MUSICAL RHYTHM
How musical rhythm in a serious game can increase the immersion and how the immersion can encourage the rehabilitation process

Master Degree Project in Informatics
Advanced Level/30 ECTS
Spring term 2012

Annunziato Fierro

Supervisor: Mikael Johannesson

Examinator: Henrik Engström
Abstract

People with motor disabilities have a limitation or a loss of capacity carrying out activities considered as normal for human beings. This may incline the relationship with the society and thus it is essential for these people to undergo therapeutic treatments. However, rehabilitation is a tedious process that often fails due to patients dropping treatment. For this reason, this thesis investigates if music in a serious game for rehabilitation can make the experience to become more engaging and, accordingly, whether positive experiences from playing such a game can encourage the rehabilitation process of a patient i.e. to make the rehabilitation process less tedious for the patient. The results, based on a pilot study conducted in a rehabilitation center, indicates that this is the case and further research on the matter is suggested.

Key words: [serious game, physiotherapy, virtual rehabilitation, music therapy, immersion]
# Table of Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2 Background</td>
<td>2</td>
</tr>
<tr>
<td>2.1 The concept of serious games</td>
<td>2</td>
</tr>
<tr>
<td>2.1.1 Application area: healthcare games</td>
<td>3</td>
</tr>
<tr>
<td>2.2 Physical Therapy/physiotherapy</td>
<td>3</td>
</tr>
<tr>
<td>2.3 Virtual rehabilitation</td>
<td>4</td>
</tr>
<tr>
<td>2.4 Music therapy</td>
<td>5</td>
</tr>
<tr>
<td>2.4.1 How music affects people</td>
<td>6</td>
</tr>
<tr>
<td>2.5 Engaging experience</td>
<td>7</td>
</tr>
<tr>
<td>2.5.1 Flow</td>
<td>7</td>
</tr>
<tr>
<td>2.5.2 Immersion</td>
<td>9</td>
</tr>
<tr>
<td>2.5.3 Flow vs. immersion</td>
<td>10</td>
</tr>
<tr>
<td>2.6 Immersion questionnaire</td>
<td>10</td>
</tr>
<tr>
<td>2.7 Music-based games</td>
<td>11</td>
</tr>
<tr>
<td>2.7.1 Rhythm action</td>
<td>12</td>
</tr>
<tr>
<td>2.8 Kinect</td>
<td>12</td>
</tr>
<tr>
<td>3 Problem</td>
<td>13</td>
</tr>
<tr>
<td>3.1 Aims</td>
<td>13</td>
</tr>
<tr>
<td>3.2 Method</td>
<td>14</td>
</tr>
<tr>
<td>3.2.1 How to measure immersion and encouragement</td>
<td>14</td>
</tr>
<tr>
<td>3.2.2 Delimitations of the IEQ</td>
<td>14</td>
</tr>
<tr>
<td>3.2.3 Expected results</td>
<td>15</td>
</tr>
<tr>
<td>3.3 Ethical aspects</td>
<td>15</td>
</tr>
<tr>
<td>4 The serious game</td>
<td>16</td>
</tr>
<tr>
<td>4.1.1 Discussion with physiotherapists</td>
<td>16</td>
</tr>
<tr>
<td>4.1.2 Material (the serious game)</td>
<td>17</td>
</tr>
<tr>
<td>4.1.3 Musical rhythm within the serious game</td>
<td>18</td>
</tr>
<tr>
<td>4.1.4 New features</td>
<td>19</td>
</tr>
<tr>
<td>5 Experiment</td>
<td>20</td>
</tr>
<tr>
<td>5.1 Preparation</td>
<td>20</td>
</tr>
<tr>
<td>5.2 Participants</td>
<td>20</td>
</tr>
<tr>
<td>5.3 Execution</td>
<td>20</td>
</tr>
<tr>
<td>5.3.1 Problems encountered at the test session</td>
<td>21</td>
</tr>
<tr>
<td>5.4 Results</td>
<td>22</td>
</tr>
<tr>
<td>5.5 Analysis</td>
<td>24</td>
</tr>
<tr>
<td>6 Conclusion</td>
<td>28</td>
</tr>
<tr>
<td>6.1 Summary of results</td>
<td>28</td>
</tr>
<tr>
<td>6.2 Discussion</td>
<td>29</td>
</tr>
<tr>
<td>6.3 Future Work</td>
<td>29</td>
</tr>
</tbody>
</table>
1 Introduction

This thesis work is focused on music aspects of a serious game for rehabilitation of knee injuries in which a Kinect, a device from Microsoft that lately has been found to be useful in the field of rehabilitation (Huang, 2011 and Huang M. et al., 2011), will recognize the movement of patients. It is well agreed upon that the process of rehabilitation for a patient, no matter of age or sex etc., is ever “very boring”, and “very tedious”. So, for these reasons, the thesis aims to evaluate whether music in a serious game for rehabilitation can make the experience to become more engaging and, accordingly, whether high engagement in a serious game for rehabilitation can encourage the rehabilitation process of a patient. In this project, the word: “encourage” means that a patient is tempted to spend more time with the game, he/she wants to play again because she/he find it interesting, funny, etc. In this way, a patient spends more time with the game which in turn means that the patient perform more movements during the rehabilitation process.

Chapter 2 will describe the problem area and the concepts that need to be addressed are defined.

Chapter 3 will discuss the problem/research question addressed in this thesis, its aims, objectives and the methods that will be used for evaluation.

Chapter 4 will focus on the experiment that was performed, including the experimental procedure, as well as the results and the analysis of the results.

Chapter 5 will contain a discussion about the results from the experiment and propose suggestions for future work.
2 Background

To be able to understand the research problem that will be explained in the next chapter, the background chapter will describe concepts as serious games, especially healthcare games, as well as concepts that regard physiotherapy, virtual rehabilitation, music therapy, engaging experience, kinect and music based games.

2.1 The concept of serious games

Can a game be serious? Even if the term serious games do not have an agreed upon precise definition, various definitions can be found on the web. For example, seriousgames.org (2012) provides the following description of serious games:

“The Serious Games Initiative is focused on uses for games in exploring management and leadership challenges facing the public sector. Part of its overall charter is to help forge productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy.”

