Master Degree Project

UNIVERSITY
OF SKÖVDE

IMPLEMENTATION OF BINAURAL BEATS IN VIDEO GAMES

The effects of a therapy based on video games and Binaural Beats on University Students

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Abstract

The goal of this study was to explore the potential of using video games with Binaural Beats as an alternative to regular Binaural Beat therapy. As previous studies have shown, music therapy, Binaural Beat therapy, and video games have been used for relaxation purposes to varying success.

To prove this, three types of therapies were held in order to test their effectiveness. 16 students participated in the test in which their goal was to partake in one of the three therapy sessions, with two interviews before and after the therapy session.

The results showed that a video game therapy with Binaural Beats could work as an alternative to a standard music therapy session, and that the Binaural Beats improved the relaxing factor in a video game. However, this area of study is quite new, which means more studies would be needed to ascertain the effectiveness of this kind of therapy.

Keywords: Binaural Beats, Music, Music Therapy, Video Games, Relaxation

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1. INTRODUCTION

Music has been used as a tool to help people relax for centuries, and in recent years alternate ways of relaxation have been created. Nowadays, Binaural Beat therapy and Video games have both shown to be possible alternatives to help an individual rest and reduce stress. In some cases, combining music with other kinds of therapies has shown better results than simply relying on a singular type of therapy.

However, while Music and Binaural beats have been used with success in the past within the medical field, no study has proven if a binaural beat therapy can be used in a gamified form. To this end, this study will research the effectiveness of a relaxing video game containing binaural beats acting as an intervention before a specific stressful event, such as an important exam. The study will begin by describing how music, video games, and Binaural Beats are used for relaxing purposes. Afterwards, the two artefacts that are going to be used for the test are introduced, a relaxing video game, and a collection of musical compositions that contain Binaural Beats of the Alpha class. The test will compare three different intervention types and measure their effectiveness.

Keywords: Binaural Beats, Music, Music Therapy, Video Games, Relaxation

2. BACKGROUND

The Background section will cover different theories and terms regarding Binaural Beats, Music, Video Games and their relation to relaxation and other changes in an individual's mental state. To start off, Chapter 2.1. will describe some common sources of anxiety, and how it may affect an individual. Chapter 2.2. will explain some theories and studies that are related to Music and its potential within therapy. Chapter 2.3. will bring up the subject of relaxing video games and the kind of effects they bring to the players that play them. Chapter 2.4. will explain what Binaural Beats is and how Binaural Beat therapy works. The chapter will also discuss what kind of effects the Binaural Beats have on an individual. The chapter will conclude by covering how Binaural Beats have been used within the Medical Field.

Many of the sources found in this paper have been found using the databases Scopus and Google Scholar. All of the sources mentioned in this text are peer-reviewed to ensure that the data is as accurate as possible. The idea to search for information in physical libraries was considered, but due to the current pandemic regarding COVID-19, the idea was put on hold due to the potential health risks involved.

2.1. EXAMS, AND OTHER SOURCES OF ANXIETY

When it comes to anxiety, it is rather common that university students feel anxious before an important exam. In study by Vitasari et al, they studied the most common sources of anxiety for University students. According to their study, there are five common anxiety types related to studies: Exam anxiety, Presentation anxiety, Mathematical anxiety, language anxiety and social anxiety. The researchers asked several students at Universiti Malaysia Phang to fill in a questionnaire regarding their experiences with anxiety. The results showed that among the five different anxiety types mentioned, Exam Anxiety is the most common type. The most common cause for this anxiety is that many of the students who participated felt that they do not often prepare themselves for exams as well as they want to. The second most common type is Presentation Anxiety, due to the fact that many students answered that they often feel their heart beating faster every time they have to make a presentation to their class. The third most common anxiety type is Mathematic Anxiety. As the name of this type suggests, this type of anxiety refers to the subject of mathematics, and the times where a student does not fully understand a mathematical subject or does not have the ability to solve a mathematical problem, which in turn creates anxiety. The fourth most common type is Language Anxiety. This type of anxiety stems from the lack of confidence while attempting to converse with others in a foreign language. In the results, the most common reason for students that felt this type of anxiety answered that they did not feel confident in their own ability while taking a class about a foreign language. The fifth most common anxiety type is Social anxiety. According to the results, the students answered that they had difficulties while studying when there were more people present in the same room as them. Some students even mentioned that the more people there were in the same room, the more difficult it became to study. (Vitasari et al, 2010)

A study by David J. Burns further explains the connection between student anxiety, expected exam performance, actual exam performance and exam preparation. The study aimed to answer how these aspects affect the students actual performance. In the study, the students who participated had to answer two questionnaires. In the first questionnaire the students were asked to write what grade they were aiming to get on the course, and in the second questionnaire which the students answered before the final exam, the students wrote what results they expected to get at the final exam, and the final grade they expected to get at the end of the course. During the course the students took three exams. Burns' findings confirmed that there is a relation between anxiety, preparation and expectations of the final exam. However the relation between these factors were more complex than initially hoped. Out of the five Hypotheses Burns presented, his study only supported one of them. The hypothesis that was supported described that the higher expectations a student set for themselves, the more anxious they feel towards the final exam. Interestingly, when watching the relation between anxiety for the final exam and previous exam scores, the results went in the opposite direction compared to the supported Hypothesis. This means that the better a student performs on previous exams, the less anxiety is felt during the final exam. (Burns, 2004)

One study by Stowell and Bennet researched student performance and anxiety were affected during an online exam compared to a normal exam on campus. Before, and during the two exams, all students had to answer an AEQ test (Academic Emotions Questionnaire) in order to allow the authors to assess how each student felt before and during each exam. In these AEQ questionnaires, the students had to answer some questions regarding how they felt about an upcoming test, such as if they felt if they were sufficiently prepared for the exam, and if they felt angry because they had to review a large amount of material. During the first exam the class was split into groups of two, where group 1 completed the test on campus, and the second group completed their exams online. The groups later switched where they took the test for the second exam. The results for this study showed that, for performance, the students performed equally well on both exams. However, when the exam results were compared with the results of the AEQ, positive feelings for the exam (such as hope and enjoyment) were more associated with good exam scores, while negative feelings were associated with poorer exam scores. When discussing the amount of anxiety felt during the exams, the results showed that the amount of anxiety varied due to preference. Students who preferred to take exams on campus. felt more anxious when taking an exam online, while students who preferred online exams felt more anxious during their exam on campus. Interestingly, when the anxiety scores were compared depending on which type of exam they preferred. The students who preferred to take online exams scored higher overall on the anxiety test, in comparison to the students who preferred to take exams on campus. (Stowell & Bennet, 2010)

In a more recent study regarding online exams, Jaap et al, studied how student performance and experience were affected when applied knowledge tests were held remotely. The importance of this study stems from the fact that it was written and published during the COVID - 19 pandemic. The COVID-19 virus has forced many schools to hold exams in different ways, and the goal of the study was to research if holding exams remotely would be more beneficial to the students, or if the experience itself would disrupt the students performance. It must be noted that the students who took part in Jaap et als survey usually performed their exams in a computer lab on campus. To gather information, they conducted anonymous surveys in order to get the students opinion on how they felt regarding this new remote setting for the exam, how their test anxiety changed compared to a normal test in a computer lab, and which of the exams were most preferable. According to the authors there were three different conclusions that could be taken from the study. In regards to accessibility and setting, the majority of students pointed out that taking an exam from a remote location did not alter the exam experience much. Some of the students felt different however, and claimed that the largest problem with this approach was that the noise from family, flatmates and neighbors disturbed them. When the students answered how anxious they felt before the remote test compared to earlier tests completed on campus, the results showed an even spread across the results. According to the study, out of the 117 students that answered the question, 47 students felt that they felt less anxiety during the remote exam than a previous exam in a computer lab. 44 students, on the other hand, felt more anxious during the remote exam due to the possibility that unexpected technical issues could appear during the exam. However, even though many students seemed less anxious with an online exam, the majority still preferred to take their tests in the computer lab, stating familiarity with taking exams there and fairness for all students as their key points.
Some students also argued that taking an exam from home felt uncomfortable since it blurred the lines from work and rest. In conclusion, the authors claim that, in light of the current COVID-19 pandemic, the usage of remote tests are considered to be a good alternative for students, since there were no evidence that pointed out that remote tests affected the students performance (Jaap et al, 2021)

2.2. THERAPY THROUGH MUSIC

Music has since the course of history been used to alter the way we feel and think. According to a literature review by Francis C. Biley, the earliest experiments regarding the therapeutic effects of music dates back to the 1800s, where many researchers at the time found evidence that music not only can affect blood circulation and blood pressure, but also assist in caring for the sick. (Biley, 2001)
Regarding the latter; Florence Nightingale once stated: “Wind instruments, including the human voice, and stringed instruments, capable of continuous sound, have generally a beneficial effect… an air...will sensibly soothe” (Nightingale, 1859).
According to Biley’s review, studies regarding music being used for therapy have branched out into many different paths in the medical field in recent years, including Surgical Settings, Critical Care, Mental Healthcare and Relaxation. (Biley, 2001)

When music was used in the surgical setting, Biley explains that the music had an overall positive effect on those who listened to it, by reducing anxiety. This included both patients and the surgeons who performed the surgeries. The surgeons who participated in the study by Allen and Blascovich actually performed better when they had the ability to pick their preferred music, in comparison to those who had a musical piece picked out by the testers. Both of these control groups performed a lot better than the group who did not listen to music at all. (1994) In a study by K.M. Stevens, where he collected data regarding the patients view on music as a form of anaesthetic. Stevens' study showed, even though a few participants didn't like the music they listened to, the majority of participants thought that the music worked well as a form of distraction which in turn reduced their anxiety and their perception of pain. However, Biley claims in his review that there is no clear pattern that can explain why music has these beneficial effects. (Stevens, 2001)

According to Biley's review, music has been used in critical care as well.
However, he claims that there are no clear conclusions that can be drawn from the studies he reviewed, since the changes found when the participants were exposed to music were miniscule, except that the participants' Psychological states were positively affected (Biley, 2001).

When discussing Music used for Mental Healthcare, Different types of music can have different effects. In one of the texts that Biley reviewed, written by C.W. Weidinger and A.S Demi, music with negative lyrics or themes could potentially have a negative impact on adolescents. In addition, they also mention that heavy metal music is the genre that had the greatest negative impact, if these negative themes are involved (Weidinger & Demi, 1991). However, despite these negative effects, music can have positive effects as well. Biley refers to a study by B.A Hamer (1991) which claims that music has the potential to improve one's ego, Social abilities and one's activity overall, all while decreasing the amount of psychotic symptoms in people who suffer from long-term mental health problems (Hamer, 1991).

One of the studies that are reviewed by Biley also explains the relaxing effects of music. The study explains the potential of relaxation through music, and how it helps the user by reducing their stress levels. However, the text argues that different music genres also potentially have different effects on the listener. The author of the text also argues that the definition of "relaxing music" is difficult, since different individuals may have different views on what "relaxing music" is. (Hanser, 1985)

Biley concludes the review arguing that all of the studies that were included in the review pointed towards the fact that music does have a positive effect on people by reducing stress and anxiety levels. However, Biley also points out that due to the varying variables that were studied, and the small sample sizes that were present during each study, no clear conclusions can be made on the effect of music.
He finishes his review by stating the following:

> "While there is a broad literature covering the application of music therapy as reported in medical press, there is general absence of valid clinical research material from which substantive conclusions can be drawn"
>
> - *Francis C. Biley* (2001)

Ever since the first studies regarding music therapy at its connection with relaxation in the 1800s, Researchers have continued to research the effects of music therapy. Recent studies regarding music therapy have shown that passive music listening could prove beneficial to people who suffer from depression. According to a review by Sonja Aalbers et al. where they compared the effects of music therapy together with other types of standardized therapy could improve patients mental health, instead of merely using standardized therapies. The results of this review showed that using music therapy together with other standardized therapies showed better results in reducing the effects of common symptoms of depression and helped the users' social functioning compared to merely using the standardized therapy. However, active participation from the participants is necessary in order for music therapy to succeed. To achieve this, the authors explain that user motivation must be kept high. The authors also argue that music therapy is not the better type of therapy, but rather that it is a great complement to already existing therapies in order to improve effectiveness (Aalbers, 2017).

