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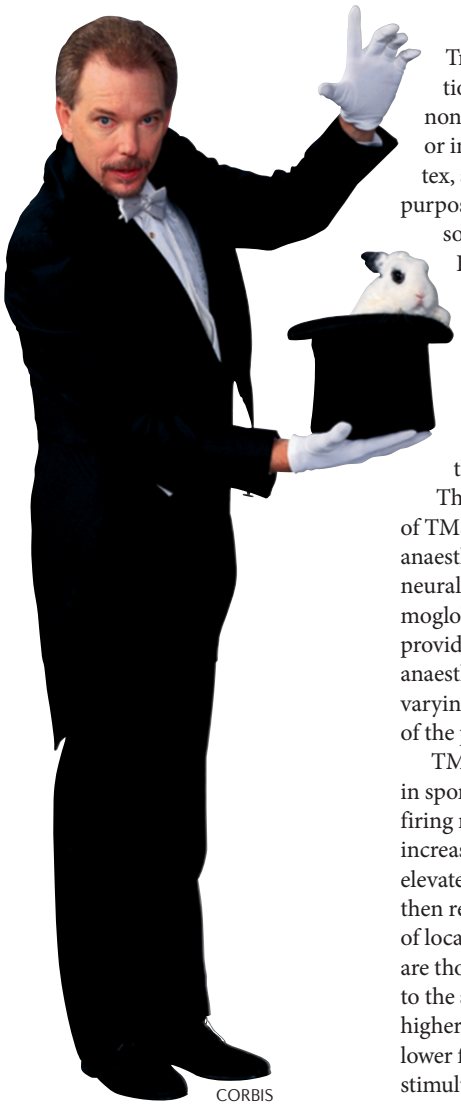
TECHNOLOGY

TMS reveals its workings



CORBIS

Transcranial magnetic stimulation (TMS) has been used as a non-invasive method to stimulate or inhibit parts of the cerebral cortex, and is used for both research purposes and to treat depression and some neurological conditions. It is unclear how TMS exerts its effects, but Allen *et al.* now demonstrate in single neurons that it changes their activity and that the direction of the change crucially depends on the type of activity that is elicited.

The authors applied a short train of TMS pulses to the visual cortex of anaesthetized cats and measured neural activity and oxygen and haemoglobin levels while intermittently providing visual stimuli (to which anaesthetized cats still respond) and varying the frequency and duration of the pulses.

TMS caused an immediate change in spontaneous neural activity: the firing rate of visual cortex neurons increased by 200%, remained elevated for about 60 seconds, and then returned to baseline. The power of local field potentials (LFPs), which are thought to reflect the input to the area, was enhanced at higher frequencies but reduced at lower frequencies. By contrast, the stimulus-evoked firing rate was decreased by half immediately following TMS, and remained suppressed for more than 5 minutes. The evoked-LFP power was similarly reduced.

Oxygen levels in the visual cortex and haemoglobin levels in the cortical vasculature increased immediately following TMS, peaking at around 10 seconds post-TMS, and then decreased and remained reduced for 1–2 minutes, regardless of whether visual stimuli were presented. The authors also showed that the TMS-induced changes in neural activity and oxygen levels were coupled and dose-dependent, as greater changes in firing rate and oxygen levels were observed with increased pulse frequencies.

With this elegant study, the authors have boosted our understanding of the mechanisms by which TMS works at the neuronal level. The finding that its effects are activity- and dose-dependent could explain the variability in TMS effects that have been observed within and between recipients.

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ORIGINAL RESEARCH PAPER Allen, E. A. *et al.* Transcranial magnetic stimulation elicits coupled neural and hemodynamic consequences. *Science* **317**, 1918–1921 (2007)
FURTHER READING Ridding, M. C. & Rothwell, J. C. Is there a future for therapeutic use of transcranial magnetic stimulation? *Nature Rev. Neurosci.* **8**, 559–567 (2007)