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In vivo low-intensity magnetic stimulation durably alters neocortical neuron excitability and spontaneous activity

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Abstract

Repetitive transcranial magnetic stimulation (rTMS), either used at high- (in Teslas, T) or low-intensity (in µT-mT; LI-rTMS), shows promise in treating human neurological dysfunctions. However, the processes activated by magnetic fields at the single neuron level remain largely unknown, preventing the optimization of potentially therapeutic TMS protocols in terms of efficacy or safety.

We investigated the impact of LI-rTMS on spontaneous activity and excitability of pyramidal cortical neurons by combining focal magnetic stimulation and intracellular recordings from the primary somatosensory cortex in sufentanil-sedated rats. Neuronal electrical properties were compared before and after 10 minutes of continuous LI-rTMS applied at 10 Hz.

LI-rTMS protocol reliably evoked firing at ~5 Hz during the stimulation period and induced durable attenuation of synaptic activity and spontaneous firing in cortical neurons, through membrane hyperpolarization and a reduced intrinsic excitability. However, inducing firing in individual neurons by repeated intracellular current injection did not reproduce the effects of LI-rTMS on neuronal properties.

These data provide a novel understanding of the mechanisms underlying magnetic brain stimulation showing that even weak magnetic fields can activate neurons and enduringly modulate their excitability.

Research Category and Technology and Methods

Basic Research: 10. Transcranial Magnetic Stimulation (TMS)

Keywords

LI-rTMS, neocortex, neuronal excitability, in vivo intracellular recordings