The effect of musical tempo on video game performance

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Tiivistelmä – Abstract

There is little research on music and audio in video games. What theory exists relies heavily upon borrowing concepts from similar fields such as film music. The empirical research conducted has been varied in scope, but small in number. This thesis explores the current state of theory and research in video game music and audio.

In order to investigate if music can affect performance in a video game, an experiment was conducted. Participants were asked to play the popular video game *Tetris* multiple times to music of varying tempi. The performance of each participant for every game played was recorded and compared across the conditions.

Although no statistically significant differences in performance were observed between the tempi, this study sets a framework for future experiments in the same field.

Asiasanat – Keywords
music, game, videogame, tempo, performance, arousal, attention, Tetris

Säilytyspaikka – Depository

Muita tietoja – Additional information

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1. Introduction

Research in the field of game music is scarce and is often regarded as an area not particularly worthy of study. Living memory holds dated views of game music as just bleeps and bloops and as such is difficult – yet essential – to challenge. As games are intrinsically tied with the rapid pace of technology, the music that people hold in their memories from twenty years ago is no longer found in the titles of today.

Practically all games have music, yet little in the way of research has been done to discover what effect the music has on the player. This thesis investigates how the tempo of music can affect the performance in a video game. It follows prior research in studies related to music and arousal, behaviour and attention as well as the precious few specifically on music and games.

This thesis attempts to justify and explain why research in the field of game audio is a valuable pursuit. The literature review (Section 2) offers a thorough explanation of the field of game music as well as the rationale for studying this area. The key concepts of this study and the field in general are laid out as well as a review of research and theory from other areas and how they relate to this field.

Following this is the methodology of the experiment (Section 3). The aims of the study are laid out with a description of the procedure as well as the reasoning for making certain methodological choices. Section 4 shows the results of the experiment and Section 5 contains a discussion of the results and research methods. Section 6 closes the thesis with a conclusion and directions for future research.

2. Literature review

Introduction

The study of game music is young and is underappreciated as both an academic field and as a legitimate musical genre. Few texts exist on the topic of music and audio in games, though as the games industry gains recognition, its music should become further acknowledged.

Academically, the study of how music can affect the performance of a player has been limited and nearly always for the purpose of learning more about another field, rather than for the studying game music itself. Little follow-up research has been performed on studies on game music leaving inconclusive and sometimes questionable results.

This literature review spans several topics including research on the impact of music on consumer behaviour and driving ability. Although these may at first seem obscure and unrelated, it is necessary to cover other fields to compensate for the gaps in the literature on game music. With this approach, it is hoped that a thorough review of theory and research across a number of fields is explored, resulting in a better understanding of essential components in the field of music and audio in games.

Definition and description of casual games

It would be reasonable to question the relevance of researching the effect of music on a game that had its popularity in the late 1980s and early 1990s. The quality and complexity of games have increased, so the question of why it is appropriate to study a comparative dinosaur is a valid one.

The beginning of the 21st century has shown a huge rise in so-called "casual gaming". This is a term that did not exist a few years ago, but is now commonly used. However, there is no clear definition of this term as the area is very young and has not been widely studied (Kuittinen, Kultima, Niemelä & Paavilainen, 2007).

The significance in studying these seemingly simple games may be surprising to some. Between 2002 and 2006, the casual gaming market grew from a $25 million dollar business to a $500+ million dollar industry (IGDA, 2008). Significantly, this was without the support of major game publishers. These figures spoke for themselves, and the "big players" in the games industry took notice resulting in mass market products such as the Nintendo Wii and its accompanying software. In 2009, the worldwide casual gaming industry had revenues across many platforms over $3 billion

(CGA, 2010). The creation of professional trade organisations such as the Casual Games Association (CGA) founded in 2005 show the rise and continued strength of the casual gaming industry.

The term "casual game" is one that has not been widely defined. The International Game Developers Association (IGDA) defines casual games as, "games that generally involve less complicated game controls and overall complexity in terms of gameplay or investment required to get through [the] game" (IGDA, 2006, p. 6). Kerr (2006) states that infrequent players of games or those who play mini games on mobile devices can be considered casual gamers.

In his book on casual gaming, Jesper Juul (2010) identifies several aspects common in casual games. The first is positive fiction; settings that are in pleasant or familiar locations. Another is usability; making games usable for those who do not often play them. The need to mimic common computer-human interfaces rather than rely on common game interfaces is emphasised. This is in agreement with the IGDA (2008) that identify simple controls as a common characteristic of casual games, offering the example of PC-based casual games utilising a control scheme with a computer mouse in a manner no different to basic computer tasks engaged in by everyday users.

Interruptibility and the need to allow players to quickly exit a game and automatically save progress is given as a common feature in casual games highlighted by Juul (2010). The IGDA (2008) explain the importance of this due to the playing styles of those that engage in casual games and the short periods of time they use to play games.

Juul (2010) also identifies a specific kind of difficulty and punishment required in casual games. He states that a casual game should not be immediately difficult, but also cannot be too easy. Furthermore, difficulty level should rise at a steady pace and require players to increase their number of skills in the game throughout, rather than requiring knowledge of them all from the start. The IGDA (2008) also identify this characteristic in casual games stating that there is commonly a "carefully-crafted ramp in game play complexity" (IGDA, 2008, p. 8). They also highlight that casual games are non-punishing and allow the player some mistakes before penalisation.

In fact, converse to punishment, "excessive positive feedback" (Juul, 2010, p. 45) or as Juul calls it, "juiciness", is important and common in casual games. This is described as features (such as visuals and sound) in the game that offer no additional information to the player but gives positive feedback for successful actions for the purpose of offering a pleasurable experience.

To obtain a better understanding of the definition of casual gaming, it is necessary to explore its alternatives. "Hardcore" gaming is often seen as the opposite to casual gaming (Fritsch, Voigt & Schiller, 2006) but is difficult to describe by itself. The IGDA define it as, "games developed for and delivered on a dedicated game console (set-top or handheld) as well as CD-ROM or DVD that generally involve more complicated game controls and overall complexity in terms of gameplay or investment required to get through game" (IGDA, 2006, p. 6). Fritsch et al. (2006) look at it from a player-centric perspective and state hardcore gamers play with a higher than average interest, take the games more seriously, and put in more time and effort into playing the game.

Similarly, Juul (2010, p. 8) states that the stereotype of a casual player is the "inverted image" of the hardcore player. His definitions of stereotypical casual and hardcore players mention the same game aspects and where the players' preferences lie. These aspects include positive or negative fiction preference, knowledge of games, investment of time and attitude towards difficulty. According to Juul (2010), casual gamers generally prefer positive or pleasant fiction, have a low knowledge of games, do not wish invest a lot of time into gaming and dislike difficult games. By comparison, the traits of hardcore gamers are – as Juul stated – the inverted image. By looking at the preference of hardcore and casual gamers, some elements of their preferred types of games can be determined.

It is worth noting that although the use of these two terms are criticised (Wallis, 2006), they are generally accepted and understood within the gaming community (Fritsch et al. 2006). However, as Kuittinen et al. (2007) highlight, this consensus does not necessarily make for a good definition and understanding, which is why it is important to explore what these terms mean and how they can be better defined.

Although the definitions of hardcore and casual games and gamers explored here rely on comparisons, this appears to be common. Because of the frequency of these comparisons when defining hardcore and casual games, it could therefore be considered that types of games and gamers fall on a gaming spectrum, with hardcore and casual located at either end. Furthermore, the examination of certain design elements of casual games can better help place and locate games on this spectrum.

From this, casual games could be defined as games that are simple to learn but have a progressive difficulty, can be enjoyed in short sessions, offer a generally positive and encouraging experience to the player and require little knowledge of other games.

