 DOI: 10.3217/978-3-85125-467-9-129

Improving Motor Imagination with Support of Real-Time LORETA Neurofeedback

Aso Fatih Muhamed [1*], Frank E Pollick [1], Aleksandra Vuckovic [1]
[1] *University of Glasgow, UK*

*a.muhamed.1@research.gla.ac.uk

Introduction: Recording cortical activity during imagined leg movement is a challenging task due to cortical representation of legs deeper within the central sulcus. Therefore Brain Computer Interface (BCI) studies typically rely on imagined movement of both legs [1]. Activity of deeper cortical structures can be estimated off-line from multichannel Electroencephalography (EEG) by using LORETA numerical method [2]. LORETA can also be calculated in real time to provide an instantaneous estimate of brain activity, but currently available solution supports only up to 19 channels (BrainAvatar, BrainMaster, Inc). In this study we propose a custom designed real time LORETA neurofeedback based on multichannel EEG to increase cortical activity at the central sulcus during continuous imagining tapping with one leg only. This strategy could be useful in neurorehabilitation of hemiplegia (i.e. stroke).

Material, Methods and Results: EEG data was recorded using usbamp device (Guger technologies, Austria), from 44 channels covering the whole cortex (sample rate 128Hz, linked ear reference, impedance under 5 KΩ). EEG was collected in Simulink/Matlab (Mathworks, USA) in 1s non overlapping windows and data were saved in *.txt file. Data was then sent to LORETA via custom designed software application written in C#. In LORETA data were extracted from a pre-defined Brodmann area and visualised through a custom made GUI (designed in C#) in a form of a bar chart, shown to a participant with a total delay of 1.25s. Two naive healthy participants took part in this pilot study (age =35±5). EEG was recorded during a baseline session, imagined right leg tapping without feedback, real tapping and 8 neurofeedback runs, lasting 2 min each. During neurofeedback participants received a visual feedback from left BA4 and 6 in 8-15Hz band. To remove noise off-line, EEG was exported to EEGLAB where it was epoched into 4 seconds, cleaned from artefacts using Independent component analysis and re-referenced to an average reference. EEG was then analysed off-line using sLORETA.

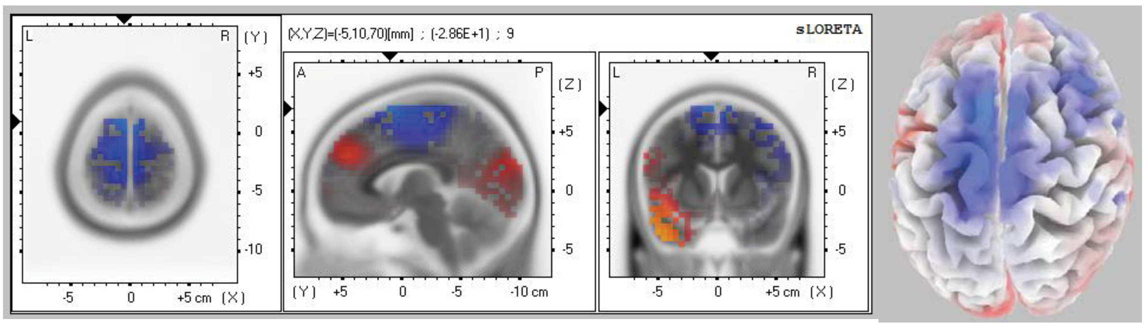

Figure 1. *Regions of most significantly increased activity (blue) between the first and last session of neurofeedback in 8-15Hz band.*

Both participants significantly increased cortical activity from 1^{st} to 8^{th} run. Figure 1 shows statistically significant difference between first and last run at the left cortex. Figure to the right is a top view showing cortical activity lateralized to the left (sensory-motor cortex of the right leg).

Discussion: We have demonstrated novel software application for providing multichannel neurofeedback that can be used to selectively activate deeper cortical structures, while participants imagined tapping with right leg only.

Significance: Selective unilateral enhancement of cortical activity can be useful for neurological recovery after stroke. This can be used as an inexpensive alternative to real-time fMRI neurofeedback training.

Acknowledgements: This work was supported by Ministry of Planning, Kurdistan Regional Government.

References

[1] G. Pfurtscheller, P. Linortner, R. Winkler, G. Korisek, and G. Müller-Putz, "Discrimination of Motor Imagery-Induced EEG Patterns in Patients with Complete Spinal Cord Injury," *Comput. Intell. Neurosci.*, vol. 2009, pp. 1–6, 2009.

[2] R. D. Pascual-Marqui, C. M. Michel, and D. Lehmann, "Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain.," *Int. J. Psychophysiol.*, vol. 18, pp. 49–65, 1994.