TOWARDS MUSICAL GAME THERAPY: A SURVEY ON MUSIC THERAPY AND GAMES FOR HEALTH PROMOTION

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ABSTRACT

This paper provides a survey of existing systems and discusses the purposes that music therapy and video games serve. The effects of musical games and singing on psychological and physical well-being, learning and cognitive training are discussed. According to previous research, singing, as a part of music therapy, has proved to impact stress hormones positively, and also commonly contributed to medical rehabilitation. This paper, therefore, aims to shed light on the prospects of previous studies inspiring future development of voice-input based games for music therapy and stress reduction.

Key words: Serious Games, Music Therapy, Mental Health.

1. INTRODUCTION

Mental diseases have been repeatedly claimed to be one of the most impacting social problems for decades which is undoubtedly paralyzing our society in many ways. It is estimated to have been affecting more than 300 million people worldwide (Renevey, 2014). The percentage of children and adolescents in the U.S. affected by anxiety disorders is 31.9%, followed by children diagnosed with behavior disorders at 19.1% and mood disorders which is 14.3% (Merikangas *et al.*, 2010). Researchers are trying to find effective means of health and mental well-being. Within a wide variety of measures that are taken for mental well-being, video games play a fairly important role.

Computer games have always been popular for all ages of people around the world for years. Around 2 to 3 billion people around the world are assumed to be engaged in gaming as a recreation (Merikangas *et al.*, 2010; Russoniello *et al.*, 2013). Limelight Networks reported that gamers around the world spent an average of 6 hours playing games every week (2018). Games have proven to not only be a source of enjoyment but also been applied for serious purposes such as – health promotion, education, simulation, etc. Additionally, many of the researches and number of assessed scientific publications have also increased in number to evaluate the originality and actual impacts as the clinical application of health games can be diversified (Kharrazi *et al.*, 2012).

As a matter of fact, there are six major types of applied games for mental health which can be categorized as exergames, virtual reality, cognitive behavior therapy-based games, entertainment games, biofeedback, and cognitive training games (Fleming *et al.*, 2017). Serious games are designed specifically with a certain purpose in mind, such as rehabilitation/remediation, in an entertaining setting. B´egel *et al.* (2018) cited in their study about games that have notably achieved encouraging results in cognitive function training over the past 10 years (Anguera *et al.*, 2013; Lumsden *et al.*, 2016; Owen *et al.*, 2010).

Within the widespread applications of video games serving various purposes, we see Fleming *et al.* (2017) mentioning three processes of internet interventions impacting mental health. First is broadening the reach of online programs, followed by improving engagement through both game-based and "serious" motivational dynamics and, third is by utilizing various techniques including therapeutic processes and gaming features that can impact the overall cause. They researched PsycINFO and Medline and conducted a systematic review of 18 papers based on serious games for mental health (treatment or prevention), published in the peer-reviewed literature from 2010 to 2016 (Fleming *et al.*, 2017). The review helped them conclude that the utilization of serious games for depression is promising, though further research is needed.

2. MOTIVATION

2.1 Impacts of Singing on Human Psychology

Singing is considered to therapeutically impact the psychology of individuals. According to Fassbender *et al.*, (2006) in existing studies it is shown that musical training has positive effects on spatial-temporal reasoning (e.g. maths, chess) and can also be used as a therapy to reduce stress or to aid children with Attention Deficit Hyperactivity Disorder (ADHD). Similarly, Fancourt *et al.* (2016) have mentioned a growing number of organizations delivering singing programs for cancer patients and careers. An example is a work by Tenovus Cancer Care in Wales. Their choirs involved over 1,000 people affected by cancer singing every week. Research around these choirs has identified

that long-term involvement has resulted in reduced levels of anxiety and improved quality of life among the affected people (Gale *et al.*, 2012). Results demonstrated that singing was associated with a decrease in cortisol, beta-endorphin, and oxytocin which are indicators of stress reduction and general activation of the cytokine network that helps regulate immunity (Fancourt *et al.*, 2016). The results show lower rates of pro-inflammatory response due to singing which can be one of the reasons for the improvement in mood. It was also noted by Fancourt *et al.* (2016) that the subjects with notably higher levels of stress and depression during the singing sessions and lower mental well-being states went through greater short-term improvements in their moods due to low pro-inflammatory responses.

Furthermore, Cevasco *et al.* (2005) had investigated female patients of substance abuse going through rehabilitation. The effects of music therapy interventions that included - singing, song composition, lyric analysis, competitive games, and discussion sessions, were measured on levels of depression, stress, anxiety, and anger of the female patients. Data collected immediately before and after every session indicated a decrease in the levels of depression, stress, anxiety immediately following the music therapy sessions. Almost every individual showed positive results and, certain patients reportedly showed a higher amount of decrease in their mental states than the others during rehabilitation and the music therapy sessions.

