Data Set

'Brain computer interfacing based on cognitive control'

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Original paper

Vansteensel MJ, Hermes D, Aarnoutse EJ, Bleichner MG, Schalk G, van Rijen PC, Leijten FS, Ramsey NF (2010) Brain-computer interfacing based on cognitive control. Ann Neurol. 2010 Jun;67(6):809-16. doi: 10.1002/ana.21985.

Abstract of the original paper

OBJECTIVE: Brain-computer interfaces (BCIs) translate deliberate intentions and associated changes in brain activity into action, thereby offering patients with severe paralysis an alternative means of communication with and control over their environment. Such systems are not available yet, partly due to the high performance standard that is required. A major challenge in the development of implantable BCIs is to identify cortical regions and related functions that an individual can reliably and consciously manipulate. Research predominantly focuses on the sensorimotor cortex, which can be activated by imagining motor actions. However, because this region may not provide an optimal solution to all patients, other neuronal networks need to be examined. Therefore, we investigated whether the cognitive control network can be used for BCI purposes. We also determined the feasibility of using functional magnetic resonance imaging (fMRI) for noninvasive localization of the cognitive control network.
METHODS: Three patients with intractable epilepsy, who were temporarily implanted with subdural grid electrodes for diagnostic purposes, attempted to gain BCI control using the electrocorticographic (ECoG) signal of the left dorsolateral prefrontal cortex (DLPFC).
RESULTS: All subjects quickly gained accurate BCI control by modulation of gamma-power of the left DLPFC. Prelocalization of the relevant region was performed with fMRI and was confirmed using the ECoG signals obtained during mental calculation localizer tasks.
INTERPRETATION: The results indicate that the cognitive control network is a suitable source of signals for BCI applications. They also demonstrate the feasibility of translating understanding about cognitive networks derived from functional neuroimaging into clinical applications.

Materials and Methods

<u>Subject</u>

The subject is patient #3 of the original paper, and an epilepsy patient with surface electrodes implanted over the left and right frontal cortex. Also several interhemispheric electrodes were implanted. The subject performed several runs of a BCI 2-target task, using the high frequency power (55-95Hz) of electrode FLm4 (#108). We provide two datasets, each of a single 4-min run of this feedback task. The subject was instructed to perform backward counting from a number given on the screen to send the cursor to the upper target and to relax to send the cursor to the lower target. For dataset #1, the task was performed overtly (i.e. out loud), for dataset #2, the task was performed covertly.

Structure of the datafile

Each run of the 2-target task is provided as a separate .mat file. The structure in the .mat file contains the following variables:

- Bandpassfilter: the hardware highpass and lowpass filters of the recording system
- Cortex: structure that can be used to generate a 3D rendering of the subject's cortex (Hermes et al., 2010)
- Datainmicrovolts: a samplepointsXchannels structure containing the actual data
- Datasource: the site at which the data were recorded
- Elecmatrix: the 3D coordinates of all subdural electrodes in subject space (Hermes et al., 2010)
- Electrode: schematic 2D electrode positions
- Electrodes: the names of the electrodes
- Event: task structure
- Md5: unique identifier
- Reference: the location of the external reference electrode
- Samplerate: acquisition sampling rate in Hz
- Task: description of the feedback task
- Taskevents: order of trials
- Taskvalue: target locations on computer screen, target 1 = upper target, target 2 = lower target
- Taskvalues: trial types
- Totaltimeinseconds: total experiment duration

Contact

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References

Hermes D, Miller KJ, Noordmans HJ, Vansteensel MJ, Ramsey NF (2010) Automated electrocorticographic electrode localization on individually rendered brain surfaces. J Neurosci Methods. 2010 Jan 15;185(2):293-8. doi: 10.1016/j.jneumeth.2009.10.005. Epub 2009 Oct 27.