Mapping BCI task imagery brain responses using MEG beta power desynchrony effects

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Abstract Title: Mapping BCI task imagery brain responses using MEG beta power desynchrony effects

ABSTRACT PREVIEW: MAPPING BCI TASK IMAGERY BRAIN RESPONSES USING MEG BETA POWER DESYNCHRONY EFFECTS

Edit Mapping BCI task imagery brain responses using MEG beta power desynchrony effects

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Abstract

Category

3. Neurophysiology / 3D. MEG

Young Investigator

- Yes

HIPAA Release

- Yes

Partners Against Mortality in Epilepsy (PAME)

- Yes

Rationale

Beta-band power desynchrony effects have been traditionally linked to brain motor-related activities, but also broadly linked to cortical engagement during cognitive processing, e.g., language [1]. We examined these by localizing magnetencephalography (MEG) responses related to both motor- and cognitive-imagery activities performed as part of a brain-computer interface (BCI) experimental paradigm.

Methods

We analyzed MEG data from two sessions of a BCI experiment completed by 17 healthy individuals, 13 males and 4 females, with a mean age of 29.3 years with 15 right-handed and 2 left-handed as per self-report. The BCI task consisted of two motor and two cognitive imagery activities. During the motor task, participants imagined the movement of both hands/both feet when the cue appeared at the screen. During cognitive imagery tasks, participants either subtracted two numbers presented as cues or generated words related to an English language letter presented as a cue (**Fig. 1A**). Each session consisted of 50 trials of each imagery task with a total of 200 trials.

MEG data were preprocessed using a combination of spatiotemporal Max-filtering, signal thresholding, and ICA decomposition. 3-second data after the presentation of a cue from each imagery tasks were analyzed using a differential beamforming analysis against 400 ms pre-cue baseline. To avoid biases due to unequal data segments, active data were segmented and analyzed at 7 non-overlapping 400 ms length windows from 400 to 2800 ms interval. The average of source intervals was reported as presentative beta power effects. Beta source power was estimated using a frequency-resolved DICS beamformer in a frequency range of beta 17-25 Hz. The cross-spectral density of active and baseline responses was estimated using a fast Fourier transform and multi-tapering with multiple tapers from discrete prolate spheroidal sequences (dpss) to have sufficiently smooth spectra. Source activations were estimated on cortical surfaces obtained from Freesurfer segmentation analysis of anatomical MR of individuals. Group average source modeling was conducted after projecting source activities of each task responses on a cortical surface template, available in Brainstorm toolbox. Source activations were reported using a 70% maximum of absolute source power.

Results

Group source localization showed prominent desynchrony effects in bilateral premotor and motor areas during hand and feet conditions, with stronger effects at the left-hemispheric regions and particularly left prefrontal cortex, known to coordinate between cognitive and motor regions. Findings for two cognitive conditions showed strong left-hemispheric desynchrony effects in the temporal (superior temporal gyrus) and parietal (supramarginal gyrus) and (inferior) prefrontal gyrus regions, all known to be involved in cognitive (language) and comprehension (arithmetic) processes.

Conclusions

Our work demonstrates the suitability of beta-power suppression effects for localizing both motor and cognitive activities in a BCI application. Biomarkers derived from beta source power can potentially be used for clinical applications, e.g., to characterize motor or cognitive impairments in patients with epilepsy.

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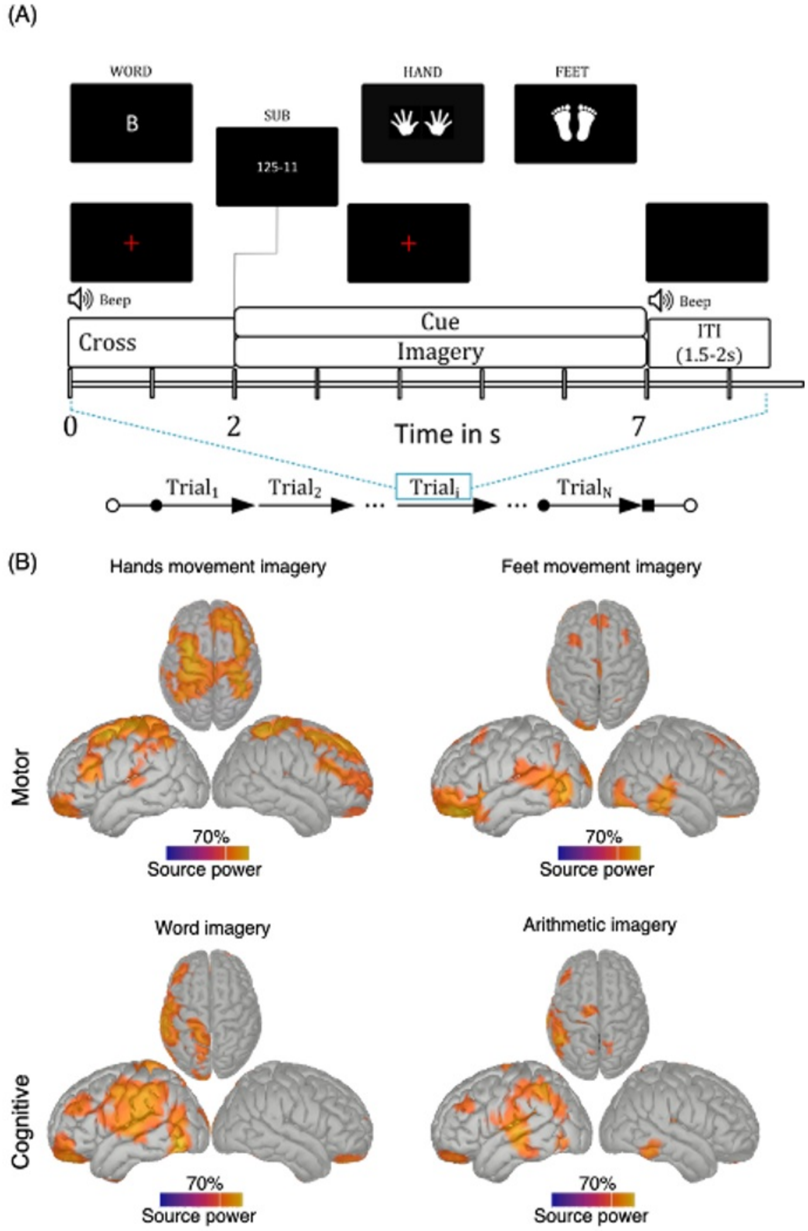

Figure 1. MEG beta-band source activities during BCI task imagery activities in 17 healthy control. (**A**) Experimental paradigm design, (**B**) group average beta-band, 17-25Hz of 4 tasks source responses.

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