

Improving Motor Recovery after Stroke by Combined rTMS and BCI Training

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Introduction: Treatment strategies to address motor impairment after stroke should optimally address both contributors towards hemiparesis, namely by encouraging activity within the lesioned hemisphere and down regulating inhibition from the healthy hemisphere. In this study, we assessed the hypothesis that combined repetitive Transcranial Magnetic Stimulation (rTMS) with motor imagery Brain Computer Interface (BCI) training would enhance hand motor function after stroke.

Methods: One stroke patient with upper extremity impairment following ischemic stroke (11.5 months post stroke) received combined rTMS and BCI treatments. Nine combined rTMS/BCI sessions were completed (three times per week for three weeks), followed by an additional nine sessions of BCI training only. Low frequency (1Hz) rTMS was applied to the motor hotspot of the non-stroke hemisphere (target muscle: nonparetic first dorsal interosseus) at 90% motor threshold for 10 minutes, immediately followed by 8-10 runs of BCI training using a virtual reality hand grasping task, with 20 trials per run. Clinical tests of motor performance, and paired-pulse TMS inter-hemispheric inhibition (IHI) tests were evaluated at three time points: baseline, post-rTMS/BCI, and post-BCI. Anatomical and functional MRI scans, both during rest and during a finger tracking test, were acquired using a Siemens Magnetom 3T scanner at all testing time points.

Results: The subject was able to achieve adequate control of the virtual reality BCI paradigm, with a daily average of nearly 70 % correct responses in the final BCI sessions, as shown in Figure 1. Performance on the finger tracking test improved significantly over time, while scores on the Motricity or Box and Block Test were stable over time. IHI testing revealed reduced inhibition from the contralesional to ipsilesional hemisphere between baseline and post-TMS/BCI time points. fMRI activation maps showed increased activation of ipsilesional motor cortex from baseline to both post-intervention time points.

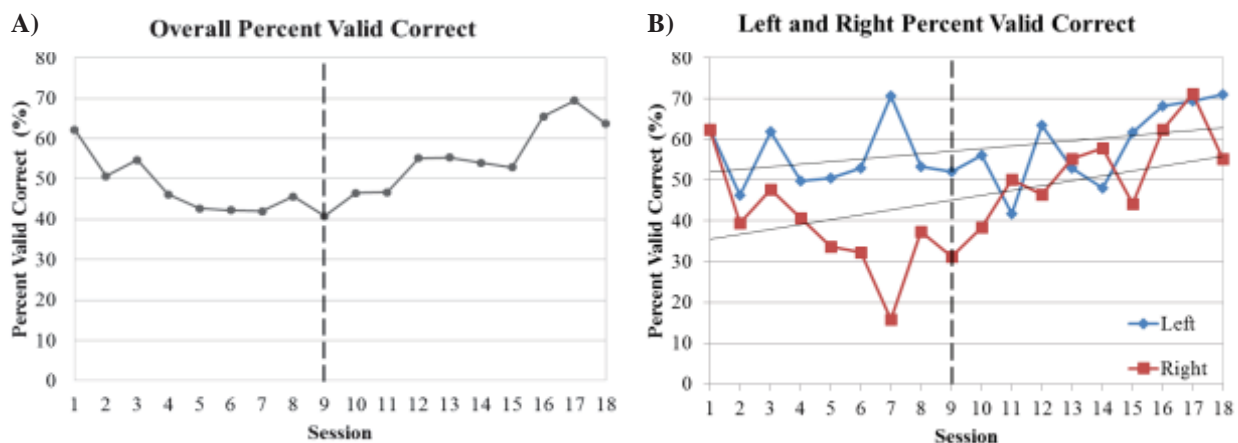


Figure 1. A) Overall daily percent valid correct in the BCI task. B) Overall daily percent valid correct in BCI task separated for left and right trials (corresponding to the stroke affected side). Dashed lines indicate separation rTMS+BCI and BCI only sessions.

Discussion: The results demonstrate that the subject was able to control the BCI task, and performance differed significantly between left and right trials when preceded by rTMS. The subject also experienced gains in hand motor function as evaluated by the finger tracking test, along with changes in fMRI activation maps suggesting increased recruitment of ipsilesional motor cortical networks.

Significance: The results demonstrate the feasibility of combining rTMS with BCI training in stroke patients, and lay a foundation for continued work with additional subjects to evaluate the potential of this combined therapy.

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