Alklind et al. (2009) define serious games as “Serious games are games that engage users in their pursuit, and contribute to the achievement of a defined purpose other than pure entertainment (whether or not the user is consciously aware of it)”

The main part of a serious game is the game. In fact, this word means something intrinsically motivating or fun, and therefore, there is a high probability of reuse it (Liarokapis and de Freitas, 2010). The main goal of these games is known as "game-learning", which is the learning of a series of tasks in a certain domain through the entertainment. According to Susi, Johannesson and Backlund (2007) serious games are used to teach and to train, but also to make something that goes beyond simple entertainment. Serious games are made for application areas as defense, education, emergency management, engineering, scientific exploration and etc. The benefits we get from the use of this category of games are different, depending on the scope in which the game is applied. For example, Tashiro (2009) listed the following advantages of serious games for healthcare education:

- Involving students in complex practice skills without risk.
- Improved psychomotor skills.
- Enhanced retention of knowledge.
- Enhanced decision-making skills.
- Interactive learning.
- Options for immediate feedback.
- Retention of knowledge related to procedures.
2.1.1 Application area: healthcare games

According to Susi, Johannessson and Backlund (2007) the use of serious games in health and health care is increasing, and so they are becoming more and more common. Today we have a fairly large number of serious games in this area. Some examples:

Nutrition education: typically, through a game, which are the correct eating habits to keep, are explained. Weight management and obesity are also explained. For example: FATWORLD is a game designed to educate the player about nutrition. The game focuses on the link between fast food, obesity and socioeconomics in the USA. (www.fatworld.org)

Physical fitness: games intend to correct bad posture and recommend the most appropriate types of exercise based on the needs of the person. An example is Just Dance 3. (http://just-dance-thegame.ubi.com/just-dance-3/it-IT/home/index.aspx)

Distraction therapy: these videogames are used during particularly annoying therapeutic treatments to distract the patient and thus make the treatment easier. Such games are addressed especially to ill children. As an example, Free Drive is designed to distract children during medical procedure. (http://www.breakawaygames.com)

Recovery and rehabilitation: in this area, serious games help, for instance, to improve motor skills in rehabilitation processes. One example is the serious game using a hand motion capture system for upper extremities rehabilitation described by Huang et al. (2011). Another is Elinor (Alklind et al., 2009) a game based tool for rehabilitation of stroke patients to be used in their home environment.

2.2 Physical Therapy/physiotherapy

According to Encyclopedia Britannica (2012):

“physical medicine and rehabilitation, also called Physiatry, Physical Therapy, or Rehabilitation Medicine, is a medical specialty concerned with the treatment of chronic disabilities and with the restoration of normal functioning to the disabled through physical modes of treatment, such as exercise. This specialized medical service is generally aimed at rehabilitating persons disabled by pain or ailments affecting the motor functions of the body. Physical medicine is one means employed to assist these patients to return to a comfortable and productive life, often despite the persistence of a medical problem. “

The restore of parts of the body of a patient is very important, when he/she has serious damage to the movement, due the ageing, injury, diseases, disorders, conditions or environmental factors. Huang et al. (2011) describe that a person with motor disabilities has a limitation or a loss of capacity carrying out an activity. Functional movement is central to what it means to be healthy and it is therefore essential that this person undergo therapeutic treatments.

In fact, according to Encyclopedia Britannica (2012), the objectives of physical therapy are sometimes relief, always improvement or maintenance of functions such as strength and mobility etc. These objectives are reached by several of the therapeutic means: massage, exercise, electrical currents etc. World Confederation for Physical Therapy (WCPT, 2012) describe that the functional movement means physical, psychological, emotional, and social
wellbeing. Physical therapy involves the interaction between the physical therapist, patients/clients, other health professionals, families, care givers and communities in a process where movement potential is assessed and goals are agreed upon, using knowledge and skills unique to physical therapists.

The purpose of physiotherapy is:

- Reduction and cancellation of pain and other symptoms and signs of suffering.
- Normalization of neurological and muscular structures.
- Functional rehabilitation.

### 2.3 Virtual rehabilitation

The term Virtual rehabilitation (VR) was used for the first time in 1986 by John Lamier (Riva, 2005). VR is a set of computer technologies that, combined, provide an interactive interface to a computer-generated world. This computer-based, often three-dimensional, environment can be navigated through, it can be interacted with by the patient and is updated in real-time (Tarr et al., 2002; Riva, 2005). Over the last decade, its potential value has growingly been recognized. In fact, this field has received more and more attention from researchers since they have seen the potential therapeutic benefits through VR’s engaging nature of the medium (Chuang et al., 2006). Research suggests that virtual reality game-based technology can be used effectively to improve motor skill rehabilitation of a range of functional deficits (Fulk et al., 2006; Fung et al., 2006). With VR, people have the chance to forget their real situation and concentrate, focusing on the task that, at that time, is simulated by the environment. It has also been verified that individuals, entities subject to the virtual rehabilitation, not only tend to forget their physical condition quite easily, but are also more motivated to continue the therapeutic process as it is fun for them (Halton, 2007).

Further boost to the progress of VR is given by the continuous technological evolution of video games, which have generated an large number of low-cost devices. Some of them can easily detect the movement of a patient (Rizzo et al., 2011). Such devices are commercially available and examples are: Microsoft Kinect, Nintendo Wii Remote, etc, which have made it possible to sense the full–body pose for multiple users without the use of markers or handheld devices, and they are low-cost device. Microsoft have also made an open source framework, XNA, available for developers to access and develop upon the technology. Today, many hospitals are using systems that are easy to install and to configure, and most of these low-cost systems support the idea that exercise can be fun, motivating and can be a form of distraction (Rizzo et al., 2011).
2.4 Music therapy

“Music Therapy is a therapeutic practice that uses music as a communication medium between patients and therapists ” (Bruscia, 1991 cited in Benveniste et al., 2009, p.1). Music therapists have been formally using music to address effects of disease and disorder in people.

The American Music Therapy Association is a large group who practice music therapy and according to musictherapy.org (2012), their website, music therapy is the use of music and/or musical elements (sound, rhythm, melody and harmony) by a qualified music therapist. Music therapy, according to the same source, aims to develop the potential functions of a person so that he/she can improve the quality of life through a process with rehabilitative or therapeutic purposes. It uses sound, music and movement to produce regressive effects and to open channels of communication. According to musictherapy.org (2012), this therapy put people in position to begin the process of preparation and recovery of the patient in the society. Aldridge (1994), Knight and Wiese (2005) and Kemper et al. (2005) describe that this therapy is addressed mainly to help e.g. cancer patients and children with ADD, but is also used for pain management, to help avoid depression, to calm patients and to alleviate muscle tension. It also provides avenues for communication that can be helpful to those who find it difficult to express themselves in words. Music therapy interventions can be designed to:

- Promote wellness.
- Manage stress.
- Alleviate pain.
- Express feelings.
- Enhance memory.
- Improve communication.
- Promote physical rehabilitation.

Bruscia (1987 and 1991) cited in Benveniste et al. (2009) asserts that music therapy is generally applied through two methods:

- Music therapy, receptive or passive, is conducted by listening to recorded music chosen by the patient or programmed by the therapist, and can help stress and help to manage pain.

