

Transcranial stimulation to prevent fear memories from returning

July 30 2020



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A research group from the University of Bologna has succeeded in modifying the negative effect of a returning memory that triggers fear, and developed a new non-invasive experimental protocol. The result of

this study, published in the journal *Current Biology*, is an innovative protocol that combines fear conditioning—a stimulus associated with something unpleasant that induces a negative memory—and the neurostimulation of a specific site of the prefrontal cortex.

This process alters the perception of an unpleasant (aversive) event so that it will no longer induce fear. "This experimental protocol combining transcranial stimulation and [memory reconsolidation](#) allowed us to modify an aversive memory that the participants had learned the day before," explains Sara Borgomaneri, a researcher at the University of Bologna and first author of the study. "This result has relevant repercussions for understanding how memory works. It might even lead to the development of new therapies to deal with traumatic memories."

Can memories be altered?

The primary focus of the research group is the process of reconsolidation. This process maintains, strengthens and alters those events that are already stored in long-term memory. "Every time an event is recalled in our memory, there is a limited period of time in which it can be altered," explains Simone Battaglia, researcher and co-author of this study. "The protocol we developed exploits this short time window and can, therefore, interfere with the reconsolidation process of learned aversive memories."

Researchers used TMS (Transcranial Magnetic Stimulation) to "erase" the fear induced by a negative memory. With an [electromagnetic coil](#) placed on the head of the participant, TMS creates magnetic fields that can alter the neural activity of specific brain areas. TMS is a non-invasive procedure that does not require surgery or any action on the participant and for this reason, is widespread in research as well as in clinic and rehabilitation programs.

"With TMS, we could alter the functioning of the prefrontal cortex, which proved to be fundamental in the reconsolidation process of aversive memories," says Sara Borgomaneri. "Thanks to this procedure, we obtained results that, until now, were only possible by delivering drugs to patients."

The trial

The research group developed this protocol through a trial involving 98 healthy people. Every participant had learned an aversive memory and the next day underwent a TMS session over the prefrontal cortex.

"First, we created the aversive memory by combining an unpleasant stimulation with some images," explains Borgomaneri. "The day after, we presented a group of participants with the same stimulus, which, in their memory, was recorded as aversive. Using TMS immediately afterwards, we interfered with their prefrontal cortex activity."

To test the effectiveness of the protocol, other groups of participants underwent TMS without their aversive memory to be recalled (no reconsolidation was triggered), and some other groups were stimulated with TMS in control brain areas, not involved in memory reconsolidation.

At that point, the only thing left to do for researchers was to evaluate the effectiveness of TMS. They waited for another day and once again tested how the participants reacted when the aversive memory was recalled. And they obtained encouraging results. Participants who had their prefrontal cortex activity inhibited by TMS showed a reduced psychophysiological response to the unpleasant stimulus. They remembered the event (explicit memory) but its negative effect was substantially reduced.

"This trial showed that it is feasible to alter the persistence of potentially traumatic memories. This may have crucial repercussions in the fields of rehabilitation and clinical medicine," says Professor Giuseppe di Pellegrino, who coordinated the study. "We're dealing with a new technique that can be employed in different contexts and can assume a variety of functions, starting from treating PTSD, which will be the focus of our next study."

The experiment was carried out by the center for studies and research in Cognitive Neuroscience at the Department of Psychology in the Cesena Campus of the University of Bologna. The journal *Current Biology* published the results of this experiment in a paper called "State-dependent TMS over prefrontal cortex disrupts fear [memory](#) reconsolidation and prevents the return of fear."

More information: Borgomaneri et al., State-dependent TMS over prefrontal cortex disrupts fear memory reconsolidation and prevents the return of fear. *Current Biology*, (2020).

Provided by University of Bologna

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