With the impact of casual games shown, it is necessary to argue the need to study and research its music. Unlike hardcore games, casual games do not have as big a budget (IGDA, 2008) and so developers cannot afford to hire composers and orchestras for huge swelling scores. However, there is still a need for music in these games. While the industry of casual gaming is gaining recognition (as seen in sales figures) and the study of casual gaming is young but existent (Kuittinen et al., 2007), the examination of music in such games has yet to done and so the impact and importance of audio and music in these games is unknown.

Game music ≠ film music

It is common for texts to apply theories and research from the field of film music to the study of game music (Zehnder & Lipscomb, 2006). Many authors have found it necessary to consult and reference texts on film audio due to their certain similarities, such as use of diegetic and non-diegetic sound (Järvinen, 2002; Whalen, 2004).

However, using theories from the study of film and its music cannot thoroughly explain all uses of music in games (Järvinen, 2002) and this approach has been criticised (Kerr, 2006). One key difference between films and games is the way they are participated in; namely interactivity. As Pidkameny (2008) highlights, films are watched passively whereas games are played interactively. Furthermore, passive films require passive scores, whereas games have the possibility of using interactive music (Pidkameny, 2008).

As technology has progressed and budgets for games increased, there has been a push to make games more cinematic. This has been shown by the increasing number of games with orchestral scores. For example, the annual Video Game Awards by American television network Spike has two categories for game music: "best soundtrack" and "best original score". Even famous film composers are being hired to write for games; for example, the main theme to the recently released *Call of Duty: Modern Warfare 2* (2009) was composed by notable film composer Hans Zimmer. For these reasons, it can be seen why applying theories from the field of film music to the field of game music can be appropriate.

However, the fields of film music and game music are very different, and another of these main differences is linearity. Films are linear one-way experiences, whereas games are non-linear interactive experiences (Eladhari, Nieuwdorp & Fridenfalk, 2006) and the music composed needs to reflect that (Pidkameny, 2008). More importantly, when studying the music of casual games, most do not have cinematic, orchestral scores, therefore the similarities to film music are greatly reduced.

Although games are interactive experiences, game audio can be considered to fall in to one of two categories; linear and adaptive. Linear music is like that of film music. It is set to timed events and is written to create a particular mood or atmosphere for scripted visuals. The music is made post-production, like in film (Marks, 2009). Adaptive audio is music and sound in a game that reacts to changes in the in-game environment and/or player response (Collins, 2008a). Adaptive audio is common in modern hardcore games, as video games are not predictable like films; the music cannot know what the player's next move will be (Marks, 2009).

The subject of casual games not having cinematic, orchestral scores is worth noting. One explanation for this could be financial; casual games generally sell for less money and as previously mentioned, have smaller budgets than their hardcore counterparts. However, it must also be considered that the need for such scores is greatly reduced in casual games. Casual games do not generally have the same level of emotional involvement or attachment as hardcore games. Because of this, it is possible that grand cinematic scores would be somewhat excessive for a player matching tiles or stacking blocks.

It can be seen that there is a lot of support for approaching game music in the same way as film music. This may be due to some similarities both fields have in common, or it may be due to the fact that it is the only similar field. However, the most similar field is not necessarily similar enough in this context. Others have highlighted how it is not always appropriate to compare game music to film music and have discussed the differences. As different genres of games require diverse musical soundtracks, it can be considered that while it is sometimes beneficial to apply theory from the field of film music, it is not always the most appropriate approach.

Game music as a legitimate field of study

The field of audio in video games has little recognition as a legitimate entity in itself. This may be due in part to the ignorance of the video games industry as a whole. Collins (2008a) remarks that when she started writing about game audio in 2002 she felt it necessary to justify her articles with statistics and sets of facts on the games industry in order to give validity to the text. She states that it is now no longer necessary to do this due to the understanding and mainstream acceptance of video games.

However, it could be argued that we are still not at such a stage. Studies on the subject of music in film need not describe the cultural impact of films and offer facts and figures regarding sales and the size of the industry. It can be assumed that this is because the average reader is already familiar

with such matters and as such, studies do not need to be prefaced with justifications. Clearly, the remark made by Collins (2008a) shows that she observes an improvement in the recognition of the games industry but by making such a remark, it serves as such an introduction suggesting justification is in some form still required.

Location and culture is one aspect that may contribute to this lack of recognition or understanding of the games industry and its music. While concert performances of music from games as well as soundtrack releases are commonplace (and have been for around 25 years) in countries such as Japan, such things are much rarer in the western world. This information would surprise many in the west. This could certainly be due to a huge cultural difference, and begs the question of how much information and research there is regarding music in games only available in Japanese.

Because of this lack of acceptance and also the comparative youth of the field, video game audio is a rarely studied topic. Collins (2008b) remarks at the slow progress that has been made in the research of game audio despite 30 years of technological advancement. It could be argued that the technology has only relatively recently reached a level where academic research in this field can be conducted. However, a stronger explanation is that of the games industry having only recently begun to gain mainstream recognition.

Outside of academia, there is a greater recognition of game music. The internet gives people with similar, perhaps obscure or niche interests to communicate and develop new online cultures and followings. Long-running western websites such as the Video Game Music Archive (founded 1996) and OverClocked ReMix (founded 1999) have provided people with a platform to discuss their interest and share arrangements of music in games. Today there are dozens of websites reporting on news of interest to game music fans. While these are known within online communities that share such interests, it is questionable how much interest and exposure they have elsewhere.

It can be seen that while the games industry and the field of game music have gained some mainstream recognition, justification of studying topics in these areas is still common. Although certain groups and communities exist online that would not require such introductions to studies, they are clearly a minority. It must be considered that the relevancy of studies on the subject of film is not as questionable as that in the field of games.

Musical preference

When considering how music may affect the performance of video game players, the players' musical preference must be considered (Wolfson & Case, 2000). However, few studies have been conducted in this area. For this reason, similar studies will be examined with explanations for their relevancy.

In gaming-related research, Cassity, Henley and Markley (2007) found that participants performed better in the skateboarding game *Tony Hawk's Pro Skater 3* when listening to their preferred music. However, the study only used two pieces of music; a song by rock band Red Hot Chili Peppers and a Mozart sonata. The purpose of the study was to discover if participants performed better when listening to Mozart, or when listening to their preferred music. The focus of the research was the effect of Mozart's music on a certain task, rather than the effect on game performance under various conditions.

Despite only using two pieces of music, this study did show that people performed better when listening to their preferred music. The Red Hot Chili Peppers song was deemed the most suitable for the game, most likely as it was in the game's original soundtrack while the Mozart piece was chosen for the purpose of the hypothesis.

Some games allow the player to change what song they are listening to. In the case of *Grand Theft Auto 3* and *4*, the player has access to an in-car radio where he or she may change the station. Each station has their own genre of music, and by allowing the player to change radio station, the game offers the player an immersive way to listen to their preferred music. Similarly, as both Collins (2008a) and Jørgensen (2008) highlight, games for Microsoft's Xbox 360 console must include the option for a player to listen to their own music rather than the in-game music if they so wish. The player is able to rip music CDs and store them on the console's hard drive, making them available as an alternative soundtrack to games.

Jørgensen (2008, p. 163) attributes this to the "golden rule in game audio design" which she defines as ensuring the player is never bored or annoyed with repetitive sound. Microsoft appear to have acknowledged this by allowing the player to listen to music of their own choosing while playing a game, however this may possibly be to the detriment of the game's aesthetics as well as the performance of the player.

Shifting attention to research on musical preference outside of gaming but that could be applied to this field, a study by North and Hargreaves (2000) may offer an insight. In the first of two

experiments, participants were asked to choose their preferred music after engaging in a high or low arousal task; either riding an exercise bike or resting on a bed. The music consisted of two choices; an arousing (loud and fast) and less arousing (slow and quiet) version of the same piece. The participants that rode the exercise bike preferred the less arousing music while the participants that rested on the bed preferred the arousing music. The researchers believed the choices by the participants were made to moderate their level of arousal.