- In active music therapy, the music is created from the patient through instruments, musical instruments, or sounds and noises emitted by the patient. There are serious games that use the active concept of music therapy to children suffering from behavioral disorders (Benveniste et al., 2009) or to patients suffering from Alzheimer’s disease (Benveniste et al., 2010).
Watson (2008) describe several approaches to stroke rehabilitation emphasizing that the rhythm is the main ingredient for music therapy techniques in the motor area. The simple act of hitting a drum, supported by preferred rhythmic music, has shown to increase endurance and strength in motor control exercises. This technique is referred to as therapeutic instrumental music playing (TIMP). Patterned sensory enhancement (PSE) is a technique that uses the melody to drive the movement of the patient. In rhythmic auditory stimulation (RAS), the music therapist, after watching how the patient walks, creates a rhythm that matches the pace of the patient.

2.4.1 How music affects people
Kemper et al. (2005) described that music has a certain effect on people. It is an experience that affects people every day. Much of the research conducted in this field shows that benefits can be obtained just by listening to music. For example:

- Aldridge (1994) describes that music affects heart rate, blood pressure, respiration (greater amount of O2 available to the various parts of the body), and the level of certain hormones, in particular that of stress.

- Kemper et al. (2005) have found that music can help people feel more optimistic and positive.

- Aldridge (1994), McCaffrey and Locsin (2002) and Kemper et al. (2005) have found that music can facilitate the healing and rehabilitation process by reducing anxiety, pain and overall stress that occurs with any medical situation.

- Aldridge (1994) describe that music with slow rhythm promotes a calm state in a person, while music with a higher rhythm can stimulate the brain waves of a person by increasing his/her concentration.

- Music helps the person to enter "into the zone" when, for example, the person is practicing yoga or self hypnosis. This can help the person to feel better (Karageorghis and Terry, 2006).
2.5 Engaging experience

Flow, Immersion, Cognitive Absorption and Presence are all concepts that emerge from the literature on digital games. This thesis will focus on the first two of them. Apparently, the concepts Flow and Immersion are related. In fact, both seem useful for quantifying the experience of engagement or game-play of a person within a game. Also, many game designers and reviewers often use both terms to refer to the same concept. In reality there are only small differences between the two. This section will present and discuss both concepts and then choose the most appropriate for this thesis.

2.5.1 Flow

According to Csikszentmihalyi (1990), founder of the concept, when a person enters into a state of so called flow, he/she loses all concept of time and all her/his attention is focused on what he/she’s doing at that moment. For him/her there is only one specific task and nothing else around him/her. In English, to describe these moments, they use expressions like "everything clicks" or "to be in the zone"; in Italy, it is often referred to as "a state of grace." In his seminal work, Csikszentmihalyi (1990), outlines that when people are in a state of flow, they are in a state of full concentration on the activity that they are doing.

Csikszentmihalyi et al. (2005, p. 601) says that flow experiences of a person in everyday life are quite rare even though everyday traditional tasks of a person: work, study, religion etc. can produce this experience. There are three very important conditions. First, flow occurs when the activity contains a clear set of goals. These goals provide direction and purpose to behavior. Their value lies in their capacity to structure experience by channeling attention rather than being ends in themselves. The second condition is the balance between perceived challenges and perceived skills. When these two variables are well assorted then the patient's attention is fully absorbed. However, it's not easy to find the right balance between perceived challenges and perceived skills. In fact, if the challenge is far below the perceived skill, then boredom is the result while, when the perceived skill is way under the challenge, anxiety is the result. Finally, the last condition for flow depends on the presence of a clear and immediate feedback on what the person is doing. The individual has the need to constantly receive positive or negative feedback when proceeding in his/her activities.
Music can help a person to reach the state of flow. In fact, research in sport has found that music promotes the flow state (Karageorghis and Terry, 2006). Karageorghis and Terry’s (2006) analysis shows the following generalizations:

1) Synchronization with musical accompaniment of sub maximal exercises produces a better final result. They described that synchronous music, with its rhythmic elements, such as beat or time, involves the person to perform repetitive movements over time. In fact, they account for one example of synchronous music in sports: Haile Gebreselassie broke the indoor 2000-meter record in 1998, while synchronizing the steps with the rhythmic pop song Scatman.

2) Music tends to increase affective states both on average and high levels of work intensity.

The research by Karageorghis and Terry (2006) has been focused on how music can affect exercise, where the music is simply used as background. The use of asynchronous music, as this is known, occurs when there is no synchronization between movement and music. Other research has examined the effects of listening to asynchronous self-selected music on flow and performance of pitches in netball (Pates et al., 2003). Starting from research by Karageorghis and Terry (1997), it was hypothesized that listening to music would promote the state of flow and would also have a positive impact on the performance of free throws. A major limitation on the research was that it was conducted on only three subjects. The three college netball players were asked to complete 11 performance tests. Each trial involved the execution of 12 3 point shots from the outside lines. The state of flow and the subjective experience were measured after each test. Participants received the intervention with asynchronous music. The results: two of the participants experienced an improvement in flow while all three participants improved performance of free throws. In addition, the
participants reported that this intervention was useful to control the emotions and the thoughts that are decisive for the performance. As a conclusion the authors suggest that intervention with self-selected music and imagery techniques may improve athletic performance and trigger emotions and cognitions that facilitate the state of flow.

2.5.2 Immersion

All games, with all their differences in design, logic and interface, have an essential element that brings them together: they must have the ability to catch people (Jenett et al., 2008). Further, according to Jenett et al. (2008), games should be a tool of distraction from worries and from daily stress. People need to find the game engaging and exciting. They should not realize that the time has passed and they should not pay attention to the environment that surrounds them, rather, their attention should be focused on the task of the game and they should feel that they are somehow a part of the game. For many, this experience is referred to as "Immersion". This concept, however, is still not well defined, but many people who are passionate about games use this word when they want to describe their degree of involvement with a game. Jenett et al. (2008) distinguish three levels of immersion: the first level of immersion has been called "Commitment", meaning that a player is in this state when he/she starts overcome the barrier of preference. Essentially, when he/she starts to like the game, he/she invests his/her time to understand its dynamics, learn the controls, interfaces, etc. In the second level, "Engrossment", the player is more involved in the game and is less aware of his/her surroundings. From engrossment he/she can go to the last state where the player is fully involved in the game: this state is called "Total Immersion". Quotations describing total immersion are:

“When you stop thinking about the fact that you’re playing a computer game and you’re just in the computer” or “You feel like you’re there” (Brown and Cairns, 2004, p. 1299)

The players are less aware of their surroundings, they lose all concept of time, all their attention is focused on game, and for them there is only the game. The first two states are much more probable than the last one, because the total immersion state requires the highest level of attention and that is a very rare and rather fleeting experience when gaming.
2.5.3 **Flow vs. immersion**

At first sight the two concepts are very similar: they both refer to the distortion of perceived time, both are about the balance between the challenge and the skills of person, etc. However, flow is a positive experience, immersion is not always. In fact, Brown and Cairns (2004) showed that immersion is a gradual experience that increases through degrees of involvement while flow is an extreme experience. For example, a person can take his/her attention to a task of the game but still manages to have the need to break away from it to go to play tennis, or go to college and so on. In this situation the player is immersed to some degree, but he/she is not as immersed as in flow. In fact, when the player gets in the flow state, he/she excludes everything that surrounds him/her. In their work Jenett et al. (2008) mention that there are games like Myst IV which does not satisfy the basic criteria of flow. In fact, in this particular case, Myst IV does not have clear goals at the beginning, and it is only with the game that the player can understand how it works and what is going on, at the same time he/she is having a highly immersive experience. Jenett et al. (2008) argued that immersion is different from other concepts like Flow, Presence etc. They state that its features include being less time-aware, being less aware of the real-world, and the sense of being involved in the task.

