Modeling EEG Dynamics of Self-Imagery Emotions: a Pilot Study

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***Abstract*— Electroencephalography (EEG)-based emotion classification has drawn increasing attention yet EEG signals associated with emotional responses are still elusive. This study applies a multi-model adaptive mixture independent component analysis (AMICA) as an unsupervised approach to identify and characterize emotional states. Empirical results showed that the AMICA was able to learn distinct models that accounted for four self-imagery emotions. While large-scale analyses and careful examinations are needed, the pilot study offers evidence for AMICA as a promising, data-driven approach to model EEG dynamics of self-imagery emotions.**

I. Introduction

Previous electroencephalogram (EEG)-based emotion studies focused mainly on developing machine-learning methods for emotion classification, yet the accuracy remained far from satisfactory. The critical challenge is that EEG signals associated with emotional responses are still elusive.

This study applies the adaptive mixture independent component analysis (AMICA) [1], as a data-driven approach that solves for a mixture of distinct independent component decompositions, to model active brain networks [2] under different emotional states. Following the design of the emotion imagination task [3], the pilot study applies AMICA to EEG data collected from a participant performing a self-imagery emotion experiment. Our goal is to investigate whether AMICA can model EEG dynamics of four emotional states and whether the EEG activities under the same emotional state can be reproduced in the experiment design.

II. Materials and Methods

The experiment started and ended with 2-min closed-eyes resting and consisted of two blocks with four emotion-imagery trials per block. Each trial started with a 30-sec instruction, followed by a 3-min closed-eyes emotion-imagery period and a 30-sec resting at the end. In each block, the subject was instructed to imagine scenarios to induce four emotions, one in each trial: happiness, sadness, anger, and peace. The same four emotions were repeated in the second block of the experiment but in a randomized order.

The EEG data were recorded with a 64-ch BioSemi ActiveTwo system. Preprocessing steps included removing channels with flat or irregular signals, high-pass filtering (1Hz), and common average re-referencing. Next, we applied a six-model AMICA to the pre-processed, continuous, yet unlabeled EEG data using the AMICA/EEGLAB plugin [4].

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III. Results and Discussion

Figure 1 shows the model probabilities, i.e. the data likelihood given model parameters, learned by the six-model AMICA decomposition averaged within resting and each self-imagery emotion phases. We found that the AMICA was able to learn distinct models of independent component (IC) decompositions (i.e. M1-M6) that accounted for different self-imagery emotion phases. For example, the M5 had a high probability in modeling EEG data in the two Happiness trials, while the M3 and M4 accounted for Sadness and Anger trials respectively. The EEG signals in Resting and Peace trials were similar and best modeled by M1 and M2.

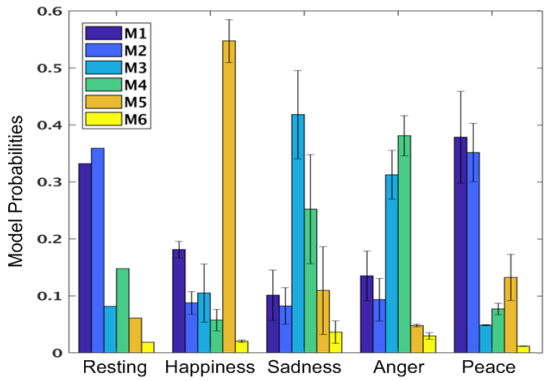

Figure 1. Model probabilities in resting and each self-imagery emotion phase obtained using six-model AMICA decomposition

The error bars in Figure 1 indicate the standard deviation of the mean model probabilities over two trails of the same imagery emotions. The results showed that similar EEG responses to the same emotion imagery could be reproduced in the block design and learned by the multi-model AMICA.

This pilot study only analyzed the result from a single subject; data from more subjects are needed. Further investigation of the distinct IC models will also enable the interpretation of different brain networks and artifacts involved in each emotion. Nevertheless, this pilot study offers evidence for the multi-model AMICA as a promising data-driven approach to study and model EEG activities during self-imagery emotions.

References

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