The Sound of Games: How Music and Rhythm Influence Player Performance in a Gamified CBM Training Application

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ABSTRACT

Over the last few decades' videogames have increasingly grown to influence our lives in different fields. They are an important media, a tool for play and interaction, as well as a cultural phenomenon. So far only a few studies regarding music and games have been conducted, but not much when it come to the serious game domain. Research is lacking in the field of mental healthcare, in particular were gamification is being used in therapy and performance level do have a real-life consequence to treatment. The main purpose of this research was to investigate how music and sound may influence player performance while completing two gamified cognitive training tasks, where music is the core game mechanic. Participants played a demo version of the *AddictionBeater* Gamification, a gamification designed as a training intervention for alcohol addiction problems. All subjects in this study played the same baseline, before playing the different experiment conditions either with sound and rhythm, or without sound following the same rhythm aligned with the selected music. Performance was measured based on accuracy, by comparing their baseline accuracy to their accuracy levels in the experiment trials. Afterwards, this paper describes the societal relevance of this research in regards of creating serious games that can truly fulfill the need of expectations in individuals gaming performance in serious games and how music can benefit such purposes.

General Terms

Game Audio Aesthetics, Aesthetics and Music, Music in Games, Ludomusicology, Gamification, Serious Games

Keywords

Music and Rhythm in Games, Gamification, Player performance, Music Games.

1. INTRODUCTION

Music and sound have always been a big influence in our lives throughout history. It influences our moods and how we feel. The right choice of sounds used in a computer games can make a huge difference in the perceived overall quality of the final product. Studies have even shown that judgment of game's visual quality depends on the quality of the sounds used alongside the on-screen graphics(Weske, Jörg, 2000). One of the most distinguished features of video games is their interactivity. A players' choice can trigger dialogue, sound effects, ambient sound, and music. For that reason, music and sound plays a huge part in the player experience, and how players interact with the game. Previous studies have shown that music and sound in general have an important effect of the degree of immersion experience by the player (Wharton & Collins, 2011).

Yet, game sound has been neglected as a research field in the growing literature on game studies. The fact that game studies is such a recent research field means that much of the needed empirical evidence has not yet been gathered or researched, and what is available is very scattered(Collins, 2016, p. 2). This research focused on experimental testing of the effects that sound and music have on player's behavior in a serious game, and it is our goal that this can help towards more research in these specific fields in the future.

In this paper, we have tried to investigate and describe the relations between specific videogame aesthetics and player performance with a crucial look on audio visual receptors. This research focused on the experimental testing of the effects that sound and music have on player's behavior in a serious game. By modifying a gamification of a Cognitive Bias Modification training application, i.e. the *AddictionBeater* gamificiation, we transformed it to specifically highlight the audio visuals that are the main foundation for experimentation in this research. We conducted several playtests where participants would listen to different songs while playing and performing the same tasks in two different conditions, one with sound, and one without sound, we then compared and analyzed the extracted data.

The addition of music and sound may interfere with the performance on the task since individuals are requested to both pay attention to the pictures and to the rhythm of the music because responses are triggered by the combination of both visual information (stimuli) and auditory information (rhythm by which stimuli are presented). The combination of these two channels of information may interfere with actual response accuracy (Roberts et. Al 2016). We therefore used a demo version of the *AddictionBeater* presenting two of the main tasks used in the training program to systematically test the effects of music and rhythm on task accuracy.

1.1 Background

Sound and music is a big part of the overall aesthetics in games, and other visual mediums like movies. Therefore, a research field called Ludomusicology has emerged to study these topics extensively. Some studies suggest that music and sound enhance performance, while other studies suggest that music can be a big distraction to performing certain tasks (e.g. car driving games). In one study, 85 young people were recruited and asked to drive around a local route with a driving instructor and a researcher watching their every move. Each time they made a mistake like speeding, tailgating or one-handed driving a note was made. The three conditions were: Driver choice (the most popular genre being dance/trance/techno), Researcher provided 'safe' music, and the final condition was no music at all. Listening to their own music the drivers were much more likely to make mistakes, they drove more aggressively and were much easier distracted. However, it turned out that the safe music provided by the researchers was safer than having no music at all (Brodsky & Slor, 2013).

1.1.1 Serious Games vs. Entertainment Games

Although prior studies in Ludomusicology has focused on Entertainment games, few studies have focused on serious games where the main purpose of such games is not only to entertain, but also to achieve a serious purpose. Unlike entertainment games, which in general have a pure goal of entertainment, serious games have a primary purpose of:

- Playing to learn
- Train adults
- Enhance skills or knowledge

Videogames simulate specific experiences that provide insights into the general relationships that drive those experiences, while serious games should strive to appeal to the greatest possible numbers of learners (Bogost, 2010, p. 241,321). Such games are not only a tool for entertainment but are also being used as a tool for education among others. According to Gabe Zicherman (Zichermann & Linder, 2010) serious games can be classified into three different sub-categories:

1. Edutainment
   (E.g. Making a concrete task more fun)
2. Advergaming
   (E.g. Marketing games to engage customers)
3. Simulations
   (E.g. Simulations of real world situations)

An advantage of serious games is that it allows for players to fail in a safe environment, and learn from their failures. Serious games can be used to create awareness, gain new knowledge or train certain skills sub-consciously. There is no doubt that learning can happen accidentally while playing a game, or that some games, even though mainly made for entertainment. may provoke a learning outcome that would be educational. An interesting example of this would be how a 10 year old boy used skills he learnt from Mario Kart to save his grandmother who became sick whilst driving (Chen, 2013). Even though Mario Kart is an entertainment game, the boy clearly learned something from playing it.

In Serious Games players are supposed to achieve a serious outcome which can interfere with the play factor found in entertainment games. The play factor is a big part of what makes entertainment games so engaging, and this freedom of play is commonly removed (or neglected) in Serious Games. The most basic freedom in play is the freedom to quit, at any time you want. With serious games players are expected to learn or achieve something, and they are not expected to quit. Play, first and foremost, is what one wants to do, as opposed to what one feels obliged to do (Gray, 2013).

