 DOI: 10.3217/978-3-99161-050-2-149

Stereo-EEG Based Brain Computer Interfacing Across a Large Patient Cohort

Michael A Jensen[1], Gerwin Schalk[1], Nuri Ince[2], Dora Hermes[2], Peter Brunner[3], Kai J Miller[1,2]

[1]*Department of Neurosurgery, Mayo Clinic, MN, USA*

[2]*Department of Biomedical Engineering, Mayo Clinic, MN, USA*

[3]*Department of Neurosurgery, Washington University School of Medicine, St Louis, MO, USA*

* 200 First Street SW, Rochester, MN 55905, USA; E-mail: jensen.michael1@mayo.edu;

ABSTRACT:

Introduction Stereoelectroencephalography (sEEG) is a mesoscale intracranial monitoring method which records from the brain volumetrically using depth electrodes. Implementation of motor Brain Computer Interfacing (BCI) in sEEG has not been well-described across a diverse patient cohort. Here in we describe the application of sEEG-based motor BCI across a large patient cohort.

Methods: Across twenty-two subjects, channels with 65-115Hz power increases during hand, tongue, or foot movements during a motor screening task were provided real-time feedback to control a cursor on a screen. Power from 70-110 Hz, estimated using an autoregressive model, in one or more feedback channel(s) was used to control a cursor on a screen in one-dimension similar to previous ECoG studies[1] (Figure 1).

Results: Eighteen subjects established successful control of overt motor BCI, but only ten were able to control imagery BCI with accuracy above 80%. In successful imagery BCI, HFB power in the two target conditions separated into distinct sub-populations, which appear to engage unique subnetworks of the motor cortex compared to cued movement alone (Figure 2).

Conclusion: sEEG-based motor BCI utilizing overt movement and kinesthetic imagery is robust across all large cohort of patients and appears to selectively engage the motor network.

Acknowledgments and Disclosures: This work was supported by the NIH U01-NS128612 (KJM, GAW, PB).

Reference:

[1] Miller KJ, Schalk G, Fetz EE, Den Nijs M, Ojemann JG, Rao RP. Cortical activity during motor execution, motor imagery, and imagery-based online feedback. Proceedings of the National Academy of Sciences. 2010;107(9):4430–4435.

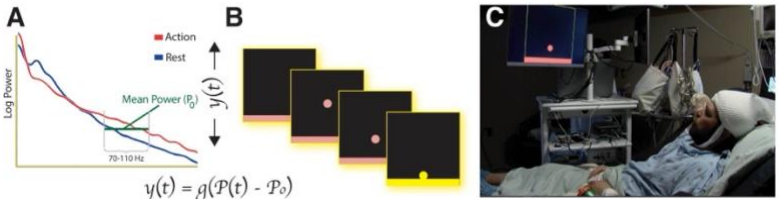

Figure 1. Schematic of online BCI feedback (A) Power from 70-110 Hz in the channel chosen in A determines the direction and velocity of the cursor on screen. (B) Targets are displayed prior to cursors to cue movement or rest and subjects attempt to direct cursors toward the rectangular target. (C) Subjects perform the BCI within their bed viewing a monitor 80-100 cm from their head.

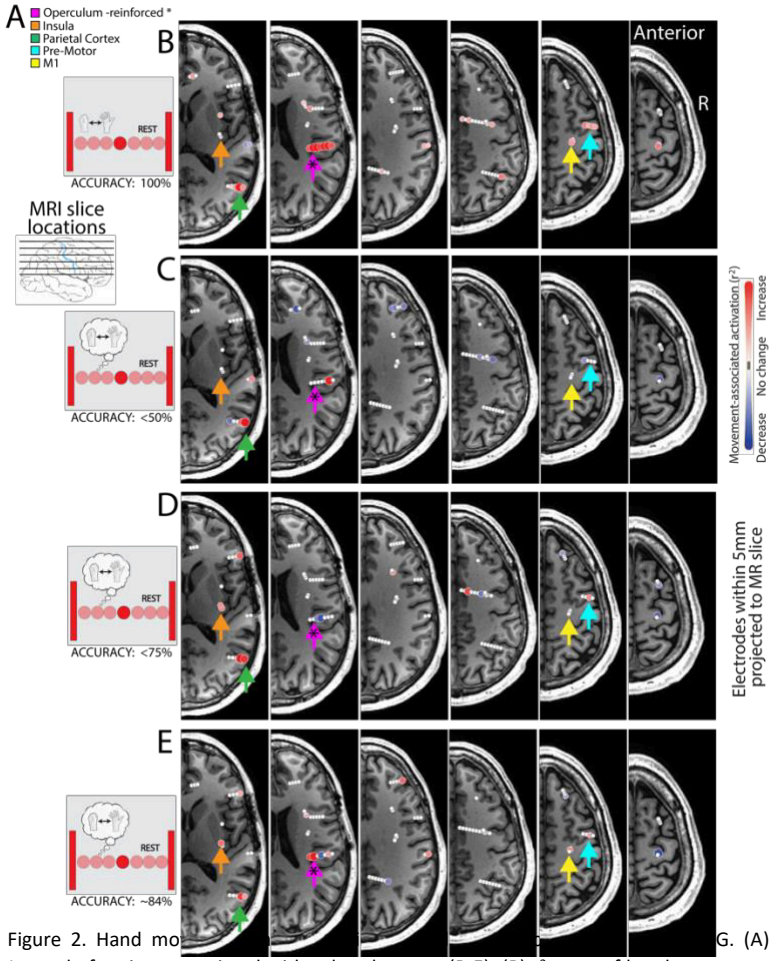

Figure 2. Hand mo G. (A) Legend of regions associated with colored arrows (B-E). (B) r^2 maps of hand movement vs rest (*No* feedback), broadband 65-115Hz power. (C-E) r^2 maps of imagined hand movement vs rest (*with* feedback), broadband 65-115Hz power. Each row represents increasing BCI control from chance (C) up to 84% (E).

Note reintroduction of feedback channel (*) activity once control Is > 80% (E) as well as the sharp drop off and gradual return of pre-motor activity as control in imagery BCI (C-E) control is established.

 Published by Verlag der Technischen Universität Graz