Measuring and Classifying Musical Engagement using EEG and Motion Capture

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Abstract

Currently little is known about the brain dynamics and expressive movements that support musical engagement. Here we applied the MoBI (Mobile Brain/Body Imaging) paradigm [1], using EEG and motion capture to study musical engagement through expressive gesture. We trained expert and non-expert participants to communicate the feeling of music as they hear it by varying expressive details of simple rhythmic U-shaped hand/arm 'conducting' gestures. During half of the trials, the participants completed a challenging non-rhythmic arithmetic task, creating a 'Less Engaged' condition in contrast to the single-task 'Engaged' expressive movement condition. To help focus and clarify their movements, we displayed their hand movements as a moving spot of light on a video display facing the participant. We recorded their brain activity using high-density EEG (Biosemi), and body movements with body motion capture (PhaseSpace). A web-based pool of viewers then rated the recorded moving-spot animations using a musical affect rating scale, and guessed the more engaged performance between pairs of animations for the same conductor and excerpt.

Affective ratings of the musical excerpts by conductors and later animation viewers were correlated, indicating that the animations were able to capture the feeling intention of the expressive movements. Web viewers were also able to choose the Engaged performance from the Less Engaged significantly more often than chance, indicating that the engagement contrast created a meaningful difference in conducting behavior. Comparison of the EEG data recorded during the Engaged and Less Engaged conditions revealed more alpha and theta synchronization in or near the right parietal-temporal-occipital (PTO) junction (Figure 1) in the Engaged condition time locked to the participants' expressive movements. This area has been shown in previous work to support the sense of agency over one's movements [4][5][6], and the sense of another's mental experience [7][8]. Our results suggest that this area supports the consolidation of motion planning with emotional expression that is required for successful, engaged musical communication.

An EEG classifier using a frequency-based common spatial patterns (FBCSP) approach [2] implemented in BCILAB [3] was able to distinguish Engaged and Less Engaged conditions with above-chance accuracy. A non-invasive method for monitoring musical engagement in both music performers and listeners could provide a useful and general tool for music perception research,

with possible wider applications to music classification, technology, and therapy [9]. A more general measure of engagement computed online from an EEG signal could be applied to the development of affective BCIs which could find uses in the entertainment industry.

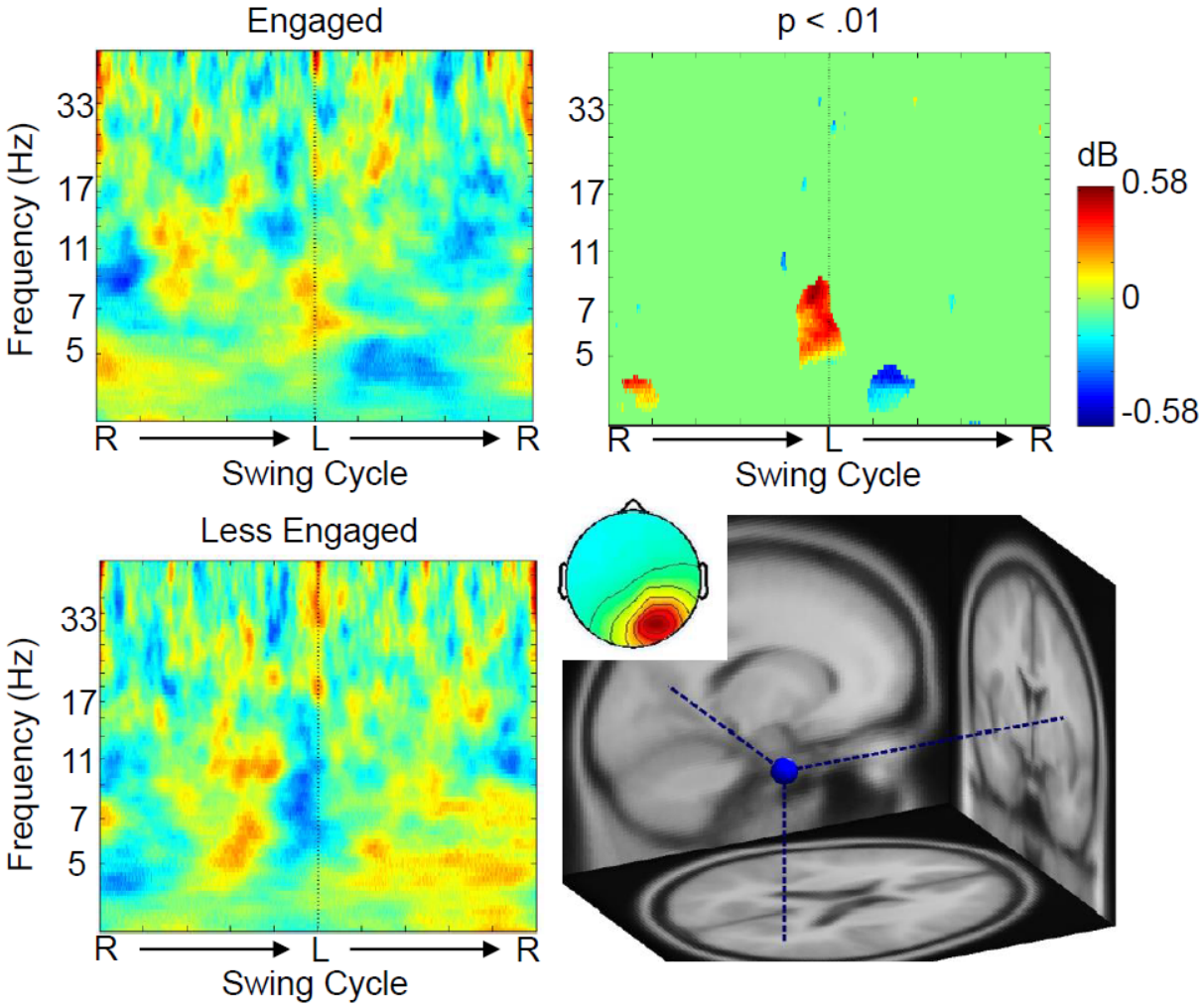

Figure 1. (Left column) Grand mean source cluster event-related spectral perturbation (ERSP) images time locked to the R→L→R swing cycle in the Engaged and Less Engaged conditions. (Top right) The difference between the two ERSP plots, masked at a p <.05 significance level reveals significant differences near the beginning of each phase of the swing cycle and also before the return (L→R) swing phase. (Lower right) Centroid equivalent dipole location (blue) for the source cluster, plus the cluster mean scalp map (inset).

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