1.1.2 What is gamification?

Serious games describes the use of complete games for non-entertainment purposes, while gamified applications use elements of games that do not give rise to entire games (Deterding et al., 2011). It is important to understand that gamification is not actual games, but more a way of camouflaging a specific task by transforming the task through different game-like elements, so as to encourage participation ("Gamification," 2010). All though it is a relatively new term, and most commonly found in marketing strategies, it is now also being implemented in many educational programs to help educators find the balance between achieving their objectives and catering to evolving student needs." (Hsin-Yuan Huang & Soman, 2013, p. 5). Put simply you can say that gamification is the use of game design elements in a non-game context (Deterding, Khaled, Nacke, & Dixon, 2011). Huang and Soman suggest a five step process for applying gamification to the educational environment:

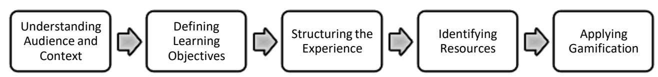

Figure 1: Gamification Flow Chart (Huang & Soman 2013)

Figure 1 describes the process of gamification in education. First it is important to understand who your students are, and to what context the training fits into the larger curricular framework. What environment, and what tool is best suitable for that audience in such a context (individuals, groups, online etc). In summary, when gamifying a serious task, research should be done into what game like elements is unnecessary, distracting or benefiting the learning outcome. After getting an overview of how the gamifying will become most optimal impact you can start the research of game genres, and the identification of resources that will help the development of the most suitable game for that specific target audience. When gamifying it is important to keep in mind that the outcome should not diverge from the original objective, but only the process towards the goal is what can be played around with (Hsin-Yuan Huang & Soman, 2013, p. 15).

When applying the gamification process, previous research has shown how different game mechanics such as progression, competition and juicy feedback could be used to engage users. For instance, gamification can produce desired behaviour change through the formation of habits by reinforcing the reward and emotional response of the individuals participating in the experience. This can be done through intrinsic (accomplishment, enjoyment etc.) or extrinsic (prizes, rewards etc.) motivation. Whichever form that is chosen the appropriate reinforcement is the key to motivate a successful behaviour change in individuals (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2015, s. 412).

Despite the profound impact of music and audio towards the overall gaming experience, few studies in gamification have examined the potential of using music as a game element to engage and motivate users, without hindering the underlying learning goals. Studies shows that music has a lot of benefits when it comes to learning, productivity and alertness, and if used properly music could be used as a game element for motivation and behaviour change. With Music therapy, we already see music being used as such a tool.

1.1.3 How music affects the neuro chemistry of the brain and our behaviour

How music affects our state of mind is something which has only recently become a field of study, but how it affects performance level of players is a subject that have not been researched a lot. With the growth of technology, music has become an increasingly important facet of a game. It is therefore necessary to understand how it does affect our behaviour, concentration and cognitive stimulation.

Music activates the whole brain, and the perception of sound and its tones is processed through the Auditory Cortex, which transfers information to the Hippocampus. The feeling we get to get up and dance is controlled by the Motor Cortex and the Cerebellum, and what moves us to get emotional involved in a song is controlled by the Amygdala as well as the Nucleus Accumbens. In general brain activity involved with music includes:

- Movement
- Motor Planning
- Attention
- Auditory cortex

Music is a unique tool that can repair brain damage and help to return lost memories (Simmons-Stern, Budson, & Ally, 2010). It can also help learning processes (Overy, 2000), as well as reduce stress levels and anxiety (Jimenes-Jimenez, Garcia-Escalona, Martin-Lopez, De Vara-Vara, & De Haro, 2013). One study published in Journal of Cognitive Neuroscience showed that stronger beats as opposed to weaker beats made participants more alert, this suggests that the metrical structure of rhythm automatically modulates orienting of attention in time and suggests that rhythm can optimize behavior (Bolger, Coull, & Schon, 2014). Another study, also done by Bolger and Schon, showed that rhythm and auditory entrainment influenced judgment and perception on visual processing (Bolger, Trost, & Schon, 2013)..

Music can also be deceiving or affect how we perceive things. In one study from 2008 participants were asked to listen to short excerpts (15 sec.) of emotional music in 3 different conditions Negative, Neutral and Positive; (Barber's "Adagio for Strings", Delibes' "Mazurca from Coppelia", and Mozart's "Flute Concerto in D major: Allegro"). The happy music made participants perceive people's faces as happier while sad music made them perceive faces as more sad (Sanches, Vazquez, Gomez, & Joormann, 2013). Another study showed that louder music tends to increase alcohol sale in bars too. Music also increases productivity and concentrations levels, and music can also improve the quality of work (Lesuik, 2016), and reduce distractions in a work area (Malhotra, et al., 2014).

Listening to sounds over 95 decibels can reduce your mental and physical reaction time by 20% , in comparison club music usually plays at 120 decibels (Oxenham, 2013). However fast, loud music may enhance optimal exercising (Edworthy & Waring, 2006). In addition studies show that music can determine how a player decide to play the game, and thus effect the overall gaming experience (Wharton & Collins, 2011). When creating a gamification which heavily relies on music it is important to take all these factors of perception and behaviour change into consideration.

Every combination of notes in music is defined by simple ratios that create harmony, and it is when music is in balance we perceive it as being harmonious. Studies do show that music release dopamine through activating the Striatum part of the brain. Music makes you feel good as it releases Dopamine and lifts your mood. When your favourite song is playing the Prefrontal Cortex is activated with anticipation. The anticipatory listening phase comes when there are changes in songs such as tempo, drop or removal of musical elements. However, when you break rules that form specific ratios, we intuitively know that something is wrong, like a car alarm howling or police sirens. Without any pitch it sounds harsh to our ears. When the various frequencies aren't simple multiples of one another there is no common pattern for the ear to respond to, and the more complex you make the ratios, the more dissonant and harsh it would sound. In such sense, how music is composed is very crucial to our perception of it and how it makes us feel.

