# DEVELOPING MUSIC TECHNOLOGY FOR EMOTION REGULATION AND MOTOR REHABILITATION

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**Abstract**

Medical technology (MedTech) involving music is increasingly being developed for various clinical and non-clinical contexts to support health and well-being. This paper focuses on two recent systems that allow users to steer their own wellness and recovery: a BCI system for emotion self-regulation in listeners (Ehrlich, Agres, Guan, & Cheng, 2019), and a motion-capture game for motor rehab (Agres & Herremans, 2017).

**Developing New Technologies for Health**

The inclusion of technology in the practice of music therapy has garnered significant interest in recent years (Magee, 2014). In line with this trend, bespoke music-based MedTech systems are being developed for several complementary contexts: assisting music therapists and health professionals in their practice (e.g., for delivering music, recording patient data); assisting clinical populations directly (e.g., providing patients with new musical capabilities, experiences, and self-expression); enabling patients to maintain a trajectory of healing *between* therapy sessions (e.g., tele-rehab systems); as a tool for preventive medicine (e.g., to motivate physical activity); and to support general well-being outside of clinical contexts (e.g., music recommendation systems to promote mental health). This paper focuses on two recent applications that empower the patient to support their own recovery, with or without the assistance of a healthcare professional. The first is a Brain-Computer Interface (BCI) that uses neurofeedback and automatic music generation for emotion regulation, and the second is a motion-capture Serious Game for motor rehabilitation and strengthening.

The BCI system, described in Ehrlich, et al. (2019), uses neurofeedback and music to teach the listener how to mediate their own emotions. An automatic music generation system creates affective music in real-time that is based on the listener's brain state, as measured via encephalography (EEG), and the BCI algorithm is calibrated for every user. The generated music adapts to the listener's EEG activity in real-time, and is capable of creating a range of affective music from low-arousal & moderately low-valence (e.g., calm or melancholy) to high-arousal & high-valence (e.g., happy). For musical examples,

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please consult Ehrlich, et al. (2019). While using the system, the listener's task is to try to change the music to sound more happy/joyful, or more calm/relaxed. To accomplish the task, the listener attempts to change her emotional state in order to guide the music generation system, so that the music gradually becomes more happy, or more relaxed. The affective music also serves to influence the emotion state of the listener. Therefore, the generated music acts both as a *sonification* of the listener's emotional state, and *influences* the listener's emotional state. The system has been successfully tested on healthy adults, and future work aims to validate the system with patients suffering from depression or anxiety.

The Serious Game described in Agres & Herremans (2017) uses motion capture and gamification to motivate users to complete their prescribed physical therapy exercises, increase range of motion in affected limbs, and engage in a regimen of physical strengthening. The user's task is to move as illustrated on the screen to the beat of the music. The system offers a solution for tele-rehab and remote tracking of the patient's progress, with individual kinematic scores and visualizations (e.g., of displacement, velocity, etc) stored across sessions. The game is tailored for stroke patients, but is also appropriate as a tool for preventive medicine for the elderly. It is part of a suite of Serious Games developed by the author and colleagues to support motor function and overall wellness (Agres, Lui, & Herremans, 2019; Beveridge, Cano, & Agres, 2018).

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