2.2 Singing as Input Modal for Games

Diving further into the recent innovations of game design and dynamics, we consider alternative input modalities for games that have been evidenced to provide a more immersive user experience. Voice-input is a fairly new approach in the world of game design. With that and the importance of singing as we discussed before in mind, we review various applications of musical games and investigate the potential role of singing or voice as an interaction tool in video games aimed towards modulating stress through this paper. However, not many studies experiment with games using non-verbal voice input in real-time through games and assess its impacts on health promotion.

3. METHODOLOGY

As we mentioned earlier, we aim to investigate the potentials of singing and music therapy applied through serious games and its various impacts on different aspects and purposes by surveying games that utilize music. To achieve such, the most relevant studies were identified from journals and databases such as - ACM Digital Library, IEEE Xplore Digital Library, Sage Publications, Journal of Music Therapy, etc. The search terms and keywords included – “serious games”, “music therapy”, “musical games”, “rhythm games for health”, “singing for health”, “psychology”, “music games for health”, “game-based learning”, “musical games for mental health”, and “mental health”.

4. LITERATURE REVIEW: APPLICATIONS OF SERIOUS GAMES AND MUSIC THERAPY

A few musical therapy-based systems are discussed below that are used as a learning aid and a trainer of sensorimotor skills for people with special needs as well as a tool for education and learning second languages respectively. The results demonstrated by these systems had also been satisfactorily positive towards the purposes they meant to fulfill. Nonetheless, sufficient research regarding a system that utilizes singing and music therapy with serious games in human psychology had not yet been carried out and thus, this paper attempts to hint towards the prospects of such a system.

4.1 Musical Game for Learning Disability

There exist a few studies that implement music in games that are utilized for those with learning disabilities. According to Flaugnacco *et al.*, (2015), it was seen that children who suffer from language impairment, sensorimotor synchronization difficulties, and temporal processing, had improved phonological and reading skills after musical training. Another such system known as GenVirtual, proposed by Correa *et al.* (2007) is an augmented reality musical game aimed to help people with learning disabilities. This game allows music composition to meet certain music therapy goals while interacting with virtual objects associated with musical notes.

The player interacts with overlapping their hands or feet on the virtual object that is shown which hits a marker and a specific musical note is played associated with that marker. Each sequence is completed with all the notes combined and new sequences show up as the player progresses with new levels of difficulty. A music therapist evaluated the system and pointed out the potential of this game by providing motor and cognitive training, and enhance creativity, concentration, memorization, visual and auditory perception.

4.2 Musical Game for Rhythmic and Sensorimotor Training

Hidalgo *et al.* (2017) experimented whether musical rhythmic training with rhythmic audio-motor games can improve temporal skills, verbal interactions and speech production in the children with cochlear implants (CIs) and hearing aids (HAs). The results showed that indeed according to the hypothesis, the temporal regularity of speech production performance was better after the musical training. The study hints that it may have not only developed predictive skills in children with hearing disorders but also has improved auditory processing in general which endorsed the idea that musical and rhythmic training helps improve sensory-motor skills and interaction in children.

Horn Fonteles *et al.* (2018) introduce us to a musical game system where the player interacts with the input taken from players' hands and fingers. MIDI files and Leap Motion Controller are used as the tools for this game and each note of a song has specified hand gestures that need to be performed to learn musical structures and rhythmic patterns. The results reflected that the participants were motivated to actively practice hand therapy and complete the tasks which were entertaining for them as well.

Additionally, yet another serious game was proposed by Bégel *et al.* (2018) called Rhythm Workers that was aimed to train perceptual and sensorimotor rhythmic skills in people with neurological or neurodevelopmental disorders who lose their perception of rhythm. These disorders can cause a deficiency in the working memory, concentration, or language and learning skills, which is why the study conducted two experiments to train in these cognitive skills.

The main goal of this game is to construct buildings associated with music or rhythmic stimulus and a level of the game. The aesthetic quality of the constructions would depend on the players' performance. The first experiment uses rhythmic patterns and musical stimuli. In the perception version, the training is performed via a test similar to a psychophysical test called the Beat Alignment Test (BAT) (Iversen and Patel, 2008). In this test, the player was asked to detect whether a sequence of sounds is properly aligned to the beat of the stimulus or not. The tapping version lets the player tap to the beats of the stimulus.