In a study conducted by Shih, Huang and Chiang, listening to music while performing a task could potentially affect the user's performance in different ways. The authors tested people aged 20-24 years old, and they were tasked with performing a task while listening to music. The participants were split up into two groups, One group listened to music with lyrics, and the other groups listened to music without lyrics. Their findings showed that the group who listened to music without lyrics performed better in a work environment than those who listened to music with lyrics. The authors argue that music with lyrics is more of a distraction, since music with lyrics is considered a more complex stimuli than instrumental music, which in turn requires more attention from the listener which distracts them from performing the tasks they are given. (Shih, Huang & Chiang, 2012)

2.3. RELAXATION THROUGH VIDEO GAMES

Similarly to how music has been used for relaxing purposes, Video Games have in recent years been used for similar reasons. According to a study by Mandryk & Birk, people who suffer from depression or high levels of anxiety tend to play video games more often in order to recover from anxiety. In the study, they referred to the PHQ-9 test to measure how well the participants felt. According to their findings, those who suffered more mental health issues tended to play video games more frequently than the participants who had fewer, or no mental health issues. In their conclusions, they deemed video games as a suitable intervention for mental health issues, since video games were played more often by people who showed signs of depression (Mandryk & Birk, 2017).

In another study by Leonard Reinecke, most of the participants played video games in order to recover from different exhausting situations. The results showed that people who dealt with stress in an emotional way (for example: distancing themselves from the issue) were more keen on playing video games for recovery, than those who prefered to cope with stress using a problem-focused way, by finding and solving the problem causing stress. The study also showed that people who had access to less social support (E.g. Quality of social relationships, availability of assistance) tended to play video games in order to recover from work-related stress than those who had better social support. (Reinecke, 2009)

However, it must be noted that playing a video game for longer periods of time may reverse the relaxation effect, turning the game into a source of stress. As an example: In a study by Pryzblski, playing a game longer than 3 hours could potentially lower player satisfaction. According to the study, the highest levels of satisfaction are felt after a low level of play, which requires approximately less than 1 hour of gameplay to achieve. (Pryzblski, 2014)

In recent years, many studies have been conducted in order to pinpoint what exactly makes a game “relaxing” but the answers to this question have been varying. But, according to Rogers & Nacke there are games that are specifically made for relaxation. In these kinds of games, there are two important aspects that are used in order to make the game more relaxing: The first aspect revolves around simplified game mechanics. The use of simplified game mechanics are very important for a relaxing game in order to not overencumber the player. Games that incorporate puzzle-like elements or farming elements are a few examples of games that are considered relaxing. The second aspect is the use of a player-controlled gameplay pace. This can be considered the most important aspect since it allows the player to take their time with the game without the risk of being rushed by existing games systems or rules, such as time limits (Rogers & Nacke, 2017). A game that utilizes both of these aspects is Monument Valley by Ustwo Games (2014). The goal of the game is easily understood and it does not utilize time limits which allows the player to experiment with the puzzles they’re given at their own pace. However, despite Rogers & Nackes explanation about the two most common aspects of a relaxing game, games that utilize more complex mechanics could still be considered relaxing. They point out that games such as Stardew Valley (ConcernedApe, 2016), which houses more complex mechanics, can still be considered relaxing with the use of an open world, calming soundtrack, and with a slow, but steady gameplay pace where the player defines his/her own goals. (Rogers & Nacke, 2017)

Another way to create a relaxing game experience, as described by Lundgren & Björk, is to help the player achieve a state of “calm flow" which the authors describe as a mental state that is considered to be calm and meditative. In this state, the player feels that they have full control over the game without being under the pressure of stress or frustration. In order to achieve “calm flow” there are a few requirements that need to be fulfilled. First, the player will need to set up long-term goals which they can work towards during their game sessions. Second, the game’s difficulty should match the player’s skill, since a game that is too difficult could affect the player's experience negatively. (Lundgren & Björk, 2012).

The way that relaxing games affect us is varying, but according to a study by Jodi L. Whittaker and Brad J. Bushman, playing relaxing video games can have various benefits on an individual’s behaviour. According to their study, if a player were to play a more relaxing game instead of a violent one, they had a reportedly better mood than those that played a violent game. Examples of games used in the study were: Endless Ocean (Nintendo, 2007) as a relaxing game, Wii Sports (Nintendo, 2005) as a neutral game, and Resident Evil 4 (Capcom, 2004) as a violent game. After their gaming session, the participants were asked to help the researcher by sharpening pencils. The players who played the relaxing game were reportedly more helpful in helping the researchers than those who played more violent games (Whittaker & Bushman, 2012).

2.4. BINAURAL BEATS AND THEIR EFFECTS

Binaural Beats is a special type of soundwave that is used within the Binaural Beat Therapy. Binaural Beat therapy utilizes two sound waves that are played through headphones. Binaural works as follows: Two similar soundwaves are played, one for each individual headphone. The difference between the two soundwaves is their frequency value. The difference in frequency (Hz) causes the brain to hear an additional auditory beat that rises and falls with a frequency equal to the difference between the two soundwaves played through the headphones. This auditory beat is what is called a Binaural Beat. In an example by Lane et al, if the first soundwave has a frequency of 100 Hz, and the second soundwave has a frequency has a frequency of 110 Hz, the brain will perceive an additional auditory beat with a frequency of 105 Hz that falls and rises with a frequency of 10 Hz, which means that the frequency for the Binaural Beat is 10 Hz. (Lane et al, 1997)

A binaural beat can be placed into different classes depending on the frequency (Hz) value of the binaural beat. There are five classes of Binaural beats: Delta, Theta, Alpha, Beta and Gamma Waves. Each of these classes of Binaural Beats have different benefits for the listener when used within therapy. The first class is the Delta pattern. The binaural beats in this class feature frequencies between 0,1 Hz to 4 Hz. The Delta pattern represents the smallest binaural beats, and are commonly used to help people reach deep sleep. The second class is the Theta pattern. A binaural beat with a Theta pattern has a frequency of 4 - 7 Hz, and is often used for relaxation and can bring several benefits such as improved meditation, improved creativity, and better sleep. The third class is the Alpha pattern. This class features Binaural Beats whose frequencies range between 7-13 Hz, and are characterized by their ability to help the listener relax in order to reduce stress, similar to that of the Theta class. The fourth class is the Beta pattern. A Binaural Beat is considered a beta pattern if it has a frequency between 13 - 30 Hz. Unlike the previous classes, Binaural Beats with a beta pattern is often used to improve the user's concentration and alertness. However, Smith claims that there is a risk of the Binaural beat causing anxiety to the listener if the Binaural Beat is close to a frequency of 30 Hz. The Gamma pattern is the fifth class of Binaural Beats. Smith claims that this particular soundwave class is able to maintain the listener's arousal levels while they are awake. This class features the highest frequencies of Binaural Beats, with frequencies that range between 30 - 50 Hz. (Smith, 2019)

According to a study by Lane et al, the use of binaural beats could potentially help the user perform better during tasks. However, the effectiveness depends on what kind of class of binaural beat is used. In their tests they tested three groups, where the first group listened to a binaural beat of the beta class, and the second group listened to a binaural beat of the Theta class, and the third group listened to a binaural beat of the Alpha class. While listening to the binaural beats, the participants were tasked with performing a vigilance test for a duration of 30 minutes. According to their results, the people who listened to the binaural beat of the Beta class performed better in their tasks with a lesser amount of errors compared to the other two groups, but they also felt better while they performed them. In contrast, some of the participants of the groups who listened to the binaural beats from the Alpha and Theta classes mentioned that they felt that the binaural beat was confusing and made them unable to concentrate during their tasks. (Lane et al, 1997)

Binaural Beats have also been used by dentists in order to reduce patient anxiety.
In a study by Isek et al, they tested the effectiveness of using Binaural Beats to reduce anxiety while an individual is waiting for surgery. The participants were split into two groups, a control group, and an experimental group. While both groups received local anaesthetic during the operation, the experimental group listened to pure Binaural Beats of the Alpha type (9,3 Hz) in addition to the local anaesthetic. In order to gather data, the participants were asked to record how anxious they felt using a VAS (Visual Analogue Scale) before and after the intervention. The results showed that using Binaural Beats to reduce anxiety while an individual is waiting for surgery is rather effective. According to the VAS, the mean value of the experimental group decreased from 5,37 to 3,59, while the scores from the control group barely changed at all with a value from 5,52 to 5,39. (Isik et al, 2017)

In a study by Wiwatwongwana et al, the effectiveness of music and binaural beats was compared within a medical setting. In the study, the authors tested if the use of music and binaural beats for a one hour period could help reduce the anxiety levels of patients who were undergoing an eye surgery (cataract surgery), which require the patient to be awake to perform. The patients that participated were split up in three groups, where the first group listened to music infused with binaural beats as intervention, the second group listened merely to music as an intervention, and the third group which acted as a control group with no added intervention. For the Group that would listen to the Binaural Beat Intervention, the Binaural Beat would be kept at 10 Hz for 50 minutes. According to the results, both the musical intervention and the Binaural beat intervention was able to efficiently reduce anxiety compared to the control group. The biggest difference between the two interventions was that the people who listened to the binaural beats actually showed signs of a slower heart rate compared to the other groups. In their discussion, the authors explain that decreasing the patients' anxiety levels before the surgery will increase their chances of success. This is attributed due to the fact that only local anesthesia is applied normally during a cataract surgery, and the fact that people who undergo a cataract surgery are awake during the procedure (Wiwatwongwana et al, 2016).

However, Sharma et al, writes in another study that Binaural Beats have one big flaw that potentially could negate the positive effects they grant. Sharma explains that binaural beats are often used either in short bursts or in longer continuous streams, but they are rarely used together in practice. The fact that not both are used causes a problem the authors call habituation. Habituation occurs when the brain subconsciously learns to block out the binaural beats due to their predictable nature. In their study they propose to create a system that utilizes both short bursts and longer streams of binaural beat signals in a randomized pattern, in order to reduce the predictability and in turn reduce the risk of habituation.
In order to combat habituation, they propose a system that features different modes based upon the desired effect of the binaural beats, such as relaxation, focus or meditation (Sharma et al, 2017).

