

Identifying the best candidates for a rehabilitative BCI targeting upper limb motor recovery.

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Introduction: Randomized Controlled Trials (RCTs) in the last decade have shown the benefits of BCIs for post-stroke motor recovery of the upper limb (UL) [1]. The paradigms are heterogeneous in terms of tasks (eg. Motor Imagery, MI vs motor attempt), feedback modalities (eg. visual vs haptic) and training protocols. As of today, there is no consensus on which BCI approach is best for which type of patient. We are conducting a RCT [2] to investigate the long-term effects of MI-based BCI with visual feedback on UL motor recovery and identify the best candidates among subacute stroke patients.

Material, Methods and Results: The study protocol foresees the enrollment of 48 patients undergoing rehabilitation after a recent (<6 months) ischemic/hemorrhagic stroke; deficit in the affected UL is assessed at enrollment (T0) as moderate or severe according to the Fugl-Meyer Assessment (FMA) (mildly affected patients excluded) and the Action Research Arm Test (ARAT). Patients are randomized into BCI and CTRL groups, performing respectively 12 sessions of BCI-supported UL-MI training or MI-training without BCI. The FMA and ARAT are repeated post-training (T1) and after 1, 3 and 6 months (T2, T3, T4). Figure 1 shows trends of FMA improvement in BCI and CTRL groups for severe and moderate patients. Qualitatively, the curves differ especially in the severely affected patients, in favor of the BCI intervention. Statistical analysis (Friedman test) at this stage of enrollment could be performed in severe patients only, showing significant improvements in FMA for both BCI ($\chi^2 = 25.04$, $p=.00005$) and CTRL ($\chi^2=12.76$, $p=.013$) groups, while significant improvements in ARAT are observed for the BCI group only ($\chi^2=20.77$, $p=.00035$).

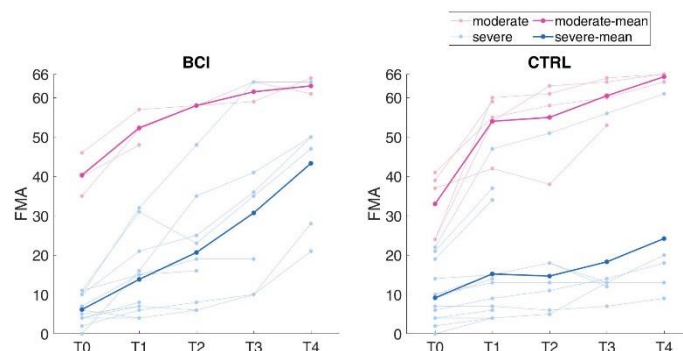


Figure 1. FMA values at the different timepoints for severe (blue lines) and moderate (pink lines) patients in the BCI and CTRL groups.

Discussion: Preliminary findings of the RCT suggest that MI-based BCI with visual feedback could be particularly useful in stroke patients with severe UL motor deficit. For these patients, MI within a BCI paradigm provides the unique opportunity to exercise the otherwise inaccessible motor system with contingent feedback. The benefits obtained via the BCI training early in the rehabilitation process allow them to eventually access other rehabilitation approaches (which require some level of motor function) and thus exponentially improve UL motor outcome along the subsequent timepoints.

Significance: While the efficacy of BCIs for post-stroke motor recovery has been sufficiently demonstrated against sham/control interventions, little is known on how to address specific BCI based intervention to those patients' categories that will benefit the most. This aspect is crucial to direct resources of private and public stakeholders and thus foster actual translation of research results into clinical practice.

Acknowledgements: Partially supported by the Italian Ministry of Health (RF-2018-12365210, GR-2018-12365874).

References

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