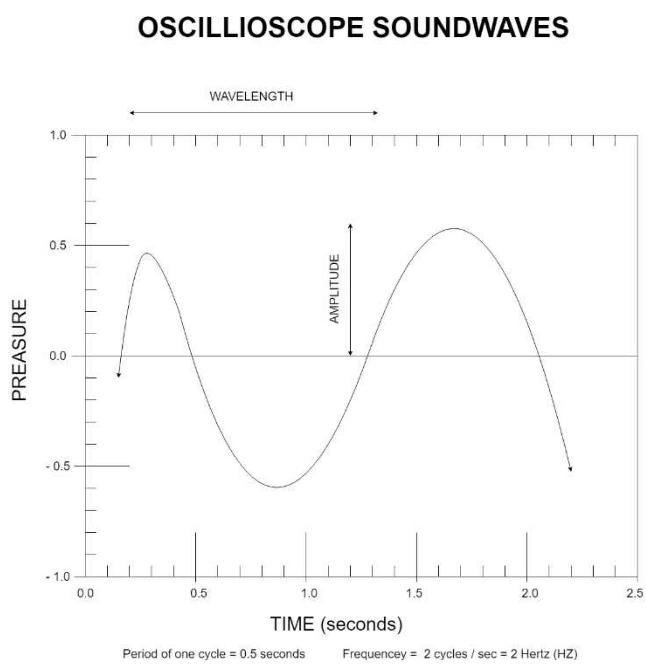

Figure 1.2: Oscilloscope reading

By using an Oscilloscope, you can get a visual image on how music looks, and in such get a brief understanding on how the music is composed and whether or not it is harmonious. Louder music creates bigger waves, while more quiet music creates lower waves. The distance between the peaks are determined by the pitch or frequency of the note. The higher the note, the shorter the distance between the peaks will be. Every combination of notes in music is defined by simple ratios. In figure 1.2 the XY display format can be used to measure the relationship between two or more synchronous signals. This measurement technique involves inputting one signal into the vertical system as usual and then another signal into the horizontal system. The frequency of music also affects the neuron activity in our brain that ensembles in the cerebral cortex and produce macroscopic neural oscillations (rhythmic activity) in the central nervous system. This can be monitored and graphically documented by EEG, and the electroencephalographic representations of those oscillations are commonly called 'brainwaves'. These oscillations are characterized by their frequency, amplitude and phase. Neural tissue can generate oscillatory activity driven by mechanism within individual neurons as well as interaction between them, and they may also adjust frequency to synchronize with the frequency of an external acoustic or visual stimulus. The different frequencies are measured in Hertz (Hz) and are as followed:

- **Gamma** (35 – 70 Hz)
  - *High brain activity*
    Associated with consciousness in awake states and lucid dreaming, as well as improved memory, increased IQ and heighten sensory experience.
- **Beta** (14 – 34.9 Hz)
  - *Engaging and up beat*
    Associated with alertness, concentration and learning. Higher levels associated with anxiety, fear and stress.
- **Alpha** (8 – 13.9 Hz)
  - *Very chill and relaxing*
    Associated with relaxation and wellbeing, super learning, light trance, and increased serotonin production
- **Theta** (4 – 7.9 Hz)
  - *Drowsy and sleepy*
    Present during REM sleep. Associated with increased learning and memory, creativity, deep meditation, hypnogogic imagery and trance. Allows access to the unconscious.
- **Delta** (0.1 – 4 Hz)
  - *Blackout*
    Present during dreamless sleep. Hormones such as prolactin and human growth hormone are released. The deepest phase of sleep.

Gamma waves are the fastest of the brainwave frequencies and signify the highest state of focus possible. Dr. Rodolfo Llinas, MD,PhD proposes that 40-Hz oscillation seen in wakefulness and in dreaming is proposed to be a correlate of cognition resultant from coherent 40-Hz resonance between thalamocortical-specific ad nonspecific loops (Gold, 1999). Stimulating these brainwaves can alternated in attentive focus, and a study published in Nature successfully demonstrates that spiking at 40-Hz in the hippocampus activates a microglia response. Gamma waves are also implicated during Rapid eye movement sleep and anesthesia, which involves visualizations. They are associated with peak concentration and the brain's optimal frequency for cognitive functioning (Reedijk, Bolders, & Hommel, 2013). Nobel prize winning scientist Sir Francis Crick believes that the 40-Hz frequency may be the key to the act of cognition. It is concluded that gamma wave activity is strongly related to the presence or absence of large amplitude slow waves, but whether or not gamma wave activity is related so subjective awareness is still not certain and more research need to be conducted in that field (Vanderwold, 2000).

1.1.4 Audio and music in games

The employment of music in games dates back to the beginning of games. However, as with all aspects of videogames, sound did not start out as a fully blown creative representation of the simulated world. It was originally just an extra detail added on to games based on space available for sound design – not at all a complete necessary component (Martello, 2010, p. 3).

According to Pieter Jacobus Crathorne (2010, p. 15) sound in games can be divided into three different categories:

1. Music
2. Sound effects
3. Ambient sounds

As this study only looks into how music affects player performance we will not go into much details about the other two categories. Music is a crucial element in the overall gaming experience, and in some games it is a quite essential part of the actual game. Singstar, Guitar Hero and Dance Dance Revolution are examples of where music is the core element of the game and an important factor to how well players might perform in the game. In the case of *Guitar Hero* or *SingStar* for example, there is a direct participatory and performance aspect to listening to the songs (Collins, 2016, p. 128). Kristine Jørgensen's (2008, p. 175) study of the reception of game sound, has shown that

> *''games suffered both as user-oriented game systems and as virtual worlds when sound was not present, which means that both the progression through the game and the sense of presence in the game environment were affected.''*