3. PROBLEM IDENTIFICATION

Music has been used as a form of recreational tool used to relieve stress for centuries and as of late, many studies regarding the calming effects of music have proven that music can be used for not only relaxation purposes, but also for medical purposes to reduce patient anxiety before a medical trial (Bailey, 2001). Music has also in some cases been used as a type of therapy that is used in addition to standard types of therapy to assist in reducing anxiety levels from patients. (Aalbers, 2017) In a similar fashion, Video Games have shown that it can be used for relaxation, and is sometimes preferred for those in the younger generation. (Reinecke, 2009) Besides being merely used for meditation, Binaural Beats have also been applied to act as an relaxing agent to reduce anxiety which have provided positive results, with studies proving Binaural beats to be useful in surgeries (Wiwatwongwana et al, 2016). In some cases, a combination of the mediums have also proven to be effective to help the player relax. As an example: how relaxing music can improve the relaxing factor of a video game. (Rogers & Nacke, 2017)

However, despite all the positive results regarding these studies, there is little research regarding Binaural beats within video games. The goal of this paper is to fill this gap, and answer the question if Binaural Beats can effectively be used within a relaxing video game to assist in reducing the anxiety levels of a potential user, or if a normal Binaural Beat therapy session is more effective. This is important since a student's anxiety levels are especially high towards exams.(Burns 2004, Vitasari, 2010) Some of the mentioned studies in this paper, such as Wiwatwongwana (2017) and K.M. Stevens (2001), have used both music and Binaural Beats together as interventions in different medical situations. With this in mind, the author wishes to research the possibility of having a relaxing video game act as an intervention for people who are undergoing a stress inducing event.

Thus, this paper presents the following research question: "How effective can a Relaxing video game that utilizes Binaural beats in its soundtrack be at reducing the anxiety levels of a University Student?"

3.1 METHODS

In order to perform a test that can answer this question two specific items are needed. The first item that will be necessary is a video game. The game that was chosen for this test is Unpuzzle (KekGames, 2017). The game follows Rogers & Nackes definition of a relaxing game, as the game itself features easy to understand mechanics, and with its puzzle elements the player is allowed to play the game at their own pace. The player's goal in Unpuzzle is to clear various levels by dragging away puzzle pieces from the playing field until all of the pieces have been removed. Some pieces are locked by other pieces, which means that the player is required to unlock them by prioritizing other pieces. As the player progresses new mechanics are introduced, such as pieces that can rotate, and marked pieces that can only be removed together with other pieces who share the same icon.

As mentioned earlier in Chapter 2.3, games that feature simple mechanics will allow players from all skill levels to play the game. Complex mechanics and any mechanic that would speed up the gameplay pace, such as time limits, could potentially be regarded as stressful (Rogers & Nacke, 2017). Therefore, games that featured such mechanics were avoided. Another reason this game was chosen was to allow testing to be performed remotely, which makes testing easier to perform due to the COVID-19 pandemic.

The second artefact is the soundtrack that was played during the test. The soundtrack was composed in a similar way to already existing music used within music therapy and relaxing video games, such as the soundtrack from Monument Valley (Ustwo Games, 2014). The music was infused with Binaural Beats that belong to the Alpha Class, due to their positive effects in reducing anxiety and stress (Smith, 2019 & Lane et al, 1997). In order for the Binaural Beats to take effect, the soundtrack needed to be of a certain length. And according to the test by Lane et al, a session of Binaural Beats therapy usually needs to be 15 - 30 minutes long, in order for the brain to take advantage of the effects. Applying Binaural Beats in this manner is similar to how Wiwatwongwana et al applied Binaural Beats with music in their test, where one of their artefacts was music which contained Binaural Beats (Wiwtwongwana, 2016). For this test, however, the Binaural Beats that were created for the soundtrack were created manually through a DAW (Digital Audio Workstation) instead of utilizing a randomized system like the system Sharma (2017) proposed in their study.

The presented research question was answered by comparing the effects of three types of therapy interventions before a stressful event, which in this case refers to an important exam. The first intervention will be the proposed video game as mentioned above. This version will have Binaural Beats infused in the soundtrack. This was later compared to the second intervention which consists of the same game, but also of another version of the same soundtrack without the Binaural Beats. The third group consists of a regular music therapy session that uses the same soundtrack that was composed for the video game therapy with Binaural Beats. This way, it will be easier to discern if the gameplay aspect from the first intervention helped the participants to relax better than a regular music therapy session. The targeted sample group for this study are students that are currently studying, or recently finished studying, at a University-level Course or programme. This refers to people within the age group of 18-25.

In order to acquire the data needed to answer the research question, a combination of qualitative and quantitative gathering methods was used. The data was acquired using laboratory tests through online chat services such as Discord and ZOOM, and through interviews and questionnaires before and after the therapy session. The Laboratory test required the user to perform interviews, and then partake in one of the three therapy types. After their therapy session finishes, the participants undertake a second interview. The interviews themselves were used to gauge the participants current mental state, which was vital in order to answer the effectiveness of the three interventions. The interviews themselves contained questions regarding how they felt about their upcoming exam, what it was about, and a VAS where the participant scored their own anxiety on a scale from 1-10 where 1 represented “no anxiety”, and 10 “represented “A lot of anxiety”.

The interviews were transcribed during the interview process. After the tests were finished, the results from the VAS were compared in order to ascertain which intervention type was more effective, and the answers from the interviews will be checked in order to search for keywords which could explain why a specific intervention type was, or was not, effective in reducing participant anxiety.

It is important to note that before any testing took place, every participant was notified about the purpose of the study, and they were also told that they have the right to withdraw from the test at any point, in which case no data will be collected. The tests were also held anonymously to ensure the participants' privacy will not be compromised. The participants were also told that they had the right to cancel their participation at any time.

3.1.1. SAMPLE OF THE INTERVIEW / VAS

The following chapter will feature an example of the questions that the participants answered during the interviewing process.

INTERVIEW PART 1:
The first part of the interview starts with a few questions regarding their current studies and stress.

- Please rate your current stress levels on a scale from 0 - 10 - This question will measure the participants current stress level, the results from this question will be compared with the results from the similar VAS in the second part of the interview (0 = No stress, 10 = A lot of stress)

- What are you currently studying? - Depending on the answers received, it is possible to conclude if a specific course is considered more stressful than others

- Are you currently for an important assignment for your course?
  If the answer is yes, what is the more stressful part - Preparation, Execution or something else?

- What do you think is the primary cause of your stress? - If the participant isn't stressed about school, this question may shed some light on what could potentially be causing stress for the participants. Otherwise, the participant may describe the most stressful part of their current course in more detail.

The participants will then partake in a therapy session in between the interviews. Depending on which group they are placed in, the Intervention type will vary. Group A will play the game with Binaural Beat music, while Group B will play the game without Binaural Beat music. Group C on the other hand, will undergo a normal Music therapy session using the music with Binaural Beats. Each test is expected to take around 13 minutes to be completed.

INTERVIEW PART 2:

The second part of the interview will begin with a second VAS and will be followed up with questions regarding their experience with the test.

- Please rate your current stress level on scale from 0 - 10 - Similar to the VAS from Part 1, the results from this VAS will be compared with the results from the previous VAS, to see if there are any changes in the participants' stress levels.

- Did you find the test relaxing? Why / Why not? - This question is asked in order to figure out what aspect of the test is the most relaxing. In addition, this question can be used to describe why the therapy session worked, or why it didn't.

- Was there any aspect of the test that you found relaxing? (Gameplay, Music, Visuals, etc.) - This question seeks to answer which of the aspects of the therapy session which were the most noticeable to the participants.

- Other Comments - If the participants have any other comments regarding the test, they can express those at the end of the test. This question may provide information that the previous questions may have missed.

3.2. METHOD DISCUSSION

The use of Video games was debated, since creating a video game from scratch would require many hours of work to complete. As a result, having a physical game, such as a jigsaw puzzle or a crossword puzzle, was considered as an alternative since they would require less work to prepare in comparison. However, in order to make a clearer connection between video games and Binaural Beats, the former option was chosen instead. However, as the author has not created a video game from scratch on his own before, the choice was made to instead choose a game that fit Rogers & Nackes (2017) description. This was done to save time, and allow progress on other necessary aspects of the study.

The choice of participants was based upon two specific reasons. The first reason was inspired by the various studies that depicted student stress, such as the studies by Vitasari et al (2010), Burns (2004), and Jaap et al. (2020). According to these studies, it becomes clear that student stress is often related to exams and other important assignments, which makes them good candidates to test with during exam periods. The second reason university students were chosen was because they were easier to contact, and have more knowledge in how to use chat services such as Discord and ZOOM.

The reason why Unpuzzle (KekGames, 2017) was chosen was due to the fact that among all the possible games that was available, Monument Valley was the best choice in terms of how well it followed Rogers & Nackes (2017) description of a relaxing game, as the game features simple controls and mechanics, and also allows the player to play at their own pace. The game is also available to play online through Kongregate.com, which allows the participant to access the game from their own home. This allowed the testing to be held without exposing the participants or the researcher to the COVID-19 virus.

If the pandemic weren't an issue the test would've featured the game Monument Valley from Ustwo Games (2014) instead. Rogers & Nacke used Monument Valley as an example of a relaxing game in their study, which would have made the game a perfect choice, since it follows Rogers & Nackes description of a relaxing game. Holding a meeting over ZOOM might complicate things, due to the risk of sudden interruptions through technical difficulties or through a third party (Roommates, Family Members or Pets). However in the light of the currently ongoing COVID-19 pandemic, it is more effective to perform a test like this through a video call through specific applications such as ZOOM or Discord in order to prevent the risk of exposing the participants to the virus.

The reason why interviews and laboratory tests will be used to gather data is because the data that the study is searching for requires more precise and detailed answers. In addition, the tests will be conducted online through chat services such as Discord or ZOOM, which makes it possible to hold interviews with the participants, and to hold the experiment without the use of an external room. The reason why all of the interviews and testing were held online is due to the COVID-19 pandemic that is currently on-going as this study is being worked on. This was inspired by Jaap et als study where they researched the effectiveness of online tests compared to tests that were held on campus (Jaap et al, 2020).

The choice of having Interviews is the sole reason why the amount of required participants is small. According to Martyn Denscombe, interviews and laboratory tests are common options when searching for more detailed data. (2014) However, Qualitative tests like these require a lot of time to complete, which means less people can participate in the tests. In comparison, Quantitative methods are best for gathering smaller, but more frequent amounts of data that can be measured, or when you need shorter answers to several questions, such as questionnaires. These tests are fairly quick to complete, which allows more potential participants to participate. (Denscombe, 2014).

In order to measure the participants anxiety levels, quantitative methods must be used. During the interviews, each participant will be given a questionnaire to answer, in order to pinpoint their current anxiety levels. The questionnaire will be based upon the VAS method used by Isik et al (2017) in their study, which utilized a few simple questions that could be answered on a scale from 1 to 10. These questionnaires will then be compared with one another in order to see if the participants anxiety levels changed during the therapy session. The results from the scale will allow the author to pinpoint which of the therapy sessions are the most effective, but they won't be able to tell why they are effective. However, since interviews are incorporated into the study design, the participants may still be able to give their opinion on the matter, and explain why the therapy either worked, or did not work. However, it should be noted that due to the small number of possible participants for this test, the answers from the questionnaires may not present any concluding results.

The use of a randomized system for the Binaural Beats, similar to the one Sharma et al (2017) describes in their study, was considered. This idea was rejected due to time constraints. The soundtrack in this study uses a more linear system instead, where the Binaural Beats are directly incorporated into the soundtrack. However, this design choice comes with its own issues. Because of the linear nature of binaural beats, the issue of habituation will remain, which could have a negative impact on the test results. However, the reason why this linear system was chosen over a randomized system is because habituation is a problem that is based on overuse. This problem will be negated due to the fact that the soundtrack that will be used for this test will be specifically composed for this study, which means that the music will be new for everyone who participated. This in turn, greatly decreases the risk of habituation.

4. RELATED RESEARCH

This chapter will bring up research that is not fully related to the proposed research question, but may contain information that could explain other aspects of the study, such as the design choices for the experiment that has been presented. As such, the sources mentioned in this chapter could potentially be referenced in the upcoming chapters.

