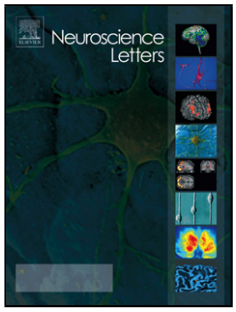

Title: Application of a common spatial pattern-based algorithm for an fNIRS-based motor imagery brain-computer interface

Authors: Shen Zhang, Yanchun Zheng, Daifa Wang, Ling Wang, Jianai Ma, Jing Zhang, Weihao Xu, Deyu Li, Dan Zhang

PII: S0304-3940(17)30535-9
DOI: http://dx.doi.org/doi:10.1016/j.neulet.2017.06.044
Reference: NSL 32925

To appear in: *Neuroscience Letters*

Received date: 11-5-2017
Revised date: 23-6-2017
Accepted date: 23-6-2017

Please cite this article as: Shen Zhang, Yanchun Zheng, Daifa Wang, Ling Wang, Jianai Ma, Jing Zhang, Weihao Xu, Deyu Li, Dan Zhang, Application of a common spatial pattern-based algorithm for an fNIRS-based motor imagery brain-computer interface, Neuroscience Lettershttp://dx.doi.org/10.1016/j.neulet.2017.06.044

Application of a common spatial pattern-based algorithm for an fNIRS-based motor imagery brain-computer interface

Shen Zhang[a,1], Yanchun Zheng [a,1], Daifa Wang[a], Ling Wang[a], Jianai Ma[a], Jing Zhang[a], Weihao Xu[a], Deyu Li[a,b,c]*, Dan Zhang[d,]*

[a] School of Biological Science and Medical Engineering, Beihang University, Beijing, China
[b] State Key Laboratory of Software Development Environment, Beihang University, Beijing, China
[c] State Key Laboratory of Virtual Reality Technology and System, Beihang University, Beijing, China
[d] Department of Psychology, School of Social Sciences, Tsinghua University, Beijing, China

[1]These two authors contributed equally to this work.

*Corresponding authors:
Deyu Li, deyuli@buaa.edu.cn, School of Biological Science and Medical Engineering, Beihang University, Beijing, China
Dan Zhang, dzhang@tsinghua.edu.cn, Department of Psychology, School of Social Sciences, Tsinghua University, Beijing, China

Highlights

- A CSP-based BCI algorithm was implemented for classifying fNIRS recorded motor imagery tasks.
- Significant improvements of classification accuracies were obtained by using CSP, compared to conventional channel-wise methods.
- The often ignored fNIRS signal variance feature was shown to be effective and provided an independent contribution from the commonly used signal mean and slope features.

Abstract

Motor imagery is one of the most investigated paradigms in the field of brain-computer interfaces (BCIs). The present study explored the feasibility of applying a common spatial pattern (CSP)-based algorithm for a functional near-infrared spectroscopy (fNIRS)-based motor imagery BCI. Ten participants performed kinesthetic imagery of their left- and right-hand movements while 20-channel fNIRS signals were recorded over the motor cortex. The CSP method was implemented to obtain the spatial filters specific for both imagery tasks. The mean, slope, and variance of the CSP filtered signals were taken as features for BCI classification. Results showed that the CSP-based algorithm outperformed two representative channel-wise methods for classifying the two imagery statuses using either data from all channels or averaged data from imagery responsive channels only (oxygenated hemoglobin: CSP-based: 75.3 ± 13.1%; all-channel: 52.3 ± 5.3%; averaged: 64.8 ± 13.2%; deoxygenated hemoglobin: CSP-based: 72.3 ± 13.0%; all-channel: 48.8 ± 8.2%; averaged: 63.3 ± 13.3%). Furthermore, the effectiveness of the CSP method was also observed for the motor execution data to a lesser extent. A partial correlation analysis revealed significant independent contributions from all three types of features, including the often-ignored variance feature. To our knowledge, this is the first study demonstrating the effectiveness of the CSP method for fNIRS-based motor imagery BCIs.