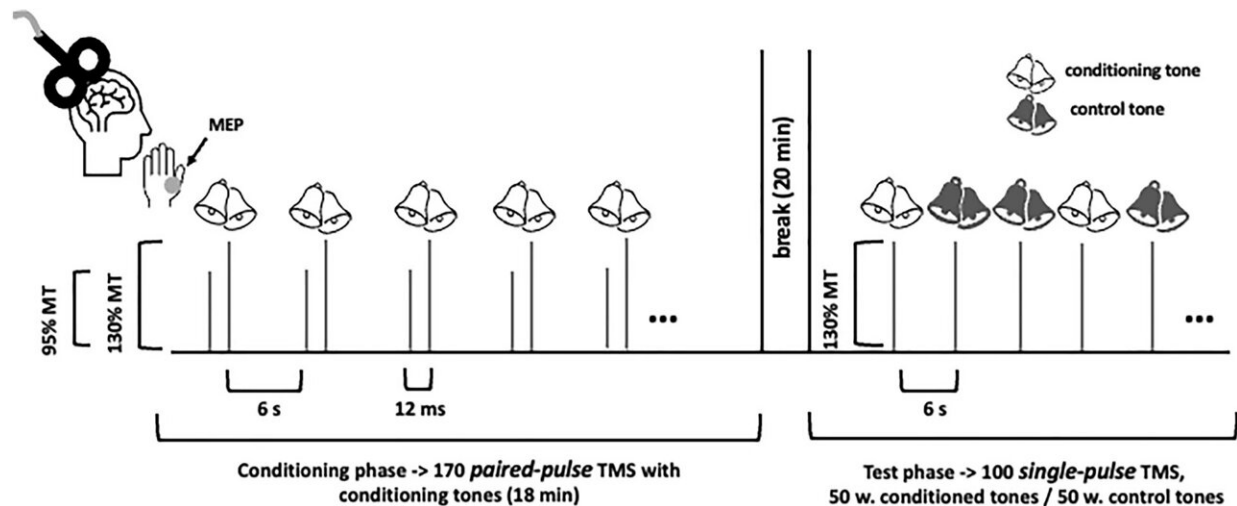


Study shows brain stimulation can be used for classical conditioning

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Experimental design. Over the conditioning phase, we applied 170 facilitatory paired TMS pulses to the representation of the right abductor pollicis brevis muscle over the left primary motor cortex while recording muscle evokes potentials (MEPs) from the target muscle. The first (subthreshold) TMS pulse was adjusted to 95% passive motor threshold (MT), the second (suprathreshold) pulse to 130% passive MT. To induce a facilitatory effect, inter-stimulus interval (ISI) between both TMS pulses was set to 12 ms. Each first subthreshold pulse of each paired-pulse TMS application was paired with one out of two acoustic stimuli (830 Hz or 1480 Hz, counterbalanced across participants). The Intertrial intervals was 6 s long. The conditioning phase was 18 min long. 20 min after the conditioning phase, the test phase started. In the test phase, we applied 100 suprathreshold single TMS pulses with the same 130% MT as used for the second TMS pulse during the conditioning phase. Fifty single TMS pulses were paired with the conditioned tone (white bells) and 50 with the control tone (dark bells). Their order was chosen pseudorandomly. The tone and the single TMS

pulse were presented simultaneously as during the conditioning phase. Like in the conditioning phase, inter-trial intervals were set to 6 s. The statistical comparison of single-pulse TMS MEP amplitudes paired with the conditioned tone vs. control tone was used to assess successful conditioning. Credit: *Scientific Reports* (2023). DOI: 10.1038/s41598-023-32894-w

Researchers at Ruhr University Bochum, Germany, have successfully implemented a special form of classical conditioning. They showed on a group of 75 people that effects of transcranial magnetic stimulation (TMS) can be triggered solely by listening to a tone.

Professor Burkhard Pleger from the Neurology Department at Berufsgenossenschaftliches Universitätsklinikum Bergmannsheil describes the results together with the medical doctoral students Stefan Ewers and Timo Dreier and other colleagues in the journal *Scientific Reports*.

Magnetic stimulation triggers contraction of the thumb muscle

To perform TMS, a magnetic coil is placed externally over a specific part of the brain. The strong magnetic field stimulates the underlying nerve cells to become active. If a certain area of the motor cortex is stimulated in this way, the [index finger](#) or thumb, for example, will move.

For their research, the Bochum-based team used the so-called paired-pulse [transcranial magnetic stimulation](#) (TMS). This involved two TMS stimuli spaced twelve milliseconds apart, which leads to a stronger [contraction](#) of a muscle than a single TMS. In the conditioning phase, the researchers always combined this paired-pulse TMS with a tone that the

participants heard via headphones while the TMS was applied.

Conditioned tone intensifies muscle contraction

In the test phase, the participants were no longer exposed to double TMS, but only to a single TMS pulse—paired either with the conditioned tone or with a tone that the participants hadn't heard before.

At the same time, the researchers once again measured the intensity of the [muscle](#) contraction on the thumb: it was significantly stronger when the participants listened to the conditioned tone, as opposed to the [tone](#) that they hadn't heard during conditioning.

Conditioning could be useful for therapeutic applications

"Our basic research proves that traditional conditioning works not only with conscious behavior patterns," concludes Burkhard Pleger. "Brain activity can also be conditioned when manipulated through external brain stimulation."

This is interesting, because TMS can also be used as a therapeutic approach, for example to improve the mobility of people with Parkinson's disease or to treat depression. "Generally, the effects of TMS are only temporary. They disappear if the [stimulation](#) is not continued. If these effects could be maintained by conditioned tones, therapy could become much more straightforward," says Pleger.

More information: Stefan P. Ewers et al, Classical conditioning of facilitatory paired-pulse TMS, *Scientific Reports* (2023). [DOI: 10.1038/s41598-023-32894-w](https://doi.org/10.1038/s41598-023-32894-w)

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