4.1. IMPORTANCE OF MUSIC IN VIDEO GAMES

The audio within video games is a crucial part of a video game, as it fills many different roles depending on what the game requires of it.. According to Winifred Phillips, music may act as representation of a specific State of Mind, as a World Building tool, as a Pace Setter, or even as an audience. (2014)

When music is used to represent a state of mind, the role of the music is to help the player reach a specific mental state called “The Zone”. This mental state is characterized by the player feeling full focus towards the game, in such a way that they concentrate fully on it. Phillips explains that there are many ways to create music that can help the player to reach “The Zone”, but it is important for the composer to think about what musical techniques to use in order to best simulate the state of mind that best represents “The Zone” for the game they are composing for. According to Phillips, Puzzle games and Strategy games tend to use music in this fashion, in order to help the players focus on the tasks they have in the game. (Phillips, 2014)

When music is used as a World Building tool, it has the goal of assisting the other aspects of the game (Graphics, Narrative and game design) in order to create a more immersive experience for the player. The music can be used to tell the story of the environment the player is exploring, and to help tell a character’s backstory to make it feel more impactful to the player. Music is often used for this purpose, but it is most commonly used in Adventure games and RPGs (Phillips, 2014).

The third role music has in video games is to act as a pace setter. When the music has this role, its goal is to help the player in making intense gameplay situations more intense with the use of high tempo music and to help players relax when the high activity gameplay sections have ended with music that features less activity. The best way to use music in this role is to compose music in such a way that the High-activity gameplay segments, and the low-activity gameplay sections feel linked. That way the gameplay experience will feel more unified, which in turn will ensure that no excitement is lost from the transition from a high-activity section to a low-activity section. According to Phillips, Action games, Racing games and Fighting games are well suited to use music as a pace setter, as they usually create high levels of excitement through their gameplay (Philipps, 2014).

According to Phillips, Music can also be used as an audience. What she means by this, is that the music reacts to the player's actions on screen. This role is widely used in video games across many genres. Phillips claims that this trope is almost as old as the video game industry and is still being used to this day. Common uses for this role is to congratulate the player on a won battle, to inform the player of a game over, or to inform that the player has managed to solve a puzzle. These songs are often short, but they can be woven into other larger tracks to make the soundtrack more dynamic (Phillips, 2014).

When discussing the Music that is present within a relaxing game, Rogers & Nacke explains that the role music has is to alter the player's perception of the game, and to increase the players' immersion, which means that creating a soundtrack that fits the game is important. Rogers & Nacke have also argued that music in video games could potentially be used within regular musical therapy, since many soundtracks from video games can be bought separately. However, even though some video game soundtracks are created to specifically be relaxing or absorbing, no actual research has been made to confirm if video game soundtracks can be used for regular music therapy. Rogers and Nacke argue that more studies on the matter could potentially answer if music itself is the most relaxing factor, or if the combination between music and gameplay create a more relaxing experience (Rogers & Nacke, 2017).

5. PROJECT DESCRIPTION

This chapter will explain two important aspects of the test.
The first one will describe some changes in the project that were recommended by two professors working at the University of Skövde, and how they were implemented.
The second aspect will describe the creation process of the artefacts, and how they relate to the current study.

5.1. CHANGES TO THE TEST DESIGN

While preparing the test for this study, the author managed to contact two professors from the University of Skövde in order to get advice on how to create a more precise test design: Sakari Kallio - Lecturer for Biosciences, and Sakari Suominen - Professor for Health Sciences.

When discussing the project with Sakari Kallio, Kallio explained that it would be good to keep the rule “cetris paribus” in mind when designing the test. Kallio explains that cetris paribus means that in an experiment, the control group and the experimental groups should be similar in all aspects except the one variable that is tested (In the case of this study: the use of Binaural Beats in a relaxing video game compared to a normal video game soundtrack). Kallio also recommended that three should be three different test groups, instead of two. He argued that by using three groups, not only will the test be able to answer the question if a video game with binaural beats are more effective in reducing stress than a video game with a normal soundtrack, but also if the usage of video games in a therapy session is more effective than a normal test. Kallio also pointed out that if an experiment is too long, possible participants may not be interested to participate, which created the need to reduce the test time. Due to this, the amount of time required for the test was reduced from 20 to 15 minutes. In terms of test design, Suominen considered the use of the VAS a good idea, when gathering quantitative data. He also stated however, that due to the small size of the participant groups, there is a risk that no clear conclusions can be drawn, except if the results from the different groups show large differences. He then recommended the author to use Statistical Power, in order to assume how many people that would be required in order to produce satisfactory conclusions, if no possible conclusions can be drawn from the final results. However, the statistical power for this study will not be calculated. This is because of time constraints, which prevents the statistical power to be calculated in an effective way.

Denscombe, in his book “The Good Research Guide: For small-scale research projects”, also warns against tests that involve too few people during research. Denscombe argues that at least 30 people are required for a test to be considered statistically correct. Otherwise, care must be taken when presenting the results. However, Denscombe also argues that in certain cases, a smaller sample group can be useful for specific studies. Especially if the chosen methods for the study gathers qualitative data, or if the goal of the study is to explore a field, rather than represent it. In such a case, it is never clear on how large the required sample for the study is from the outset, but instead becomes more clear as more details about the study becomes set in stone (Denscombe, 2014)

Despite the small groups, Suominen acknowledged that the results may still be used as a guiding arrow, if there are two interviews for the test, where the first is held before the experiment, and the second interview is held after the experiment. This is a design choice that Isik et al used in their study, so a similar design was implemented to this study.
When discussing the matter of the intended participants, Suominen recommended that all the participants should be healthy, which would make the final analysis easier to perform, and the results easier to interpret.

According to both the professors, there was no problem with the project in an ethical way. According to Suominen, Binaural Beats combined with Video Games poses no threat at all to the participant or their health, which created no obstacles for the test ethically. He also explained that there should be no cause for concern regarding the participants' privacy either.

5.2. ARTEFACT PRESENTATION

To start the creation of the artefact, research regarding what relaxing music is had to be conducted. As previously mentioned in chapter 2.2, Bailey explained that Classical music has been considered relaxing since the 1800s, mainly due to the genre's relaxing effects during therapy (2001). This makes the genre an ideal choice for this test. However, in more recent times, the use of New Age music, which often utilizes synthesizers, soft pads and ambiance in combination with strings or woodwinds. An example of New Age music is the mix "Relaxing Sleep Music • Deep Sleeping Music, Relaxing Music, Stress Relief, Meditation Music (Flying)" by Soothing Relaxation on Youtube (2016). This song tends to use a combination of soft pads, ambiance and orchestral instruments, such as woodwinds, pianos and violins to create its sound. These two different music genres became the foundation for the artefact that was created for this study.

However, since the music composed for the test is to be played together with a video game, it became important to take the game in mind too during the composing process. As previously stated by Rogers & Nacke, the music in a Video Game has the ability to alter a player's perception of the game. This means that the music can alter the player's mood to a specific mindset.

The artefacts themselves are two versions of a music mix with two music tracks, which both feature elements of New Age and Classical Music. One of the versions will contain Binaural Beats, while the second version will not. The music that was featured in this study was created in the DAW Cubase Elements 9.5 (Steinberg, 2019), and features the virtual instruments Kontakt from Native Instruments (2018), and Hybrid 3 from AIR Music Technologies (2015). In this chapter, the creation process of both the music tracks will be presented in detail. First, the macro analysis of each track will be shown. This defines the chosen Key, Tempo and chords. Second, The choice of instruments and effects will be explained. Third, an explanation of how the Binaural Beats were implemented in their respective versions. The music tracks will be presented in order of appearance. The Binaural Beats in this artefact were created with the Binaural Generator which was created by the company SaschArt. (SaschArt, 2020)

It should be noted that the total runtime of this mix is 6 minutes and 33 seconds, which according to previous studies is not enough time for the Binaural Beats to affect a person. Thus, the mix will be looped once, bringing the total runtime to 13 minutes and 6 seconds, which will allow the Binaural Beats to give a more apparent effect (Lane et al, 1997 & Wiwatwongwana et al, 2017).

5.2.1. Music Track 1: Tranquil Mind

Form: A - B - A1 - C - B

Beat Type: 4/4

Tempo: 75 bpm

Key: A Minor

Part A/A1 Chords: C, Am, D

Part B Chords: Am, D

Part C Chords: Am, D

The first song in the mix, which was given the name Tranquil Mind, was created with a minimalistic New Age style in mind, hence the few chords that are present.
The New Age theme in this arrangement has also taken inspiration from the original soundtrack to Monument Valley (Ustwo Games, 2014), which features music with elements from the New Age genre. The synthesizers are the most important instruments in this arrangement, as they act as ambiance, bass and the leading instrument for most of the arrangement. The ambiance consists of the Relaxation preset within the AIR Hybrid 3 synthesizer (2015), and a pre-recorded fountain. While the Synthesizer was chosen for its natural fit within the theme of relaxation, the fountain was added due to positive personal experiences with rain effects in music.
Similar to the ambiance and the leading instrument, the bass featured is also a part of the Hybrid 3 instrument, which used the preset “Soft Soul Bass”. The fountain ambiance is present throughout the entirety of this arrangement, however due to the recording being shorter than the arrangement of Tranquil Mind, multiple instances of the recording had to be added. The transition between the different instances were masked by creating a crossfade effect. The arrangement also makes use of the Virtual Instrument Kontakt (Native Instruments, 2020) and the Library “The Giant”. This library contains a specific piano which in this arrangement plays the majority of the bass tones chords.

Figure 1: A View of the “The Giant” instrument within the Kontakt VST. This screenshot shows what options were selected for the instance of the instrument used in this project.

Part A starts very light and minimalistic, using only singular notes on “The Giant" piano in combination with the fountain ambiance and the Hybrid 3 Synthesizer using the Relaxation preset. This was done to create a gentle start to the arrangement, since using too many instruments without proper build-up could potentially ruin the relaxing atmosphere that the music is attempting to embody. The use of the Relaxation preset in the Hybrid was inspired by the New Age genre, which tends to use Synthesizers as Ambiance in their music. (Soothing Relaxation, 2016) Because of this design choice, however, it becomes difficult to distinguish any of the chords played, due to the lack of important notes in the chords. An additional synthesizer which played the bass tones was also added in order to fill out the sound. The mentioned bass used a preset called ”Soft Soul Bass” which is a library within the Hybrid 3 Synthesizer. After a brief pause in Bar 9 and 10, where the synthesizer ambiance from the Hybrid 3 (2015) slowly fades, Part B starts to play.

Figure 1: A Picture of the Hybrid 3 Synthesizer, which is used in this project. This picture shows how the Harmonyx preset is structured.

