

## Towards Bio-responsive Control for Music

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**Abstract**— Music and audio applications are well suited to tactile control [1]. In sound and music computing there can be a disconnect between design of human-computer interfacing and application congruent design. A categorical approach is proposed, considering active and passive control methods. This work has implications for the design of adaptive or ‘on-the-fly’ recalibration of music and sound in various contexts, including health and wellbeing, video game soundtracking, and perceptual evaluation of auditory stimulus (e.g., noise annoyance, concentration and attention, relaxation and mindfulness). Due to a lack of agreement on suitable evaluation strategies, a multi-criteria decision aid strategy adopted from the auditory display community is suggested.

### I. INTRODUCTION

Bio-physiological interfacing (for example heart rate, skin response, or brain activity as measured via electroencephalography) is beginning to offer tools which might realistically be adapted to sound and music computing, facilitating new ways of interacting with music, and widening participation to maximise the health and wellbeing benefits which music can provide the listener. Music has been shown to improve athletic performance, reduce stress, increase mindfulness, and aid concentration. There is a large potential audience of individuals who might otherwise be unable to take part in music making via traditional means (either due to lack of training, or physical disability), who might benefit from biophysiologicaly-informed computer aided interaction with music. Additionally, the delivery of adaptive music benefits from listener-state information which can be gathered via biosensors. In order to be useful, the mapping between biophysiological cue and audio parameter must be intuitive and useful to a neophyte audience.

### II. CATEGORICAL APPROACH

We propose three categories of system: conscious, unconscious, or hybrid. Various HCI systems for interacting with music have been developed which can be placed in these categories: an emotion-driven music generator under the control of galvanic skin response (GSR) [2] would fall under the unconscious category. An audio mixer using alpha and beta waves measured by EEG to adjust fader gains is an

example of a conscious control [3]. Hybrid systems would make use of both active and passive control. In an end user/consumer context, the use of audio mappings could give the listener a new way to select, create, or manipulate emotionally-congruent music (e.g., biophysiologicaly informed playlist generation) to enhance a mood or emotional state – perhaps relaxation or concentration. This requires a system to respond adaptively and intuitively without direct user input, in order to avoid distracting the listener from the intended emotional state. The user responses could then be utilised to train a machine learning algorithm, adjusting the mapping on-the-fly according to biophysiological response for optimal performance. This would allow significant progress in developing individual and adaptive systems.

### III. FURTHER WORK

Significant further work involving careful mapping between the categorical, context-mapping, and adaptive loop remains. Evaluating the success of such systems is difficult partially due to the infancy of the field and the lack of agreement regarding appropriate strategies. We propose borrowing from the world of auditory display where multi-criteria decision aid analysis has been shown to be useful [4]. Criteria should be selected in line with the end use goals; e.g., utility of control, congruence of mapping to audio feature. The challenge is interdisciplinary and requires collaboration end-user populations, computer scientists (particularly in the training stage of the feedback response), and specialists in biophysiological measurement.

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