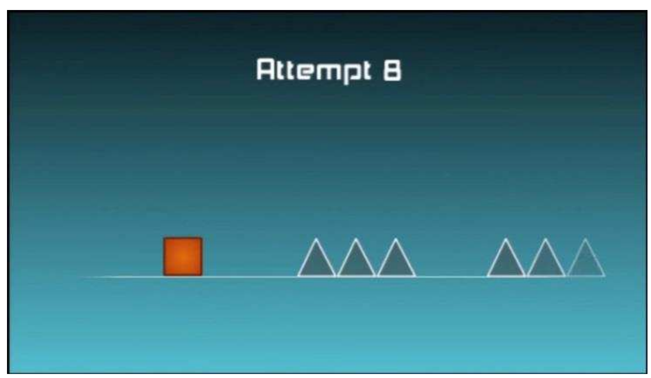

Figure 1.3; The Impossible Game Screenshot 1st level example (2009)

Another interesting game where music is quite important for the player performance is The Impossible Game (Grip Games 2009), an arcade platformer game that is available for several devices such as smart phone, computer, tablet and even consoles like Xbox and Playstation. The obstacles of the game are highly interacted with the beat of the music. Unlike Singstar or Guitar Hero where the music is pre-genereted, the music in The Impossible Game are especially designed for the game. The music consists of tehcno beats and is supposed to increase your motivation as well as your tension. The objests are following the rhythm of the beat, and the more upbeat the game becomes the quicker and faster the obstacles come towards you. Being immersed in the music can actually help the players determine what obstacles they may expect to come next. Accuracy in the game is very much based on miliseconds so the audio cues are essential in helping players overcome the obstacles. Game audio has grown beyond fulfilling functions to becoming an art form in its own right. Nevertheless, the nature of video games as nonlinear, participatory media continues to create many interesting challenges of a technological and aesthetic nature (Collins, 2016, p. 167).

Parappa the Rapper and *Dance Dance Revolution* are good examples of where music becomes a central part of the gameplay. Here, usually the players' quick reactions make either the rhythm or other parts of the music. The aim of these games is to help with the creation of the actual music. Thus the console or computer could actually be seen as a musical instrument. These games form a genre known as "rhythm games" (Furlong, 2010, p. 22).

1.2 CBM AddictionBeater Gamification

The Cognitive Bias Modification (CBM) was developed for the purpose of being used as a tool in therapy for people struggling with addiction to alcohol. CBM has shown to be a promising digital training program, by effectively training away maladaptive cognitive processes implied in substance abuse, such as the tendency to automatically approach substance-related cues in the environment (Wiers, Gladwin, Hofmnn, Salemink, & Ridderinkhof, 2013). Although promising, the repetitive nature of CBM has promoted the development of a music game referred to as the *AddictionBeater* to improve user engagement and reduce patient dropout rate. This gamification is based on the CBM modules for approach bias (AAT training Wiers et al., 2013) and cue-specific inhibition training (Go/No-Go training; (Houben,, Nederkoorn, Wiers, & Jansen, 2011)) which have been used in alcohol addiction treatment.

As the CBM have already been used for clinical testing the gamification already have a lot of player data as well as being an easy game to learn for new players. As the gamification highly relies on music, it only made sense to test out the key role the music might have on the performance level of the players. The CBM *AddictionBeater* gamification could give us accurate results, which we could easily analyze to see changes in participants performance levels. As the game is very simply designed, and there is very repetitive nature, measuring accuracy would seem fairly easy. Claudia Gorbman suggests that there is a ''mutual implication'' between image vs. audio and perception (Collins, 2016, p. 169). As *AddictionBeater* is merely visual and audio stimuli it is a very suitable game to test out the effect of the music as the core element in the game and how it can affect the performance level of the players.

The rationale for exploring the effects of music and sound in the *AddictionBeater* gamification comes from the fact that CBM is based on speeded reaction-time tasks requiring very fast accurate responses (in the order of milliseconds) to visual stimuli presented at fixed intervals. Optimal training effects are the result of learning a correct association between alcohol-related stimuli and correct response (e.g. "stop" response to alcohol in the Go/No-Go task or avoid response in the AAT training). Overal the goal of the *AddictionBeater* Gamification is behavior change in relations to alcohol.

With the modified version of the *AddictionBeater* we made the rhythm of the music decide the pace and speed of the aligned picture objects, following a beat that was in harmony and balance with the music. In kinetic games sound serves as a motivating factor, arousing the player physically, and is also the part of the game on which the player must respond (Collins, 2016, p. 129). Music was carefully selected to fit the target audience, as well as being unfamiliar for the participants. None of the songs we selected were mainstream, and none of the participants had heard any of the songs before playing the actual game. This was done with purpose as unfamiliar music may increase motivation in players and familiar songs seem to be more distracting for players according to research done by Kristine Jørgensen (Jørgensen, 2008).

1.3 Goal of the study

In games, there seem to be a lot of presumptions to whether the audio aesthetics do matter for the overall player experience. The problem today is that not a lot of research has been conducted on researching the specific elements in aesthetics, such as what impact and influence music might have on player performance, immersion and perception. In this research, we try to get a better understanding of how we can use audio aesthetics to engage players through sound and music and make them perform at an optimal level. The objectives of this study are to understand how audio aesthetics may enhance player performance.

The main goal of this research study is to see whether music does increase performance in games where players must perform a concrete cognitive task using the CBM *AddictionBeater* gamification as a foundation for our research. The main purpose of this experiment was to understand how sound and music affects player performance, and whether the use of music as a game mechanic in gamified cognitive tasks is helpful for learning, or performing specific tasks, or if it impairs the performance of such tasks.

1.3.1 Research question

Does audio increase performance level among participants where they have to play a concrete cognitive task with auditory and visual stimuli?

To test the effects of music and rhythm on player performance on the AAT and Go/No-Go task paradigms used in the AddictionBeater gamification a mixed design approach was adopted by assigning player to two experimental groups (i.e. play with sound or play with rhythm and sound muted), and by comparing their performance accuracy on the same tasks without any music and rhythm (i.e. stimuli presented on fixed time intervals) with the tasks including the music or rhythm only.

2. METHODOLOGY

2.1 Participants

The participants were recruited through posters around Roterseiland Campus and around Science Park 904 in Amsterdam. Digital flyers were also shared on the social media Facebook, and Booking.com's internal employee forum online, some participants were gathered through colleagues and friends. The recruitment process took place in the months of July and August 2016.

