An EEG and Motion Capture Based Expressive Music Interface for Affective Neurofeedback

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Abstract. This project examines how the expression granted by new musical interfaces can be harnessed to create positive changes in health and well-being. We are undergoing experiments to measure EEG dynamics and physical movements performed by participants who are using software designed to invite physical and musical expression of the basic emotions. The present demonstration of this system incorporates an expressive gesture sonification system using a Leap Motion device, paired with an ambient music engine controlled by EEG-based affective indices. Our intention is to better understand affective engagement, by creating both a new musical interface to invite it, and a method to measure and monitor it. We are exploring the use of this device and protocol in therapeutic settings in which mood recognition and regulation is a primary goal.

Keywords: EEG, BCMI, BCI, aBCI, Motion Capture, Affective Computing, Neurofeedback, NIME

1 Précis

Current methods of inviting emotional response in a laboratory environment rely on passive media, such as images from the International Affective Picture System (IAPS), which are chosen to incite one of a few basic emotions when displayed to an experiment participant. However, full affective engagement may require active participation, and physical expression is one avenue by which a participant may be invited to actively experience an emotion. We are demonstrating a new musical interface that maps expressive gesture to sound, designed to invite participants to affectively engage in the basic emotions. In its present form, the interface consists of a Leap Motion [1] device that tracks repeated small expressive gestures made by a participant's hand. Concatenative synthesis software [2] translates these gestures into an expressive wash of sound by mapping the first and second principal components of the recorded movement to the computed spectral centroid and periodicity of each sound segment selected for playback. A dry-electrode EEG system [3] records EEG as the participant performs gestures corresponding to a basic emotion (anger, grief, joy, etc.). The artifact subspace reconstruction (ASR) method, as implemented in the

BCILAB toolbox [4] for Matlab, is used to remove local peak artifacts in the EEG data that arise from participant movement. The EEG accompanying each emotion state is classified in real-time using a predictive model that estimates the probability of each state across short EEG data time windows, also implemented in the BCILAB toolbox. An ambient music engine cycles through textures and musical intervals composed to suggest and induce a spectrum of affective states [5].

This project is informed by previous experiments [6], for which the first author and colleagues developed a method for studying musical engagement using simple expressive rhythmic 'conducting' gestures matching a musical pulse, inspired by Manfred Clynes' sentic cycles method [7]. Expert and non-expert participants attempted to communicate the feeling of heard musical excerpts using simple rhythmic U-shaped hand/arm 'conducting' gestures that animated, in real time, the movement of a spot of light on a video display while body motion capture and high-density EEG recorded their hand/arm movements and brain activity. We identified an area of right parietal cortex that supported this affective gestural communication during trials when participants were fully engaged in the task (and not when participants simultaneously performed a distractor task). We were able to train a classifier to distinguish the engaged trials from the less engaged trials, showing 85% accuracy within each participant's data. Thus we successfully demonstrated an affective brain-computer interface that classifies high vs. low musical engagement of the participant [8].

This project attempts to clarify the role that expressive gestures can play in improving emotional health. If successful, the proposed musical system for affective neurofeedback may help those with mood regulation challenges. In particular, our preliminary field research suggests that such a device and method could serve as an adjunct to expressive movement therapy for individuals with autism spectrum disorder, for whom mood recognition and regulation can be a challenge.

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