Predicting Performance of a P300 Speller Using Classifier-Based Latency Estimation

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Introduction: Accurately assessing the performance of a P300 Speller is a necessary step in determining its usefulness. However, this process can also be time consuming due to the amount of data required. The Classifier-Based Latency Estimation (CBLE) algorithm can predict accuracy with a small amount of data [1]. This work further investigates how well the CBLE algorithm performs while varying the amount of data used. Additionally, we assessed the predictions made by the CBLE model when the classifier weights and testing data were collected on separate days.

Materials, Methods, and Results: The data analyzed here was originally presented in Thompson, et al [2]. We excluded any participant with an incomplete dataset, resulting in 32 remaining participants. All remaining participants typed one training sentence on Day 1 and three testing sentences on Days 1, 2 and 3.

For each day's data we used the same classifier weights obtained from applying the least-squares classifier to the training sentence on Day 1. We selected the first *X* characters to be used from the testing sentences, where *X* ranges from 1-20. This set of characters was used to build two models. The first uses the accuracy observed on the *X* characters from each participant as the predictor. The second model uses the variance of the CBLE (vCBLE) values from each participant obtained by applying the CBLE algorithm presented in [1] as the feature set. The model is then built using linear regression with these features and the *X* character accuracy. The root mean squared error (RMSE) was calculated between the predictions of each model and the accuracy observed on the remaining characters in the testing sentences from that day. This process was repeated for each day.

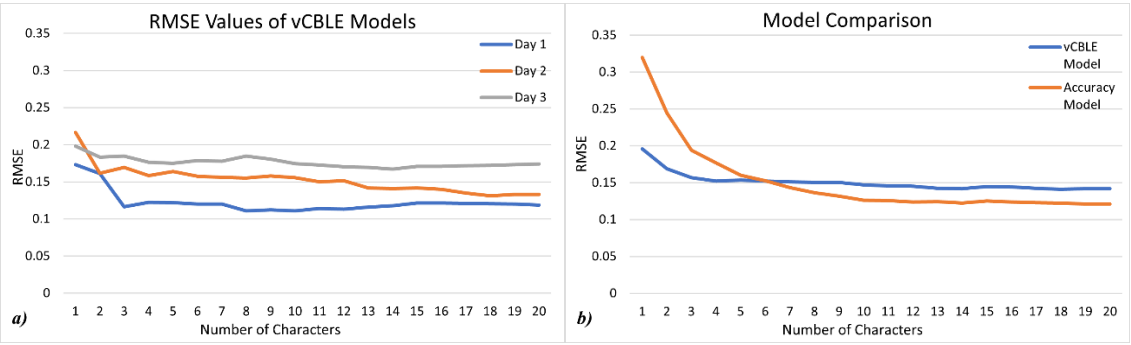

Figure 1. *a) Comparison of the vCBLE models across different days and different numbers of characters used to train the model (lower is better). b) Comparison between the vCBLE and Accuracy models, both averaged over the three days (lower is better).*

As can be seen in Fig. 1a, our Day 1 vCBLE model achieved lower RMSE values than the Day 2 or Day 3 models. The vCBLE model outperforms the accuracy model when there are less than 6 characters, according to Fig. 1b, which averages results from all three days. Moreover, the Day 1 vCBLE model outperforms the Day 1 accuracy model for all numbers of characters.

Discussion & Significance: The vCBLE models seem to perform worse when the classifier weights are collected on different days than the data that is used to build the model. However, the vCBLE models still outperform the accuracy models across all three days when less than 6 characters of data are used. Overall, this work demonstrates the ability of a vCBLE model to predict accuracy of P3 speller performance with a relatively small amount of data.

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