"This need not be the most optimal experience, often falling far below being a fulfilling experience, nor even representative of a person's general experience of playing games. Immersion rather is the prosaic experience of engaging with a videogame." (Jenett et al. 2008).

In this way, the immersion concept can be separated from the result of the game. People don’t play because they want to become immersed, it is just something that happens. For these reasons, in this report, the concept of immersion will be used to measure the engagement of the experience of a patient, and if music can affect it.

2.6 **Immersion questionnaire**

Jenett et al. (2008) conducted three experiments to develop a questionnaire which measures the level of immersion. The name of this questionnaire is Immersion Experience Questionnaire (IEQ) (see Appendix A). IEQ has also been used in other studies on immersion, for example in Ferrai’s (2007) (based on earlier work by Jenett) investigation of the relationships between immersion, body movements and extraversion. Another study was performed by Gámez (2011).

To be able to properly catch the level of immersion of a person when he/she plays game, IEQ, which it is divided into six sections in total, can be used. The first three sections are concerned with varying degrees of attention to the task: basic attention, temporal dissociation and transportation and the last two sections are concerned with the game factors: challenge and control.

More in depth, the questionnaire consists of 31 items overall: basic attention (4 questions), temporal dissociation (6 questions), transportation (6 questions), challenge (6 questions), emotional involvement (5 questions) and enjoyment (4 questions).
Participants are asked to rate from a scale of 1 to 5 how they felt at the end of the game (where 1 = not at all and 5 = very much so. With this scale, the maximum immersion value is 155 and the minimum immersion value is 31).

With this mix of questions, Jenett et al. (2008) broke up immersion experience into five factors:

1. Cognitive involvement: describes the level of subjective perceived usefulness and engagement to the game.

2. Real word dissociation: describes to what extent the players feel disconnected with the real world.

3. Emotional involvement: indicates to what extent the players are related to the emotional attachment to the game. For example, IEQ includes questions such as ‘at any point did you find yourself becoming so involved that you wanted to speak to the game directly’, etc. (12 immersion questions of the questionnaire are associated with this factor, this means that the maximum immersion value is 60 and the minimum immersion value is 12).

4. Challenge: indicates the difficulty level that the player perceives.

5. Control: refers to players’ perceived dominance in game play.

The IEQ offers not only a total immersion score but also five immersion factor scores. This distinction will be very important for evaluating the second hypothesis of this thesis (see section 3.2.1), where only the emotional involvement data will be used.

2.7 Music-based games

Video games are split into different genres: there are MMORPGs, First Person Shooters, classic video games and sports games etc. When a video game has music at the center of everything, it is classified as a music-based game. Examples of music based games are Guitar Hero, Donkey Conga and so on. Kayali and Pichlmar (2007) present a separation of music based games in two main classes: the first class consist of all instrumental games. The second class includes all those videogames that have musical rhythm at the center of everything. This class is defined with the term Rhythm-action games.

Kayali and Pichlmar (2007) described some effects that the music based games take to psychology: synaesthesiea, kinaesthesia, and performance.

- Synaesthesia is a neurological condition in which two or more senses are connected. For example, music might be seen in colors and patterns, or taste may be seen in shapes, etc. “sensory perception of any kind may manifest itself as sensory experience of another” (Brougher et al., 2005, cited in Kayali and Pichlmar, 2008, p.5).

- Kinaesthesia is the sense of moving a body part. Music based games cause a reaction of movement of player. In fact, Jenkins (2005) described that using tools like
feedback, gestural input and music-based games, a person can become encouraged to do reaction movements.

- Performance is closely linked to Kinesthesia play. Some music-based games lend themselves particularly to being played during a live performance. For example when playing Guitar Hero, players think of participating in a sort of live performance.

2.7.1 Rhythm action
As suggested by Kayali and Pichlmar (2008), in rhythm games, the gamer has to mainly understand the rhythm the game sets. In fact, all game tasks will be performed by the player in a rhythmic way. This rhythm will be provided by the game. As the player becomes more experienced, the rhythm of the game starts to change, for example increases the speed and its complexity. In this way it can trigger a kind of competition among various players through the scores. These games offer less freedom of expression compared to instrumental games. In this category the player reacts in a certain sense to the sound of the game. This category is subdivided in other subcategories. In fact, Kayali and Pichlmar (2007), divided the rhythm action category, into three different classes:

- Linear rhythm action: this category of games includes Guitar Hero, Rock Band Vib Ribbon and all other games where the focus is on playing music. Songs are mapped to the game-space in the form of progressing rhythmical patterns that must be matched by correct sequences of button mashes (or their equivalents, like touches, strums, shakes or waggles).

- Mimicking: the purpose of these games is to listen to a short musical sequence and the player has to reproduce exactly the same sequence previously heard through button presses. Games that are part of this category are: Rhythm Tengoku, Zelda ocarinas, etc.

- Non-linear rhythm action: the player in this category of games uses rhythmic combinations to perform the tasks of the game. For example, in Patapon, the player moves a small army in a hostile environment through rhythmic combinations. All movements of the army, as a retreat or attack, are activated by rhythmic sequences.

2.8 Kinect
The Kinect sensor is a physical device of Microsoft that contains cameras and a microphone array (Kinect SDK, 2012). This device was created as a controller for the Xbox 360, also a brand of Microsoft. With the release of SDK kinect, from the same company, it has become a device used for multiple purposes because it provides spatial information of a person in range through the use of a 3D scanning system based on infrared sensors. For more information about Kinect, go to the documentation on Microsoft's Kinect SDK.
3 Problem

People with motor disabilities have a limitation or a loss of capacity carrying out an activity considered as normal for a human being. For example, disability may drastically limit the ability to perform activities such as bathing, dressing, grooming, and can in practice restrict all the features that are essential aspects of everyday life. Moreover, these aspects may incline the relationship with the society: participation in recreational and social activities is reduced, and sometimes disability can jeopardize their career prospects. In order to alleviate the problems described above, it is essential for these people to undergo therapeutic treatments. Huang et al. (2011) show that repetitive exercises can stimulate the brain to achieve an improvement in movements. However, Huang et al. (2011) show that only 31% of people who have a physical disability perform their exercises as recommended. Often people mention a lack of motivation as an impediment for them to regularly perform their exercises. Rehabilitation is a tedious process that often fails because the patients drops the treatment. Therefore, identifying motivating and effective methods for encouraging people with motor disabilities to perform exercises is crucial in helping them to retain or enhance their motor control and increase their independence. For this reason, this thesis investigates the possibility that musical rhythm, in a serious game, can improve some aspects and can eliminate the lack of motivation from people in a rehabilitation process.

