professor and Chair of the Department of Neurobiology and Behavior and Co-Director of the Neurosciences Institute at Stony Brook Medicine.

In the paper, titled "Cholinergic Signaling Controls Conditioned Fear Behaviors and Enhances Plasticity of Cortical-Amygdala Circuits," Dr. Role and colleagues used a fear-based memory model in mice to test the underlying mechanism of memory because fear is a strong and emotionally charged experience.

The team used opto-genetics, a newer research method using light to control cells in living tissue, to stimulate specific populations of cholinergic neurons during the experiments.

Two of the team's findings stand out. First, when they increased

acetylcholine release in the amygdala during the formation of a traumatic memory, it greatly strengthened memory making the memory last more than twice as long as normal. Then, when they decreased acetylcholine signaling in the amygdala during a traumatic experience, one that normally produces a fear response, they could actually wipe out memory.

"This second finding was particularly surprising, as we essentially created fearless mice by manipulating acetylcholine circuits in the brain," explained Dr. Role. "The findings provide the basis for research examining novel approaches to reverse post-traumatic stress disorder."

The challenge of continued research is that cholinergic neurons remain difficult to study because they are intermingled with other types of neurons and are few in number compared to other types of neurons in the brain.

Because acetylcholine is a natural signaling mechanism and seemingly essential for memory, additional research will center on non-pharmacologic ways to manipulate or fine-tune memory.

"The long-term goal of our research is that we would like to find ways – potentially independent of drug administration – to enhance or diminish the strength of specific memories, the good ones, and diminish the bad ones," summarized Dr. Role.

More information: Li Jiang et al. Cholinergic Signaling Controls Conditioned Fear Behaviors and Enhances Plasticity of Cortical-Amygdala Circuits, *Neuron* (2016). DOI: 10.1016/j.neuron.2016.04.028

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