Motor Imagery-Based Brain Computer Interface: Contribution of TMS to the Understanding of Training-induced Effects on Motor Cortical Excitability*

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INTRODUCTION

Recent attention has been given to the use of Brain Computer Interface (BCI) technology to restore motor function by “guiding” activity-dependent brain plasticity to improve rehabilitation outcome after brain disorders such as stroke [1]. In this prospective, we investigate if and how a BCI training based on motor imagery (MI) paradigm would induce plastic changes at the motor cortical level by means of Transcranial Magnetic Stimulation (TMS) technique; this latter provides for a non-invasive objective measure of motor cortical excitability modulation occurring under different behavioral motor settings [2].

METHODS

Scalp EEG and TMS data were collected from ten healthy volunteers (mean age 30±7 years) who underwent TMS mapping sessions performed prior and after a MI-based BCI training consisting of 6-8 training sessions for each subject. Single TMS pulses were delivered through a figure-of-eight coil in the optimal position to elicit Motor Evoked Potentials (MEPs) in the contralateral Opponens Pollicis (OPP) and Extensor Digitorum Communis (EDC) muscles. TMS map volume (expressed as uV*cm²) was obtained by contrasting MEP amplitudes obtained during MI and rest conditions.

RESULTS

The spatial and spectral analysis revealed homogeneous EEG reactivity patterns of successful control (>80%), localized over the scalp central areas, within a range of frequency typical for sensorimotor EEG rhythms (SMR; 12-14 Hz). TMS functional mapping showed that the ECD and OPP excitability areas estimated before and after BCI training varied significantly according to the type of MI tasks that subjects generated to achieve BCI application control. Indeed, only those subjects who achieve control by performing MI of hand grasping displayed a significant increase in the map volume relative to the OPP muscle, after training.

DISCUSSION

The main finding of the present TMS study is that motor cortical excitability can be dynamically modulated by MI performed and actually practiced via a BCI training. Moreover, this modulation maintains a muscular pattern specificity. These neurophysiological evidences corroborate the idea of exploiting BCI technology to train and practice those MI tasks that can have a facilitating effect on the excitability of the hand motor area.

References


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