3.1 Aims

This thesis aims to evaluate whether music can make the rehabilitation process to become less boring and tedious for a patient and two hypotheses will be used.

1. Hypothesis 1: music in a serious game for rehabilitation can make the experience to become more engaging.

2. Hypothesis 2: high engagement in a serious game for rehabilitation can encourage the rehabilitation process of a patient.

There is a transitive relationship between these two hypotheses.

Figure 2 Aims in the thesis
3.2 Method
In this section the method for validating or rejecting the two hypotheses, will be reported. Also, the methodology to evaluate the levels of immersion and encouragement for each patient, will be accounted for.

3.2.1 How to measure immersion and encouragement
In order to validate or reject the two hypotheses described above, the idea is the following: there will be two versions of the same basic serious game. The first will be without music, the second will contain music, which will thus be their only difference. In the experiment that will be carried out (major details in Chapter 4), every participant will only play one of the two serious game versions. When the game will be over, he/she will be asked to fill in the IEQ (Jenett et al., 2008). Through the data of the Immersion Experience Questionnaire, the immersion levels of the patients which played the version with music and the corresponding levels for the patients that played the version without music, will be compared. This matching will evaluate the first hypothesis. In order to evaluate the second hypothesis, the subset of the IEQ data that correspond to the third immersion factor, emotional involvement, will be used to extract the level of encouragement of a patient, which will be compared with the level of immersion of the same patient in order to understand whether there is a relationship between the level of encouragement and the level of immersion (high engagement) for each patient. The emotional involvement factor was used since contains questions very close to the concept of encouragement mentioned in this thesis (major details in Chapter 5).

3.2.2 Delimitations of the IEQ
IEQ is composed of 31 questions, and it is divided in 6 sections. The number of questions is a problem that should not be underestimated. A large number of questions may annoy the patient and so he/she can lose his/her attention. One way to avoid this problem could be decrease the number of questions, but such a choice could affect the result about the immersion and about the encouragement. Therefore, it was decided to use the whole IEQ. A second factor that could affect the immersion result or the encouragement result was that the IEQ needed to be translated into Swedish since the patients’ skills in English were unknown. The Swedish translation may differ somewhat from the original English version due to that it is not always possible to find exact corresponding terms. All this choices have to be considered when evaluating the hypotheses.
3.2.3 Expected results
This thesis does not have the goal to check if the immersion level is high, because the serious game that was created still has room for improvement, but rather to check if there is a difference in level of immersion between the version with music and the version without it. If the level of immersion is higher for patients who played with musical rhythm, then, since the versions are equivalent except for the music, it can be concluded that the music effected the immersion in a, presumably, positive way. The same reasoning can be applied to the concept of encouragement, this thesis will focus on the difference between the level of encouragement for patients who played the version with music and the level of encouragement for patient who played the version without music. This in order to evaluate if a higher level of immersion means a higher level of encouragement in the patient.

3.3 Ethical aspects
In order to perform the experiment, the physiotherapists have given the opportunity to do the experiment in the rehabilitation center. Even young patients with severe injuries in the knee were selected by physiotherapists. Each patient participated voluntarily and was informed, through a form (see Appendix B) about the experiment and about the possible risks with it. The patient was also informed that if he/she should feel pain during the game, he/she can leave the session test at any time. For avoiding long waiting between sessions, each patient was scheduled to perform the test at a specific time. Each patient performed the test session in a room, inside the rehabilitation center, without embracement and discomfort.
4 The serious game

In this chapter, the discussion with the physiotherapists about using music within the serious game and its role, will be reported. Also, the features of the serious game used in the experiment, will be presented.

4.1.1 Discussion with physiotherapists

Regarding the introduction of sound feedback and musical rhythm to the serious game, the discussion held with the physiotherapists during the development of the serious game shows two contrasting aspects:

- About sound feedback, the physiotherapists were very interested, in fact they suggested to introduce sound feedback like applause, when the patient carries out a correct movement and, noise for faulty ones, this in order to give the right feedback to patients whether the movement is correct or not. The idea is to create sound feedback for several levels of correctness in a movement. For example, an erroneous movement is associated with noise, an almost correct movement is associated with a positive sound and a correct movement with an even more positive sound.

- Regarding music and musical rhythm, the physiotherapists became more interested over time. At first, the physiotherapists were not very impressed by the idea to use music within the serious game, but they became more interested after some discussion. The recommendation was to find a rhythm that was neither too fast nor too slow to perform rehabilitation exercises. Velocity was regarded as an important concept. A good balance between speed and rhythm of the proper motion that the patient must perform, had to be found.

For the issue of music, there are two ways to apply the same concept:

- Music asynchronous with patient movement: in this case, the patient listens to rhythmical music but his/her movements must not match with it. Here, the music only functions as a guideline in the serious game.

- Music synchronous with patient movement: in this case, every movement must match with the music rhythm. It is fundamental for the patient to perform the movement with the correct rhythm in order to perform tasks inside the game. For example, in Patapon, the player moves a small army in a hostile environment through rhythmic combinations. This thesis work will focus on this latter concept: how can music rhythm synchronous with patient movement in a serious game be introduced.
4.1.2 Material (the serious game)
To be able to properly understand how the music rhythm was added to the serious game, there will first be a short description of the version of it without music.

The serious game consists of a 3D model caught by a Kinect device, which represent the patient’s whole body, situated on a flying platform. This platform is driven by movements of the patient. In the game, the patient has to avoid the numerous obstacles, like a studded ball, in order to not decrease the score that has been gained until that moment. The goal of the game is to get as many points as possible. There are two ways achieve this goal:

1. The patient can collect coins that appear in the ancestral environment. Each coin corresponds to one point.

2. The patient will fight with three bosses and receive points for killing each of them. For fighting a boss, the player will have a gun with 8 bullets (see figure 3).

![Figure 3](image-url) The serious game

From the discussion with physiotherapists, several types of movements that the patient can carry out to drive the platform, was defined:

- Forward: the flying platform moves forward.
- Right and Left movement: the flying platform moves right or left.
- Jump: reload the gun.
- Clap: shoot the bullets to the boss.
The patient can choose which knee, right or left, that will undergo rehabilitation treatment. When the patient performs one of those movements, if the movement is correct, there will be a positive sound. If incorrect, a negative sound will follow. Regarding the jump movement, the patient will perform two sub-movements: jump on one leg or jump with both legs. Xna will be the framework when creating the serious game.