In part B, the Harmonyx synth is introduced after a short melody from the piano.
The piano alternates between playing the Am chord and a D chord. While the Am Chord is easy to hear, the D chord might be difficult to hear, due to the lack of the third tone in the chord, which is B minor. This was done to make the melody simple to digest, since the goal is to help the user relax. As shown in the chord analysis, the main chords here alternates between A minor, and D major. At the same time as the Harmonyx synth is introduced in Bar 15, the Relaxation ambiance starts playing again. The Harmonyx synth acts as the lead instrument in this segment, as it plays the main melody. The Ambiance from the Relaxation preset alternates between playing C and D in order to fit the chord that is played, with the note C being the third note in the Am chord, and the note D being the first tone in the D chord. To finish this part, the Ambiance plays the note D for five beats (From Beat 22 to Beat 26), all while the Harmonyx synth plays the melody on Beat 24 and Beat 26.
In order to ensure that none of the instruments would be hearable, some instruments, especially the piano, had their velocity decreased. The velocity in this case is referring to how loud the notes are, or how hard the instruments are playing them back. By reducing the velocity from the piano, sounds from the other instruments did not risk having their sound drowned out. Similarly to the previous parts, the bass synth still plays the tonic of each chord

Part A1 is introduced on Beat 28. Part A1 is rather similar to Part A, but features a few additions to differentiate itself from part A. The piano now plays the Bass tones, and adds the fifth tone in the chords C and D while the third is added to the Am chord, in comparison to the bass synth which still only plays the tonic of each chord. At the end of Bar 33 and 35, the piano plays some extra notes, in order to prepare the listener for the next part of the arrangement. During the course of Part A1, the melody from the Harmonyx is played, with

the same melody that was played at the end of Part B. The ambiance from the Hybrid 3 instrument and the fountain recording are used here in a similar fashion to Part A with no changes.

The piano becomes the lead instrument in part C, with the Ambiance from the Hybrid Instrument and the Fountain in the background. The Harmonyx synth is not used in this part of the arrangement. Compared to the other parts in the arrangement, the Relaxation now plays the bass tones, which are A and D of each respective Chord. In this part, the chords are more distinguishable, since the piano plays the thirds of the chords in this Part. After Part C, the Arrangement ends with Part B being played one final time, with the arrangement ending with the sound of the Fountain fading out. In the replay of Part B, no major changes were made in the arrangement.

5.2.2. Music Track 2: Spring Garden

Form: A - B - C - A1 - D - A2

Beat Type: 4/4

Tempo: 75 bpm

Key: G Major

Part A/A1/A2 Chords: G, Csus4

Part B Chords: G, C, G, D

Part C Chords: Am, D, Am, D

Part D Chords: G, C, G, D

The second track, “Spring Garden”, draws more inspiration from classical arrangements than the previous track. This is because of Bailey’s description of how classical and orchestral Music has been used for relaxation purposes ever since the 1800s (Bailey, 2001). Despite this, Spring Garden also utilizes some New Age elements with the use of the Harmonyx synth from the Hybrid 3 Synthesizer being used in this track. Aside from the Harmonyx synth, the piano “The Giant” is also being used for this track. Other similarities “Spring Garden” has with “Tranquil Mind” is that not only do they share similar instruments, but they also share the same tempo at 75 bpm. This was done to create a connection between the two music tracks, to make them feel like they are a part of the same soundtrack.
However, ”Spring Garden”, features more varied instruments than the track “Tranquil Mind”. In this arrangement, there are three sets of strings and a set of shakers that are added to the instrumentation. The first string section acts as melodical stems that complement the melody that’s played by the Harmonyx synth. The second set of strings, the Bass Strings is used throughout the track, and acts as the arrangements bass instrument. The third strings section consists of Pizzicato strings and they are featured in Part C of the arrangement.

The string instruments that are featured in this track come from the Kontakt libraries “Session Strings” and “Kontakt Factory Library” which are usable through the Kontakt Virtual Instrument (Native Instruments, 2018). The shakers are from the Kontakt Library “DrumLabs” (Native Instruments, 2018)

In Part A of Spring Garden, The arrangement starts with “The Giant” piano playing a little melody along with the chords G and Csus4. At the start of Bar 71, the lead melody from the Harmonyx synth is introduced to the arrangement. Similarly to “Tranquil Mind”, “Spring Garden” only uses a few instruments in the introductory part in order to ease the listener into the arrangement, in order to prevent the start from being too sudden.

At the start of Part B, the string of chords change (see the chord analysis above).
At the same time, the Sustain strings, the Bass strings and Shakers are added to the arrangement, creating a more full experience. The Sustain strings play in different parts alongside the Bass Strings which play the bass tones of each chord, which in this part alternates between G, C, G and D. The role of the shakers is to act as rhythmic percussion, which adds to the experience. At the start of Bar 79 in the mix, the Harmonyx synth is introduced as the leading instrument. The melody played by the Harmonyx synth melody is repeated once before the “The Giant” piano finishes Part B at the end of Bar 86 with a transition that directly leads to Part C.

Part C begins differently than the other parts in the arrangement, as it starts with the A Minor chord, which then leads into a D chord. The two Chords alternate with one another through the entirety of Part C. The reason why Part C is composed this way is to change up the style of the arrangement for a slight moment, in order to decrease the predictability factor of the arrangement. If the Binaural Beat version would become too predictable, the risk of habituation would increase, which in turn would harm the effectiveness of the Binaural Beats. However, while the melody and the chords have changed, the present instruments and their respective roles have not (Sharma et al, 2017). The rhythm played by the Shakers has been altered in this part for similar reasons.

The start of Part A1 is similar to that of Part A, since they both start off with the piano playing a short introductory melody. After the short intro to A1, the arrangement plays out in a similar fashion as Part A, but with the addition of the Sustain Strings and the Bass Strings. The Sustain strings play complementary stems to the Melody that is played by the Harmonyx synth. The shakers return to playing the same rhythm that is present in Part B. This part then leads directly into Part D with a short transition from the Sustain strings at the end of Bar 105.

In Part D of “Spring Garden”, the roles of the Harmonyx synth and the Sustain Strings are switched, with the Sustain Strings playing the lead melody while the Harmonyx synth plays an accompanying stem to the melody. In this part the Piano and the Bass Strings are silent in favor of the Pizzicato Strings, which are present for this part only. The Pizzicato Strings takes on the role of playing the chords and the bass tones in a less direct fashion, as seen in Figure 3 below. The shakers are playing a different rhythm in this part, with a single “shake” being played every second beat.

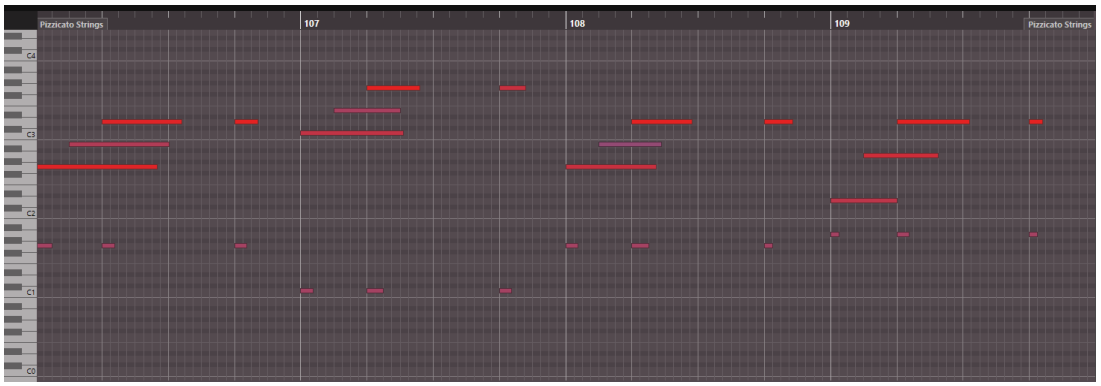

Figure 3: A visual representation of how the Pizzicato Strings are played in Part D. Note how the notes in each chord are played one after the other. The smaller notes below on the piano are the bass tones which play the tonic of the current chord.

After Part D has concluded, a short intro plays that leads into Part A2. Part A2 is structured similarly to Part A1, with the only exception being a different melody being played in the sustain strings. The Arrangement then ends in a C chord.
In the Binaural Beat version of this track, the Binaural Beats will completely fade out across 2 beats, signaling that the therapy is over. This will be used to clarify to the participants that the test itself is completed.

In the Binaural Beat versions of the music tracks, the Binaural Beats were played at a similar frequency as the tonic notes in every chord. This means that depending on the chord that was played, the frequency of the Binaural Beats would change as well. As an example: If the A minor chord is played, the frequency of the two sine waves would be 110 Hz and 118.2 Hz, while a D Major chord would have sine waves with the frequencies 147 Hz and 155.2 Hz. The Frequencies for each note was found with the help of the guide Physics of Music created by B. H. Suits (1998). However, changing the frequencies of the two sine waves did not affect the frequency difference between them in any way. This is because the Binaural Beat Generator that was used had the ability to maintain the frequency of the Binaural Beat by altering the value on the “Binaural” Slider (A visual example to this is seen in Figure 3 below). The reason why the Binaural Beats change their frequencies in order to match the tonic of a chord is to avoid dissonance, which can harm the listening experience. With this perspective in mind, the best option to avoid dissonance was to treat the Binaural Beat generator as its own instrument.

In order for the Binaural Beats to be effective, they needed to be heard at all times (Lane, 1997). This required the entire arrangement to have their volume altered, in order to allow the Binaural Beats to be heard. While working with the Binaural Beat Generator, it was instead treated like a sound effect instead of being treated like a normal VST. This prompted me to utilize Automations in order to Edit the Binaural Beat in real time, instead of utilizing a MIDI-controller. However in order to create the Binaural effect, the Audio Track that featured the Binaural Generator needed to be copied so the two sound waves could be played from each side. The soundwave panned to the right played the Base Frequency, while the soundwave placed on the left played the Binaural frequency.

Figure 4: A view of the Binaural Beat Generator. The Generator is playing a frequency that is similar to the tone D3, which has a frequency of 147 Hz. The Binaural slider shows what frequency the Binaural Beat has.

The frequency difference between the two beats (also known as the Binaural Beat) was kept at 8.2 Hz, which is considered an Alpha class Binaural Beat according to the description of Lori Smith (2019). The reason this Binaural Beat was chosen for this arrangement is because of previous studies proving their effectiveness in reducing anxiety. As an example, in the study by Wiwatwongwana, the Music featured in the study featured Binaural Beats of the Alpha class, which turned out to have some effectiveness against stress, and lowering the patients' heart rate (2016). This made the Alpha class a perfect choice for this test. However, this was not the only possible choice. According to Smith, since Alpha waves and Theta waves (5-7 Hz frequency difference) have similar relaxing effects (2019), It would've been a possible alternative to use Binaural Beats of the Theta class instead of the Alpha class in the arrangements.

6. ANALYSIS

In this chapter, the results from the study will be presented and analyzed in order to find possible clues whether or not a video game with Binaural Beats could potentially be used as a potential alternative to regular music therapy. In Chapter 6.1, the results of the study will be presented, and the results will be presented by group. The results will later be analysed and compared between each other in Chapter 6.2.

6.1. TEST RESULTS

A total of 16 people participated in this study, all of which are currently studying, or recently finished, a University Level course or programme. All of the participants were split into groups of 5, with the exception of Group A which had 6 participants.
In this chapter, all of the participants will be given nicknames depending on their group and the order they participated in their group (Example: A-1, A-2, B-1... etc.).
During the test, all of the participants were asked the same questions during the interviews, but the type of experiment varied depending on which group they were placed in. As previously stated in Chapter 3.1.2., Participants in Group A tested with a video game with Binaural Beat music, Group B tested with the same video game but with music without Binaural Beats, and Group C listened to the music with Binaural Beats in a normal music therapy session. The goal for Group A and B was to play the game Unpuzzle (KekGames, 2017) while listening to the music that was created by the author for this test. However, the original music from the game had to be muted. The only original sounds that were not muted were the sound effects.The only goal they were given was to play the game at their own pace, and that the test ended after 13 minutes had passed. Group C, on the other hand, were tasked with listening to the music while attempting to relax. The participants in Group C were also informed about how long the track was.

