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Median nerve stimulation to predict MI-BCI performances

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Approximately 30% of individuals fail to effectively use a Brain-Computer Interface (BCI), a phenomenon known as BCI deficiency [1]. Predicting BCI performance is thus crucial for optimizing system parameters, selecting users, and harmonizing participant groups. While BCI performance prediction based on motor imagery (MI) remains an open question, various neurophysiological predictors assess motor cortex activation ability [2, 3, 4, 5]. We propose a novel predictor based on Median Nerve Stimulation (MNS) [6, 7], specifically, the minimum value (200–800 ms post-MNS) of the Event-Related Desynchronization (ERD) at electrode C3 using a small Laplacian filter. Right-hand MI vs. rest BCI performance was evaluated offline using a Tangent Space Logistic Regression classifier in 31 subjects. BCI accuracy strongly correlated with post-MNS ERD (Spearman's $\rho = -0.71$, $p < 0.001$) [8]. Beyond correlation analysis, we actually predicted BCI performance using a Least Absolute Shrinkage and Selection Operator (LASSO) regression model, trained on six MNS-based features: minimum ERD (200–800 ms) and maximum ERS (800–1500 ms) post-MNS in mu, beta, and mu+beta. Using only these features, LASSO predicted MI-BCI accuracies with a correlation of $\rho = 0.65$ ($p < 0.01$) between real and predicted accuracies (Fig. 1A). We also tested whether the three post-MNS ERD could predict a performance group, rather than the exact accuracy score (Fig. 1B) [9]. LASSO achieved 74.19% accuracy for two groups, though performance decreased to 45.16% for three groups. Based on reports from the literature, our new MNS-based predictor seems to outperform state-of-the-art alternatives, including SMR and MeanSP ($\rho = 0.53$) [2, 5], PPfactor ($\rho = 0.48$) [4], and Spectral Entropy ($\rho = 0.65$) [3]. These results suggest an inherent neurophysiological predisposition for MI-BCI success. Future work will integrate multiple predictors into a single model for improved accuracy.

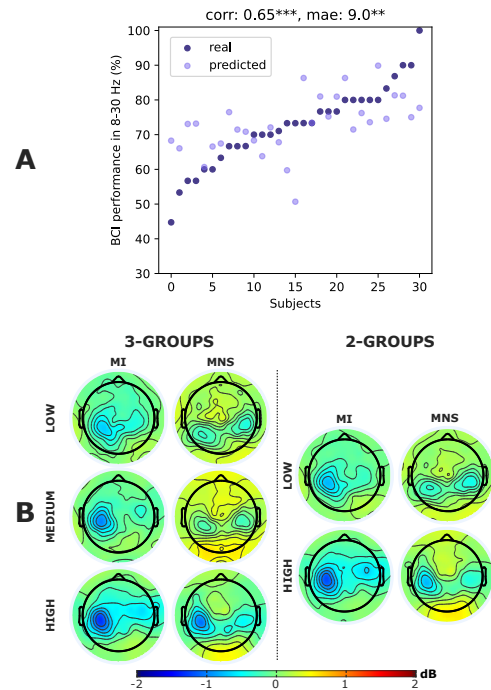


Figure 1:

A. Real and LASSO predicted BCI performances ($n=31$) in mu+beta, with Spearman's correlation and average mean absolute error between real and predicted performances (and statistical significant levels).

B. Topographies of EEG power in mu+beta for right-hand MI and MNS, 200-800 ms after the go signal. Left: average across of three balanced groups based on 1/3 and 2/3 accuracy quantiles; right: average across of two balanced groups based on median accuracy.

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