The second of the two experiments was carried out in the same way as the first, with one difference. The participants were asked to choose their preferred music during their activity, rather than after. This resulted in opposite results to the first experiment; the participants preferred the music that suited their present state of arousal.

From these results, the authors suggest that the participants preferred music based on their goals. The participants in the second experiment chose music to help them achieve their goal; the participants on the exercise bike wanted to reach a high level of arousal, whereas those resting wished to reach a low arousal level. Conversely, the authors suggest that when participants were asked to select their preferred music, they had already finished exercising or relaxing and no motivation or need to sustain their state of polarised arousal.

It can be argued that engaging in a game of *Tetris* will lead to a high state of arousal, especially as the screen starts to fill with blocks towards the top. More arousing music could be preferred by the player as it suits their goal of performing well in the game. Less arousing music may be preferred afterwards, though that is not within the scope of the study.

This would be significant as it has been showed that players perform better when offered a choice to listen to their preferred music. However, caution must be applied when using the findings of a study to theorise in another field. While it is possible that a similar phenomenon could be observed when studying game players, it cannot be assumed.

Clearly, musical preference is quite likely to have an impact on gameplay performance. It is possible that preferred music will result in better performance, however it has been noted that familiar music may be a distracter. Perhaps a worse influence than this would be any music that repeats too often. Music that suits the present goal of the player has a possibility of positively affecting gameplay performance, however there is no direct evidence to support this.

Uses and roles of music and audio in games

The need for music in a game at all could be questioned. Investigating further, the uses and possible roles music has in relation to how a player interacts and communicates with the game can be explored.

In connection with her PhD research, Jørgensen (2008) performed a qualitative study of 13 players of real-time strategy game *Warcraft III* or stealth game *Hitman Contracts*. Participants played for 25-30 minutes with the sound being unexpectedly removed roughly halfway through. They were questioned about their experiences and how it affected the way they played.

As Jørgensen (2008) highlights, the uses and roles of audio in games varies from game to game as well as genre to genre. Two uses of audio in games were highlighted as a result of this experiment; creating an atmosphere that involved players into the game world, and alerting players to important events in the game. The former can be described as *immersion*. However, as Zehnder and Lipscomb (2006) highlight, very little experimental research has been conducted on the topic of the role of music in creating an immersive experience.

Outside of academia, one example of the debate of immersive music in games exists in online discussions and fan-made projects for Bethesda's 2006 role-playing game *The Elder Scrolls IV: Oblivion*. In this first-person game, the player is free to explore the in-game world. The audio consists of light orchestral music as well as ambient sound such as bird calls and the wind blowing through the trees. Most significantly, when an enemy is nearby, the music changes to a more menacing battle theme. This is where some players claim to be a problem.

Online discussion shows some players prefer to play without any music citing immersion as a reason (see Tarnsman and others, 2007). In addition to providing technical assistance to other players interested in disabling music in the game, there are also projects specifically to replace the soundtrack, such as the "Oblivion Background Music Project" (OBMP) which specifically lists "No Battle Music!" as a feature. The creator states that the original battle music is "immersion-shattering" and adds that it "brings the fear of uncertainty back to the game so you'll need to be more careful and alert" (OBMP, ----).

However, *Oblivion* is considered to be a hardcore game, so the importance of immersion must be considered in casual games. According to Juul (2010), players of casual games invest less time in gaming. Casual gamers also have a greater desire for relaxation and enjoyment rather than seeking adrenaline and other such stimulation (IGDA, 2008). It is rare to find violence or sexual themes in

casual games which are more common in hardcore games (IGDA, 2008). The lack of such themes in casual games suggests that immersion is not as an important element in casual games, or at least exists in quite a different form.

In addition to immersion, narrative and communication are also assisted by audio (Zehnder & Lipscomb, 2006). Music in games communicates important information (Livingstone & Brown, 2005) and Jørgensen's (2008) research highlights this. Players were required to multitask in the strategy game, and relied on audio cues to inform them of important events and notifications. They relied only on their hearing for certain in-game tasks, such as the completion of a structure or an enemy attack. Similarly, audio cues in the first-person stealth game alerted players to events such a doors opening off-screen which would be missed entirely without the audio.

When asked about playing after the audio was removed in Jørgensen's (2008) experiment, players likened the experience to being left in the dark or losing a leg. This is consistent with Stockburger (2003) who emphasises the importance of sound objects to assist the player situate themselves in an in-game environment. While these elements may not be as important (or even present) in a casual game, sounds to inform and alert the player of certain events are.

The limited amount of literature available on specific uses and roles of music and audio in games makes it difficult to make generalisations. Interestingly, in a study on physiological stress response to playing a game, Hébert et al (2005) found no significant difference in player performance when the original game audio was audible or silent. Such conflicting findings show how this field is still in its infancy as far as theory and experimental research.

Licensed/familiar/preferred music (music as a distracter)

Since the advent of disc-based consoles, the use of licensed music in game has become prominent. Before this, songs had to be transcribed, programmed and played back through the console's inbuilt sound chip. The resulting quality was obviously nowhere near that of the original recording, though it still proved popular in games such as *Michael Jackson's Moonwalker* (1989-1990).

10-15 years ago, the use of big name artists would help games sell. However, it is now quite common for music sales to increase after a song has been featured in a game. Collins (2008a) offers the following examples. Rock band Fall Out Boy sold 70,000 copies of their album after a song featured in *Tony Hawk's American Wasteland* and reggae artist Selasee gained success after one of his songs featured in *FIFA 2006*. Racing game *Driv3r* used music of new bands from around the world as well as previously unreleased songs from known acts. Marc Canham, the

director of Nimrod Productions – the company that made *Driv3r* – called this, "amazing marketing fodder for the music press" (Canham, 2004, cited in Collins 2008a).

Marketing music through video games is also discussed in detail by Kärjä (2008) but in a rather unilateral manner. While the use of a certain song in a popular game may help it sell, the effect that song has in the game must also be explored. Furthermore, it must be considered what difference it makes to the game from an aesthetic and performance-based perspective whether a certain song became famous through the game, or if a song is already known by the player.

While Cassity et al. (2007) found that players perform better when listening to their preferred music, Collins (2008a) argues that using well-known songs and styles may be a distraction for players. However, the justification given for this relates to the study of film music, which as discussed, is not always the most appropriate field to essentially borrow theory and research from.

Kärjä (2008) highlights one example where borrowing theory of music in film cannot apply to the field of game music. Games where music is the main focus must be considered differently. In games like *Dance Dance Revolution* and *Guitar Hero* where players must specifically focus on the music in the game, being familiar with a particular song can give the player an advantage (Lecky-Thompson, 2008). Indeed, games like *Singstar* that are essentially a form of karaoke require the player to be familiar with the music in order to gain a good score.

It can be seen that games can have an effect on music in terms of sales, though as Collins (2008a) remarks, it is not known whether licensed music can have effect on games. There are mixed views on how the use of licensed music affects the performance of the player. Although the genre of music-based games is not new, the broad appeal of them and their familiar music have only come to attention in recent years. As such, there is little in the way of research in this particular field. It can be assumed that familiarity of music in a game can affect the performance of the player, however factors such as frequency and repetition as well as musical preference must surely also contribute.

Music and arousal

As discussed earlier, the field of game audio has not been extensively studied, and the field of film music allows only for a one-way experience. Games are an interactive experience, and as such, studies performed on interactive tasks such as driving are a close alternative, and certainly one more accurate than reaction to film music.

