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An Affective Brain-Computer Music Interface

I. Daly[1*], D. Williams[2], A. Kirke[2], J. Weaver[1], A. Malik[1], F. Hwang[1], M. Wairagkar[1], E.R. Miranda[2], S.J. Nasuto[1]

[1]Brain Embodiment Lab, School of System Engineering, Univiersity of Reading, Reading, UK; [2]Interdisciplinary Centre for Music Research, University of Plymouth, Plymouth, UK

*E-mail: i.daly@reading.ac.uk

Introduction: Music is a powerful method for evoking emotions in music therapy. We develop a hybrid affective Brain-computer music interface (aBCMI) for modulating its user's affective (emotional) state via a music generation system. The aBCMI aims to passively modulate a user's affective state by first identifying their current affective state and then generating appropriate music to move them to a new affective state.

Methods and Results: The aBCMI consists of four components: (1) electroencephalogram and physiological signals recorded from the user, (2) an affective state detection system [1], (3) a case based reasoning system to identify the best method to move the user to a target affective state, and (4) a music generator to produce novel piano music to dynamically target different affective states [2].

Eight participants (ages = 20-23, 6 female, all right handed, recruited by flyer from the student population, and naive to experiment details) attended 5 sessions over several months. In each session participants had their EEG (32 channel, impendence < 10kΩ, 1kHz) and physiological signals (galvanic skin response, electrocardiogram, respiration and pulse oximeter) recorded by a BrainAmp amplifier (BrainProducts, Germany).

The first four sessions were used for offline training of the affective state detector (a support vector machine classifying EEG band-powers and physiological signals) and the case based reasoning system. The final session was used to test the efficacy of the aBCMI during online use. Participants listened to generated music targeting discrete regions in the valence-arousal space, while reporting their current felt emotions via FEELTRACE [3].

The online session attempted to verify whether the aBCMI could be used to successfully move the user from their current affective state to a new target affective state. Each trial was 60s long and was used to attempt to achieve one of the objectives listed in table 1.

The objectives were achieved significantly often in 7 participants ('make happy' and 'calm'), 6 participants ('reduce stress'), and 1 participant ('excite'). Participants reported affective state changes during use of the aBCMI that matched the objective. An example is illustrated in figure 1 for 'reduce stress', note that arousal is decreased and valence is increased by the aBCMI.

Table 1. Testing session objectives.

Aim	Affective state transition
Make happy	Low valence -> High valence
Calm	High arousal -> Low arousal
Reduce stress	High arousal, Low valence ->Low arousal, Neutral valence
Excite	Low arousal -> High arousal

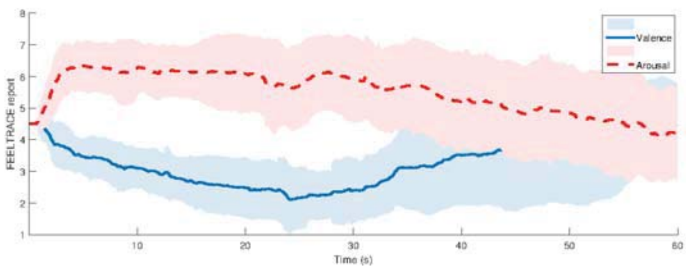

Figure 1. *Mean FFELTRACE reports (shaded area = ±1 STD.) of felt valence and arousal from participant 2 during the 'reduce stress' condition.*

The aBCMI was able to detect felt affective states with a mean accuracy of 0.54 (3 class) for valence and 0.46 for arousal classification. Significant ($p<0.05$) classification (measured against a null binomial distribution, chance level of 1/3) was achieved with 7 participants for valence and 2 participants for arousal classification.

Discussion: Our aBCMI is able to modulate a user's current affective states significantly more often than chance for the majority of participants. This is most effective for calming, pleasing, and de-stressing participants. Thus, the developed system provides a unique tool to allow it's users to interact with music in a way that could be potentially beneficial for their emotional state.

Significance: Our work represents the first attempt to use affective Brain-computer music interfacing to passively modulate emotions. This has potential applications in music therapy. Our future work will seek to explore this work further with patient groups with the potential to benefit from our aBCMI.

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References

[1] I. Daly, A. Malik, J. Weaver, F. Hwang, S. J. Nasuto, D. Williams, A. Kirke, and E. Miranda, "Identifying music-induced emotions from EEG for use in brain-computer music interfacing," in *6th Affective Computing and Intelligent Interaction*, 2015.

[2] D. Williams, A. Kirke, E. R. Miranda, E. Roesch, I. Daly, and S. Nasuto, "Investigating affect in algorithmic composition systems," *Psychol. Music*, pp. 1–24, Aug. 2014.

[3] R. Cowie, E. Douglas-Cowie, S. Savvidou, E. McMahon, M. Sawey, and M. Schröder, "'FEELTRACE': An Instrument For Recording Perceived Emotion In Real Time," in *Proceedings of the ISCA Workshop on Speech and Emotion*, 2000, pp. 19–24.