Participants were young professionals, expats and students living in Amsterdam.

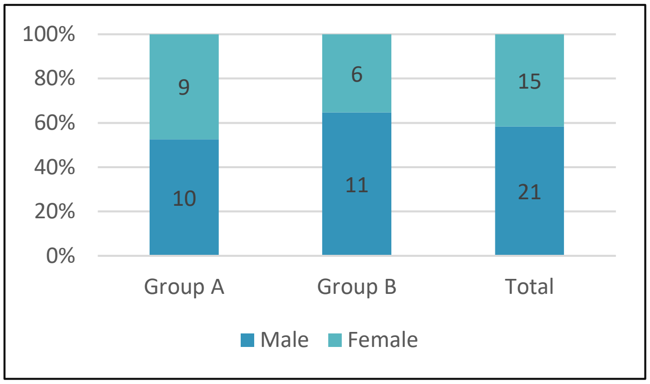

Figure 2.1 Gender distribution ratio

The average gamer is 31.6 years old (Williams, Yee, & Caplan, 2008), and the participants recruited for this experiment were between the ages of 21 and 34, as we wanted to recruit young adults with a good response rate as reaction time decreases with age (Tun & Lachman, 2008). As the looking-doing latencies of people of 30 years of age and above tend to be slower (Thompson, Blair, & Henrey, 2014) we did not want to recruit people that were diverging at lot from this age. The mean age between the participants for this experiment was 27, consisting of 15 females, and 21 male participants (N=36, F=15, M=21). The participants were not paid to participate in the experiment. The distribution of ages (Mean=27.11; SD=3.67) in our sample is reported in Table 1. Data is grouped into the two main conditions Group A (Rhythm) and Group B (Music and Rhythm). The age difference in the two groups did not diverge a lot from each other; Group A (Mean=26.5; SD=3.54), Group B (Mean=27.7; SD=3.83).

	Group A (Rhythm)	Group B (Music and Rhythm)	Group A + Group B
Mean average	26.5	27.7	27.11
Standard Deviation	3.54	3.83	3.67
Variance SD	12.59	12.5	13.53
Population SD	3.45	3.45	3.62
Variance Pop. SD	11.92	11.92	13.15

Table 1; Age Distribution Statistics

2.2 Experimental Design

All the experiment sessions were conducted in the Game Room at Science Park 904, University of Amsterdam in August 2016. The experiment was divided into two parts; Baseline and Experiment sessions and a brief group chat afterwards. Beforehand all the participants were assigned randomly to one of the two groups: A *(Rhythm)* or B *(Music and Rhythm)*. At the start of the study, participants signed a consent form. The study has been approved by the Ethics Review Board of the Faculty of Social and Behavioral Sciences, of the University of Amsterdam (Protocol N. 2016-DP-7199). Participants had to play a total of 4 blocks of the baseline tasks, two in each of the 2 different training tasks *(2 blocks of Go/No-Go and 2 blocks of AAT)*. After a small break of 5 minutes participants continued with the experiment modules consisting of another 4 blocks each. All participants followed the same structure playing 2 songs in Go/No-Go and 2 songs in AAT, with one easy and one more difficult song in each module. When the participants were done with the experiment the group briefly discussed the *AddictionBeater* Gamification, and how they thought the different songs might have influenced their performance level. Group B also discussed the chosen songs in the *AddictionBeater* Gamification and how they enjoyed them. Group A mainly discussed the lack of music and how they thought music could impact their performance. Each group session lasted about 40-50 minutes in total, including the brief discussion at the end.

2.3 Materials

Materials used for this experiment included mainly a demo version of the *AddictionBeater* gamification. *AddictionBeater* was modified from its original version and especially shaped to fit the experiment design. The customized experiment version of the *AddictionBeate*r used module 1 *(Go/No-Go)* and module 3 *(AAT)* of the original game. Module 2 included a different variety of AAT training, which was removed from the experiment due to time constrains and to the medium performance difficulty (Module 1 is very basic and Module 3 is the most difficult out of the three).

2.3.1 Baseline and Experiment modules

In the modified version, we removed all elements that could be distracting for the participants and/or be a disadvantage when measuring accuracy level. The *AddictionBeater* gamification was stripped down to a bare minimum, keeping only core game mechanics essential for gameplay.

Module 1 (Go/No-Go): Participants have to press the space bar key whenever a picture appears ("go" response) but withhold the response when an X cue is present on the picture ("no-go" response). Non-alcohol pictures appear both in "go" and "no-go" format (e.g., 50% and 50% each) while alcohol pictures always appear in "no-go" format. Goal of the task is to learn a stop response towards alcohol stimuli.

Module 3 (AAT): Response cue focuses only on image content (alcohol/avoid and soft-drink/approach). Participants have to respond to the content of the stimuli with up/down arrow keys and the picture will either zoom in or zoom out (e.g., up "push away" (alcohol) => pictures zoom out; down "grab" (non-alcohol) => pictures zoomed in). Goal of the task is to rehearse internalize and avoid response to alcoholic stimuli.

Baseline modules: The baseline modules had the same rules for play as the experiment modules. In the experiment modules, the pictures would follow the rhythm of the beat of the selected songs based on the amplitude of the songs, which determines when the pictures would show up on the screen. The picture presentation format would appear more random and unpredictable to the players, as they were not aware that the pictures would be aligned with the beat of the music. The baseline versions of the tasks were designed to be fixed, without any music or rhythmic presentation of the pictures, with a fixed interval between pictures randomly falling in the range of 500-1000 milliseconds.

2.3.2 Music in Addiction Beater v2.2

In the original *AddictionBeater* players are free to choose between a reasonable amount of songs in different categories, but for this study we removed that option because of distractions and impacts it could perhaps add to the overall results on performance levels of the participants. In the modified version of the *AddictionBeater* we pre-selected a total of 4 songs for the experiment, 2 songs for each experiment module.