Music has been found to affect driving. It is suggested that listening to music while driving is a possible distraction which can negatively affect driving performance (Dibben & Williamson, 2007). Listening to faster music has been shown to affect simulated and perceived driving speed as well as increased traffic violations compared to listening to slow or mid-tempo music (Brodsky, 2001).

Similarly, drivers that listened to music displayed less aggression in congestion than those who did not listen to music (Wiesenthal, Hennessy & Totten, 2003). However, those listening to music reported lower levels of aggression, but only in situations with less time urgency. The authors suggest that music can work as a distraction from frustrating situations, but only when certain other factors that could cause stress, such as time, are minimal.

The significance of studies of driving and music in the context of game audio is twofold. Firstly, it has been found that people listen to music most regularly when driving (Rentfrow & Gosling, 2003), and secondly, studies involving driving with music have more in common with studying gameplay performance to music than watching film clips to music. Furthermore, some studies focusing on driving performance use games or simulations as their test environment (North & Hargreaves, 1999; Brodsky, 2001).

Research in this field suggests that music can influence the participation in an interactive task that requires a certain degree of concentration. There is further support in this field for the argument that listening to music could be a distracter. There is also further evidence towards a possible link between music and arousal levels. Similar to the study by North and Hargreaves (2000), Brodsky (2001) found correlation between the level of arousal represented in music and the actions of participants.

North and Hargreaves (2000) claim that preferred music in an arousing task depends on the goal of the individual, and Brodsky (2001) found an effect in performance related to the level of arousal in the music listened to. The findings of Brodsky (2001) could support the idea that fast and relatively arousing music may impair the ability of a person engaging in *Tetris* due to the increase of mistakes participants made in the study. Furthermore, as perception of speed was affected by fast music, it is possible that such music may adversely affect performance in a game.

Music and behaviour

It is important to consider how music can affect the behaviour of a player by judging their performance. Unfortunately, as no such studies have been conducted, research in similar fields

must be sought. A proportion of research of the impact and effect of music on behaviour has been done in the field of consumer behaviour.

It can be argued that the study of music and consumer behaviour relates to game music and its effect on the player. Both shopping and playing a game are interactive experiences; arguably a more valid comparison than watching a film. Furthermore, music is often not actively listened to in both situations yet can affect peoples' behaviour.

In a classic study in the field of music and consumer behaviour, Milliman (1982) found that the tempo of music played in a supermarket affected the speed of shoppers. Under three conditions – no music, slow music (less than 73 bpm) and fast music (greater than 93 bpm) – the time it took shoppers to travel between two points in a supermarket was measured. Shoppers took the longest time under the slow music and the shortest time under the fast music. The no music condition resulted in a time in between these.

Milliman (1982) emphasised that these results only pertained to the research conditions and that a number of other factors must also take a role. However, subsequent research has found support for Milliman's findings. When the length of time it takes for diners to finish their meals in a restaurant environment is analysed, playing slow music has been shown to result in longer dining times with fast music resulting in shorter dining times (Milliman, 1986; Caldwell & Hibbert, 2002).

The effect of loudness on consumer behaviour has also been studied. Sullivan (2002) found that soft music played in a restaurant resulted in longer dining time than loud music. In addition to tempo and volume, preference for music has an impact on observed consumer behaviour (Caldwell & Hibbert, 2002; Sullivan, 2002). In addition to (or perhaps in connection with) longer dining times at restaurants, musical preference can affect peoples' liking of an environment.

Research has shown that slow tempo music leads to longer shopping and dining times and the opposite has been demonstrated with fast tempo music. This is significant, as both are situations where people are able to operate at their own speed and music has been show to influence that speed. It could be theorised that if music can alter behaviour in people in as much as the speed in which they conduct tasks, the same may be true for a game.

Similarly, research has shown that the loudness of music played affects the speed people take in certain tasks. It can be considered whether similar effects apply to people playing a game. While no research has been specifically conducted on this topic, the similarities of gaming and shopping compared to other fields as previously discussed suggest there may be crossover effects.

Music and attention

Similar to the relevancy of music and behaviour to gaming, the way music affects peoples' attention must be examined. Research on music and attention has focus in areas other than gaming. One such area is the study of the effect of music in the workplace, analysing elements such as employee morale and productivity. As employees must complete tasks within a certain environment, usually without music, studying the impact of music on such areas is significant. To compare this to gaming, a casual game will have a task that must be completed within the in-game environment, often with music. It is important to know how this music affects attention.

In one of the most well-known studies in this field, Oldham, Cummings, Mischel, Schmidtke and Zhou (1995) conducted research to determine the effect of music in an office workplace on workers' performance as well as other emotional measures. For a four-week period, a number of employees were given personal music players to listen to during work, and others were not. The researchers measured employee performance of both groups and found improved performance in the group that listened to music.

Focusing on performance, workers that listened to music on their personal music players showed significant improvement. This is in contrast to Lesuik (2005) who conducted a similar study and found the quality of work was lowest without music when comparing a music and no-music work environment.

These seemingly conflicting results show that music has an effect on attention, but that it may manifest itself in differing ways depending on the environment. In addition to these results, Lesuik (2005) also found that time spent on a task was longest when music was not present. This may suggest that workers focused their attention further due to the minimised distraction of music.

If music has such an effect on the performance and attention of workers in their workplace, a similar phenomenon could occur in a person playing a game. However, because of the conflicting results, it is hard to theorise whether listening to music would result in better or worse performance than playing in silence. Furthermore, musical preference is a contributing factor that must be considered to influence performance.

Use of *Tetris* in academic studies

Tetris has been used in a number of academic studies over a long period of time and is possibly one of the most commonly used games in academic research. One explanation of this could be because

of its age and widespread familiarity (Jordan, 2009). There are quite literally too many academic studies that have utilised *Tetris* in some way to list them all, and doing so would be beyond the scope of this literature review. However, the following shows several examples.

Tetris has been used as a visual-spatial task to assist in the study of brain activity (Haier, Karama, Lebya & Jung, 2009) and in studies of spatial ability (Sims & Mayer, 2002) and mental rotation (De Lisi & Wolford, 2002). It has also been used as an aid in reducing trauma-related flashbacks (Holmes, James, Coode-Bate & Deeprose (2009) as well as in hypnotherapy with a patient with brain damage (Winter, 2001). Effects on visual attention have been studied with video games including *Tetris* (Green & Bavelier, 2003) as have effects on memory and executive control (Boot, Kramer, Simons, Fabiani & Gratton, 2008).

It is not uncommon to find *Tetris* to appear in studies that utilise a video game in some way. A study of the effects of interference and distraction on playing a video game used *Tetris* (Wentura, Voss & Rothermund, 2009). The ability of an amnesic patient who was able to learn how to play *Tetris* to a very high level has been reported (Winter, 2002). *Tetris* has even been used as tool to measure the performance of physicians (Laczika et al., 1995).

In the field of mathematics, the possibility of winning *Tetris* has been studied (Brzustowski, 1992). Even the effect of playing *Tetris* itself has been studied. It has been documented that playing *Tetris* can result in the player having mental images and dreams of the game, such as visualising falling blocks and how they fit together (Earling, 1996). Stickgold, Malia, Maguire, Roddenberry and O'Connor (2000) found that even amnesic patients had such visions after playing *Tetris* despite not remembering having played the game.

There is still much to be learned about this so-called *Tetris effect*. Similarly, there is still room for further studies to utilise *Tetris* in some way. There is also opportunity to conduct similar research to the studies mentioned, but using other games to see if *Tetris* itself is significant, or if just the playing of a game is required to cause a similar effect.

Conclusion

As has been demonstrated, academic studies on music and audio in games are extremely limited. Because of this it is necessary to investigate other topics where music and its effects in various situations and contexts have been studied. Arguably, this provides a more thorough and systematic analysis of possible effects of music on the performance of a game. By examining other particular

fields and considering their relevance and application to the effect of music in games on people, a more comprehensive and considered approach is gained.

