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Combining Methods To Predict Accuracy of Individual Brain-Computer Interface Selections

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Introduction: Brain-computer interfaces (BCIs) provide a direct communication pathway between a user's brain and an external device to enable communication for people with severe motor impairments [1]. This study used off-line analysis of recorded data from a letter-by-letter spelling P300 BCI [2].

BCI accuracies average 77-90% with speeds of (1.4-4.5 char/min) [1]. Performance can be improved by abstaining selections that do not meet a predetermined P300-Certainty threshold [3]. However, there are multiple ways to predict the accuracy (correct or incorrect) of individual BCI selections. Monitoring attention through the power in the EEG alpha band (8-13Hz) [4] can also predict the accuracy of selections [5]. BCI selection accuracy can be improved by applying an alpha threshold for subjects that exhibit high alpha variance. This study used off-line analysis to examine the potential of combining the P300-Certainty algorithm and alpha-band monitoring of BCI data to improve BCI performance.

Materials, Methods and Results: Off-line data from 16 subjects (exhibiting high alpha variance) was used in this analysis [2]. Figure 1 shows the raw BCI accuracy of each subject and the improvement in performance from using either the P300-Certainty algorithm, an alpha-based threshold, or a combination. The mean accuracy for raw BCI performance, only P300-Certainty, only an alpha threshold, and both P300-Certainty and an alpha threshold were 85.38 ± 5.79%, 89.38 ± 3.44%, 89.69 ± 4.03%, and 92.13 ± 2.99%, respectively. Using a t-test, all methods produced statistically significant improvements over the raw BCI accuracy with P300-Certainty alone ($p = 0.026$), an alpha threshold alone ($p = 0.021$), and the combination ($p = 0.0004$).

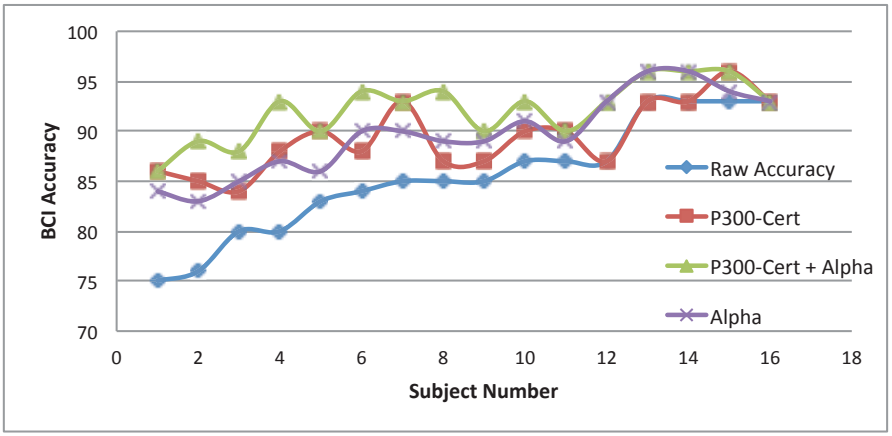

Figure 1. *Potential improvement of accuracy using P300-Certainty, an alpha threshold, and P-300 Certainty + an alpha threshold*

Discussion: Both P300-Certainty and an alpha threshold increase accuracy by abstaining erroneous selections. However, combining both methods improves accuracy more than using either method alone.

Significance: A BCI that can abstain erroneous selections that are "uncertain" (P300-Certainty) or that exhibit low attention levels (alpha) creates a BCI that is resilient to wandering user attention. Ultimately, a BCI using both methods allows users to type with a higher accuracy and at their own pace.

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