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Generalization across participants in continuous hand trajectory decoding

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Introduction: One of the challenges in the BCI field is to achieve a decoding model that can be employed in an unseen participant without the need to tailor the model with participant-specific calibration data. It would significantly improve a BCI's usability by saving the time to acquire the calibration data. In this study, we investigated such a scenario in the context of hand trajectory decoding from EEG.

Material, Methods and Results: We utilized a dataset with 10 participants [1] with 3 sessions of measurement. Participants followed a target on the screen with their dominant hand, but the hand's movement was restricted. The online visual feedback was realized for each measurement block by mixing different percentages between the target and the EEG decoded position in 2D (0%, 50%, and 100% EEG). A partial least squares (PLS) and a square-root unscented Kalman filter (SR-UKF) were trained with 2 types of features from EEG signals: sensor-space and source-space signals extracted according to the averaging method described in [2]. The decoder was trained with data from the 0%EEG block, i.e., simulated feedback, of session 1 in a leave-one-participant-out (LOPO) manner and applied to every measurement block without any update. A recursive exponential weighted PLS (REW-PLS) [3] was utilized to overcome the memory limitation due to the large pool of training data. Figure 1 illustrates boxplots of group-level correlation with a 95% upper bound chance level from the shuffling approach plotted as black lines. The median correlations were less than 0.1 in every case, regardless of the type of features. There were no clear observable trends when considering the correlation in a time progression manner.

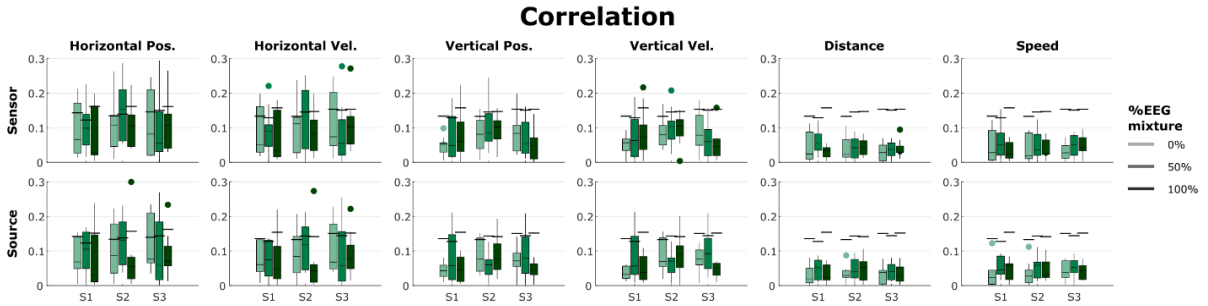

Figure 1. *Group-level correlation of 0%-100%EEG blocks from sessions 1 to 3 (S1-S3). Upper row: sensor space results, lower row: source space results. Dots show outliers. Black bars indicate the chance level.*

Discussion: The correlations suggested that the decoder could not be generalized well enough to perform above chance level in unseen data. Note that the attempted movement was typically reported to have a lower correlation than the executed, so this could reduce the generalization capacity of the decoder.

Significance: Despite less-than-chance results, this is the first step to examining the generalization of hand movement decoding from EEG, which will be further expanded in the subsequent study.

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