The tests themselves were held online using services such as Discord and ZOOM. This was done due to the current pandemic brought difficulties in finding physical locations to perform tests in. In order to allow data to be collected, the author held the interviews through these chat services, and used the service to stream the music live to the participants, while participants from Group A and B streamed their gameplay sessions at the same time. Group C did not need to stream anything from their side, since they were not required to play any game for their experiment.

In this chapter all of the results will be sorted by Group, while the answers from the different groups will be compared in the chapter “Data Analysis” (Chapter 6.2.). The full answers on the interview questions from each participant are available in Appendix A.

6.1.1. RESULTS FOR GROUP A

Group A's answers on the first VAS regarding their stress were usually valued around 7. The lowest answer on the VAS belonged to participant A-3 who answered 3. The highest answer belonged to A-4 with an 8. The mean value from the VAS for Group A was calculated at 6,42.

All participants in Group A were students studying a course related to IT studies, such as Web Development, Video Game Programming, and Big Data Studies. According to the answers from Group A, they were all currently performing at least one important assignment for their course and they also expressed that their studies were the biggest source of their stress at the moment. When they were asked about what part of their studies were the most stressful, the most common answer was related to their planning and preparations to their studies such as gathering information. A-2 developed his answer further and said that it became harder to study ever since their studies were adapted to be fully taught through online classes, and it became even more difficult due to his studies being a Master's level course.
A-4 and A-5 were more stressed regarding their performances, especially since they have multiple assignments to complete with their own specific deadlines.
Participant A-6 was the only participant who did not have an important assignment, since they recently had completed their studies. This however, caused another stress source to appear, which was the stress of trying to find a job.

After Group A had participated in the experiment, their updated VAS scores from the second VAS showed a significant change, with the majority of the participants dropping their VAS scores by 2 points. As an example: Participant A-2 changed his VAS score from a 7 to a 5 after they took part in the experiment. The only participant who broke this trend was participant A-5 who, after participating in the experiment, halved their score of 7 and turned it into a 3,5 in the second VAS.
The mean score for Group A's second VAS was lowered to 4,16.

All of the participants found the test to be relaxing, and the majority thought that combining the calm music with a puzzle video game created a calming experience. As an example: A-5 answered that the combination of playing the game and listening to the music, allowed them to think about something else, which gave their current sources of stress no place in their mind. A-3 thought that the music was the most relaxing aspect, since it reminded them of space. A-2 however thought that the experience was hampered due to the music clashing with the sound effects from the game.

Other than the test being a fun experience for the participants, there were not many comments that were added regarding the test. A-1 thought that the test went a little too fast, and A-4 who wished they had muted their discord app before participating in the test. A-5 mentioned that they could have played for a little longer.

6.1.2. RESULTS FOR GROUP B

Group B had in total the lowest scores on the first VAS, with the most common answers being 3 and 4. The Highest score came from participant B-4, who valued their stress at a score of 6,5. Together, the mean score for Group B's VAS answers was 4,1.

The majority of the participants in Group B studied IT related studies such as Web Development, but other studies were reported. B-1 for instance studied Cognitive Neuropsychology, while B-5 studied a Master's course in Leadership.
When discussing their current studies, B-1, B-2, B4- and B-5 considered that they were currently working on an important assignment for their course, ranging from group projects to written assignments. Some participants, like B-1 explained that searching for previous research for their assignments was rather stressful. Participant B-4 had a similar story, in which they were required to prepare multiple presentations and reports, which caused them some stress. B-2 stated that the 10 minutes before a test are the most stressful, but they also stated that their stress levels lowered drastically when they were actually doing the test. B-5 stated similarly that the few moments before you start taking a test are the most stressful. B-3 on the other hand, did not work with any assignments.

While some participants from Group B said that their main source of stress were related to their studies, the main sources of stress for this group were more related to their future after their studies, such as getting a job, or working on their own projects.
B-1, B-2 and B-5 had feelings of stress towards the future in this regard.
Participant B-3, on the other hand, were stressed and worried about the health of one of their parents.

After the experiment, Group B's answers on the second VAS showed only slight changes for some participants. Participants B-2 and B-4 showed a slight decrease in stress, with the scores 2,5 and 4 respectively. Participants B-1 and B-5 showed no change in stress, and recorded the same score as they recorded in the first VAS.
Participant B-3 actually showed an increase in stress from a score of 4 in the first VAS to 5 in the second VAS. The mean score for Group B's second VAS was 3,5.

The majority of the participants did find the test relaxing, pointing out that the music and the gameplay were good for relaxation. B-1 thought that the game allowed them to reach a state of flow. B-2 and B-4 both thought that the game itself allowed them to think on the game, and not on things that cause them stress (as in the case for B-2, other, more stressful games). B-5 thought that while the test was relaxing, they felt that the game was a little competitive, causing them to play at a faster pace. B-3 was the only participant to not think the test was relaxing, as they felt the game was fun but not relaxed. When B-3 was asked what the most relaxing aspect was, they answered that the music was relaxing since it made them sleepy, but the game made them feel exhilarated. The other participants were divided when describing the aspect they felt was the most relaxing. Participant B-2 thought that the game was more relaxing than the music, because of the game's unique concept of unpuzzling a puzzle. Participants B-4 and B-5 thought that the music was the most relaxing aspect. B-4 stated that the piano played a calm tempo, combined with another instrument created a calming experience, while B-5 said that the music allowed them to enter the "zone", a mental state where they felt they could focus on the game but still could relax. Participant B-1

however, thought that the combination of music and gameplay was the most relaxing aspect. When asked for further comments, some participants praised the test, stating that it was easy to understand, and the test itself was a fun experience.

6.1.3. RESULTS FOR GROUP C

Group C had the highest answer on the first VAS, with participant C-3 scoring their stress with a 9. Participants C-1, C-2 and C-4 scored their stress with a 8, 6,5 and a 7 respectively. Participant C-5, however, had the lowest VAS score in the group with a 3. Together they had a mean score of 6,7, which is the highest among the different groups.

The participants from this group had varying studies, with only two of the participants (C-2 and C-3) studying an IT-related course. C-1 was studying a course focused on Law Studies, C-4 was studying to become a veterinarian, and C-5 was studying Health to become an Occupational Therapist.

Everyone in Group C, except C-1, were currently working on an important assignment for their course. C-2 were working on their thesis work for their course, C-3 were working on a Group Project in which their task was to assign tasks to their colleagues, and C-5 was preparing for a presentation, in which the execution was considered to be the most stressful part. C-4 was studying on how to identify illnesses in pets and how to effectively treat them, and added that the stress comes from the art of trying to balance the act of finding and treating a pet's illness, while also making sure that the pet and their owner are comfortable. All of the participants in Group C considered that their studies were their primary sources of stress. As an example, C-1 was stressed because of the large amount of tests they had to complete online. C-3 added that they felt stressed about their family alongside their studies.

Group C's results on the second VAS showed that the stress levels from the participants who scored higher than a 6 on the first VAS actually decreased.
The biggest change came from C-3 who recorded their stress at a value of 3, compared to the first VAS where the recorded value was 9. However, the stress levels of Participant C did not change and kept their stress levels at a value of 3.

All of the participants in Group C found the experiment to be relaxing in different ways. A few examples of this: C-1 complimented the simplicity and the Harmony of the music, while C-4 Found the sounds from music very soft and calming. Participant C-5 added while the test was relaxing, it was not the kind of music they would listen to in order to relax, since the track had too many different sounds for their tastes. When the participants discussed the most relaxing thing about the experiment, they all praised different aspects of the music. C-2 for example, praised how the violins helped them to calm down. While C-5 did not think the entirety of the test was relaxing, they still felt that the moments where no percussion was involved in the music were the most relaxing. C-4 did not only think the music itself was relaxing, but the way the questions were structured during the interviews eased their anxiety for the test.

Group C had no other comments about the test, but they thought that it was a good test. C-4 even praised how good the test was structured, and how the music was composed.

6.2. DATA ANALYSIS

The analysis will be split up in two parts. In the first part, the results from the first interview will be compared with one another in order to analyze what kind of stress is most common for the participants. In the second part, the results from the second interview will be compared between the groups in order to distinguish which of the three therapy types are the most effective, and in what ways the participants were affected by their therapy experiences.

6.2.1. Interview 1

In the first interview, the results from the VASes showed that amount of stress each participant felt during the start of the Interview. The results from the first VAS are shown in Figure 5 below:

VAS 1	Group A	Group B	Group C
Participant 1	6	3	8
Participant 2	7	4	6,5
Participant 3	3,5	4	9
Participant 4	8	6,5	7
Participant 5	7	3	3
Participant 6 (A only)	7		
Mean Value VAS 1 =	6,42	4,1	6,7

Figure 5. The results from the first VAS. Group A and C had a similar value with a tiny margin, with Group B having the smallest mean value in regards to stress.

As seen in Figure 5 above, the participants in Group A and Group C had fairly similar scores on their VAS during Interview 1, with Group A having a mean score of 6,42 and Group C having a mean score of 6,7. The mean scores between these two groups had a 0,28 difference. The lowest scores from the two groups were also similar, with the scores from Participant A-3 and Participant C-5 who rated their scores at 3 and 3,5 respectively. Group B had the lowest stress levels in Interview 1, with a total mean score of 4,1. This is because the participants rated their stress rather low compared to the other groups, as seen in the figure above.

When comparing the answers from the groups, it became clear that Group A and Group B contained mostly IT students, in comparison to Group C, whose participants had different studies and subjects from each other, with Law Studies, Veterinarian Studies and Health studies being notable from the group. This creates a divide in the groups, since Group A and B consisted mostly of IT students and Group C consisted of students who studied in many different University programmes.

Across the different groups, all of the participants except participant A-6, B-3 and C-1, were doing an important assignment related to their studies. Among these participants, both preparation and execution were considered to be the most stressful part about their assignments. It was common that the execution was deemed more stressful if the participant

had more than one assignment to complete, as stated by participants A-4, A-5. These answers can be linked to the study by Vitasari et al, whose study explained that among the different sources of stress a student can have, with the exam stress being the most common type among university students (2010).

A smaller group of two participants (A-2 & C-1) commented on how studies held online affected them negatively. These answers are similar to some answers from the study by Stowell & Bennet (2010), where people who preferred doing tests on campus were more stressed about doing online tests, and vice versa. In the results for this study, Participants A-2 and C-1 explained that the reasons for this were that they could not learn as easily online as they could on campus, which made the studies more stressful. These answers can also be linked to Jaap et als study regarding tests being held online. In his study, Jaaps mentions that even if a student is able to work with online studies without losing any of their performance, some might still want to take tests on campus only because of preference. (Jaap et al, 2021)

According to the majority of the participants, their current primary source of stress was related to their studies. As a few examples: A-3 felt some stress over a new assignment they got and worried over how to best handle the task, and A-4 and A-5 who were working on multiple assignments at the same time. These answers can also be linked to Vitasari's study regarding the most common stress sources for a university student. However, for some participants, such as A-6, B-1, B-2, B-5 and C-5, school was either not the biggest source of stress or the only source of stress they had. These participants were more worried about their future, such as future jobs or side projects they wanted to create in their spare time. An even smaller trend that was shown was with the stress regarding one's family, as stated by participants B-3 and C-3. For them, the stress was related to the health and well-being of a close relative, like a parent.