Song	Duration	Detector	Delay	Threshold	BPM
Go/NoGo 5.5 Easy No Lyrics	00:01:55	Bass	0.0004	0.008	101
Go/NoGo 5.7 Hard Lyrics	00:03:27	Bass	0.005	5E-05	117
AAT 4.1 Easy No Lyrics	00:01.31	Midi	0.9	0.02	105
AAT 4.6 Hard No Lyrics	00:03:55	Midi	0.006	0.003	170

Figure 2.2: List of selected songs for experiment

For Module 1 we chose two different rock songs for each trial in the Go/No-Go tasks, and for Module 2 we chose two different electronic songs for the AAT tasks.

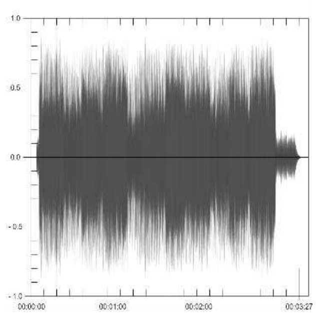

Figure 2.3: G/NG5.7

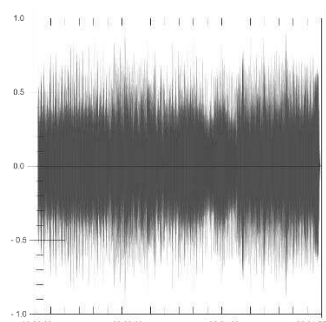

Figure 2.4: G/NG5.5

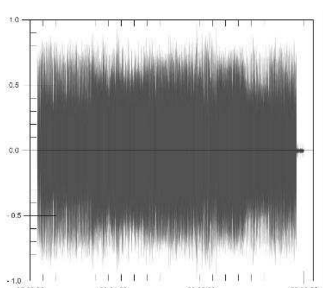

Figure 2.5: AAT4.6

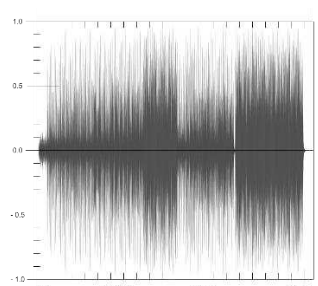

Figure 2.6: AAT4.1

We tried to choose one more difficult song as their second trial in each task, as their performance level would naturally increase as a result of learning. Song 5.7 (Hard) in Module 1 had lyrics, while the rest of the songs were instrumental. Having harmonious songs that were not off pitch was essential for this experiment. Figure 2.3, 2.4, 2.5 and 2.6 show a visualization of the soundwave of the selected songs used for the experiment trials.

2.4 Procedure

The participants were randomly divided into groups consisting of 2 – 5 participants, each group would play the same experiment setup A *(rhythm)* or B *(music and rhythm).* A total of 12 groups of experimental sessions were conducted. All participants were assigned their own unique participant ID that they would use when playing the experiment version of the *AddictionBeater*, this was done so we could track their performance level digitally, but also to protect their identity when analyzing the data. Before playing the experiment sessions, the participants were given a brief about the experiment and its procedure. Participants were also informed about the intentions of the gathered data, and how it would be analyzed in the aftermath. Participant's drinking behavior was also assessed with the Alcohol Use Disorders Identification Test (AUDIT) questionnaire (Saunders, et al., 1993). Each participant was assigned their own laptop, a set of headphones, and a step by step instruction note to follow. Participants were told to ask the researcher if they had any questions during the experiment. The participants were not informed beforehand that accuracy level was the main interest of this experiment. Approximately each session took about 40 - 60 minutes in total.

Phase 1: Briefing and consent form *(approx. 5 min).* Participants got a brief about the experiment and an introduction on how to play the game. They got a cheat-sheet with a step by step process on how to play the *AddictionBeater* and were told to ask the researcher if they had any questions during the sessions.

Phase 2: Baseline *(approx. 10-15 min*). Participants log in to the computer with their own unique ID to play the 4 different baseline trials that have no music.

Phase 3: Small break *(approx. 5 min).* After playing the baseline the participants got a small break to collect themselves before continuing to the experiment trials.

Phase 4: Experiment trials *(approx. 15-20 min).* The participants log in to their computer with their second ID that leads them to the experiment trials. Depending on what group they are in they will either play the trials with music or without music.

Phase 5: Casual chat about the game *(approx. 10-30 min).* After the experiments the groups were gathered to have some drinks and chat about the game experiences with the other participants.

3. RESULTS

Originally, we were able to recruit 36 participants for the experiment, but in the end 6 participants; 4 females and 2 male participants had to be removed from the study. 31G and 24E only played the baseline of the *AddictionBeater* Gamification, and we could therefore not use their results in the final analyzing of the data. Some of the other participants had to be removed due to not completing the baseline tasks, or not playing the experiment session of the playtest. In the end, we had data from 30 participants. 16 participants from group A (*rhythm*) and 14 participants from group B (*music*).

3.1 AUDIT Results

The AUDIT results revealed that the average standard deviation in both groups were 4.81, with a variance of 23.14. The standard deviation in Group A was slightly lower than in group B. Scoring above 14 could be a sign that participants could be struggling with alcohol addiction. Only a few participants scored above 14.

	Group A (Rhythm)	Group B (Music)	Total
Number of participants	19	17	36
Median	1.5	2.5	2
Mean	8	9.4	8.6
Standard Deviation	3.54	5.94	4.81
Variance (SD)	12.55	35.38	23.14
Population (SD)	3.44	5.7	4.7
Variance (Population SD)	11.89	33.3	22.5

Table 2; AUDIT Standard Deviation

3.2 Player Performance

N=16 participants were assigned to Group A *(Rhtyhm)* and N=14 to Group B (*Music).* Participants' accuracy rate was computed for each task at each round, by aggregating data over the two songs: Accuracy = (number of correct responses) / (number of correct response + number of incorrect + number of misses) x 100. Task accuracy for both the Go/No-Go and the AAT was analyzed with a mixed Anova, with round (baseline – round 2) as within-subject factor and group (music – rhythm) as between-subject factor. The performance level of the participants was determined by accuracy level in comparison with baseline trials.

