

Effect of prestimulus SMR amplitude on BCI performance

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INTRODUCTION

Recently, several studies investigated the ongoing brain oscillations preceding the presentation of a stimulus in perception as well as motor and cognitive paradigms. In particular, the amplitude in the alpha frequency band is often correlated with performance. On the other hand, Dickhaus et al [1] developed an *SMR-predictor*, which shows a positive correlation of the sensorimotor rhythm (SMR) amplitude in a rest condition with BCI feedback performance. Here, we study the influence of pre-stimulus SMR on timing and strength of motor imagery induced SMR modulations with the aim to develop an SMR-state-dependent BCI.

METHODS

Thirty data sets from 30 BCI naïve volunteers performing left and right hand motor imagery were investigated. Three spatial filters per class were calculated on the calibration data by Common Spatial Patterns (CSP) analysis and an LDA classifier was trained on the obtained CSP features. Trials of feedback data were analyzed separately in 2 groups according to pre-stimulus band power (*high-* and *low-*group). Feedback data were classified in sliding time intervals of 1000ms duration as used, e.g., in cursor control.

RESULTS

The classification error for the *high-*group was lower than for the *low-*group over the whole trial length (Fig. 1a). In particular, this difference was significant between 550 and 2650 ms after the cue is presented ($p < .01$, denoted by black *). Interestingly, the difference in performance can be attributed to the ipsi- rather than to the contralateral hemisphere as can be observed in the grand average ERD curve (Fig. 1b) and the maps of r^2 -values for left vs. right hand motor imagery (Fig. 1c).

DISCUSSION

Trials with higher pre-stimulus SMR amplitude can be better classified than the ones with low amplitude. This effect occurs early after cue presentation (550 ms) and can thus be exploited for applications requiring faster decision making. In future work, neurofeedback training will be explored to increase users' SMR amplitude and an SMR-state-dependent BCI will be developed to take advantage of the faster and more accurate classification.

References

[1] Thorsten Dickhaus, Claudia Sannelli, Klaus-Robert Müller, Gabriel Curio, and Benjamin Blankertz. Predicting BCI performance to study BCI illiteracy. BMC Neuroscience 2009, 10:(Suppl 1):P84, 2009.

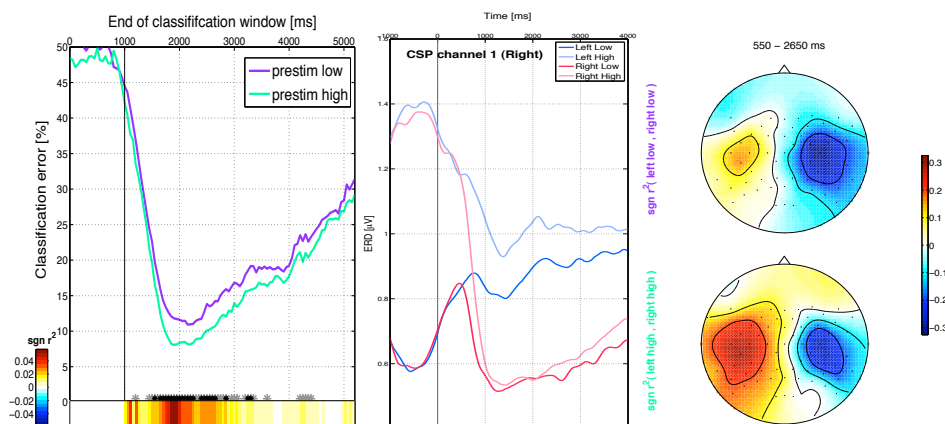


Figure 1: (a) Classification error as a function of window position for high and low groups. (b) Grand average ERD in CSP channel for the different classes and groups. (c) Grand average scalp distributions of the r^2 -values