The second experiment is a pilot study to validate the usability and motivation of this system as a serious game and testing the training protocols in healthy young players. The findings of the proof-of-concept pilot study suggest that players were motivated enough to complete the game and achieve aimed scores for the two weeks of the test protocol. The perception version of the system did show a remarkable positive effect on the rhythmic skills training and in BAT's performance of the players, whereas, the tapping version did not cause any changes. However, this system needs future assessment to be done as to how effectively it can improve movement and sensorimotor activities in the neurologically challenged patients.

4.3 Musical Games for Learning

Musical video games are used as a learning tool as we look back at how music positively affects intelligence and memory. Fassbender *et al.* (2006) mention Georgi Lozanov (1978), a Bulgarian psychologist who found the concept of 'suggestopedia' implemented different aspects of positive suggestions in learning. He conducted a psychological experiment to investigate the extent of memory under suggestions with 416 students who were given 600-900 words to memorize. As far as the method is concerned, Lozanov used relaxing musical pieces to bring the students into a learning-friendly state of mind. The average remembrance rate achieved was 93.16% as he insists, "well-organized suggestopedia accelerates learning 5 times on an average" (Lozanov, 1978).

Similarly, an experiment by Dehaan *et al.* (2010) using interactive media or a musical video game as a tool investigated the possibilities of learning a second language faster. Eighty Japanese students were grouped in pairs of two and were based on their English and game proficiencies. One in the group was asked to play the game Parappa the Rapper 2, while the other person would be watching the gameplay. After the gameplay, the groups were then assigned to take a vocabulary recall test, a cognitive load measure, an experience questionnaire, and a two-week delayed vocabulary recall test and the results were later assessed by the t-test. It is found that both members in the group had a satisfactory score in learning, however, the watcher learned relatively faster than the players (Dehaan *et al.*, 2010).

A summary and comparison of all the existing work we have discussed so far are shown below in Table 1.

Table 1. Comparison of existing musical systems in the following aspects sorted by their year of publication in the descending order: (A) Singing as input modal (B) Rhythm training – keeping track of musical notes and rhythms with time (C) Multiple interactive levels (D) Changes in the game world depends on players' performance (E) Experimented for other health problems (sensorimotor, learning, and perception disabilities, etc.).

	(A)	(B)	(C)	(D)	(E)	Description
Hämäläinen *et al.*, 2004	✓	-	✓	-	-	The movement of the player is controlled by using voice and pitch matching. Correct singing lets the hedgehog move forward along with the vertical twists.
Correa *et al.*, 2007	-	✓	✓	-	✓	AR musical game aimed to help people with learning disabilities. The player is required to follow a series of notes and colored virtual objects to complete a musical sequence.
Dehaan *et al.*, 2010	-	✓	✓	-	✓	The game system lets the player complete lines of the rap by pressing controller buttons while keeping up with the rhythm and time.
Bégel *et al.*, 2018	-	✓	✓	✓	✓	Aimed to train people with neurological or neurodevelopmental disorders. The game is played by following music or rhythmic stimulus and constructing buildings associated with the gameplay and performance.
USC Games Program, 2018	✓	-	-	✓	-	A game where singing is used to build path and complete certain tasks as the player goes forward in the game to interact with the game world
Horn Fonteles *et al.*, 2018	-	✓	✓	-	✓	A musical game where hand gestures are associated with musical notes

5. CONCLUSIONS AND FUTURE WORK

In summary, singing has proven to therapeutically impact both physiology and psychology in a positive way and music as a therapy has already been fused with serious games to achieve desired results regarding its effects on health. Music acts as an integral part of a game and can play a huge role in the moods of the players. Zhang and Fu (2015) quote Zehnder and Lipscomb (2006), who insisted that music can serve to "enhance a sense of immersion, cue narrative or plot changes, act as an emotional signifier, enhance the sense of aesthetic continuity, and cultivate the thematic unity of the video game" (Zhang and Fu, 2015). Undoubtedly, musical games and their implementations are a growing field of research that has a lot of potentials to be looked into further. There exist controversies as well regarding the effects of music and games on people's psychologies. In this paper, we try to hint at the potentials of musical games in different aspects of health and learning. We learn about various systems that focus on different aspects of health, cognitive training and learning through music therapy. However, we were unsuccessful to identify a system that can be used to address areas such as - psychological well-being and mental disorders. In the future, keeping the objectives of this survey paper in mind, we aim to conduct further research as to whether designing systems using singing modules which also fulfills all the aspects from the table above can promote mental well-being. We hope that further research regarding singing as a game input modality in serious games and player experiences will be inspired that will certainly benefit people and open doors towards new possibilities.

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