	Group A (Rhythm)	Group B (Music)	Group A + B
Go/NoGo baseline	97,005%	97,85%	97,08%
Go/NoGo modified	95,77%	97,59%	96,47%
AAT baseline	78,45%	81,36%	78,99%
AAT modified	81,35%	83,035%	80,27%

Figur 3.1: Average accuracy level in each group and total

For the Go/No-Go task, while there was no main effect of round ($F(1,28) = 0.93$ $p= 0.34$), Group did show an effect on task accuracy ($F(1,28) = 5.25$ $p= 0.03$), with the Music group performing generally slightly better than the Rhythm group. No round*group interaction effect was detected ($F(1,28) =0.41$ $p = 0.52$). The AAT showed no main effect of round ($F (1,28) = 0.81$ $p = 0.35$), nor did it show a main effect of the Group ($F(1,28) = 0.48$ $p = 0.49$).

Overall the findings of the results showed no significant changes in performance level for either of the two groups.

3.3 User interviews

In discussions with the participants after the game, some of the participants in group B mentioned preferences for different songs, but no songs stood out as a main favorite for all participants. While some participants enjoyed the song *(5.7)* which had lyrics, others felt that the song was distracting as they would start to sing along and lose focus on the task. Other participants said they would like to choose their own music, and believed they would have performed better if so. Overall there was some agreement among the participants that the AAT task was more difficult than the Go/No-Go task, and the participants seemed to agree on this whether they were playing the muted version or the version with sound. For some participants, the lyrics in song 5.7 made them loose focus on the actual task as they enjoyed the song and wanted to sing along. Many participants expressed that they had difficulties separating alcohol pictures from the non-alcoholic pictures, even if it was a red cross on top of the alcohol one. Some mentioned that beer bottles, vodka bottles and wine bottles could easily be confused as water. The actual size of the pictures was also annoying for some and they would have liked to have bigger pictures.

4. DISCUSSION

Music is a highly subjective matter when it comes to enjoyment, and it was uncertain whether the chosen music could have actual impact on the performance level of the participants. However, the results from this study shows that there was no significant difference in accuracy level between the rhythm and music, and the rhythm only conditions.

It is likely, that the role of music in this particular game is less impacting the players' performance than in other kinds of games. It might be that background music is not the crucial part of the auditory experience when it comes to making choice, the reception and the outcome. Maybe other audio types in games such as sound effects (interactive sounds) play a bigger role in motivating players and affecting their actions, and not the actual playback music.

Sound effects are often used to give the player feedback about their performance, or confirm that their action was registered by the system (game). Sound effects teach the player what is good, and what is bad, and can help improve their gaming skills and get a better understanding of what and what not to do. Once the player has interpreted a sound as ally generated, the player can also consider the sound relevant for cooperation. The same goes for "enemy-related" sounds, which once interpreted as such, are identified as conflict-related. Not much research has been conducted on sound effects role on performance level of players. But as video game musicologist Karen Collins (2008) states;

> *"Sound effects were extremely important in the development of early games since the sound was a key factor in generating the feeling of success, as sound effect were often used for wins"*

It is also possible that the music in itself is not responsible for the performance level of the participants, but rhythm was in an equal manner affecting their score. Perhaps that different songs would have given a different results, and maybe looking at the interaction with different brainwaves and selecting songs with lower decibels could have had a different outcome.

In addition, perhaps the lack of familiarity towards the selected songs may have had an impact on the gameplay experience and thus performance of the players. Some participants did mention that the song with lyrics was making them less immersed in the game, distracting them from gameplay. The song with lyrics also affected the gameplay experience, as some subjects said that they wanted to listen to the song rather than play the actual game. Participants would attempt to make connections between the lyrics and the game.

One study of musical choice found that listeners had a higher heart rate when they could not choose the music themselves. Furthermore, they found that having choice significantly lowered galvanic skin response, indicating lower arousal (e.g. excitement/stress). The study also found that preferred music was potentially able to reduce the tension component of arousal in older adults. (Miller et al. 2008). Therefore, being able to listen to music that one chooses, could result in lower levels of physical arousal. However, although participants selected familiar songs as to achieve a desired emotional state or greater immersion in the game, they seemed to be unaware of the actual effects of their chosen songs, and were not able to predict which songs would increase their level of immersion or enjoyment in the game. This suggests that players lack the experience in understanding the complex interplay between music and gameplay, and thus fail to choose the right songs that would help them achieve the desired effect. In our study, participants playing the demo version of the *AddictionBeater* had the music chosen for them, as to reduce any source of bias. The question still remains open about the potential impact of freedom of music choice on the performance on the *AddictionBeater* training tasks.

One study conducted by the University of Waterloo examined the influence that player's choice of music has on the player's experience in one particular game, *Fallout 3: Operation Ancorage*. The players chose music specifically for the purpose of relieving anxiety, improving tactics and the experience immersion. The results showed that players were unable to predict which music would improve immersion, but were able to choose appropriate music to influence the tactics and anxiety levels in their gameplay. Wharton and Collins suggests that the involvement of the player, alters the relationship that some players had to game music, depending on their levels of expertise and experience. In their study familiarity towards the selected songs had an impact on the experience for the players. Some subjects said their chosen songs was making them less immersed in the game, or distracted, as some subjects would sing along to the song, distracting them from the gameplay.

Having specially composed music that would be designed entirely for the *AddictionBeater* gamification could perhaps help the players be more alert and concentrated when performing the tasks. For instance, in Bioshock the game consists of entirely non-diegetic music, especially composed for the game, as well as some snippets of previously released singles from the 1930's to the 1950's being incorporated as diegetic sound objects within the gaming environment. This helps the game to succeed at creating the correct atmosphere for the in-game surroundings that make the universe believable for the players (Crathorne, 2010, p. 20).

5. CONCLUSION

The results showed that the music does not seem to have an impact on player performance in games where the participants need to perform a cognitive task. For each of the groups the results showed no significant findings in accuracy, and no decrease in performance level of participants. This might suggest that unfamiliar music is not increasing player performance, but neither decreasing it. If the participants were to choose their own favorite music the outcome might have been different, and this would be a suggestion for further research.

