A small electrical zap to the brain could help you retrieve a forgotten memory

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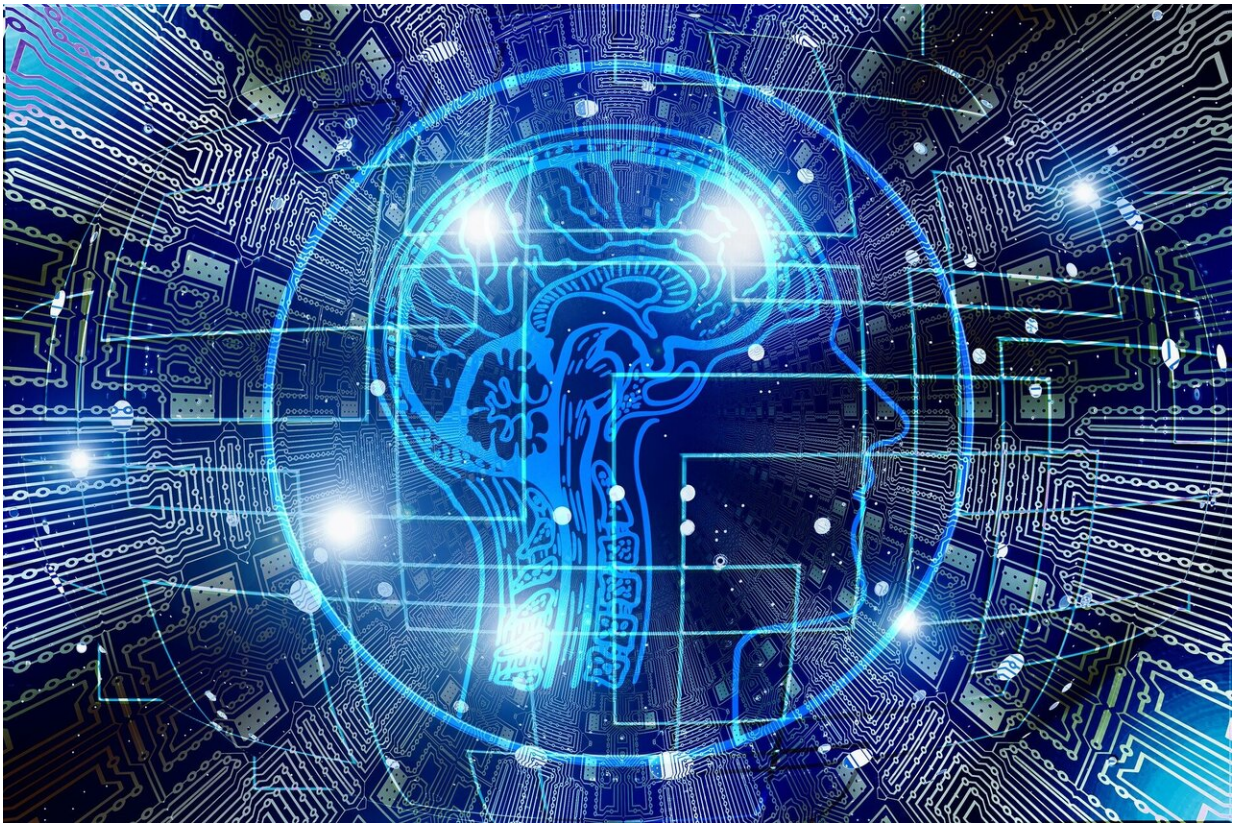

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A study by UCLA psychologists provides strong evidence that a certain region of the brain plays a critical role in memory recall. The research, published in the *Journal of Cognitive Neuroscience*, also shows for the

first time that using an electrical current to stimulate that region, the left rostrolateral prefrontal cortex, improves people's ability to retrieve memories.

"We found dramatically improved memory performance when we increased the excitability of this region," said Jesse Rissman, a UCLA assistant professor of psychology, and of psychiatry and biobehavioral sciences, the study's senior author.

The left rostrolateral prefrontal cortex is important for high-level thought, including monitoring and integrating information processed in other areas of the brain, Rissman said. This area is located behind the left side of the forehead, between the eyebrow and the hairline.

"We think this brain area is particularly important in accessing knowledge that you formed in the past and in making decisions about it," said Rissman, who also is a member of the UCLA Brain Research Institute.

The psychologists conducted experiments with three groups of people whose average age was 20. Each group contained 13 women and 11 men.

