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Music & Neuroscience as a Digital Therapeutic for Walking

Brian Harris
MedRhythms, Inc., brian@medrhythms.com

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Music & Neuroscience as a Digital Therapeutic for Walking

Abstract

With the advancement of both neuroscience and clinical research demonstrating the ability of music to enhance functional outcomes, there is an ever-growing need to identify opportunities to deliver and solutions to facilitate these improved outcomes to patients. This need is amplified in the face of a growing and aging population that faces rising healthcare costs and a fractured healthcare delivery system. Digital therapeutics will play an important role in bringing these interventions to the people who need and deserve to have them.

Music and Health Institute Terms

Functional Status; Music Entrainment; Music Therapy; Neurologic and Muscular Disorders; Physical Therapy; Receptive Music Methods

Disciplines

Music Therapy | Neuroscience and Neurobiology

Music & Neuroscience as a Digital Therapeutic for Walking

Brian Harris, MA, MT-BC, NMT/F
CEO, MedRhythms, Inc.

Music has power. This sentiment is one that has pervaded all cultures and time periods throughout human history. As we ponder the power of music, we ask ourselves: “What is the nature of that power?”

As humans, we know that music has the ability to evoke profound emotions across a broad spectrum from happiness to sadness, and calmness to anxiety or fear. The influence of music on the evocation of such emotions has been studied historically through social science mediums; however, recent advancements in neuroscience have prompted a shift in perspective to view music also purely through the lens of neuroscience. By understanding music’s objective impact on the brain, it can be harnessed and translated into interventions (virtually or with a trained clinician) to help recover lost neurologic function.

At a high level, neuroimaging research has demonstrated that music globally and uniquely engages multiple regions of the brain simultaneously (Peretz & Zatorre, 2005). The research also demonstrates that engaging in music aids in neuroplasticity (Moore, et al., 2017). Neuroplasticity is the brain’s ability to create new connections or to strengthen existing connections through learning or in response to injury. These two principles provide a solid foundation for the use of music to help people in novel and meaningful ways.

One of the most widely researched areas of music and neuroscience is in the use of music to enable and enhance motor control. Early seminal research by Melville and Rosignol (1976) showed that there were auditory-motor connections via the reticulospinal tract, and that priming the motor system could be accomplished via the auditory system. Further research to date has demonstrated the auditory system has strong connections to motor centers from the spinal cord upwards on brain stem, subcortical and cortical levels (Felix, Fridberger, Leijon, Berrebi, & Magnusson, 2011; Koziol & Budding, 2009; Schmahmann & Pandya, 2006). Due to these auditory-motor connections, consistent auditory rhythmic stimuli create stable and anticipatory temporal signal templates for auditory neurons to fire; these in turn cause motor neurons to fire in synchrony. This synchronization is known as “entrainment” (Large, et al., 2002; Nozaradan, Peretz, Missal, & Mouraux, 2011; Thaut & Kenyon, 2003) and it is a process that can happen below levels of conscious awareness (Thaut, Miller, and Schauer, 1998; Large, et al. 2002).

Since the mid 1990’s, the principles of rhythmic entrainment have been translated into a clinical intervention called Rhythmic Auditory Stimulation, which when systematically applied, can improve the motor function of those suffering from neurologic injury or disease (Thaut, McIntosh, Prassas, & Rice, 1992; Thaut, McIntosh, Prassas, & Rice, 1993; Thaut, Schleiffers, & Davis, 1991). This enhanced motor function includes improved functional outcomes in cadence, symmetry, stride length, and velocity in populations including stroke, Multiple

Sclerosis, cerebral palsy, and Parkinson's disease (Suh, et al., 2014; Conklyn, et al., 2010; Kim, et al., 2012; Bukowska, et al., 2016).

Challenges arise in the ability to administer such an intervention at scale due to a lack of skilled, trained clinicians. There are fewer than 5% of music therapists in the United States who are also physical therapists. Thus, technology assumes an important role in enabling such interventions to scale and in providing access to those who may derive benefit. Software can provide convenient, location-agnostic, closed-loop solutions to this problem of scale. It can receive and analyze inputs, such as biomechanical or physiological data from devices and instantaneously react to deliver tailored interventions with stimuli such as music. This type of offering fits into an emerging field in biotech termed "Digital Therapeutics." This is an industry that delivers evidence-based therapeutic interventions that are driven by high quality software programs to prevent, manage or treat a medical disorder or disease, and which are reviewed and cleared or approved by regulatory bodies as required to support product claims regarding risk, efficacy, and intended use

Digital therapeutic products may focus on a broad range of categories and disease states, to include software built on techniques from psychology, (such as the digitization of CBT to address substance and opioid use disorders [Pear Therapeutics]) or from neuroscience (such as video games to treat ADHD [Akili] or to address post-operative pain [AppliedVR]), in addition to many other forms of interventions (click here to learn more about [Digital Therapeutics: The Emergence of a Patient Centric Asset Class](#)).

MedRhythms is developing a digital therapeutic platform that uses sensors, software and artificial intelligence to replicate Rhythmic Auditory Stimulation and allow it to be delivered independently in the clinic or in a person's home without the need for a clinician present at each session. MedRhythms has a pipeline of products for multiple neurologic injury and disease states, each that will be developed with vigorous clinical evidence according to FDA regulation.

Beyond the treatment of individual patients, the benefit of digital therapeutics generally, and MedRhythms' platform specifically, is that data generated via use of the products may be compiled: to develop population-level insights, to more deeply understand disease progression, to unlock diagnostic features that predict events, including falls and cognitive decline, and to personalize the algorithm even more for these patients.

With the advancement of both neuroscience and clinical research demonstrating the ability of music to enhance functional outcomes, there is an ever-growing need to identify opportunities to deliver and solutions to facilitate these improved outcomes to patients. This need is amplified in the face of a growing and aging population that faces rising healthcare costs and a fractured healthcare delivery system. Digital therapeutics will play an important role in bringing these interventions to the people who need and deserve to have them.

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