Furthermore, by avoiding excessive comparison to the field of film music, a broader view is gained as opposed to attempting to specifically link one theory or research finding to the field of game music. However, considering results from studies in other fields and attempting to apply them to the field of game music is tentative but is the strongest method available when existing literature is scarce.

A casual game can be defined as a game that is simple to learn but has a progressive difficulty. They do not need to have to have much time dedicated to them as they can be played in short sessions. Casual games provide a generally positive and encouraging gaming experience, suitable for players that are not overly familiar with other games.

The significance of studying music in casual games is not widely recognised and often has to be justified. This may be because of the relative youth of the genre, or that the size and impact of the gaming industry in general is not broadly acknowledged. Similarly, music in games is not seen as legitimate a genre or use of music compared to that of music in films, for example.

Music in games shares some similarities to music in films, though it is heavily dependent on the genre of game. Casual games do not offer a similar experience to hardcore games which in turn have more in common with films. The general roles and uses of music and audio in games vary from genre to genre. Most research has been done on the roles and uses of music in hardcore games, with very little on casual games. This may be because it is seen as less necessary to justify studies on film music, and hardcore games have been noted to have more in common with films than casual games. It may also be due to the relative youth and still not widely acknowledged size and importance of the industry.

Considering the factors related to music that may contribute to an effect in gameplay performance, musical preference is important. Studies and theory directly on the effect of musical preference in gameplay performance offer conflicting results. Studies on other factors often mention the need to consider the impact of musical preference, but little has been done to broaden knowledge in this field. The effect of using familiar music in the form of licensed songs has been explored, but the theory again offers conflicting views. The available studies on this topic do not offer convincing evidence to support the theory.

On the topic of music and arousal, it has been shown that certain musical factors – such as tempo – can affect driving ability. It can be considered that driving requires a similar level of interactivity as a game, making a good comparison. There is also further evidence to support the argument that music may act as a distracter in certain situations.

Research in the field of music and behaviour was explored as behaviour was shown to be modified in the driving-based research. Similar to driving, shopping is an interactive experience, and as such, research on the effect of music on consumer behaviour is relevant to explore. Again, certain musical factors such as loudness and tempo have been shown to effect behaviour.

Investigating the field of music and attention, studies based on workplace performance show that listening music may positively affect attention and performance. However, musical preference is not taken into consideration. Furthermore, there is additional support for the argument that music may act as a distracter and have a negative effect on concentration and attention.

Jointly summarising these various areas, it is clear that music affects people in their level of arousal, their behaviour and their level of concentration and performance. These factors are significant elements of engaging in a game, so from this it can be theorised that music will in some way affect gameplay performance. However, the way it will be affected cannot be broadly determined.

Music can reduce levels of aggression and divert feelings of frustration when stress and stressful factors are small. If a stressful factor such as lack of time is involved, the effect of music may be different. Musical variables influence the behaviour of people; when exposed to slow music, people tend to act slower, with the opposite true for faster music. A similar effect is observed with quiet and loud music; quiet music leads to slower actions and louder music results in faster actions. Attention and performance of some tasks can be improved when listening to music, however this strongly depends on the context and situation. Similarly, within this framework, the musical preference of a person must also have an impact, although it is difficult to claim if it is a positive or negative one.

3. Methodology

Aim of the study

The aim of the study was to investigate how the tempo of music in a video game may affect the performance of the player. The possibility that either faster or slower music could increase performance or become detrimental to the player was investigated. A brief overview of the study is described here with further details following.

Participants were recruited to play six two-minute games of *Tetris*. The aim of each game was the same; to clear as many lines as possible. The number of lines cleared as well as the number of pieces played were recorded for each condition for each participant. These scores were not compared between participants but rather between conditions in order to see if there were any common trends in performance. The same piece of music was used in each game, however it was manipulated slightly each time. The six conditions were: the original music, no music, 8% slower, 4% slower, 8% faster and 4% faster.

Participants and ethical considerations

Participants were recruited by use of posters around the university campus and by emails to student mailing lists. By this nature the participants were primarily, but not exclusively, university students. This meant most participants were aged 20-30 with gender mixed fairly evenly.

It is important that an experiment involving participants is conducted with the utmost respect for their wellbeing. All participants were given the same instructions which included the information that they had the right to leave the experiment at any time. They were also asked before each game if they were ready to continue, just to further ensure their willing participation. As no children or vulnerable adults were involved in the research, informed consent was not necessary.

Details of procedure

The research was conducted in a controlled environment with 21 individual participants. Each participant instructed in the same manner what the experiment involved. Participants' questions were answered and their willingness to participate confirmed before continuing. Each participant was given two minutes to play *Tetris* to familiarise themselves with the game and its controls. Help

was provided for participants that wished to be told the controls, where other participants effectively taught themselves.

Before each game, the participant was asked if they were ready to continue. After each game their results were recorded on the computer and then asked if they were ready to continue and the process repeated until the participant had played in all six conditions. The order of the conditions that the participants were exposed to was randomized to eliminate the chance of a practice effect.

A desktop computer was used to play *Tetris*, play the music and record the results. An audio mixer was connected to the computer and stereo speakers connected to the mixer. The loudness of the music was identical across all participants and across all conditions.

Why these methods were chosen

The version of *Tetris* used was *Tetris Ultra*, available on the *Tetris Friends* website, an official site of the Tetris Company. It is important and significant that this site and this particular version of the *Tetris* game were used in this study.

Firstly, many versions of *Tetris* exist. Making a version of the game is often the first project for amateur programmers (Rouse III, 2005). With so many versions of *Tetris* available, and the quality not necessarily always high, it is a strong choice to use a version of the game from the Tetris Company.

The reason for using *Tetris Ultra* is that simply is has a time limit of two minutes. The design of the game shows that two minutes is sufficient time for a game of *Tetris* which adds weight to choosing this length for this study. Furthermore, the longer the game is, the higher the chance of boredom affecting the performance of the participants. Two minutes is long enough to avoid a floor effect where there is not enough time to perform depending on the condition. Similarly, it is enough time to gain meaningful performance data. Having the participants play for five or ten minutes per condition would not increase the integrity of the data but would increase the chance of performance degradation due to boredom or fatigue.

The potential for any boredom effect is minimised by the short gameplay time. If gameplay was extended to five minutes per game with six conditions, boredom or irritation would be highly likely to increase and cause an unwanted effect.

As mentioned earlier, the music for each condition was manipulated in various ways. The piece of music used for this study is the music from *Tetris Ultra*. There are a number of reasons why this

was chosen. Firstly, similar to the justification of the two minute time limit, the music is part of the design of the game and is therefore especially intended for that purpose. Using the same piece of music with various tempi isolates the musical factor that might impact on performance.

Using a different piece of music for each condition was considered but ultimately discounted. The advantage to having different music is that the boredom effect should be limited. However, musical preference would be a larger factor in the game performance. It would be impossible to conclude that tempo is the primary factor in any performance differences when different music was used. Musical preference has already been shown to affect game performance.

However, using the same piece of music would increase the chance of a boredom effect. Results could be influenced by such an effect so it is an important issue to consider. However, the alternative – using different music in each condition – has a greater chance and a higher number of potentially unwanted effects.

Two scores were recorded to measure performance; the number of lines cleared and the number of pieces played. The number of lines cleared is simply a total of how many lines of blocks the participant was able to clear within the time limit. The number of pieces played is how many tetronimoes fell during the two minutes.

The score was not recorded for several reasons. The score is more dependent on the skill and experience a player has. For example, clearing two lines at once gives a higher score than clearing two lines separately. Similarly, more complicated moves such as T-spins and tetrises net even higher scores and bonuses (Trefry, 2010).

