

Transcranial magnetic stimulation uses a pulsed magnetic field to induce localized neuron depolarizing currents in the cerebral cortex. Recently, TMS in combination with SPECT, PET, and MRI has generated considerable interest in using TMS to stimulate/inhibit local response for neuroimaging investigations of functional connectivity. Typically applied in trains, it has been possible to observe PET activation with 5 5-pulse trains of TMS at 10 Hz (25 pulses) and BOLD-fMRI response to 18 sec trains of 110% motor threshold (MT) TMS pulses at 1 Hz (18 pulses). However, the only functional neuroimaging technique in which the response to single pulse TMS has been observed is EEG, providing high temporal resolution, but spatial resolution inferior to both PET and fMRI.

Interleaved TMS and fMRI was used with an averaged single trial (AST) protocol in which a single 120% MT TMS pulse was applied on alternate 12 sec epochs to determine if the effect of a single TMS pulse could be detected by BOLD-fMRI. During each epoch, 20 5-slice packages of BOLD-EPI images were acquired at the rate of 0.6 sec per package. The cycle was repeated 15 times. Five healthy volunteers were studied.

BOLD-fMRI response to single TMS pulses was detectable in ipsilateral motor cortex under the TMS coil, in contralateral motor cortex, and bilaterally in auditory cortex. Significantly, the 1.5-2% signal increase in auditory cortex due to the sound of the TMS pulse was greater than the 1-1.5% increase induced in motor cortex by the TMS pulse itself!