4.1.3 Musical rhythm within the serious game

The serious game was not specifically designed to be a music based game, rather a movement game to which music could be added. The first question, accordingly, was how to add elements where the movement of the patient should be synchronized with music in the game.

The idea was the following: as described above the patient has two ways to get points. The musical rhythm concept applies for the second; when the patient is in front of the boss. If the player shoots his/her bullet by clapping his/her hands synchronized with the rhythm of the music then he/she will get more points as well as the boss’ health decrease. The length of the music sample is about 30 seconds, and this sample is repeated through the entire session with the boss. In the beginning of each repetition, the gun is reloaded. This means, if the player fires the gun in synchronization with the rhythm, the gun will always be charged, which in turn means that the player need not reload the gun by jumping. In this way the patient is enticed to shoot with rhythm because he/she will get more points and his/her gun will be always reload automatically.

More specifically, for creating the musical rhythm two pieces of music were merged:

1. The first piece of music was the main sound track. It had a regular beat every 3-4 seconds (rap style music). In this music only piano and drum were used.

2. The second piece was a simple sound clap and was used for highlighting the end of each beat.

Using free music software, the two pieces of music were carefully merged into one track. When the patient hears the sound clap, he/she can decide to shoot in order to get more points. The sound clap is essential because only if the patient claps his/her hands in rhythm with it, he/she will get more points. This way of using music is similar to non-linear rhythm action in music based games.
4.1.4 New features

For evaluating the hypotheses, two versions of the serious game were used, one with music and one without music. A problem that emerges with these two different configurations of the same serious game is that they are not longer logically similar. In fact, when a patient play the serious game with music he/she can get more points than a patient who play the version without music, since the latter lacks the concept of movement synchronized with music, which can give more points. This difference can be very important when the test will be carried out. For avoiding this problem, it was decided to add a new feature to both versions. For the whole duration of the game the patient can see circles to the lower left: a red circle or green circle that is repeated cyclically. The logic behind these two circles is the following: when the patient is in front of a boss, if he/she shoots at the boss when the circle is green, he/she will get more points as well as the boss’ health is decreased. The same logic is used for the version with music. A difference, though, is that in the version with music, the red and green circles are synchronized with rhythm. In this way, the difference between the two versions is only in the presence of music.

Another way would have been that to test 4 versions of the game for evaluating the experienced immersion of the patients: one version without musical rhythm and sound feedback, but with the red and green circles as visual components, a second version with musical rhythm and sound feedback but without circles, a third with the visual components and music and the last without music and visual components. With this approach, more test sessions would have to be performed. This alternative was disregarded with respect to the low number tests that could be organized with real patients as players and physiotherapists as evaluators.

In consideration to the latter restriction, it was chosen that both versions would have the same sound feedback.
5 Experiment

This chapter will explain the phases of the test session, from preparation to the performance of it, with an overview of the problems encountered during the test session.

5.1 Preparation

The room which the test session was performed in, was a room situated inside the rehabilitation center. It was very suitable because it had many features for a good test, for example: it was spacious and almost empty, ideal for avoiding problems regarding recognition of other objects in the environment by a Kinect device. In the room, speakers for sound and a projector linked to a laptop, was used.

5.2 Participants

The physiotherapists scheduled two days for the test of patients of the rehabilitation center, the first day with three patients and the second day with four patients. Three were females and all of the patients had a knee related injury.

5.3 Execution

The schedule was the following: the first participant played the version without music, the second participant played the version with music, the third participant played the one without music and so on.

Every patient did a pre rehab warm up before the test. When the participant was ready, he/she came in the room in order to do the test. The test session was divided in the following steps:

1. Presentation: the game developers explained to the participant that the test was a study for understanding how serious games can be used as an aid in rehabilitation training and that the project was conducted in cooperation with the rehabilitation center and students of the University of Skovde.

2. Privacy: the privacy paper was given to the participant. In this paper there was information about the collection of data through the questionnaire and about publishment of the results. Patients were informed that would all data should be anonym zed and that no information could be traced back to a single individual.
3. Tutorial: after this two steps the participant put himself/herself in front of kinect and saw the game tutorial which shows to him/her the goal game, that is to get coins and avoid obstacles, which type of movements he/she needed in order to move the platform, which kind of movement he/she needed to shot to the boss etc. For the serious game version with music, there were instructions for how to interact with the game synchronized with the musical rhythm.

4. Playing the game: in this phase, the participant was ready to play with the game. The play session was about 10 minutes.

5. Questionnaire (IEQ): when the participant completed the play session, he/she filled in an immersion experience questionnaire.

5.3.1 Problems encountered at the test session
In the first test, the participant was not able to understand the major aspect about the movement of the platform and how to shoot at the boss, through the game tutorial. There were also problems related to the incompatibility between the projector and the computer. Unfortunately this aspect caused interruptions of the game when the participant played it. For this reason, a live test was performed the second test day, by a game developer. He played a small game session and explained all aspects related to the game to the participant. For the problems encountered at the first test day, there were further alterations because of the collected data got by IEQ.
5.4 Results

The total immersion was computed for each participant. In addition, scores for the five immersion factors: cognitive involvement, real world disassociation, emotional involvement, challenge and control, were calculated as well. These five factors were calculated in order to understand how the musical rhythm affects each of them. The results are represented in the following tables:

**Table 1**  Total immersion of the patients who played the serious game version without music

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>IEQ Immersion Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Male</td>
<td>91</td>
</tr>
<tr>
<td>D</td>
<td>Male</td>
<td>103</td>
</tr>
<tr>
<td>F</td>
<td>Female</td>
<td>112</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>-</td>
<td><strong>102</strong></td>
</tr>
</tbody>
</table>

In this table the total immersion score is reported for each patient who played with the version without music. The mean for each category is the total divided by the number of participants.

**Table 2**  The five factors of immersion experience of the patient who played the version without music

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Cognitive Involvement</th>
<th>Real World Dissociation</th>
<th>Emotional Involvement</th>
<th>Challenge</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Male</td>
<td>33</td>
<td>16</td>
<td>33</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>D</td>
<td>Male</td>
<td>37</td>
<td>20</td>
<td>37</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>F</td>
<td>Female</td>
<td>41</td>
<td>18</td>
<td>43</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>-</td>
<td><strong>37</strong></td>
<td><strong>18</strong></td>
<td><strong>37,6</strong></td>
<td><strong>12</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

In table 2, the scores divided upon each of the five factors of immersion experience: cognitive involvement, real world dissociation, emotional involvement, challenge and control for each patient who played the version without music.
Table 3  The total immersion of the patients who played the version with music

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>IEQ Immersion Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Female</td>
<td>117</td>
</tr>
<tr>
<td>C</td>
<td>Male</td>
<td>106</td>
</tr>
<tr>
<td>E</td>
<td>Male</td>
<td>120</td>
</tr>
<tr>
<td>G</td>
<td>Female</td>
<td>116</td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>114,7</td>
</tr>
</tbody>
</table>

Table 3, shows the results of the total immersion of the patients who played the version with music.