It is also hard to determine how "well" a participant has played from the score. A player can obtain a higher score by performing special moves and tricks than a player who clears many individual lines. As clearing lines is the main aim of the game this was chosen over score. Experienced *Tetris* players may only care about score, but this demographic was not present in the participants. Furthermore, as this study uses *Tetris* as an example of a casual game, competitive scoring is not a consideration.

The number of pieces played was also recorded. This was to observe that if there were changes in the number of lines cleared in certain conditions, was there also such a change in the number of pieces played. It can help to see if there is strict correlation or if accuracy improves or worsens in certain conditions. Accuracy can be suggested by comparing the change between the number of lines cleared and number pieces played between the conditions.

Tempo

As previously mentioned, the tempi of the manipulated conditions were 8% slower, 4% slower, 8% faster and 4% faster compared to the tempo of the original music. These levels of manipulation were chosen as they correspond to the findings of prior research on the level of the just noticeable difference (JND) in tempo.

Madison (2004) conducted an experiment where participants listened to a series of clicks where the tempo gradually accelerated or decelerated and had to identify when they perceived a difference in tempo. This study found a JND of about 4%.

A similar study by Drake and Botte (1993) focused on how participants discriminated tempo, rather than a change in tempo. In addition, the researchers compared musicians and non-musicians. As Quené (2007) summarises, the JND for non-musicians was 6-10% and 3-8% for musicians.

Quené (2007) also highlights an unpublished study by Perron (1994) regarding tempo deviation in electronic drum machines. It was found that although the machines have an average tempo deviation of about 3.5%, most listeners – including professional drummers – do not detect this. As Quené (2007) states, this suggests that the JND is at least 3.5%.

The 4% tempo change used in this study was selected on review of what is the minimum tempo change most listeners will be able to detect. 8% was chosen for the larger manipulations as it is double the JND value selected for this study, and is clearly a more noticeable change in tempo. It is also fast enough to be detected by listeners according to the research. Furthermore, it is not so fast that it is an unrealistic tempo; an important consideration to ensure the ecological validity of the study is not jeopardised.

Stimuli

The audio was modified using the latest stable release of Audacity (1.2.6). Audacity was chosen as it is the leading open source audio editor and its built-in effects were appropriate for the purposes of the experiment.

For the condition that played the music at the original tempo, a modified version was created. This was to eliminate the factor that any audio artefacts from the modifications could influence the outcome of the experiment. With all audio conditions being subjected to modifications, this was

not an issue. For the modified version at the original tempo, the tempo was increased and then decreased again by the same amount.

4. Results

The aim of the experiment was to discover if the tempo of music in a game can affect the performance of the player or if music was a distracter. After the data was inserted into Microsoft Excel, it was screened for outliers and any other potential problems, but none were found by visualising the data. The data from all 21 participants was used in the analysis.

Music versus no music (music as a distracter)

To discover any difference between the original music and silent conditions, a t-test was performed between the silent and original music conditions. Although more lines were cleared when no music was played (mean 14.7 lines) than during the original music (mean 14.1 lines, see Figure 1), this was not statistically significant ($t[20]=-0.35$, p=ns (not significant)).

Effect of tempo

To discover any differences in performance between the various tempi, a repeated measures ANOVA was conducted between all six conditions. For the number of lines cleared, no differences between the conditions emerged ($F(5,114) = 0.039$, p=ns). Similarly, for the number of pieces played no significant differences were observed ($F(5,114) = 0.057$, p=ns). For the mean pattern of results across the conditions, see Figures 1 and 2 for lines cleared and pieces played, respectively.

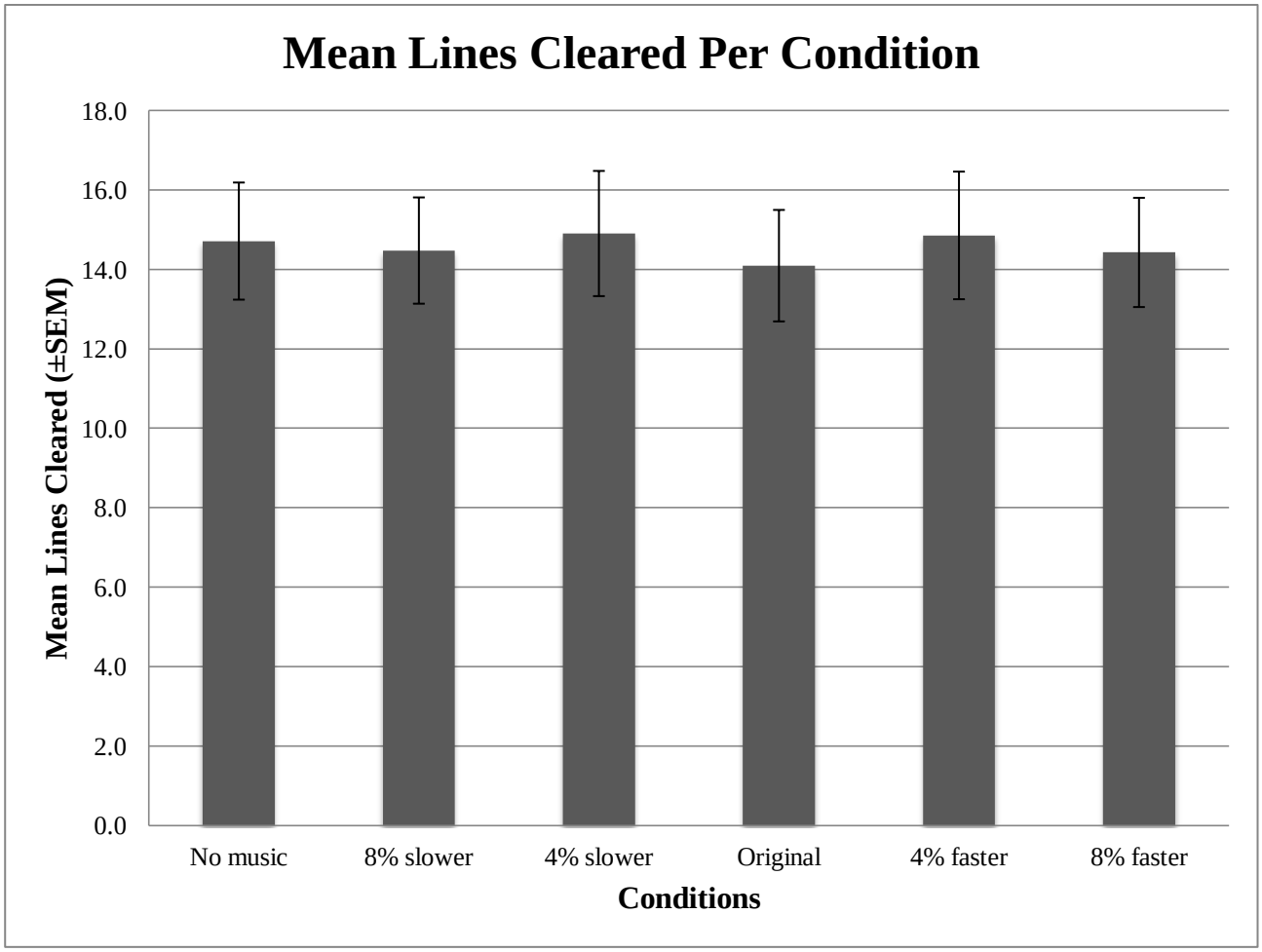

Figure 1. Mean lines cleared across conditions.