6.2.2. Interview 2

When looking at the results from VAS 2, a clear change can be seen, as many of the participants recorded a lower score on VAS 2 than on VAS 1. The results of VAS 2 can be seen in the figure below:

VAS 2	Group A	Group B	Group C
Participant 1	4	3	5
Participant 2	5	2,5	6
Participant 3	1,5	5	3,5
Participant 4	6	4	3
Participant 5	3,5	3	3
Participant 6 (A only)	5		
Mean Value VAS 2 =	4,16	3,5	4,1
Total Difference	−2,26	−0,6	−2,6

Figure 6. The results from the second VAS. The results from the second VAS show a significant change in Group A and C, but only a slight change for Group B. Total difference in this case is referring to the difference between a group's mean values from VAS 1 and VAS 2.

When looking at the results of VAS 2, it becomes clear that the therapy types used with Group A and Group C had a significant effect on the participants' stress levels, with the new values 4,16 for Group A, and 4,1 for Group C. When compared with the mean values from VAS 1, the difference shows that Group A reduced their stress with a mean value of -2,26 , and Group C with a mean value of -2,6. Group B, however, did not record a significant change in stress with a mean value of 3,5, which led to a change of only -0,6, which is a small change compared to Group A and C. Group B also recorded the only increase in stress from VAS 1, where Participant B-3 recorded a value of 5 in VAS 2, compared to the 4 that was recorded in VAS 1. The answers in the VASes show that the video game based therapy with binaural beat music the group A tested with is almost just as effective in reducing a user's stress levels as using Binaural beat music in a normal music therapy session, as shown by Group C.

When discussing if the test was relaxing, the majority of the participants from all three groups agreed that it was. In group A, many comments were praising the music, and some were praising the relaxing effects of the gameplay. A-6 for example pointed out that even though a lot was happening in the music, it did not disturb the relaxing effect. A-4 praised the meditative feeling they got when they focused on something while they did not have anything to do. Some participants in Group A also thought that the gameplay and music managed to create a relaxing experience when combined. When comparing these answers with Group B It was pretty common to see that both groups overall enjoyed their sessions with the different video game therapies. As a few examples from Group B: B-4 thought the game was the most relaxing aspect, while B-1 enjoyed the relaxing experience created by both the Music and gameplay.

The only exception to the trend above was participant B-3, who thought that the music was relaxing, but the experience was hampered due to clashing elements with relaxing music and non-relaxing gameplay. This answer was the only answer that was opposite to the norm across all the other groups, who found their tests to be relaxing. However, even if the game caused the test to not be relaxing overall, B-3 still agreed that the music was relaxing.

Another smaller trend that was noticeable across both group A and group B, was that some participants, for example A-5, B-1 and B- 5, commented that the game and the music managed to reach a state of mind that allowed them to focus on the game without feeling stressed. These answers can be linked to Winifred Philips explanation regarding how the music can be composed to cater certain roles. In this case, it is similar to Phillips description of music being used as a state of mind. When music is used for this purpose, the goal is to help the player reach the desired mental state of “The Zone” (2014), and with the answer received from this group, it is clear that the music could mirror the state of mind that the test required.

The participants in group C gave more detailed answers about the music itself in comparison with the other groups. This is most likely due to group C not playing any video games in their therapy sessions, which gave them more space to think about the music itself. However, their answers were still positive about the music, which was similar to the other groups. This could mean that the music that was produced worked well both as video game music, and as music used in music therapy.

However, across all of the tests for Group A and C, none of the participants in those groups seemed to acknowledge the Binaural Beats being present in the music when answering the interview questions. This could be due to the fact that during the composition process the Binaural Beats were treated as an instrument in order to make them fit the music. This however can potentially be a problem, since it could mean that the Binaural Beats was not heard at all.

7. CONCLUSIONS

7.1 SUMMARY

The goal of this study was to research if therapy involving Video Games and Binaural Beats could prove to be an alternative to regular Music therapy with Binaural Beats
As such, the author presented the following research question: “How effective can a Relaxing video game that utilizes Binaural beats in its soundtrack be at reducing the anxiety levels of a University Student?”

The music tracks that were composed for the study were based on music that was used in what is considered “relaxing games” today. Among the two music tracks that were created, one of them contained Binaural Beats of the Alpha class.
16 participants in total, split into three different groups, participated in the test.
The test itself was split up in three parts, consisting of two interviews and a therapy session in-between the interviews. The therapy type varied depending on what group the participant belonged to. In the first interview the participants had to answer some questions regarding their current stress and where they believed it came from, and the second interview contained questions regarding their experience with the therapy. The answers from the interviews were then compared with each other in order to determine which of the therapy types were the most effective in reducing stress and why they were successful in doing so.

The results confirmed that the use of binaural beat-infused music in a video game is more effective in reducing the user’s stress levels than using a normal soundtrack for the same game. In addition, when comparing the results from Group A and Group C, one can draw the conclusion that using a video game therapy session such as the one Group A had, is almost as effective at reducing a user’s stress level as undergoing a normal music therapy session.

7.2. DISCUSSION

The main results of this study has proven the effectiveness of Alpha binaural beats, as stated by Smith (2019), Lane et al (1997) and Isek et al (2017). According to them, the Alpha Binaural Beat is the most effective when used for relaxing purposes, which worked well for the theme of this study. However, while the results proved that a video game with Binaural Beats can work well as an alternative to a standard music therapy with Binaural Beats, the results can be considered misleading for two reasons. The first reason is the mean score difference from the VASes, where Group B had a lower mean score in VAS 1 compared to Group A and C, which means that the score for Group B did not have the same potential of decreasing in VAS 2 as the other two groups. The second reason is the small number of participants that participated in the study. Since only 16 people participated in the study, the results from the VASes could be considered weak, even with the answers from the Interviews supporting these results. Since the VAS is a Quantitative method of data collecting, more participants would be required in order to get more reliable results.

The music that was used in this test was around 13 minutes long. The music was kept at this length in order to avoid taking too much of the participants' time. These results fall in line with the test made by Isek et al. whose participants recorded that their stress dropped after only 10 minutes of exposure to binaural beats. However, other studies regarding Binaural Beats have held tests that lasted around 30 to 60 minutes (Lane, 1997 & Wiwatwongwana, 2016) With these texts in mind, it is possible to argue that a Binaural Beat therapy session needs to last at least 30 minutes in order for the Binaural Beats to provide their full effect. This points out a possible flaw in this study, as one can argue that the therapies used in this study were far too short to allow the Binaural Beats to provide their full effect. This could mean that, if the therapies used in this study were extended to 30 minutes, the results could be even more favourable towards the Binaural Beat therapies. However, extending the test in such a manner with the music that were made for this test would require more music to be composed, or loop the current music additional times. Going with the latter option would increase risk for habituation for the participants, which could potentially harm the experience overall.

The answers from Group A & B can be linked with Rogers & Nackes definition of relaxing games, as it shows that if games feature simple mechanics that allows the player to play at their own pace, it can be used by the user to help them relax (2010). This test can also be linked to a question that Rogers & Nacke asked in their study, that if the music was the most relaxing aspect of the game or not, and if it can be used for relaxation purposes outside of the video game medium. As seen in the results, the music mix that was played for both group A and C was used with similar success, and many of the participants thought that the music was a crucial aspect of the relaxing experience. This shows potential regarding the matter of using Video Game music in normal music therapy sessions. Since many of the participants from groups A & B thought that it was the combined effect from the gameplay and the music that together created a relaxing experience, the question cannot be considered fully answered through this study alone, and may require future studies in order to give a clear answer.

When discussing the subject of student stress, one can mention the study Vitasari et al wrote on the subject. While Vitasari's study is more related to written tests that are held on campus instead of written assignments, many students that participated in this study mentioned that it was either difficult to plan on how to tackle an assignment (Participant A-3), or either felt like it would be stressful to prepare enough for their assignments (Participant B-4), which can be seen as a direct reference on how the participants feel like their performance is lacking, similar to the results from Vitasari's study.

There is one specific link that can possibly be made when discussing the results.
The link is related to the answers made by Participant A-2 and C-2 during the first interview, who argued that ever since their different study curriculums were adapted to be held through distance studies. When linking this answer with the studies made by Jaap and Stowell & Bennet, we see a possibility that even if a student's performance is not affected by a test held online, as per Jaap's study, they still might feel more stress towards it since the test is held in a way that does not match their preference, as mentioned by Stowell & Bennet (2010).

When comparing the answers between Group A and Group C, it is clear that the music played a huge part during the relaxation process. This phenomenon is not new, as music has been used by people for relaxation purposes ever since the 1800s Biley (2001). However, while participant C-5 did find the music somewhat relaxing, it was not the music they would have preferred to listen to in order to relax.
C-5's answer can be linked with Hansers (1985) study regarding relaxing music where Hanser explains that different people have their own definitions on what "relaxing music" is.

The results of participant B-5 introduces a possible problem with the video game therapy approach. In the interview with participant B-5, they explained that even though the test was relaxing, the fact that they were playing a video game caused them to become more competitive. This caused participant B-5 to play at a faster pace. This introduces the possibility of a player's competitiveness interfering with the relaxing effect of the therapy.

When looking at the results of participant B-3 and C-3, the results pointed towards stress related to the well-being of a family member. These answers may hint at the possibility that student stress does not always have to be related to their studies. In addition, the results from B-3 may show that video game therapy may not always be effective in reducing stress that originates from family. This could mean that the video game therapy used in this study might not be suited to reduce stress whose source is related to one's family. However, since B-3 said that the relaxing music clashed with non-relaxing gameplay, this cannot be considered a conclusion in this case, but a possibility for future study.

This study provides evidence of using Binaural Beat therapy to reduce stress in the short term. However, it does not explain how long the relaxing effects of the Binaural Beats last in the long term. Previous studies referenced in the Background chapter does not clarify on this matter either. As an example: the studies by Isek et al (2017) and Wiwatwongwana (2016) only report the effects of Binaural Beats shortly after a test, or the effects during a test.

7.3. FUTURE STUDIES

While studies regarding Relaxing Video Games and studies regarding Binaural Beats are quite plentiful as fields of their own, there are not many studies regarding the use of Binaural Beats in Video Games. This means that the subject can be taken in various different directions in the future. One possible direction is using different Binaural Beat classes in video games, in order to research the potential benefits, and obstacles they can provide to a video game. An example of this would be to research the effects of Beta binaural beats being used in a video game environment and what kind of effects they could bring to an individual. If a future study of this kind proves to be successful, this could open new doors in how video games and video game music may be created in the future.

This study can be researched further by utilizing different types of Binaural waves. As an example, Binaural Beats of the Beta class are more effective at helping the individual with their focus and concentration. This means that future studies can research if video game therapy utilizing Binaural Beats of the Beta class could help university students that struggle with their studies.

This study has touched upon the subject of using Binaural Beat music in video games as a means of relaxation. However, as the results showed, not many of the participants noticed the Binaural Beats when they answered the interview questions. In order to get the participants' opinion regarding the Binaural Beats, future studies in this subject could research if using pure Binaural Beats while playing a relaxing video game has either a similar, or a different effect on an individual. In the results of this study, many of the participants who were partaking in the video game related therapies were studying a programme or a subject that was related to IT studies. With this in mind, another question could be researched. The question in this case being if this type of therapy is effective on students from different study programmes, such as Law or Health studies.

While this study has proven the effectiveness of the therapy that utilizes Binaural beats in video games for University students, a similar test could potentially be held for a younger audience, such as children ages 10 - 14, in order to test how this kind of therapy would affect them. In order for this to work however, many of the interview questions may need to be altered or rewritten to make them easier to understand for a younger audience. While the age might seem random, video games are extremely popular in this day and age, especially among younger audiences. This means that a therapy based around video games could potentially be more appealing to them, in comparison to a normal music therapy session.