Table 4  The five factors of immersion experience of the patients who played the version with music

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Cognitive Involvement</th>
<th>Real World Dissociation</th>
<th>Emotional Involvement</th>
<th>Challenge</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Female</td>
<td>40</td>
<td>19</td>
<td>48</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>C</td>
<td>Male</td>
<td>37</td>
<td>21</td>
<td>44</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>E</td>
<td>Male</td>
<td>46</td>
<td>23</td>
<td>43</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>G</td>
<td>Female</td>
<td>42</td>
<td>20</td>
<td>40</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>41,2</td>
<td>20,7</td>
<td>43,7</td>
<td>14,2</td>
<td>25,2</td>
</tr>
</tbody>
</table>

Table 4, as table 2, shows the five factors of immersion experience of the patients who played the version with music.
5.5 Analysis

The average immersion level of the patients who played the version without music is as 102 (of 155) (where 155 is maximum immersion value and 31 is the minimum immersion value). This means that every participant in average answered 3,3 to every question. The average level of immersion for the patients who played the version with music is 114,7 (of 155). This corresponds to an average answer of 3,7. The low-normal immersion was not surprising, partly because the game was a prototype and partly because the game was very different from most other games, accordingly, the level of immersion, for each patient, obtained from the experiment does not correspond to third level of immersion: “Total Immersion” state, as mentioned in chapter 2. But, as described above, the aim of this thesis is investigate if the musical rhythm increases the immersion and, if so, if there is a difference in level of immersion between the two versions. The difference in averages described above indicates that the music/musical rhythm increases the immersion. The major difference is illustrated in Figure 4.

![Figure 4](chart.png)

**Figure 4**  The difference between the two average levels of immersion
It is also interesting to understand which of the five immersion factors is more affected by music.

Figure 5 highlights that the cognitive and emotional involvement factors were more increased by musical rhythm; there is more difference between the two versions for these than for other factors. This is not surprising, because the challenge and control factors that are related to the difficulty of a game and to the environment graphics, are factors to which music has no effect. Also, the real world dissociation was higher in the version with music than the one without music, but the difference was less significant compared to cognitive involvement and emotional involvement.
Encouragement, as described in the thesis introduction, means that the patients is enticed to spend more time with the game, he/she wants to play again because he/she find it interesting, funny, he/she feel good etc. In this way the patient spend more time for the game and this leads to more movement in the rehabilitation process. As described above, in order to measure the encouragement of a patient, the emotional involvement factor of the immersion could be considered. This since it contains questions very close to the concept of encouragement mentioned earlier. For example, Would you like to play the game again?, How much would you say you enjoyed playing the game?, To what extent did you forget about your everyday concerns?, When interrupted, were you disappointed that the game was over? Etc. Worth mentioning as the music affects the encouragement, illustrated in Figure 6, before to examine the second hypothesis.

![Figure 6](image)

**Figure 6** The difference in encouragement (in average) between the two versions of the game

The patients who played the version with music had a level of encouragement as 43,7 (of 60, in average) which should be compared to the patients who played the version without music and which only had a level of encouragement as 37,6 (of 60, in average). The patients who played the version with music had a higher level of encouragement than the other patients. The encouragement level of the patients who played the version without music was about 37,6 (of 60, in average) while patients who played the version with music was as 43,7 (of 60, in average). This means a difference of 6,1 points. In percent, the patients who played the version with music had about a 10% (in average) higher level of encouragement compared to the patients who played without music.
Another aim of the thesis, as explained above, is to evaluate whether the level of immersion (high engagement) in a serious game for rehabilitation can encourage the rehabilitation process of a patient. In fact, in the graph in Figure 7, this can be emphasized:

**Figure 7** The relationship between level of immersion and level of encouragement

To be able to properly describe the concept, for example, in the graph, the E patient has a high immersion but his/her level of encouragement (emotional involvement) is less than patient A, which has a level immersion lower than him/her. Another example: patient F has an emotional involvement higher than patient G, but his/her level of immersion is lower than for patient G. This means that the level of encouragement grows with level of immersion, but it does not grow proportionally with the level of immersion.
6 Conclusion

In this chapter, the data that was obtained by analysis will be discussed. This will be followed by suggestions for future work that could be performed for improving the study in this field.

6.1 Summary of results

The aim of this research is to investigate whether music and immersion, music and encouragement, immersion experience and encouragement are related to each other. Furthermore, the aim of this thesis is to investigate how music within a serious game for rehabilitation can make the experience become more engaging and whether high engagement in a serious game for rehabilitation can encourage the rehabilitation process of a patient. The results, described in the chapter 5 suggest that there is a relationship between music and immersion and that there is a relationship between engagement and level of encouragement. In fact, in the first case, the patients who played the version with music had a level of encouragement higher than patients who played the version without music. In terms of numbers, patients who played the version without music had an average value of immersion as 102 (of 155, the maximal value of immersion). Patients who played the version with music had an average value of immersion as 114.7 (of 155). This means that there were approximately 13 difference points in absolute between these two concepts. In percentages, the patients who played the version with music had a 9% (in average) higher level of immersion than the patients who played without music. The results are in line with Aldridge (1994), McCaffrey and Locsin (2002), Kemper et al. (2005) mentioned above, in that they suggest that music can facilitate the rehabilitation process. They are also in line with Watson (2008) in that she suggests that the rhythm is the main ingredient for music therapy in the motor area.

In the second case, comparing the level of encouragement with the level of immersion for each patient, can be concluded that there is a high encouragement (emotional involvement) from a high engagement (high level immersion). Accordingly, a high engagement in a serious game for rehabilitation encourages the rehabilitation process of a patient. Even if the level of encouragement does not grow proportionally with level of immersion.
6.2 Discussion

All though this experiment gave positive indications, it should be considered that it was a pilot study with a limited number of subjects. For this reason, the results that were obtained should be interpreted with care. At the same time, there is no single result that music decrease immersion. It may very well be that the result would be similar even making a much bigger study. As Karageorghis and Terry (1997) suggested, the participants who listened to self-selected music could improve their athletic performance and cognitions that facilitate the state of flow. Most probably, if people could choose music after their own taste in the game, the level of immersion of this people could be still higher. Obviously, this means to design a serious game in which every kind of music can be synchronized with the game logics. This is not easy, maybe even impossible. However, even if possible, there could be some disadvantages, for example, if a person only likes very fast music, this aspect collides with physiotherapist’s requirements about to a good balance between speed and rhythm.

