

Randomized pilot study: BCI with FES motor priming to enhance the effect of physical therapy

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Introduction: Priming is a type of implicit learning where exposure to one stimulus causes a an altered response to another stimulus [1]. While the effect of Brain-Computer Interface (BCI) has been attributed to motor priming, it has not been previously explored whether it can improve the effect of a subsequent physical therapy. In this study we explored the effect of Brain Computer Interface guided Functional Electrical Stimulation just prior to hand therapy on the motor and neurological outcome.

Materials, Methods and Results:

Ten people with subacute Spinal Cord Injury (SCI) were randomly assigned to intervention and control groups, with 5 participants in each group, each receiving 20 sessions. The intervention group undertook 30 motor attempt guided BCI to control Functional Electrical Stimulation (FES) applied to the hand muscles of the dominant hand (refer [2] for more technical details). This was immediately followed by 30 min of conventional hand therapy. The control group received 40 min of conventional hand therapy. The outcome measures were changes in Manual Muscle Test (MMT), range of movements (ROM), latency of somato-sensory evoked potential (SSEP), event related desynchronisation (ERD) and the ratio between eyes opened and eyes closed EEG power (EC/EO).

Both groups showed improvement in MMT and ROM and a decrease in SSEP latency but there were no statistically significant differences between groups. EC/EO increased in the treatment group but decreased in the control group. ERD laterality was preserved in the intervention group only (Fig 1), while ERD in the control group is shifted towards the parietally occipital regions.

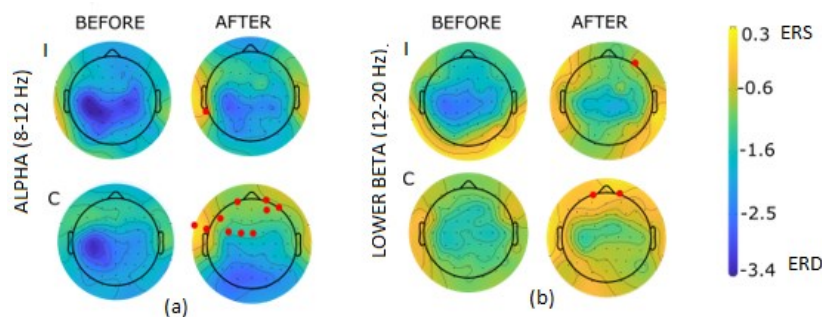


Fig. 1. Event related synchronisation (ERS) and desynchronisation (ERD) before and after 20 sessions in the intervention (i) and control group (C) in a) alpha and b) beta 12-20 Hz. The red dots show statistically significant changes.

Discussion:

The duration of BCI FES in this study might have been too short, and the number of participants too small to notice a significant effect of motor priming on motor recovery. However, the intervention group preserved a contralateral cortical activity during motor attempts and increased EC/EO ratio, which is a measure of thalamic response to external sensory stimuli, that could decrease following SCI, being indicative of a risk of developing neuropathic pain [3].

Significance:

In clinical settings, BCI is delivered as an adjunct to standard therapy. Their interaction should be explored in order to maximize the cumulative effect of both therapies.

References:

- [1] M.E. Stoykov, S. Madhavan Motor priming in neurorehabilitation, *J Nerol Phys Ther.* 3991:33-42, 2015.
- [2] R. Kumari *et al.*, Short-term priming effect of brain actuated muscle stimulation using bimanual movements in stroke. *Clin Neurophysiol.* 138:108-121, 2022.
- [3] A. Vuckovic *et al.* EEG predictors of neuropathic pain in subacute Spinal Cord Injury. *J Pain*, 19(11):1256.e1-1256.e17, 2018