The parameters suggested are not sufficient to give us a real understanding of the underlying effects. It is likely, for instance, that the role of music in this particular game is less important than in other kinds of games. There were many important findings in research of this study that will warrant further research and exploration with a larger group of participants. An important finding in Jørgensens research showed that altering the music in a game changes meaning, actions, effects, and emotional response to the game. Music and sound extends the virtual space into real space and helps immersion by extending the interactive space of the virtual world into physical space. Understanding sound in games in terms of other media, it is important to understand that music opens a whole new world of interactivity, and listening to music as one may familiarize the player with music he or she did not already know, and to re-contextualize music into something else is very much out of the game designers control. In such, a suggestion for future work could be to highlight best friends and worst enemies when they appear on the screen. If specific sounds are connected to enemies (alcohol), and allies (non-alcoholic beverages), this might cause an underlying learning process towards separating them from each other faster.

It might be that background music is not the crucial part of the auditory experience when it comes to making choices, reception and learning outcome when playing certain games. This approach might be referred to as Interactive Audio, meaning sound effects occur in response to player action. Another approach might be focusing on adaptive audio, which means the sounds reacts to events in the environment. Meaning the sounds could react to the proposed enemies and allies in the game. Adaptive audio may affect the player's choice of action. However, the audio is proactive by demanding evaluation or action on part of the player. Following this, interactive audio is reactive in that it occurs as an immediate response to player action (Jørgensen, 2007). Every ludic experience is characterized and individuated with reference to the various rules and resources available to the person (Rodriguez, 2006). Even though we might be enjoying ourselves, and feel more immersed in the game while having music and sound effects, it might still be a distraction for our concentration and learning outcome. This is especially important when it comes to serious games. Finding the right kind of music for certain tasks is important, and how it affects players needs to be taken into consideration. Music is a tool for evoking emotions in people, but as music is a very subjective matter the emotional experience is very much dependent on the preferences of the individual. Further research need to be conducted in this field.

5.1 Limitations

With only 36 volunteers, and where 6 participants had to be removed it left us with only 30 participants data to analyze. This only gave us a brief indication of the actual effect the music would have on performance level. A bigger sample size of participants would have given us a broader and more accurate insight to how much the music and rhythm does affect the players' performance while playing a concrete cognitive task such as the *AddictionBeater* Gamification. In addition, as this research only focused on the actual music in the game and did not consider the effects of other audio types such as sound effects on hit points, combos or negative sound when missing a target, we are limited in the conclusion we can draw in regard to the impact of audio on player performance. We could also have been more selective in what kind of music we did chose for this experiment, and but more focus on the parameters chosen. Another subject group with a neutral gameplay not having rhythm either as a condition in the experiment trials would have given us better understanding of the data as it is now uncertain how big of an impact rhythm did have on participants accuracy levels.

6. FUTURE WORK

Players are different, and enjoy to play games differently, making it hard to create only one game that would fit everyone. According to *Bartle taxonomy of player types* (Bartle, 1996) you can group players into four categories; achievers, socializers, explorers and killers. As such it is important to design or gamify the task that would be most appealing to every type of gamer, or keep in mind that there should be elements in the game that would appeal to every type of gamer, or keep in mind that there should be elements that would appeal to every group of players. Since not only games, but every game play and game player is different, one future research direction would be to explore which methods we can use to determine how players hear, use and interpret game audio. This is clearly an area that needs significally more research, particularly considering the increasing role that dynamic media forms are having on our daily lives. There is also the issue of rhythm-action and other music or audio based games, and how these affect the reception of the audio. More research needs to be undertaken into how audio functions in games and other dynamic media. As this research only focused on the actual music in the game and did not consider the effects of additional sound effects like hit points, combos or negative sound when missing a target, we do not really know how much this actually affects the performance level of the players and this is something that should be looked into for future studies. Not only this, but audio in games is heard in highly repetitive atmospheres, and we must examine if this has any effect on performance level (Collins, 2016, p. 168). We do know that music in general does make your brain release dopamine, and activates the whole brain in different areas. Future research could be done on selecting low pitch music that stimulates the brain and make players more alert and attentive. Participants mentioned that they felt distracted when playing the song with lyrics (5.7) and several studies have shown that vocal music does have a greater disruptive effect than instrumental music, but this is not found when the vocal component is hummed (Smith, 1990). This is something to be taken into consideration when developing the *AddictionBeater* gamification for therapeutically use further. Another way of selecting music for the gamification could be to consider making use of music that has gamma waves or use binaural beats (white noise) as this seems to be helping concentration and indulges productivity. Another interesting thing to look at would be the use of alpha and gamma binaural beats as songs for the *AddictionBeater*. One study showed that binaural beats, regardless of frequency can affect divergent, but not convergent thinking, and do seem to affect performance level, cognitive functioning and even the mood (Lane, Kasian, Owens, & Marsh, 1998). Binaural-beat illusion arises when two tones of slightly different frequency are each presented to different ears. Thus, most people will hear only one tone rather than two different ones (Oster, 1973). Use of binaural beats that stimulates gamma waves could be an interesting future study to consider in regards of games, concentration and performance levels of players. More research needs to be done on use of different kinds of music as to make players perform at an optimal level. More research should be conducted towards creating games with 'safe music' that is not distracting and that could increase cognitive functions as well as concentration levels among players. As the *AddictionBeater* gamification is a game where music is the core element, developing a game that would be more musically emersed with the visual could be something that would engage players even more, and perhaps making them perform even better. As the therapies used in the *AddictionBeater* rely strongly on visual cues when doing the treatment, displaying audio through visual elements would be an interesting way of getting players more immeresed. Some participants did mention that they had a hard time diferanciating between the picture objects, and whether or not they were alcoholic or non-alcoholic. More visual cues could be useful to avoid confusion. This would allow for the players to have a best possible starting point to perform the tasks at an optimal level without losing focus.

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