 DOI: 10.3217/978-3-85125-467-9-135

BCI-approach for cognitive rehabilitation in stroke: pilot data from patient with spatial neglect

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Introduction: Stroke remains a primary cause of morbidity throughout the world mainly because of its effect on cognition [1]. Nowadays rehabilitation of post-stroke cognitive deficits is underdeveloped. Spatial neglect is a post-stroke cognitive deficit occurring in about 70% of patients after right hemisphere stroke; it persists in one third of patients and worsens stroke outcome [2]. Current therapeutic approaches in neglect do not include any learning strategies [2], which would be more effective for long-term training effect. BCI-methods might be an alternative for neglect rehabilitation also by presenting neurofeedback (closed-loop) to patients with accompanying anosognosia. In the present study we aimed to explore evoked-response potentials (ERP) and oscillatory features preceding and accompanying distinct performance features (attention orientation to left/right, hit/miss trials) during visuospatial task in neglect patients to evaluate the potential of BCI-methods for neglect rehabilitation.

Material, Methods: We recruited one patient with right fronto-parietal infarct, 53 years, 10 days post-stroke showing neglect deficit, admission NIHSS=2. The 32-channel EEG was recorded in resting state and during conducting of spatial task. The latter was a Posner-like paradigm [3] with central cue (duration 2000 to 3000 msec) pointing equally to the left or right followed by target (duration 1000 msec) presented in the valid hemifield in 90% of trials. The ERP-responses and oscillatory features upon cue and target presentation were analyzed in dependence to the cue lateralization and hit/miss trials. The frequency band of [7-9] Hz was analyzed using the Common Spatial Patterns (CSP) algorithm for the oscillatory features, whereas for the ERP responses, the intervals corresponding to early negativity and late positivity were used as features for the classification stage. Three aged-matched healthy subjects represented a control group.

Results: A total of 170 trials were recorded for the stroke patient with classification of ERP- and CSP-patterns upon left/right cue was not better than chance level, whereas in healthy subjects it was above 66%. ERP-based classification of hit/miss trials for the patient was only 60%. Channels of the undamaged left hemisphere were the most informative for classification hit/miss trials (Fig. 1), while no such lateralization effect was observed in healthy subjects. We were not able to detect features preceding hit/miss trial in the patient's data. Interestingly, the early ERP-response even in miss trials could be observed confirming that neglect is a disorder of high-level attention function [4].

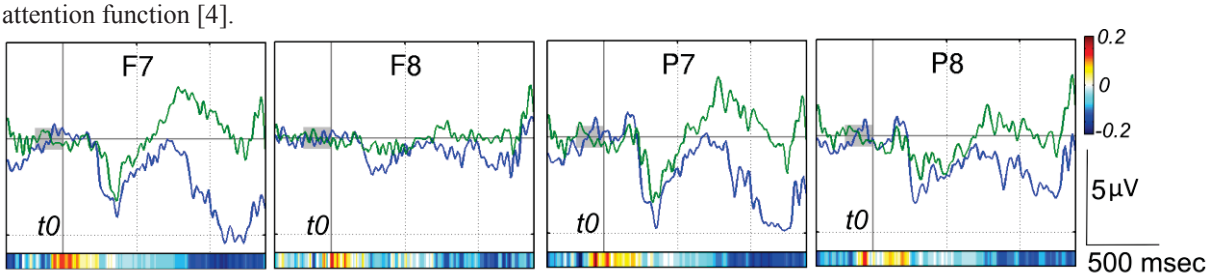

Figure 1. *ERP-responses to hit (blue) and miss (green) trials in acute stroke patient with neglect. T0 points to the target presentation.*

Discussion, Significance: This is the first pilot application of BCI-method in acute stroke patient with neglect. The failed classification upon left/right cue in patient's data demonstrates that application of BCI-methods in patients with territorial stroke is challenging and distinct compared to healthy subjects, but feasible. Though hit/miss trials classification exceeded the chance level, the detection of their preceding features would be more valuable to establish the method for rehabilitation. Further data acquisition is required, as well as optimization of classification algorithms due to the distinct ERP/CSP-patterns in stroke.

Acknowledgements: This work was (partly) supported by BrainLinks-BrainTools, Cluster of Excellence funded by the German Research Foundation (DFG), grant number EXC 1086.

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