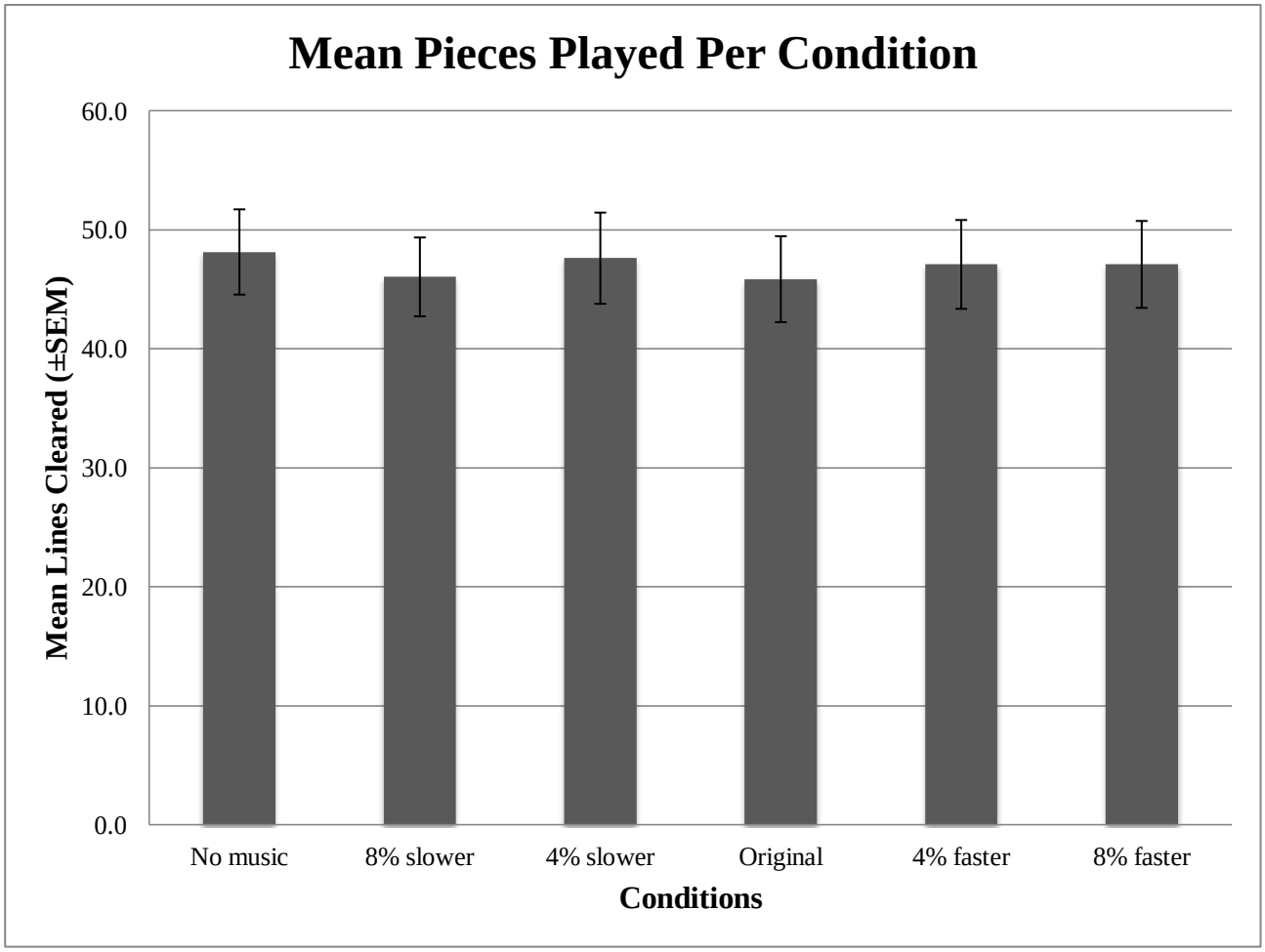

Figure 2. The mean lines cleared across conditions.

As can be seen in both Figures 1 and 2, there is clearly no visible pattern with respect to different tempi, nor a pattern that would discriminate faster and slower stimuli. As the statistical tests support, there are no statistically significant differences between the conditions; the minor differences between each condition are only random fluctuations.

Correlation between lines cleared and pieces played

In order to support the validity of the data, the correlation between the number of lines cleared and the number of pieces played for each participant was investigated. This was examined by calculating the Pearson correlation coefficient between the results of the two measures. A significantly high correlation between the number of lines cleared and the number of pieces played was observed ($r(124) = 0.95$, $p<.001$), shown in Figure 3. In other words, the two measures used to quantify the performance in the game were highly consistent with each other.

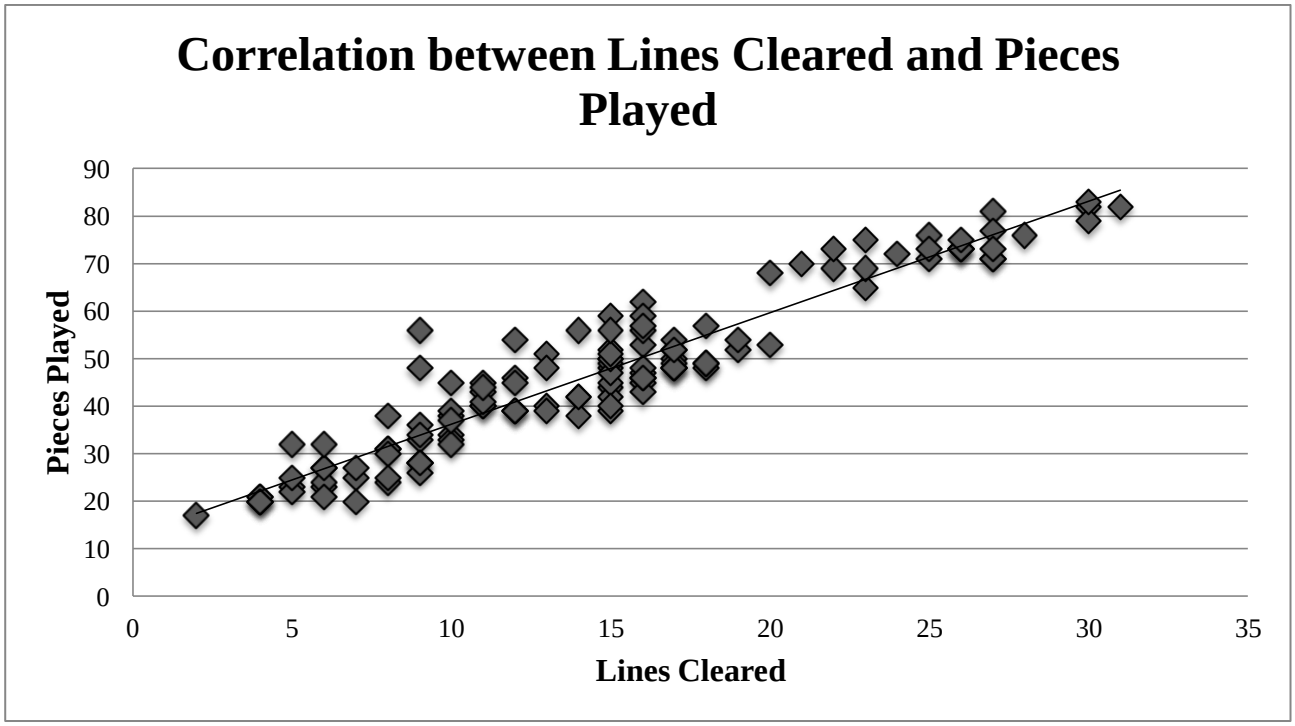

Figure 3. The correlation between lines cleared and pieces played.

To summarise, after performing the analysis and statistical tests on the data, no significantly different results across the tempo conditions were observed.

5. Discussion

There is no significant difference between the conditions and hence the null hypothesis remains in effect. The reasons for the non-significant results must be explored. There are a large number of considerations to make in any research project, and many options and alternative methods and choices that can be made. By examining these various factors, potential issues may be found that can aid the direction of future studies in this area.