Participants were shown a series of 80 words on a computer screen. For each word, participants were instructed to either imagine either themselves or another person interacting with the word, depending on whether the words "self" or "other" also appeared on the screen. (For example, the combination of "gold" and "other" might prompt them to imagine a friend with a gold necklace.)

The following day, the participants returned to the laboratory for three tests—one of their memory, one of their reasoning ability and one of their visual perception. Each participant wore a device that sent a weak electrical current through an electrode on the scalp to decrease or

increase the excitability of neurons in the left rostrolateral prefrontal cortex. Increasing their excitability makes neurons more likely to fire, which enhances the connections between neurons, Rissman said.

(The technique, called transcranial direct current stimulation, or tDCS, gives most people a warm, mild tingling sensation for the first few minutes, said the study's lead author, Andrew Westphal, who conducted the study as a UCLA doctoral student and is now a postdoctoral scholar in neurology at UC San Francisco.)

Jesse Rissman. Credit: Stuart Wolpert/UCLA

For the first half of the hour-long study, all participants received "sham" stimulation—meaning that the device was turned on just briefly, to give the sensation that something was happening, but then turned off so that no electrical stimulation was applied. This allowed the researchers to measure how well each participant performed the tasks under normal conditions. For the next 30 minutes, one group of participants received an electrical current that increased their neurons' excitability, the second group received current that suppressed neuron activity and the third group received only the sham stimulation. The researchers analyzed which group had the best recall of the words they saw the previous day.

First, the scientists noted that there were no differences among the three groups during the first half of the study—when no brain stimulation was used—so any differences in the second half of the experiment could be attributed to the stimulation, Westphal said.

Memory scores for the group whose neurons received excitatory stimulation during the second half of the study were 15.4 percentage points higher than their scores when they received the sham stimulation.

Scores for those who received fake stimulation during both sessions increased by only 2.6 percentage points from the first to the second session—a statistically insignificant change that was likely was due to their increased familiarity with the task, according to the paper. And scores for the group whose neuron activity was temporarily suppressed increased by just five percentage points, which the authors also wrote was not statistically significant.

"Our previous neuroimaging studies showed the left rostrolateral prefrontal cortex is highly engaged during memory retrieval," Rissman said. "Now the fact that people do better on this memory task when we excite this region with electrical stimulation provides causal evidence that it contributes to the act of memory retrieval.

"We didn't expect the application of weak electrical brain stimulation would magically make their memories perfect, but the fact that their performance increased as much as it did is surprising and it's an encouraging sign that this method could potentially be used to boost people's memories."

The study's reasoning task asked participants to decide in seven seconds whether certain pairs of words were analogies. Half of the trials featured word pairs that were true analogies, such as "'moat' is to 'castle' as 'firewall' is to 'computer.'" (In both pairs, the first word protects the second from invasion.) The other half had word pairs that were related but not actually analogous.

Researchers found no significant differences in performance among the three groups.

For the final task, focusing on perception, subjects were asked to select which of four words has the most straight lines in its printed form. (One example: Among the words "symbol," "museum," "painter" and "energy," the word "museum" has the most straight lines.) Again, the researchers found no significant differences among the three groups—which Rissman said was expected.

"We expected to find improvement in memory, and we did," Rissman said. "We also predicted the reasoning task might improve with the increased excitability, and it did not. We didn't think this brain region would be important for the perception task."

Why do people forget names and other words? Sometimes it's because they don't pay attention when they first hear or see it, so no memory is even formed. In those cases, the electrical stimulation wouldn't help. But in cases where a memory does form but is difficult to retrieve, the stimulation could help access it.

"The stimulation is helping people to access memories that they might otherwise have reported as forgotten," Westphal said.

Although tDCS devices are commercially available, Rissman advises against anyone trying it outside of supervised research.

"The science is still in an early stage," he said. "If you do this at home, you could stimulate your brain in a way that is unsafe, with too much current or for too long."

Rissman said other areas of the brain also play important roles in retrieving memories. Their future research will aim to better understand the contributions of each region, as well as the effects of brain stimulation on other kinds of memory tasks.

More information: Andrew J. Westphal et al. Anodal Transcranial Direct Current Stimulation to the Left Rostrolateral Prefrontal Cortex Selectively Improves Source Memory Retrieval, *Journal of Cognitive Neuroscience* (2019). DOI: 10.1162/jocn_a_01421

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