Spatiotemporal representations of rapid visual target detection: a single-trial EEG classification algorithm.

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Abstract:

Brain computer interface applications, developed for both healthy and clinical populations, critically depend on decoding brain activity in single trials. The goal of the present study was to detect distinctive spatiotemporal brain patterns within a set of event related responses. We introduce a novel classification algorithm, the spatially weighted FLD-PCA (SWFP), which is based on a two-step linear classification of event-related responses, using fisher linear discriminant (FLD) classifier and principal component analysis (PCA) for dimensionality reduction. As a benchmark algorithm, we consider the hierarchical discriminant component Analysis (HDCA), introduced by Parra, et al. 2007. We also consider a modified version of the HDCA, namely the hierarchical discriminant principal component analysis algorithm (HDPCA). We compare single-trial classification accuracies of all the three algorithms, each applied to detect target images within a rapid serial visual presentation (RSVP, 10 Hz) of images from five different object categories, based on single-trial brain responses. We find a systematic superiority of our classification algorithm in the tested paradigm. Additionally, HDPCA significantly increases classification accuracies compared to the HDCA. Finally, we show that presenting several repetitions of the same image exemplars improve accuracy, and thus may be important in cases where high accuracy is crucial.

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