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Prediction of Subject Ratings of Emotional Pictures from EEG Features

DJ McFarland[1], MA Parvaz[3], W Sarnacki[1], RZ Goldstein[3], and JR Wolpaw[1,2]
[1]National Center for Adaptive Neurotechnologies, Wadsworth Center, New York State Dept. Health, Albany, NY; [2]Dept Neurology, Stratton VA Medical Center, Albany, NY; and [3]Depts Psychiatry and Neuroscience, Icahn School of Medicine at Mount Sinai, New York, NY.

Introduction: Emotion dysregulation is a major component of many brain disorders. Brain-computer interface (BCI) technology might enable a valuable new approach to enhancing therapeutic self-regulation of emotions. One possible BCI method would be to provide stimulus-specific feedback based on subject-specific electroencephalographic (EEG) responses to the stimulus. Up to the present, the correlations of three EEG features with emotional salience/arousal have been evaluated in group-averaged data. These features are: asymmetry in alpha activity over frontal cortex; amplitude of theta activity over frontal midline cortex; and the late positive potential over central and posterior mid-line regions. We examined the subject-specific correlations with emotional salience/arousal for these three features.

Materials, methods and results: Twenty healthy participants (14 women, 6 men; ages 23-59) rated each of 192 pictures from the IAPS collection in terms of valence and arousal twice (96 pictures on each of 4 days over 2 weeks). EEG was collected simultaneously and used to develop models based on sparse canonical correlation to predict subject-specific single-trial ratings. Separate models were evaluated for the three EEG features: frontal alpha asymmetry; frontal midline theta; and the late positive potential. In each case, these features were used to simultaneously predict both the normed ratings and the subject-specific ratings. The correlations varied greatly across subjects. Most models successfully predicted subjective ratings on training data; however, generalization to test data was less successful. Sparse models performed better than models without regularization.

Discussion: The results indicate that, if BCI-based feedback is to enhance emotional self-regulation, feature selection should be subject-specific. At the same time, the results to date suggest that the frontal midline theta is most often the best candidate for BCI-based modification of emotional reactions. Whether BCI-based feature modification will actually translate to better emotional self-regulation remains to be determined.

Significance: The present results suggest that appropriate use of BCI technology might facilitate emotional self-regulation. BCI-based EEG feature assessment could provide the timely feedback after each trial that is needed for effective self-regulation.

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