Participants

The number of participants for the study may be a factor in the non-statistically significant results. In basic terms, data from experiments has greater relevance when there are a higher number of participants. Limiting the number of participants can mean a lower chance of gaining a statistically significant result. However, in this study the number of participants allowed for statistical significance.

Monitoring the demographics of the participants and limiting access to the experiment to a particular demographic may have changed the results. A closely monitored demographic would offer a more pinpointed result, although it would not necessarily offer any higher significance.

The demographics of the participants were not considered for the purpose of this study. There are two arguments why this is a strong choice.

Firstly, *Tetris* and casual games in general are designed for a wide audience, as explored in the review of literature earlier. Therefore, it was decided that any person willing to take part in an experiment such as this one is a suitable participant.

Secondly, by limiting the study to a certain demographic of people its overall usefulness is decreased. Although unlikely, even if the experiment had found that 22-year-old male blonde bassoonists were greatly influenced by tempo manipulations, it must be questioned how relevant that finding is.

By making these decisions on the demographics of participants, the study has a stronger ecological validity. Although the results are not significant, it can be viewed that the consideration given to the demographics of participants was high and most likely not a contributor to the non-significant result.

Difficulty

The issue of difficulty is one that could impact or influence the results of a study such as this one. A poor choice of difficulty can introduce a floor or ceiling effect. The potential of such an effect must be reduced as much as possible in order to gain meaningful data.

If an experiment is too easy, it is likely that all participants will score high. While this may not be a problem for all experiments, if there is a maximum score limit that can be attained it reduces the relevance of the data. Equally as unwanted is the possibility that an experiment is too difficult. This would result in many participants getting a low score; either the lowest possible (or none) or at least so low that there is little difference between participants. This severely reduces the range of scores and thus reduces the chance of gaining any significant result.

The results of the experiment do not suggest any sign of such effects. There is no common lowest or highest score and between all of the participants the numbers of lines cleared and pieces played have extremely high correlation.

Practice effect

If a participant repeats the same task during an experiment, there is a strong chance that their ability in that task will increase in that time. This can therefore have an unwanted influence on the data collected.

Randomising the order of conditions can help counter this practice effect. In doing this, any improvement in performance based on repeated actions are spread out across all conditions evenly. This eliminates a potential upward curve of results which would skew and essentially devalue the data obtained.

It is possible in this experiment that the longer each participant was exposed to the game, the more their skill increased. It is also possible that this factor could have influenced the game scores. As it is an unwanted effect that can greatly reduce the validity of the data, this issue was considered in the experiment design. The conditions the participants were exposed to were presented in a randomised order. This was to eliminate any influence of a practice effect. Even if one was present, it would have little influence on the results.

Tempo subtlety

Significant results can be harder to obtain if differences between conditions are too discrete or subtle. One explanation for the non-significant result in this study is that the differences between the tempi were too subtle. Perhaps increasing the manipulation in tempo or expanding the range of tempos would yield a clearer outcome.

However, one argument against this idea is the statistical significance was not even close to being statistically significant, which suggests that even a greater manipulation would not have resulted in a significant result to a sufficient degree.

Furthermore, there was a solid reason for adjusting the tempos (tempi) of the music by those particular amounts in the experiment. Greater tempo manipulation could have been performed but there would be little theoretical reason to do so and hard to justify.

It is important for a study to have ecological validity. It can be considered that even an 8% increase of tempo is highly noticeable and borders on the limit of realistic tempo changes in music. If this study or a future study used even greater tempo manipulations the results – even if significant – would not have great ecological validity. Similar to the discussion regarding demographics of participants, the overall value or worth of this study would be greatly reduced if unrealistic factors were used.

Boredom

Another consideration in any study with a repeated design is that of the attention and concentration of the participants. It is possible that participants could have become bored or restless during an experiment; potentially influencing the results.

It is possible that the repeated game play or music in this experiment could have contributed to feelings or boredom or even irritation in participants. This could have in turn affected the results of the study; perhaps decreasing the possibility of obtaining a significant result for example.

However, it is highly unlikely that boredom was a contributing factor to the result of the experiment. There were only six conditions with a game play time of two minutes each. Two minutes is a short amount of time, but long enough to get meaningful data and eliminate any potential floor effect. It was possible to have a longer period of time for each game but this was

decided against because of the potential of a boredom effect as well as remaining true to the original design of the game, as discussed earlier.

The repeated music could have irritated players. However, it was only played five times (as one condition was silent) and for only two minutes at a time. Different music could have been chosen, as discussed in the methodology, but musical preference would then become a factor. Even then, it would not eliminate the possibility of potential irritation or boredom with disliked music. Using different music for each condition would not have solved this issue. A different piece of music manipulated for each condition would have just the same problem.

By keeping the length of each game short and having only a few different conditions, the chance of participants' boredom affecting the results of the experiment are kept to an absolute minimal level.

6. Conclusion

Overview of the study

This thesis studied the effect of tempo on video game performance. It aimed to discover if tempo has any kind of effect on how a player interacts with a game, be it beneficial or detrimental. It also sought to find if the presence or absence of any music has an impact on how the player performs.

The review of literature explores in detail the realm of casual games as well as the topic of game music. It is necessary to justify and explain the importance and relevance of the subject of this thesis as it belongs to a relatively young and unexplored field. Prior research on music and arousal, preference, behaviour and attention is discussed as they are well established fields of study which contains theory that was applied to the principles of this thesis. The literature review provides a deep and insightful background to field of music in games and the various ways that music can affect people.

The results of the experiment did not show any significant difference in performance due to tempo or the presence or absence of music. Possible reasons for this are explored and discussed in detail with suggestions for improvement and directions for futures studies in this field.

Implications of the study

The findings of this study have no major implications on the theory of how music and audio is used in games, or how music and audio can affect the performance of the player.

The process of this study should assist further research in the field of game music, particularly in the investigation of the effect of music on performance. The research methodology and subsequent evaluation of methods should be of value to others conducting experiments in this field.

Suggestions for improvement

There is room for further investigation of this particular subject. Although the results for this study were not statistically significant, the possibility remains that tempo does have some kind of effect on video game performance. A different research design with slightly different aims may be able to better detect the influence that tempo has in game music.

The experiment design was thoroughly considered before it was conducted and has been extensively scrutinised in the discussion section. Variations on the experiment set up as discussed above would have either jeopardised the validity or significance of the study or would have the same issues. However, a similar study could be conducted for different genres of games, such as first-person shooters or driving games, to explore the possibility that tempo may have a greater effect on players in certain genres of games.

Another consideration to make is that focusing on factors other than tempo may offer more a significant result. To approach a similar study but from another perspective could hold great value. Tempo was the common musical factor in the research on music and arousal, behaviour and attention discussed in the literature review. However, this does not necessarily mean it is the only element of music that could have an effect in various situations, for example in game performance. Future studies may utilise a similar research design as in this study, but factors other than tempo may be examined.

Suggestions for further study

As explored in the literature review, the academic study of game music is a fairly untouched field and only in recent years has been touched upon. Although some research has been done in the area, it has yet to prove itself as a "worthy" field of study.

The role of sound effects and audio feedback on the performance of players would be an interesting topic to study. The literature review touched on the various forms of feedback that are present in casual games which includes audio as well as the visuals. Even more "traditional" types of games such as shooters and racing games utilise sound effects and use audio cues to aid the player; for example when to manually change gears.

The study by Jørgensen (2008) showed that some players rely on audio cues to more competently play certain games. A quantitative study exploring this notion further would be of great value to help increase understanding just how players perceive and use audio in games. This can be extended further than simply looking at the music, but at audio cues. Replacing or removing certain audio cues or changing the music and sound effects would certainly provide the framework for a fascinating experiment.

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