Another interesting aspect obtained from the experiment was how the patients who played the version with music, were more immersed than other patients and so even their sense of moving the body, this relates to Kinaesthesia described in the chapter 2, were more strengthened than the other participants. For this reason they left their initial position in front of Kinect and walked to the device and they didn’t bother much to making correct movements. This can be a risk that should be not underestimated, since this moving of the patient can compromise the correct performance of the rehabilitation exercise. It can be interesting to continue to study how the music affects the level of immersion, but also how it affects performance of other rehabilitation exercises that the patient has to carry out.

6.3 Future Work

From this thesis, two issues for future research could be stressed: obviously, the first aspect is musical rhythm and the second, equally important, is the synchronization between music and patient movement in a serious game. With these two issues in mind, it is suggested that a new serious game is developed. In this, there should be a stronger connection between the logic of the game and musical rhythm. For example, a new serious game could have:

- Obstacles, as a studded ball that move in synchronization with musical rhythm
- All bosses always shoot in synchronization with musical rhythm, so the patient can avoid the monster’s bullets just by reacting with the rhythm of music

All this new features of the game aim should strengthen the connection between musical rhythm and movement of the patient so they become synchronized. An increase in these two aspects probably improves the immersion level of patients which in turn encourage the patient to do more exercising in the rehabilitation process. Without encouragement people lack of motivation as an impediment for them to regularly perform their exercises. Another possible approach could be, as described in the discussion section, to make a serious game that synchronize several parts of the game, like killing the boss, with several type of music that chosen by the patient.
References


Benveniste J. Jouvelot, P., Lecourt, E. and Renaud M. (2009). Designing Wiiprovisation for Mediation in Group Music Therapy with Children Suffering from Behavioral Disorders, IDC, Como Italy.


Jenkins, H. (2005), 'Games, the New Lively Art', in J. Raessens and J. Goldstein (eds), Handbook of Computer Game Studies, MIT Press, Massachusetts.


Appendix A - IMMERSION EXPERIENCE QUESTION (IEQ)

Your experience of the game
Please answer the following questions by circling the relevant number. In particular, remember that these questions are asking you about how you felt at the end of the game.

1. To what extent did the game hold your attention?
   Not at all 1 2 3 4 5 A lot

2. To what extent did you feel you were focused on the game?
   Not at all 1 2 3 4 5 A lot

3. How much effort did you put into playing the game?
   Very little 1 2 3 4 5 A lot

4. Did you feel that you were trying you best?
   Not at all 1 2 3 4 5 Very much so

5. To what extent did you lose track of time?
   Not at all 1 2 3 4 5 A lot

6. To what extent did you feel consciously aware of being in the real world whilst playing?
   Not at all 1 2 3 4 5 Very much so

7. To what extent did you forget about your everyday concerns?
   Not at all 1 2 3 4 5 A lot

8. To what extent were you aware of yourself in your surroundings?
   Not at all 1 2 3 4 5 Very aware

9. To what extent did you notice events taking place around you?
   Not at all 1 2 3 4 5 A lot

10. Did you feel the urge at any point to stop playing and see what was happening around you?
    Not at all 1 2 3 4 5 Very much so

11. To what extent did you feel that you were interacting with the game environment?
    Not at all 1 2 3 4 5 Very much so

12. To what extent did you feel as though you were separated from your real-world environment?
    Not at all 1 2 3 4 5 Very much so

13. To what extent did you feel that the game was something you were experiencing, rather than something you were just doing?
    Not at all 1 2 3 4 5 Very much so
14. To what extent was your sense of being in the game environment stronger than your sense of being in the real world?
   Not at all 1 2 3 4 5 Very much so

15. At any point did you find yourself become so involved that you were unaware you were even using controls?
   Not at all 1 2 3 4 5 Very much so

16. To what extent did you feel as though you were moving through the game according to your own will?
   Not at all 1 2 3 4 5 Very much so

17. To what extent did you find the game challenging?
   Not at all 1 2 3 4 5 Very difficult

18. Were there any times during the game in which you just wanted to give up?
   Not at all 1 2 3 4 5 A lot

19. To what extent did you feel motivated while playing?
   Not at all 1 2 3 4 5 A lot

20. To what extent did you find the game easy?
   Not at all 1 2 3 4 5 Very much so

21. To what extent did you feel like you were making progress towards the end of the game?
   Not at all 1 2 3 4 5 A lot

22. How well do you think you performed in the game?
   Very poor 1 2 3 4 5 Very well

23. To what extent did you feel emotionally attached to the game?
   Not at all 1 2 3 4 5 Very much so

24. To what extent were you interested in seeing how the game’s events would progress?
   Not at all 1 2 3 4 5 A lot

25. How much did you want to “win” the game?
   Not at all 1 2 3 4 5 Very much so

26. Were you in suspense about whether or not you would win or lose the game?
   Not at all 1 2 3 4 5 Very much so

27. At any point did you find yourself become so involved that you wanted to speak to the game directly?
   Not at all 1 2 3 4 5 Very much so

28. To what extent did you enjoy the graphics and the imagery?
   Not at all 1 2 3 4 5 A lot
29. How much would you say you enjoyed playing the game?
Not at all 1 2 3 4 5 A lot

30. When interrupted, were you disappointed that the game was over?
Not at all 1 2 3 4 5 Very much so

31. Would you like to play the game again?
Definitely not 1 2 3 4 5 Definitely yes
Appendix B - Privacy paper

Research project about games and rehabilitation training

Researchers and students at the University of Skövde are examining how computer games are used in different situations. In this particular experiment, we are conducting a study in how computer games can be used as an aid in rehabilitation training. The project is conducted in cooperation with Skövde rehab center and participation is voluntary.

We kindly ask you to contribute in this study. If you participate, we will collect information through gaming sessions, interviews and questionnaires. The eventual information we collect will be used by the research team for research purposes only. The published results will be anonymous and no information can be traced back to a single individual.

Principal Investigator, Per Backlund, University of Skövde.

I agree that the information is used as described above.

Forskningsprojekt om spelbaserad rehabiliteringsträning

Forskare och studenter vid Högskolan i Skövde undersöker hur dataspel används i olika situationer och vilken uppfattning spelare har om dem. I det projekt vi ber dig delta i här, studerar vi hur dataspel kan användas som ett hjälpmedel i rehabiliteringsträning. Projektet genomförs i samarbete med Skövde Rehabcenter och deltagande är frivilligt.

Vi kommer att samla in information via loggning av spelsessioner, intervjuer och enkäter. Den information som vi samlat in om dig kommer enbart att användas av forskargruppen för våra forskningssyften. De resultat som publiceras kommer att vara anonymiserade och ingen information kan ledas tillbaka till en enskild individ.

Ansvarig forskare är Per Backlund, Högskolan i Skövde.

Jag godkänner att informationen används enligt ovanstående beskrivning.

Skövde 2012-____ - ____

________________________
Namnteckning

________________________
Namnförtydligande