Shocks to the brain improve mathematical abilities

Benefits of electrical brain stimulation lasted months but critics point to study's small size as a weakness.

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The 'three Rs' of reading, writing and arithmetic could become four. Random electrical stimulation, a technique that applies a gentle current through the skull, leads to a long-lasting boost in the speed of mental calculations, a small laboratory study of university students has found[1].

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A gentle electrical stimulation to the brain improved university students' abilities at performing simple arithmetic calculations.

If unobtrusive brain stimulation proves safe and effective in larger classroom trials, the technology could augment traditional forms of study, says Roi Cohen Kadosh, a cognitive neuroscientist at the University of Oxford, UK, who led the study. “Some people will say that those who are bad at mathematics will stay bad. That might not be the case.”

Cohen Kadosh’s team made headlines in 2010, when it showed that a different form of electrical jolt — transcranial direct-current stimulation (TDCS) — helped volunteers to learn and remember a number system made up of unfamiliar symbols[2].

In TDCS, electrical current flows continuously between electrodes placed on different parts of the scalp, activating neurons in one area and quieting them in another. It feels like a baby tugging gently on your hair. By contrast, with transcranial random-noise stimulation (TRNS), “people ask ‘are you sure it’s on?’” says Cohen Kadosh. As the name implies, the technique involves electrical currents flowing through electrodes in random pulses, activating neurons in multiple brain areas. There is no evidence to suggest that either method is unsafe, he says.

In the latest study[1], his team tasked 25 Oxford students with rote memorization of mathematical facts (such as 2 x 17 = 34) and more complicated calculations (for example, 32 – 17 + 5). Thirteen volunteers received TRNS to their prefrontal cortices, a part of the brain involved in higher cognition, while doing these problems for five days in a row. They became faster at both tasks than volunteers in the control group, who were electrically stimulated only briefly.

Surprise test

The volunteers (and their experimenters) thought that the study would end there. But six months later, Cohen Kadosh’s team got 12 of them back in the lab and tested how quickly and accurately they answered similar maths problems — this time without electrical stimulation.

The six returning volunteers who had previously received stimulation were on average 28%, or more than a second, faster than the control group at correctly answering the problems involving calculation. When Cohen Kadosh’s team tested them for rote learning, they found no difference between the two groups. The results are published today in *Current Biology*.

The researchers also measured the activity of participants’ brains with a tool called near-infrared spectroscopy, which measures changes in blood flow to particular areas of the brain. They found that after six months, prefrontal cortex activity during calculations peaked more quickly in volunteers who had received stimulation than in controls. Cohen Kadosh speculates that the maths improvements are, in part, the result of more efficient cognitive processing.

“The findings are intriguing,” says Daniel Ansari, a cognitive neuroscientist at the University of Western Ontario in London, Canada, but he doesn't find the long-term improvements overwhelming, owing to the small number of volunteers who returned for testing. Ansari adds that the findings should be applied to the classroom with caution. “The training used here is highly contrived and does not resemble the way in which math skills are typically acquired,” he says.

Cohen Kadosh hopes to find funding to test electrical brain stimulation among real pupils in a classroom setting, rather than in a laboratory with students at one of the world’s leading universities. He says that new approaches are desperately needed to help the roughly 20% of children who have significant difficulties learning mathematics.

The machines that generate TRNS are not yet widely available, but TDCS machines can be had for a few hundred dollars and made for less. Kadosh receives regular e-mails from people asking for advice on brain stimulation, or for explanations as to why it didn't work for them. He doesn't recommend the approach: "Don't try it at home," he says.

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References

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2. Cohen Kadosh, R., Soskic, S., Iuculano, T., Kanai, R. & Walsh, V. *Curr. Biol.* **20**, 2016–2020 (2010).