This study can also serve as the basis for using this kind of video game therapy for other purposes, such as reducing anxiety levels for hospital patients. Previous studies have shown how effective music therapy and Binaural Beats have been in reducing patient anxiety. A few examples of this, are the studies made by Biley (2001), who gathered a lot of evidence of Music therapy being used in the medical field with positive results, and Isik et al (2017) who proved that using Binaural Beats while waiting for a medical trial could greatly decrease patient anxiety. These previous studies prove that using music and Binaural Beats for medical purposes already has been used to positive results, which means that there is a possibility to use a therapy type utilizing video games and Binaural Beats in a medical setting.

As explained in the Discussion chapter, This study does only provide evidence of Binaural Beats working in a short-term period, and not the effects in the long-term. However, this could open up a possible future study, in the form of a study on how long the effects of Binaural Beats last.

This study was written during the COVID-19 pandemic which meant that many restrictions were in place which prevented the use of certain methods for this study. One of these being able to test with the participants on site. Future studies should focus on holding their tests on-site in order to get more accurate data.

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APPENDIX A - Answers from the Interviews

In Appendix A, the participants' full, transcribed answers from the Interviews will be shown. However, it should be noted that most of these Interviews were held in Swedish, and will be kept as such for authenticity. However a small amount of the interviews were held in English. The interviews that were held in English will be marked with (EN) by the Participant's name, and will also have their answers in English. The real names of the participants will not be disclosed.

A - 1

Intervju 1:

- VAS 1: 6
- IT: Webbutveckling / Programmering
- Det Praktiska arbetet är det stressigaste
- Inlämningen av Del 3 är den största källan av stress.

Intervju 2:

- VAS 2:4
- Ja! (Varför finns på frågan under)
- Spelet (Gameplay) och Musiken
- Testet startade lite snabbt!

A - 2

Intervju 1:

- VAS 1: 7
- IT: Data Science, Big Data
- Ja, Förberedelserna. Distansstudierna trivs jag inte med, man lär sig inte lika lätt som en vanlig föreläsning på Campus. Kombinationen med Distansstudier och Avancerade studier (Master) gör studierna mer stressigare
- Studierna är den största stressen just nu.

Intervju 2:

- VAS 2: 5
- Ja, ett icke-krävande pusselspel, Harmonisk, spa Musik. Man fokuserade mer på avslappning
- Kul att försöka hitta rätt pusselbit utan någon stress.
- Trevligt test

A - 3

Intervju 1:

- VAS 1: 3.5
- IT: Webbutveckling
- Ja, Stressar över hur jag ska lösa den (Planering)
- Den nya uppgiften som jag fått är den största stresskällan

Intervju 2:

- VAS 2: 1,5
- Ja, det var avslappnande att lösa pussel
- Musiken var rätt bra, hjälpte till slappna av, med en lugnande melodi, kändes som man var i rymden typ.
- Tack så mycket för testet

A - 4

Intervju 1:

- VAS 1: 8
- DSU: Spelprogrammering
- Ja, Utförandet. Det är grupp projektet som är mest stressiga, då man känner att jag måste snabba på att komma i fas, annars så är mängden av individuella uppgifter jag har lite stressigt också.
- Mängden av uppgifter jag har är det mest stressiga.

Intervju 2:

- VAS 2: 6
- Ja, Det är alltid skönt att ta en paus från det jobbiga. Musiken var bra, men ljudeffekterna clashade med musiken
- Det meditativa, att fokusera på något när man inte har något att göra. Alltid trevligt att chilla lite, speciellt när man gör det för ett experiment.
- Nej, förutom att det var trevligt. Skulle dock ha tystat min Discord.

A - 5

Intervju 1:

- VAS 1: 7
- IT: Master till Civilingenjör
- JA. Ett antal faktiskt, en stor och några små. Faktumet att det finns en deadline och att det finns fler uppgifter man måste bolla med orsakar en del stress.
- Studierna är din största stresskällan just nu, utan tvekan

Intervju 2:

- VAS 2: 3.5
- Ja, Det var som man fick fokusera om tankarna på något annat. Med pusslet och musiken så fick hjärnan inte tid att tänka på stressen.
- Jag skulle vilja säga musiken, men kombon med att man måste tänka på något annat medans man lyssnar på musiken av hjärn mindre plats för stresstankar.
- Väldigt kul, med pusselspel kan man lätt sitta med en stund till!

A - 6

Intervju 1:

- VAS 1: 7
- (Färdigstuderad) IT: Webbutveckling
- Nej! Är nyss färdigstuderad
- Att hitta ett jobb efter studierna är den största stress källan just nu.

Intervju 2:

- VAS 2: 5
- Ja, Det hände mycket i musiken, men inte för mycket så det störde den avslappnande effekten. Det var lugn musik, helt enkelt.
- Kombinationen av Musiken och spelet skapade en lugnande upplevelse.
- Inte vad jag kommer på!

B - 1

Intervju 1:

- VAS 1: 3
- Vitae: Kognitiv Neuropsykologi
- Ja, Förberedelser: Hitta research
- Jobb - Sidoprojekt - Hur det ska utföras

Intervju 2:

- VAS 2: 3
- Ja, Hamnade i ett flow med Hjärngympan
- En kombination av Musik och spelet
- Nej! (Se till så att deltagaren kan höra musiken!)

B - 2

Intervju 1:

- VAS 1: 4
- IT: Webbutveckling
- Ja, ska börja med det. Tentamen (De tio minuterna innan tentan är värst, men under tentan är ganska lugnt.)
- Stressen är relaterad till framtiden efter studierna, exempelvis Jobb efter sommaren

Intervju 2:

- VAS 2: 2,5
- Ja, Pusslet var mer lugnande än musiken (Deltagaren gillar pusselspel som introducerar mekaniker gradvis)
- Spelet var det mest avslappnande, pusselspel med ett unikt koncept.
- Ett väldigt bra test, skönt att ta en paus från mer stressande spel!

B - 3

Intervju 1:

- VAS 1: 4
- IT: Webbprogrammering
- Nej!
- Min pappa har varit sjuk ett tag

Intervju 2:

- VAS 2: 5
- Nej - För man får tänka mycket typ “Hur ska det här funka?” Det var kul, men inte så super avslappnande. Spelet gjorde mig uppspelt, medan musik gjorde mig sömnig.
- Musiken var avslappnande, spelet: not so much
- Nej

B - 4

Intervju 1:

- VAS 1: 6.5
- IT: Interaktionsdesign
- Ja, Vi har ett projekt som ska vara klart om två veckor som kräver förberedelser för presentationer och rapporter.
- Själva uppgiften är den största stresskällan

Intervju 2:

- VAS 2: 4
- Ja, det var skönt att tänka på något som stimulerar hjärnan men som ändå är lugnande
- Musiken var mest avslappnande, det var ett lugnt tempo pianot var också lugnande (Jag lyssnar på pianomusik samt spelar piano själv för att stressa av) Instrumentet som “plingade” var också lugnande. Allt detta fick musiken att kännas avslappnande
- Testet var lätt att förstå, väldigt minimalistiskt spel!

B - 5

Intervju 1:

- VAS 1: 3
- Ledarskap: Masterprogram inom Chalmers
- Ja, med tentor så är det både förberedelser och utförande, generellt så är det stunden innan utförandet är det mest stressiga
- Skolan: tentor, Generellt: Osäkerheten specifikt med Coronaviruset, sommarjobb och Utbytesstudier.

Intervju 2:

- VAS 2: 3
- Ja, på ett sätt. Men eftersom det var ett spel så ville jag göra det så snabbt så möjligt, så det var lite avslappnande, men också lite tävlingsinriktat
- Jag tänkte väldigt mycket på musiken, Musiken tillät mig att gå in i zonen, så det var avslappnande men också fokuserad på spelet.
- Nej, förutom att det var kul!

C - 1 (EN)

Intervju 1:

- VAS 1: 8
- Law Studies, Basically We study Constitutional law studies, Economy studies, and English (British Parliament), Philosophy. Law History. “Compared Law“ Studies.
- No.
- Because of all the tests that I had to do online. The classes are not as interesting when held through ZOOM. A lot of technical difficulties happen, and I cannot interact with the teachers as I usually do (asking them questions, and the like).

Interview 2:

- VAS 2: 5
- Very relaxing, Because of the song, a lot of Harmony, a lot of simplicity and a lot of piano that made the songs chill. Made me feel refreshed!
- How the music made me calm down
- I think it was a really good test!

C - 2

Intervju 1:

- VAS 1: 6.5
- IT: Spelutveckling: Programmering
- Ja, Exjobbet, Pressen på kvalité med höga förväntningar (Prestation, Utförande)
- Exjobbet är den största stresskällan just nu.

Intervju 2:

- VAS 2: 6
- Ja, “It just set the relaxing mood, y’know?” Det var lugnt helt enkelt, man kunde göra någon nytta genom att bara lyssna på musik!
- Stränginstrumenten var mest avslappnande, en konstant grej genom många låtar.
- Nej

C - 3

Intervju 1:

- VAS 1: 9
- IT: Webbutveckling/Programmering
- Ja, Projektarbete. Att dela ut arbeten till mina kollegor
- Plugg samt familj är de största stress källorna

Intervju 2:

- VAS 2: 3.5
- Very much so! (Var på väg att somna!) - Det kändes avslappnande, något med musiken var avslappnande men ändå lekfullt.
- Musiken, och faktumet att det enbart var musiken gjorde erfarenheten mer avslappnande. Jag fick tid att fokusera på musiken.
- Nej, det var kul!

C - 4 (EN)

Intervju 1:

- VAS 1: 7 (Wishing to perform well in their studies)
- Veterinarian Studies (Biology, Animal Anatomy and Customer Service on how to treat the animal’s owners)
- “Right now we are studying the different illnesses our pets can have; and animals can't tell us what actually is hurting them, so trying to find the cause of the sickness in an animal that is scared because they don't understand what the vet is doing is very stressful, especially if the owner is also scared or worried of what might be wrong with their pet”
  Trying to balance the act of finding the pet’s illness and ensuring that the pet and it’s owner don’t get too uncomfortable, since it could become a serious problem otherwise.
- The studies are the biggest source of stress as of right now. “Yes, I have a lot of trouble retaining some information, so studying becomes even harder due to it, so instead of studying the same amount my friends do I have to put in double effort to get the information. Also, i suppose i ask so much of myself for fear of failing and messing up in the future when I'm working in a clinic”

Intervju 2:

- VAS 2: 3
- Absolutely, the sounds were very soft and calming
- “The music was a good part of the relaxing process, but I'll admit that before starting the test I was nervous, but the way you asked the questions and carried yourself made me calm down considerably”
- “I don't know what else i could add honestly, I think you did a superb job, both on the interview and as a compositor”

C - 5

Intervju 1:

- VAS 1: 3
- Hälsosjukvård: Arbetsterapeutsprogrammet på Göteborgs Universitet
- Ja, en presentation. Utförandet kommer vara stressigast!
- Just nu så är det presentationen som stressar mig mest. Allmänt så är det om vad man ska göra efter studierna.

Intervju 2:

- VAS 2: 3 (för att den förra var låg redan från början)
- Till viss del! Det var avslappnande att bara lyssna på någon form av musik, men det är inte den musiken jag hade valt för avslappning. Det var lite för mycket olika ljud i musiken så den var inte optimal för mig.
- Det var en del i mitten som var mer lugn i det hela, Tror att de var när cellon kom in. När trummorna inte var med så var musiken som lugnast.
- Nej! Det var kul att få lyssna på det.